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COMMUNICATION

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COMMUNICATION

The perceptions of high school students on the habitat of the crab *Ucides cordatus* (Linnaeus, 1763) (Crustacea: Decapoda: Ucididae) in northern Rio de Janeiro State, southeastern Brazil

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Abstract: The study evaluated the perceptions of high school students (15 to 22 years old) on the value and ecosystem services (ES) provided by mangroves in the Paraíba do Sul River estuary, which is the habitat of the crab *Ucides cordatus* in northern Rio de Janeiro State, southeastern Brazil. One of the schools, Colégio Estadual Ercilia Muylaert de Menezes (CEEMM), is located in a rural area close to the mangroves, while the other school, Colégio Estadual Benta Pereira (CEBP), is located in an urban area 50km from the mangroves. The CEEMM students (n= 62) mainly attributed economic value to the ecosystem, while the CEBP students (n= 67) attributed ecological value. Students of both schools recognize the provision of services relating to commercial fishing of the crab *U. cordatus* as the main ES provided by the mangroves. The value of direct use (crab fishing) can encourage ecosystem conservation, however, it should not be the only resource considered for this purpose. We recommend that both schools implement environmental education activities to consolidate student knowledge about mangrove dynamics and its importance as an environment that supports and regulates coastal areas.

Keywords: Crab, ecosystem services, education, environmental value, mangrove.

Portuguese: O estudo avaliou a percepção de estudantes do Ensino Médio (15 a 22 anos) sobre o valor e os serviços ecossistêmicos (SE) prestados pelo manguezal do estuário do Rio Paraíba do Sul, o habitat do caranguejo *Ucides cordatus* na costa norte do estado do Rio de Janeiro, SE, Brasil. O Colégio Estadual Ercilia Muylaert de Menezes (CEEMM) está localizado em área rural, próximo do manguezal, e o Colégio Estadual Benta Pereira (CEBP) se localiza em área urbana, a 50 km do manguezal. Os estudantes do CEEMM (n= 62) atribuem principalmente valor econômico ao ecossistema, enquanto os estudantes do CEBP (n= 67) atribuem valor ecológico. Os estudantes de ambas as escolas reconhecem a provisão como principal SE proporcionado pelo manguezal, relacionado com a pesca comercial do caranguejo *U. cordatus*. O valor de uso direto (caranguejo) pode incentivar a conservação do ecossistema, porém não deve ser o único recurso considerado para essa finalidade. Nós recomendamos atividades de educação ambiental nas duas escolas para consolidar o conhecimento dos estudantes sobre a dinâmica do manguezal e sua importância como ambiente de suporte e regulação de áreas costeiras.

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Author contribution: Study design: LHOC and APMDB; field work, data analysis and writing the first draft: LFQR; APMDB: writing the final version.

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INTRODUCTION

Mangrove forests are coastal ecosystems located in the transition areas between terrestrial and marine environments, and in Brazil, they occupy approximately 14,000km² of the coastline between 02°N & 25°S. These ecosystems have high productivity and provide natural resources for humans (e.g., fish, mollusks, crustaceans, wood, medicinal plants) (Côrtes et al. 2014, 2018; ICMBio 2018). One of the resources is the crab *Ucides cordatus* (Linnaeus, 1763). This crustacean occurs in the mangroves along the western Atlantic Ocean from 24°N to 28°S, and it is the most exploited species within the Brazilian mangroves (Neto & Baptista-Metri 2011; Côrtes et al. 2014; Nascimento et al. 2017).

Ecosystem services (ES) are benefits provided by nature that have economic, social and cultural importance, and they are grouped into four categories: provision, regulation, support and culture (MEA 2005; Kaltenborn et al. 2017). In mangrove areas, the provision services are responsible for providing natural resources for utilization or commercial purposes, such as crabs, mollusks and fish. Regulation services are responsible for regulating environmental conditions, such as by maintaining climate and water quality and controlling coastal erosion. The support services, such as photosynthesis and soil formation, maintain other types of ES. Cultural services provides populations with recreational, spiritual and aesthetic benefits. Currently, many natural ecosystems are affected by pollution, fragmentation and loss of habitat, threatening the well-being of humans and other species through ES loss (Barbier et al. 2011; Kaltenborn et al. 2017).

The mangroves of the Paraíba do Sul River estuary (21°23'S) are located in northern Rio de Janeiro State, southeastern Brazil. These mangroves cover approximately 725ha, and local communities have carried out commercial fishing of the crab *U. cordatus* for decades (Filho & Filho 1995; Passos & Di Beneditto 2005; Côrtes et al. 2014, 2019). This study evaluated the student perceptions of the value and ES provided by this ecosystem. The assumption was that the recognition of the value and ES would be greater among students of the rural school, who live close to the mangroves and whose relatives use their natural resources, compared to students of the urban school, who live further from this ecosystem. We expect that the daily experiences of the students living near this ecosystem would increase their knowledge about it and would not be limited to the information transmitted formally by the school.

MATERIAL AND METHODS

At first, we contacted the school administrations to deliver the 'Letter of Consent' (*Carta de Anuência*). This document described the aims of the study and asked for permission to carry it out with the students (Brasil 2015). The *Colégio Estadual Ercília Muylaert de Menezes* (herein named CEEMM) is a school located in a rural area close to the mangroves of the Paraíba do Sul River estuary (Figure 1). The *Colégio Estadual Benta Pereira* (herein named CEBP) is an urban school situated 50km from mangroves (Figure 1). The students were interviewed in May and August 2018, and at that time, CEEMM had 95 students at the high school level (62 participated in the study), and CEBP had 367 students (67 participated in the study). The age of the students ranged from 15 to 22 years. Previous studies that have applied questionnaires to obtain data on the knowledge of a homogeneous population, such as high school students (present study), have considered 15–20 questionnaires sufficient for representative results (Crouch & McKenzie 2006; Guest et al. 2006).

The questionnaire had one open question: 'Describe what the mangrove represents to you'. It was applied in the classroom after the study aim was explained to the students and everyone had agreed to participate. The same questionnaire was applied to all students individually and simultaneously, according to the assumptions of the repeated information technique in a synchronous situation (Goldenberg 1999). The authors classified all information resulting from the open question as the values and ES provided by the mangroves.

The categories to assess the value of the mangroves were based on Henkel (2017). The economic value was assigned to reports that attributed financial or food values to the mangrove resources. The ecological value was assigned to the recognition of the importance of mangroves for maintaining environmental quality. The cultural value was defined as the utilization of mangrove areas and their resources for leisure and tourism. Reports that did not provide context or that did not attach any importance to the mangrove were classified as 'null', and reports that demonstrated recognition of the mangrove as an ecosystem, without specifying any value, were considered as 'other' (Table 1).

The ES provided by the mangroves were classified according to MEA (2005) and Steger et al. (2018). Provision services were referenced by reports on direct supplies, such as food and raw materials. Regulation services were described by reports on the importance of mangroves in the regulation of ecosystem processes, such as biological, climatic, disease and water purification

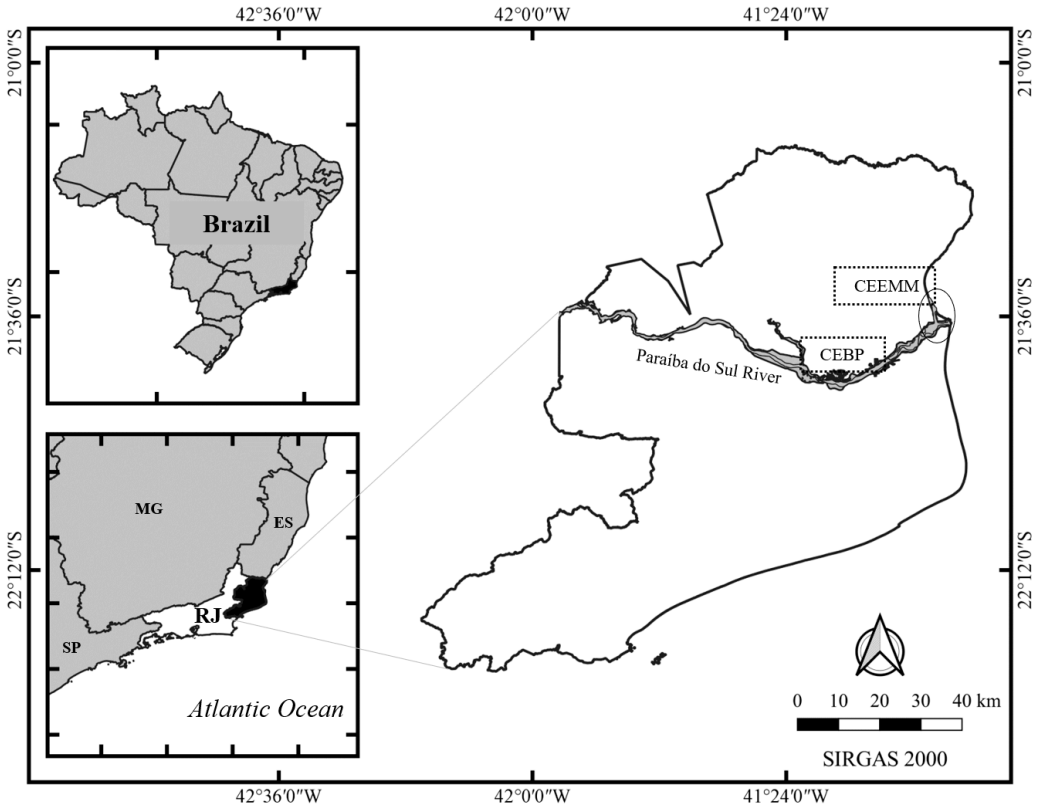

Figure 1. Location of the schools in northern Rio de Janeiro State, southeastern Brazil (CEEMM: Colégio Estadual Ercília Muylaert de Menezes, CEBP: Colégio Estadual Benta Pereira). The black circle is the mangroves in the Paraíba do Sul River estuary.

regulation. Support services included the conditions for the existence of other ES, such as oxygen production, nutrient cycling and primary production. Cultural services were described by reports on the utilization of mangrove areas for recreational, aesthetic, educational and spiritual purposes. Reports that did not show any recognition of the ES provided by the mangroves were classified as 'do not recognize' (Table 1).

The results were analyzed by frequency (%), and each student could mention one or more values and/or ES. The difference between schools was tested with a normal chi-square test ($p < 0.05$) in Statistica for Windows 12.

RESULTS

According to the response classification, 46% of the CEEMM students considered the mangrove as a source of economic value, mentioning its importance for the livelihoods of local families. In CEBP, this percentage was lower (15%) in reference to the use of the ecosystem for the commercialization of the crab *U. cordatus* (Table 1). Meanwhile, most CEBP students (51%) recognize the resources provided by the mangrove as having ecological value, while at CEEMM, this proportion was lower (16%) (Table 1). The students highlighted the importance of the main ecological roles of the ecosystem in the maintenance of native species, nursery area and air purification ('filter') as the main ecological roles. The cultural values were also different between the two schools (CEEMM: 16%; CEBP: 4%; Table 1) and were related to leisure and tourism. Decontextualized reports or those that did not attribute any value to the mangroves (null responses) were present for 16% and 29% of respondents from CEEMM and CEBP, respectively.

The main ES recognized by CEEMM (49%) and CEBP (46%) students were provision services, which were related to the commercial fishing of the crab *U. cordatus*. The importance of ES regulation for the balance of other ecosystems was reported by 17% of respondants at CEBP and only 6% at CEEMM, however, CEEMM students recognized cultural ES more than the CEBP students did (18% vs. 4%) (Table 1). The support services were poorly recognized in both schools (4%), and more than 20% of respondents in the schools did not recognize any ES provided by the mangroves (Table 1).

Table 1. Comparisons between the high school students from CEEMM (Colégio Estadual Ercilia Muylaert de Menezes) and those from CEBP (Colégio Estadual Benta Pereira) regarding the values and ecosystem services (ES) provided by the mangroves in the Paraíba do Sul River estuary (*p < 0.05).

Ecosystem values/services	% Positive		*p*-values
	CEEMM	CEBP	
Values			
Economic	46	15	<0.001*
Ecological	16	51	<0.001*
Cultural	16	4	0.014*
Null/No response	16	29	0.050
Others	6	1	0.962
Ecosystem services			
Provision	49	46	0.709
Support	4	4	1.000
Regulation	6	17	0.031*
Cultural	18	4	0.006*
No response/do not recognize	23	29	0.394

DISCUSSION

The assumption that the value attributed to the mangroves from the Paraíba do Sul River estuary and ES recognition would be higher among CEEMM students because of their proximity to the mangrove area, their daily experiences and the economic dependence of local families on the mangroves was not confirmed. In fact, due to the Brazilian educational model, students from both schools were expected to demonstrate a greater understanding of what the mangrove ecosystem represents and to recognize the value and the provided ES.

In Brazil, the guidelines for educational practices in basic education (elementary and high school) are established by the National Curriculum Parameters (*Parâmetros Curriculares Nacionais* - PCNs), which are documents from the Ministry of Education. In these documents, 'environment' is one of the transversal themes that must be addressed by Brazilian schools in a continuous, systematic and comprehensive way (Brasil 1997; Chaves & Barbosa 2015). Thus, it is expected that all Brazilian students, regardless of their regional origin, proximity or distance from natural ecosystems, would have comparable knowledge about the environment. Bomfim et al. (2013) evaluated 'environment' and 'health' as transversal themes in Brazilian schools and concluded that they were recognized but not covered comprehensively. In general, these themes are included in events on the annual school calendar and addressed in a fragmented way.

Most CEEMM students attributed economic value to the mangroves, emphasizing provision services and frequently mentioning the crab *U. cordatus*. This corroborates the results of Côrtes et al. (2019), who analyzed the sustainability of this crab fishery in the same region from interviews with local fishers, many of who were relatives of CEEMM students (A.P.M. Di Beneditto, personal observation). The fishers attributed high economic value to the ecosystem, with a direct use value because of their economic dependence (crab fishing). In contrast, the CEBP students live in urban areas and have no direct economic relationship with mangroves. Thus, the low perception of the economic value of the ecosystem was already expected, however, these students recognized provision as the main ES provided by the mangroves. This might be related to crab marketing and consumption. In northern Rio de Janeiro State, the production of *U. cordatus* is mainly destined for Campos dos Goytacazes city, where CEBP is located, with sales in natura of live animals in markets and even on the city streets (Côrtes et al. 2014).

The difference between students regarding mangrove ecological value (CEEMM: 16% vs. CEBP: 51%) was unexpected since the educational guidelines are the same for both schools (Brazil 1997). One possible explanation would be the differences in the way that each school addresses the 'environment' (and ecosystems) as a transversal theme, but this different was not verified for further conclusions. The ecological value attributed to the mangrove would presuppose the recognition of both support and regulation ES, however, these were the least commonly recognized ES in both schools (Table 1). These values are more critical for CEEMM, which is located close to mangroves and educates students who are related to fishers. Because of their daily contact with this ecosystem, the local inhabitants can affect it more directly (e.g., cutting trees, dumping domestic waste and solid waste, illegal hunting) and, therefore, should act as partners in its conservation.

The students differed in their perceptions of the cultural value (and cultural ES) provided by the mangroves. At CEEMM, the greater value/recognition can be attributed to their utilization of mangroves for daily leisure, as previously described in Côrtes et al. (2019). The cultural ES provide several benefits for human beings, such as recreation, religious practices and cognitive development (Andrade & Romeiro 2009). The geographical distance of the CEBP students from the mangroves explained the low value/recognition the cultural purposes of this ecosystem.

More than 20% of students (in each school) did not recognize any ES provided by the mangroves, which is a cause for concern. Limited knowledge of mangrove-related values indicates that the education about environmental issues in schools is insufficient. The difficulty in recognizing ecosystem functions may be related to fragmented teaching, which does not encourage students to assimilate and integrate information (Vairo & Filho 2010; Bomfim et al. 2013). When perceiving themselves as agents of change for the environment, students can positively assist in conservation.

In conclusion, the importance of the mangroves was mainly related to their economic role (economic value and provision ES) and not to their ecological role. The importance of the ecosystem was attributed mainly to the value of direct use (economic), such as crab fishing, which can encourage the conservation of its resources as a whole, however, this value cannot be the only parameter considered for the conservation of the ecosystem. Thus, we suggest that environmental education activities should be performed regularly at CEEMM and CEBP, including lectures and guided visits to the mangroves and the distribution of alternative material, such as booklets and brochures that detail what mangroves represent to the balance of coastal areas. These activities will consolidate student knowledge about the ecosystem and highlight its importance in providing support and regulation for coastal areas and as a hotspot for tropical biodiversity conservation that goes beyond the habitat of the crab *U. cordatus*.

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