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Neotropical dragonflies (Insecta: Odonata) as key organisms for promoting community-based ecotourism in a Brazilian Amazon conservation area

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ABSTRACT

Incorporating insects into ecotourism activities increases awareness of their importance in ecosystems. However, the inclusion of this group in ecotourism activities is still rare. In this context, we identified the perception of indigenous and non-indigenous leaders and residents about the potential of Odonata (dragonflies and damselflies) as key organisms for promoting community-based ecotourism (CBET) in the Tapajós-Arapiuns Extractive Reserve, Brazilian Amazon. We designed a semi-structured questionnaire and conducted interviews with 415 indigenous and non-indigenous residents (222 women and 193 men) from 73 communities and villages. When shown images of dragonflies (Anisoptera and Zygoptera), 98.55 % of respondents recognized them, predominantly identifying them as "jacinas" (55.11 %). Respondents noted differences between Anisoptera and Zygoptera based on body color and size, identified them as part of the insect group (45.78 %), and associated their habitat with forests and jungles (57.34 %). Most participants (96.38 %) indicated that current ecotourism activities do not include information about invertebrates, emphasizing the need for greater understanding of their biology and ecological significance (44.64 %), and management (29.16 %). They stated that seeing (99.52 %) and observing (99.04 %) dragonflies could attract tourists due to their striking appearance (57.10 %) and beautiful (39.03 %). Most respondents recognized the importance of dragonflies for the environment (99.52 %), culture (63.13 %), and economy (55.66 %), acknowledging their potential to generate income through tourism. Additionally, 89.88 % expressed a desire to participate in the development of ecotourism activities involving Odonata. The results reflect the enormous potential of dragonflies to be included as key organisms in the development of CBET, allowing for environmental awareness, biodiversity conservation, cultural appreciation, and

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income generation for local communities. Furthermore, the study highlights the need to implement educational and training programs on Odonata, along with the development and funding of public policies to ensure the success and sustainability of such initiatives.

1. Introduction

The class Insecta is the most biodiverse taxonomic group in the world, with approximately 5.5 million species (Stork, 2018), comprising about 75 % of the recorded fauna (Loxdale, 2016). Their presence and function in ecosystems are vital for maintaining environmental balance and providing various ecosystem services, particularly those involving organic matter cycling and energy transfer (Allan and Castillo, 2007). Despite their great importance, a global decline in insects has been reported, mainly due to habitat loss from intensive agriculture, chemical pollutants, invasive species, and climate change (Cardoso, 2020; Ceballos et al., 2017; Maxwell et al., 2016; Tilman, 2001). In addition, the negative or avoidant perception of insects, driven by fear or their classification as pests, hinders conservation efforts (Huntly et al., 2005; Kellert, 1993; Lockwood, 2013). The misconception that insects are abundant and do not require protection programs further exacerbates the issue (Horwitz et al., 1999). Hence, promoting greater awareness and sensitivity regarding their ecological, social, economic, and cultural relevance is essential.

Within insects, the order Odonata, commonly known as dragonflies and damselflies, stands out for its significant contribution to aquatic ecosystems by serving as bioindicators of environmental quality in various types of freshwater systems worldwide (Bonada et al., 2006). Their distribution, species composition, and richness are closely related to the physical environmental conditions (Williams et al., 2004; Monteiro-Júnior et al., 2013). They also play an important role in nature by regulating the overpopulation of other organisms, such as mosquitoes responsible for transmitting various diseases to humans (Corbet, 1999; Ilahi, 2019) and attacking agricultural pests (Relyea, 2008). Odonates systematically respond to modifications related to prey availability (Oliveira-Junior and Juen, 2019) and are harmless to humans (Corbet, 1999).

Beyond their ecological function, odonates also possess significant cultural and social relevance. They have been used in rituals (Lawal and Banjo, 2007), traditional medicine (Costa-Neto et al., 2006; Cudera et al., 2020), and even as food (entomophagy), with notable consumption of larvae and adults from the families Libellulidae and Aeshnidae (Cudera et al., 2020; Omuse et al., 2024). While the role of dragonflies in some Asian societies is well-documented, human-odonate relationships in Western society are less understood (Lemelin, 2009).

In Japan, the cultural importance of Odonata is profound, with the country's ancient name, "Akitsu Shima," meaning Dragonfly Island. This has led to their central role in Japanese artistic expressions such as painting, sculpture, and poetry, inspiring patterns and children's games (Primack et al., 2000). Enthusiast groups, known as "dragon hunters", specialize in collecting and identifying different Odonata species in wild environments (Lemelin, 2009). The admiration for this order is also reflected in the creation of associations, festivals, ponds, and sanctuaries dedicated to their protection and sighting, fostering insect tourism (entomotourism) and bringing economic benefits to local populations (Hvenegaard, 2016; Kadoya et al., 2004; Lemelin, 2009; Primack et al., 2000). Various studies confirm that the uniqueness and beauty of dragonflies make them excellent vehicles for environmental awareness and public education, thus promoting their conservation (Suh and Samways, 2001; Lemelin, 2009). Despite their relevance, the inclusion of insects in ecotourism activities is still in its infancy and under-researched worldwide (Gómez and Gasca, 2022).

Community-based ecotourism (CBET) is experiencing notable growth in protected areas such as nature reserves, sanctuaries, and natural parks (Baquero and Parrado, 2021; Guerrero-Moreno and Oliveira-Junior, 2024a), which are often inhabited by traditional communities, both indigenous and non-indigenous (Olmos-Martínez et al., 2022; West et al., 2006). This trend offers the opportunity to integrate insects into tourism activities sustainably. CBET focuses on biodiversity conservation, involving local communities in managing and operating tourism activities, promoting local culture, and fostering socioeconomic development (Benites and Mamede, 2020; Guerrero-Moreno and Oliveira-Junior, 2024a). The participation and perception of host communities are vital for planning and developing this type of tourism. Understanding collective notions and knowledge can reveal insights into local attitudes towards biodiversity (Costa-Neto, 2002).

Various studies have evaluated different types of tourism in protected areas of Brazil (Medeiros et al., 2021; Souza et al., 2018; Vasconcellos and Castley, 2014). However, there are no studies on entomotourism with Odonata in conservation areas, nor have the perceptions of traditional populations regarding this topic been addressed, constituting a significant gap in the scientific literature. In this context, the objective of the present research was to identify the perception of indigenous and non-indigenous leaders and residents regarding the potential of Odonata (dragonflies and damselflies) as key organisms to promote community-based ecotourism in the Tapajós-Arapiuns Extractive Reserve (Tapajós-Arapiuns Resex), in the Brazilian Amazon. This hypothesis is that local communities will positively perceive the integration of Odonata into ecotourism activities. The Tapajós-Arapiuns Resex hosts a rich biological and cultural diversity, supported by the deep traditional ecological knowledge of the local communities. This unique combination provides a conducive environment for exploring the potential of integrating dragonflies and damselflies into CBET activities, potentially generating sustainable economic benefits, diversifying income sources, and strengthening the local economy. The promising economic benefits could significantly contribute to the socioeconomic development of the region.

2. Methods

2.1. Study area

The present study was conducted in 73 traditional communities, divided into 39 communities and 34 indigenous villages, belonging to the Tapajós-Arapiuns Resex (Fig. 1). This protected area for sustainable use is located between the municipalities of Santarém and Aveiro, in the western region of the state of Pará, Brazilian Amazon. It covers a total area of 647,610 ha, bordered to the east by 140 km of margin with the Tapajós river, and to the west by 120 km of margin with the Arapiuns river (ICMBio, 2014). The reserve is bounded east by the Tapajós river, west by the Maró river, north by the Arapiuns river, and south by the Escrivão community (Brasil, 1998). Access to these communities is exclusively by waterway.

The literature initially reported 72 villages and communities in the Tapajós-Arapiuns Resex, according to the Management Plan of 2014 (ICMBio, 2014; PSA, 2015). During fieldwork, it was found that the number of villages had increased in recent years, as several community members identified themselves as part of the indigenous population, leading to the emergence of new villages within the reserve. Based on the principle of equality, these villages were included in the data collection process and incorporated into the study with prior authorization from the leaders of each village. By comparing the data with maps published by PSA (2015) and CITA (2015), it is estimated that there are currently around 39 communities and 41 villages in the reserve, totaling approximately 80 traditional communities. Under this assumption, the sampling conducted in this research represented 91 % of the total traditional communities in the Tapajós-Arapiuns Resex.

2.1.1. Socioeconomic context and CBET initiatives

Most of the communities in the Tapajós-Arapiuns Resex are located along the banks of the Tapajós and Arapiuns rivers, but there is also a minority along the Maró, Inhambú rivers, and the Mentai and Amorim Streams, located further inland within the reserve (Oliveira et al., 2022; ICMBio, 2014). The population is approximately 23,000 inhabitants, distributed among approximately 4853 families (PSA, 2015). It is noteworthy that there are indigenous movements within the reserve, supported by the Indigenous Awareness Group and the Tapajós-Arapiuns Indigenous Council (CITA- *Conselho Indígena Tapajós-Arapiuns*), aiming to achieve recognition and

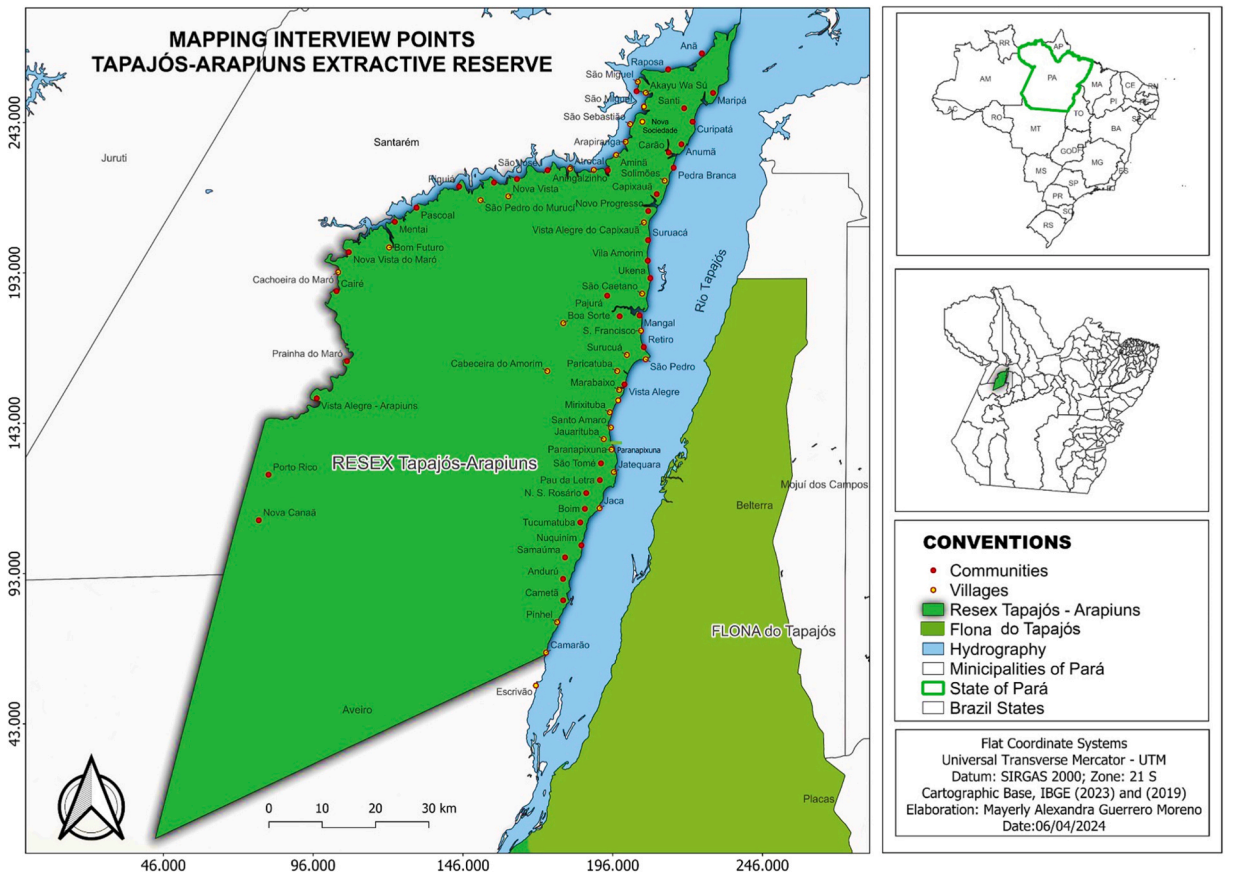

Fig. 1. Mapping of the interviews carried out in the communities (red dots) and villages (yellow dots) of the Tapajós-Arapiuns Resex, Brazilian Amazon.

legitimization of indigenous peoples within the reserve area (ICMBio, 2014).

The subsistence of the residents directly results from the use of existing natural resources in the area, family agriculture, and the raising of small animals (Morais, 2018; PSA, 2015). Additionally, some emerging activities include handicraft production, beekeeping, carpentry, and tourism (ICMBio, 2014). Due to the growing interest of community members and visitors in the development of sustainable tourism, the Participatory Management Plan of the Resex was elaborated (ICMBio, 2014), which included a tourism sub-program aimed at identifying the tourism potential of the protected area, mobilizing resources, diversifying tourist attractions, and promoting initiatives around the development of community-based tourism, thus giving rise to the Public Use Plan of the Tapajós-Arapiuns Resex (ICMbio, 2022). In this plan, guidelines for public use were established to promote the sustainable development of Community-based Tourism, which responds to the principles of biodiversity conservation, cultural valorization, community protagonism, and social equity (ICMbio, 2022), fundamental pillars shared with community-based ecotourism, which also prioritizes environmental sustainability and community control of the tourism sector (Benites and Mamede, 2020; Mtapuri and Giampiccoli, 2018), essential elements for the development of tourism in protected areas inhabited by traditional communities. Previous studies in the Tapajós-Arapiuns Resex, such as that of Medeiros et al. (2021), also show the viability of alternative tourism at an economic, cultural, environmental and social level.

2.1.2. *Dragonflies and damselflies in the Tapajós-Arapiuns Resex*

On the other hand, according to the study conducted by Oliveira-Junior et al. (2022), the Tapajós-Arapiuns Resex possesses significant species richness and abundance of the order Odonata (Fig. 2), finding species such as *Argia* sp.*, Epipleoneura capilliformis, Heteragrion bariai,* and *Oxystigma williamsoni*, which have high demands regarding environmental conservation in their habitat, reacting rapidly to environmental changes (Oliveira-Junior et al., 2015). Another aspect to highlight is associated with the National Biodiversity Monitoring Program (Monitora Program) of the ICMBio (*Instituto Chico Mendes de Conservação da Biodiversidade*), which aims to assess the state of biodiversity in protected areas. This program currently utilizes basic knowledge of the biology, ecology, and distribution of the Odonata to infer the environmental quality of streams in the Brazilian Amazon (Brasil et al., 2020; Oliveira-Junior et al., 2022; Oliveira-Junior and Juen, 2019). This is relevant to the present research as it reflects the importance and relevance of including dragonflies and damselflies in alternatives such as CBET, as together with the Monitora Program, they can enhance both the sustainable management of conservation areas and community participation and local development, thus contributing to the comprehensive protection of the environment and biodiversity.

2.2. *Data collection and analysis*

2.2.1. *Data collection*

Before starting the research, the necessary authorizations were obtained from the following Brazilian entities: i) SISBIO/ICMBio (*Sistema de Autorização e Informação em Biodiversidade*) - Authorization to conduct research in a protected area (authorization number 80927–1); ii) CONEP (*Comissão Nacional de Ética em Pesquisa*) - Authorization to conduct research with humans (authorization number 5.848.259); and iii) CITA - Approval to include indigenous population in the study. Once these authorizations were obtained, data collection proceeded (Fig. S1).

Data collection was conducted *in locus*, meaning we traveled to the places where each of the indigenous and non-indigenous leaders and residents belonging to the Reserve live or work (Fig. 3). To move from one community to another, we used both river and land transportation, with river transport (canoes and small boats) being predominant (Fig. S1).

The chosen data collection method, semi-structured interviews, was selected for its unique flexibility. This method, comprising a guide with both open and closed questions, empowers the interviewer to add questions as needed. This flexibility allows for a more comprehensive understanding of the research topics, enriching the investigation process and delving into areas of broad relevance (Sampieri, 2014).

In line with this, a script was developed consisting of a total of 28 open and closed questions divided into three groups: i) Demographic data: includes information about sex, age, ethnicity with which they identify, educational level, and profession or activity;

Fig. 2. Photographic records of some dragonflies found during field work in the Tapajós-Arapiuns Resex, Brazilian Amazon. **(a)** *Orthemis* sp. **(b)** *Erythrodiplax* sp. (suborder Anisoptera) and **(c)** *Mnesarete* sp. (suborder Zygoptera). Photos by the authors (2023).

Fig. 3. Interview with leaders and residents (indigenous and non-indigenous) in their houses and jobs in the Tapajós-Arapiuns Resex, Brazilian Amazon. Photos by the authors (2023).

ii) Perception and general knowledge about Odonata: common names, sensations and experiences, characteristics, differentiation between dragonflies and damselflies, group to which they belong, habitats they frequent and associated environmental conditions, uses, observation and collection, and level of skills and knowledge; iii) Ecotourism potential: inclusion of invertebrates in ecotourism activities, observation and collection as an ecotourism attraction, best times and habitats to observe odonates, potential interest of tourists, the environmental, cultural, and economic importance of dragonflies, meaning and intention of working with dragonflies.

2.2.2. Sample calculation

The statistical method selected to determine the sample size was sample calculation, using a confidence level of 95 % and a margin of error of 5 %. This means that if the survey is repeated indefinitely, 95 percent of the time, its results will coincide with those obtained from a complete population, meaning the results obtained will be representative and reliable (Aguilar-Barojas, 2005).

$$n = \frac{NZ^2S^2}{d^2(N-1) + Z^2S^2}$$

Where: n = sample size; N = population size; Z = confidence level; S = variance of the study population; d = level of absolute precision.

Thus, upon performing the calculation based on the total population (23.000) reported by PSA (2015), it was initially determined that the optimal population size was 379 leaders and residents, both indigenous and non-indigenous, belonging to the Tapajós-Arapiuns Resex. However, due to the increase in the number of villages within the reserve and with the purpose of obtaining a comprehensive perception of the populations inhabiting the Tapajós-Arapiuns Resex, the number of interviewees increased. The sample was predominantly composed of one leader (chiefs, presidents, shamans, or other community-endorsed leaders) and five family representatives per community or village. Upon entering each village and community, we introduced ourselves and sought permission from the leader in charge to access their territories and conduct interviews. To facilitate this, we presented all printed authorizations along with the interview forms and explained the research in detail. Several community members were already familiar with the project, which made it easier to gain access and foster trust. On some occasions, we were asked to present the research at a community meeting, where the members collectively decided whether to participate in the study (Fig. S1). This resulted in a total of 415 interviewees, of which 184 (44.34 %) were indigenous and 231 (56.66 %) were non-indigenous (Table 1). In cases where the leader was not present and there was no substitute, only the residents were interviewed. The interviewed individuals had to meet the following inclusion criteria beforehand: i) be recognized or identified as leaders or residents of the community/village; ii) be over 18 years old; iii) reside in the community/village for at least one year; and iv) sign the Informed Consent Form (TCLE- *Termo de Consentimento Livre Esclarecido*), document essential to ensure that participants understand and voluntarily consent to the use of the information provided for academic and scientific purposes, as well as the use and publication of their image (Fig. S1).

Finally, each of the interviews was compiled in physical forms and later transcribed and organized into analysis categories associated with demographic data, perceptions and knowledge about dragonflies, and ecotourism potential using a data matrix. Each transcription was systematically analyzed to understand the general perceptions and contextual meanings of the participants (Fig. S1).

Table 1
Description of traditional communities interviewed in the Tapajós-Arapiuns Resex, Brazilian Amazon. N. = absolute number.

Population type	Traditional populations interviewed				Total	
	Indigenous		non-indigenous			
	N.	%	N.	%	N.	%
Leaders	31	7.47	36	8.67	67	16.14
Residents	153	36.87	195	46.99	348	83.86
Total	184	44.34	231	55.66	415	100

The statistical analysis was conducted by calculating relative frequencies of the given responses, using tables and graphs in Microsoft Excel (Version 2019) for the subsequent discussion of results.

3. Results and discussion

3.1. Demographic data

Of the 415 interviewees, 44.34 % are indigenous and 55.66 % are non-indigenous (Table 2). This highlights the cultural diversity within the reserve. The riverside communities of the Lower Tapajós, Arapiuns River, and Maró River are composed of 8 indigenous ethnicities: Arapium, Maytapu, Tupaiú, Tupinambá, Cara-Preta, Munduruku, Kumaruara, and Arara Vermelha. These ethnicities are represented by CITA and by FUNAI (*Fundação Nacional dos Povos Indígenas*-National Foundation of Indigenous Peoples), entities that work together to recognize and protect the rights of indigenous peoples over their territories (Soares, et al., 2022; PSA, 2015; Simaika and Samways, 2008).

At the sex level, the sample consisted of a total of 53 women (53.49 %) and 46 men (46.51 %). There is a predominance of women's participation among both indigenous (n=98; 23.61 %) and non-indigenous populations (n=124; 29.88 %). This reflects that,

Table 2
Sociodemographic characterization of traditional communities interviewed in the Tapajós-Arapiuns Resex, Brazilian Amazon. N. = absolute number.

Sociodemographic variables	Traditional communities				Total	
	Indigenous		Non-indigenous			
	N.	%	N.	%	N.	%
Sex						
Female	98	23.61	124	29.88	222	53.49
Male	86	20.72	107	25.78	193	46.51
Total	184	44.34	231	55.66	415	100
Age range (in years)						
25–35	43	10.36	53	12.77	96	23.13
36–45	50	12.05	63	15.18	113	27.23
46–55	37	8.92	54	13.01	91	21.93
> 55	54	13.01	61	14.70	115	27.71
Total	184	44.34	231	55.66	415	100
Color/ethnicity						
Brown	4	0.96	207	49.88	211	50.84
Indigenous	179	43.13	7	1.69	186	44.82
White	0	0.00	15	3.61	15	3,61
Black	1	0.24	2	0.48	3	0.72
Total	184	44.34	231	55.66	415	100
Residence time (in years)						
1	6	1.45	1	0.24	7	1.69
2–5	5	1.20	15	3.61	20	4.82
6–10	13	3.13	17	4.10	30	7.23
>10	28	6.75	48	11.57	76	18.31
Lifetime	132	31.81	150	36.14	282	67.95
Total	184	44.34	231	55.66	415	100
Education						
Elementary school	50	12.05	65	15.66	115	27.71
Middle school	57	13.73	83	20.00	140	33.73
High school	38	9.16	40	9.64	78	18.80
University education	29	6.99	23	5.54	52	12.53
Specialization	1	0.24	2	0.48	3	0.72
Postgraduate	1	0.24	6	1.45	7	1.69
Dont study	8	1.93	12	2.89	20	4.82
Total	184	44.34	231	55.66	415	100
Activity/ Profession						
Family agriculture	154	37.11	199	47.95	353	85.06
Teaching	10	2.41	12	2.89	22	5.30
Artisanal fishing	6	1.45	5	1.20	11	2.65
Homemaker	1	0.24	5	1.20	6	1.45
Retirement	2	0.48	3	0.72	5	1.20
Administration	2	0.48	3	0.72	5	1.20
Craftsmanship	4	0.96	0	0.00	4	0.96
Healthcare	2	0.48	1	0.24	3	0.72
Domestic services	1	0.24	1	0.24	2	0.48
Carpentry	1	0.24	1	0.24	2	0.48
Construction	1	0.24	0	0.00	1	0.24
School management	0	0.00	1	0.24	1	0.24
Total	**184**	**44.34**	**231**	**55.66**	**415**	**100**

increasingly, women play vital roles in matters associated with leadership, development, and progress of Amazonian communities. Moreover, several of the interviewed leaders were women (32.84 %), demonstrating their political influence in local decision-making (Sacchi, 2023). Women also have extensive participation in the productive chains of the Tapajós-Arapiuns RESEX by leading associations and cooperatives such as MUSAS (*Mulheres Sonhadoras em Ação*- Dreaming Women in Action), COOPRASU (*Cooperativa Agroextrativista de Surucuá*- Surucuá Agroextractive Cooperative), TURIARTE (*Turismo e Artesanato da Floresta*- Forest Tourism and Crafts), the *Mulheres Empreendedoras da Floresta* Project, and AMPRAVAT (*Associação de Moradores Agroextrativistas e Indígenas do Tapajós*- Association of Agroextractive and Indigenous Residents of Tapajós).

The predominant age range among the total interviewees is > 55 years (n=115; 27.71 %). This is associated with the fact that in most cases, especially in indigenous villages, the leadership indicated older individuals to be interviewed as they are considered great connoisseurs of the customs, traditions, and dynamics of the Tapajós-Arapiuns Resex. This reflects the respect and cultural values attributed to the elderly in tribal life (Viscogliosi et al., 2020; Jervis et al., 2010).

Regarding color or ethnicity, 50.84 % (n=211) of the total participants identify as brown and 44.82 % (n=186) identify as indigenous. The predominance of the brown population in the Tapajós-Arapiuns Resex coincides with the self-declaration of many residents in the state of Pará, Brazil (69.87 %) (Ibge, 2022). Conversely, the indigenous populations make up only 0.85 % of the inhabitants of the State of Pará. The self-recognition by 44.82 % of the indigenous people in the reserve underscores the importance of Conservation Units as means of livelihood and subsistence for indigenous peoples. This is because, for centuries, various indigenous peoples have inhabited and preserved large swathes of natural areas, which are now recognized as protected areas (Olmos-Martínez et al., 2022; Guerrero-Moreno and Oliveira-Junior, 2024a).

Regarding the length of residence, a significant portion (n=282; 67.95 %) indicates that they have lived in the Tapajós-Arapiuns Resex their entire lives. This is particularly significant, especially considering that many of the interviewees are over 55 years old, as it demonstrates the generational permanence within the protected area, as well as the deep-rootedness and knowledge possessed by the local population. It is noteworthy that, despite the formal creation of the reserve in 1998, the traditional communities have inhabited these territories for hundreds of years, even before the arrival of Portuguese colonizers (Signor et al., 2022).

At the educational level, it is found that the predominant level of education is secondary education (grades 5–9 in Brazil) (n=140; 33.73 %), with a low level of schooling in high school (*Ensino Médio* in Brazil), university education (n=52; 12.53 %), and postgraduate education (n=7; 1.69 %). Despite around 70 indigenous and non-indigenous schools in the Tapajós-Arapiuns Resex, most are municipal schools that offer only up to the fundamental level of education (Nóbrega-Spinola et al., 2022). The provision of secondary education is precarious and is offered modularly in some communities, requiring students who wish to pursue it to travel from one community to another, sometimes traversing long and complex journeys by river. Since there are no higher education institutions within the reserve, most students, upon completing their schooling, must migrate to Santarém city and other cities to complete their studies, a situation that the majority cannot achieve due to a lack of economic resources.

Finally, a large part of the interviewees is primarily engaged in family agriculture (n=353; 85.06 %), which focuses on the cultivation of cassava, beans, corn, black pepper, medicinal plants, vegetables, and fruits. According to Hurtienne (2005), many rural Amazonian residents are primarily engaged in family agriculture, especially in the states of Pará and Rondônia, who sell their produce in local and regional markets. Family agriculture is immersed within the solidarity economy as it presents essentially distributive characteristics and has socio-cultural traits that allow for better adaptation to sustainability practices and the preservation of natural resources, enabling a variety of productive activities such as agroextractivist systems (Tedesco, 2001).

While tourism was not mentioned as a primary activity, it was indicated as an emerging secondary activity that complements the income generated from family agriculture and small-scale animal husbandry, due to its seasonality and the fact that tourism in the Tapajós-Arapiuns Resex is still incipient, concentrated in just 10 communities that develop community-based tourism activities: Anã,

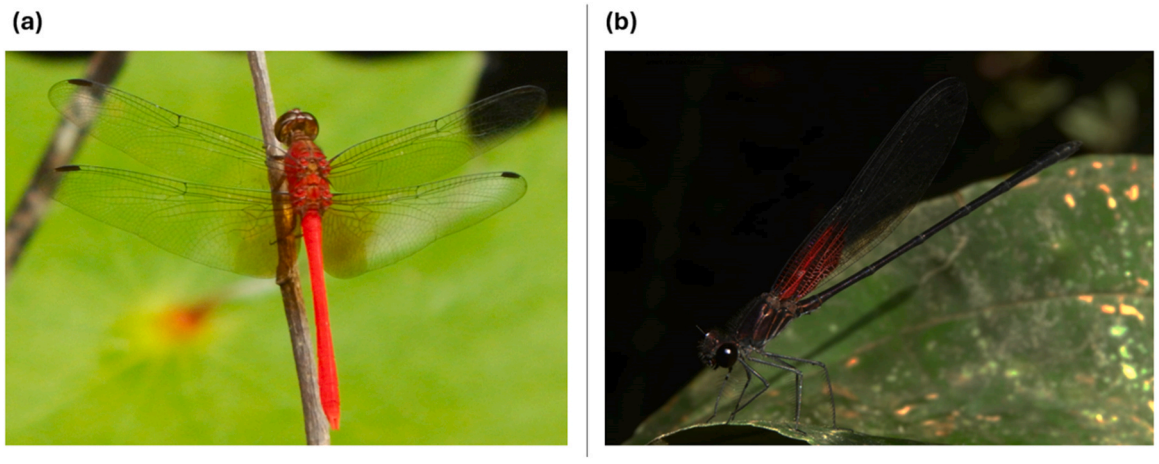

Fig. 4. (a) Image of Anisoptera (dragonflies). Photo by the authors (2023). **(b)** Image of Zygoptera (damselflies). Photo by Mendoza-Penagos (2022).

Boim, Capixauã, Carão, Maripá, São Miguel, São Marcos, São Pedro, Suruacá, and Vila Franca (ICMBio, 2014).

3.2. Perception and general knowledge about Odonata

3.2.1. Recognition and common names

At the beginning of the interview, two photographs were presented: one of Anisoptera (dragonflies) (Fig. 4a) and another of Zygoptera (damselflies) (Fig. 4b). Based on the visualization of the Odonata images, participants were asked whether they were familiar with them or not and what names they used to identify them.

98.55 % of indigenous and non-indigenous residents affirmed recognizing them (Fig. 5a). Among the most common nominations were *jacinas* (55.11 %), *jacintas* (20.88 %), and dragonflies (11.69 %) (Fig. 5b). When asked about the meaning of the most frequent designations in the Tapajós-Arapiuns Resex (*jacina* and *jacinta*), they indicated that they did not know, but it surely had an indigenous origin. To confirm this assertion, an exhaustive literature review was conducted, finding that in the indigenous Tupi language, the term "*jacina*" appears, which translates to "brown butterfly with light blue wings" (Gonçalves, 1858; Silveira, 1987). From there, it could be inferred that possibly the designation "*jacinta*" is more recent and emerged as a linguistic variant of the original term, "*jacina*". Furthermore, the meaning of the word "*jacina*" seems to coincide with the description of some species of the genus *Zenithoptera,* which have brown bodies with metallic blue wings and are distributed from Nicaragua to Argentina, including the Amazon region (Garrison et al., 2006). Also coincides with the perception that dragonflies are part of the butterfly group, probably due to similarity in flight capability, habitats they frequent, and their striking coloration (see Fig. 9).

It is also worth noting that these two common names (*jacina* and *jacinta*) are frequently used both in the northern region (especially in the states of Amazonas, Amapá, and Pará) and in the northeastern region of Brazil (Brasil and Vilela, 2019; De Andrade and Da Silva, 2021), which may be associated with the migration of northeasterners to the Amazon during the rubber boom (Brasil and Vilela, 2019; Nascimento, 1998). On the other hand, the name dragonfly is a common term used worldwide, alluding to its gliding flight and ability to hover in the air (De Andrade and Da Silva, 2021).

Among the less frequent names are cicadas (5.53 %), helicopters (3.97 %), and buttocks-washer (3.01 %). The designation "*cicadas*" seems to be closely related to the sound made by Anisoptera dragonflies when flapping their wings when caught; several of the interviewees indicated that they "generate loud vibrant sounds". In relation to this, a study conducted by Gurung (2003) in a village in Nepal found that dragonflies had the onomatopoeic name "jhingauraa" (based on the sound they produce), which refers to "chirping noise", an etymological root shared with cicadas. The designation "helicopters" is associated with the physical and aerodynamic similarity to Odonata, this due to the shape of their body, the arrangement of their wings, and their ability to hover, accelerate, and maneuver in different directions at high speeds (Thomas et al., 2004). Finally, the name "buttocks-washer" represents an interpretation of the behavior shown by some female Odonata, which "beat" their ovipositor on the water surface to lay eggs (Brasil and Vilela, 2019).

At a general level, it is identified that the common names of Odonata are influenced by the sociocultural and geographical context of populations, as well as by morphological, functional, and behavioral characteristics observed in these insects. This reflects the knowledge, linguistic richness, and cultural wealth of local communities, and their connection with nature. In line with this, Samways (2002) asserts that for the development of conservation and environmental education programs, it is fundamental to use indigenous or vernacular names as they constitute an effective way to increase public interest and awareness, as well as to highlight the traditional knowledge possessed by local cultures.

3.2.2. Feeling and experience

Both the sensation (n=407; 98.07 %) (Fig. 6a) and experience with dragonflies (n=265; 63.83 %) (Fig. 6b) are positively evaluated by many indigenous and non-indigenous residents. These insects are considered charismatic and attractive to the public due to their

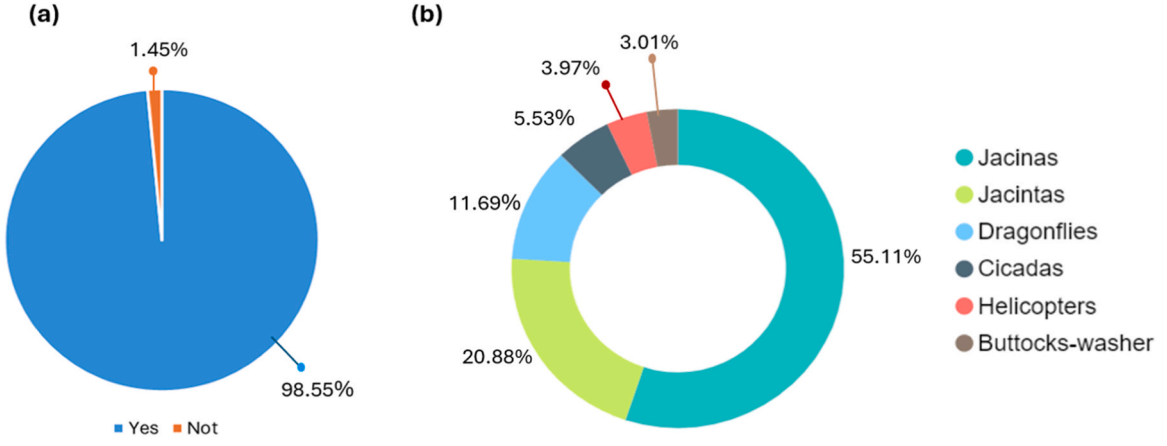

Fig. 5. (a) Image recognition. **(b)** Common names associated with dragonflies. Perceptions of the residents of the Tapajós-Arapiuns Resex, Brazilian Amazon.

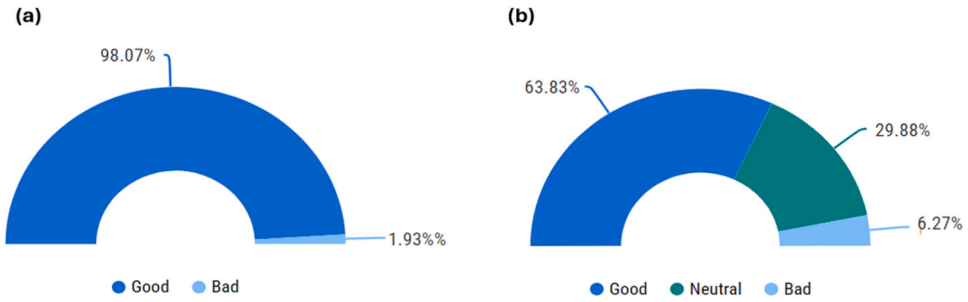

Fig. 6. **(a)** Sensation that dragonflies generate **(b)** Experiences in contact with dragonflies**.** Perceptions of the residents of the Tapajós-Arapiuns Resex, Brazilian Amazon.

size, vibrant colors, and aerial maneuverability, which generates widespread sympathy among humans, making them one of the most iconic and emblematic groups alongside butterflies and bees (Barua et al., 2012; Pinto, 2024). According to Kellert (1993), positive attitudes are more frequent when organisms have aesthetic, utilitarian, ecological, or recreational values, as is the case with Odonata. Overall, positive perceptions of invertebrates are of great importance for conservation efforts in protected areas as they lead to greater awareness of their relevance in ecosystems (Huntly et al., 2005). This is especially important given that the loss of insect biodiversity is an increasingly public concern (Cardoso et al., 2020; Harvey et al., 2020; Scudder, 2009).

While negative sensations and experiences with Odonata are scarce (6.27 %), some of the interviewees mentioned fearing them due to their size, as they are "larger than most insects," their jaw size "seems threatening," and they generate feelings of fear when they congregate during the summer, resembling "swarms of wasps." This reflects that fear and aversion towards certain organisms, particularly insects, are often linked to physical or behavioral characteristics perceived as a threat to survival (Lockwood, 2013), even towards those that are harmless to humans, such as dragonflies. While aversion to insects or entomophobia is driven by a range of emotional, cognitive, and behavioral traits that evolved to avoid diseases (Fukano and Soga, 2023), excessive or unfounded fear can have significant negative impacts on the conservation of these organisms (Soga et al., 2023). This is because it contributes to a lack of interest in invertebrates, hinders understanding of the importance of insects in ecosystems, and impedes the implementation of effective conservation measures for their protection. In this context, implementing environmental education initiatives with residents and tourists can be instrumental in demystifying these fears.

3.2.3. Dragonflies' features

The most mentioned characteristics of Odonata are their beauty (*n*=150; 32.26 %), their harmlessness (*n*=129; 27.74 %), their

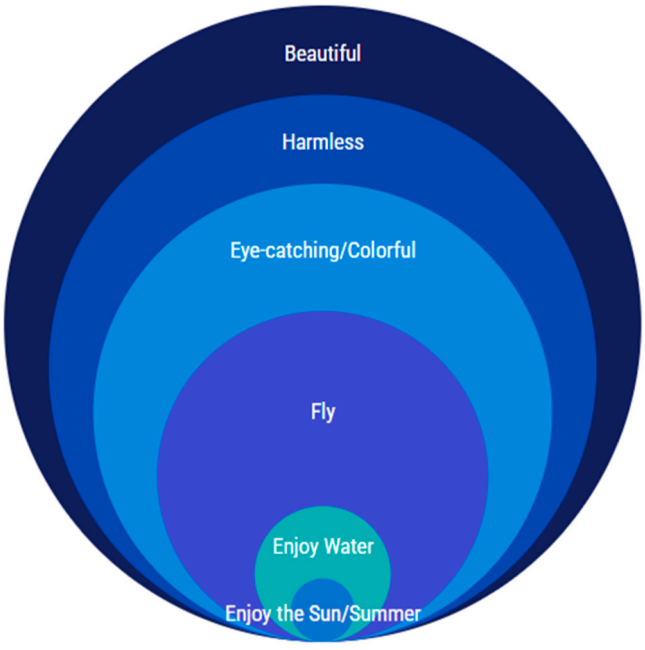

Fig. 7. **S**tacked bubbles chart of the dragonflies' features. The size of the circles indicates how frequently the features were mentioned. Each participant provided more than one answer. Perceptions of the residents of the Tapajós-Arapiuns Resex, Brazilian Amazon.

striking and colorful appearance (*n*=108; 23.23 %), and their flying ability (*n*=78; 16.77 %) (Fig. 7).

Dragonflies constitute an excellent group to include in conservation programs as flagship species since they are part of charismatic microfauna (Barua et al., 2012). Charisma is a term frequently used in conservation biology to describe species that the general population considers beautiful, impressive, or endangered (Albert et al., 2018). According to Samways (2020), the most popular insect taxa that receive the most attention from audiences of all ages are those that are beautiful, striking, large, benign, highly visible in everyday environments, mobile, and interesting, such as butterflies, dragonflies, bumblebees, bees, grasshoppers, and beetles. In the case of Odonata, their elegant and aerodynamic flight has not only caught the attention of the general public but has also sparked interest in the field of bioinspired engineering in exploration systems (May, 2019; Thomas et al., 2004). Finally, it is worth noting that while the use of flagship species is essential in various conservation programs, some authors emphasize the importance of also including "less charismatic" species that share habitat or face similar threats with charismatic species (Albert et al., 2018).

3.2.4. Differentiation between dragonflies and damselflies

The differences identified by the participants between dragonflies (Anisoptera) and damselflies (Zygoptera) mainly focused on color (*n*=399; 41.52 %), body size (*n*=358; 37.25 %), wing shape and size (*n*=80; 8.32 %), eyes (*n*=65; 6.76 %), head (*n*=50; 5.20 %), and to a lesser extent, the abdomen (*n*=9; 0.94 %) (Fig. 8).

Although color is not a distinguishing feature between the two suborders (Anisoptera and Zygoptera), bright colors on the body, wings, and eyes are characteristic of adult Odonata, as they play a fundamental role in mate choice, species recognition, predator avoidance, and adaptation to abiotic conditions (Corbet, 1999; Prum et al., 2004; Suárez-Tovar et al., 2022). In contrast, dragonflies tend to have larger bodies, robust wings at their base, and closely spaced compound eyes, while damselflies are characterized by smaller bodies, narrower wings at their base, and widely separated compound eyes at the top of the head (Corbet, 1999; Pinto, 2024). Thus, the morphological differences between Anisoptera and Zygoptera, as described in general by the interviewees, reflect a broad level of knowledge acquired regarding Odonata. This could be closely related to their early interaction with these insects through observation and collection for recreational purposes (see Fig. 12).

3.2.5. Classification group of Odonata

A large portion of the interviewees classified dragonflies and damselflies within the group of insects, either explicitly (*n*=190; 45.78 %) or implicitly, associating them with butterflies (*n*=92; 22.16 %), mosquitoes (*n*=12; 2.89 %), and moths (*n*=8; 1.92 %) (Fig. 9).

This result is consistent with the study by Ulysséa et al. (2010), who analyzed the perception and uses of insects among inhabitants of a traditional community. In their research, they found that 43 % of the participants classified dragonflies within the group of insects, suggesting that they recognize the distinctive characteristics of the Insecta Class. Overall, it is observed that the association of Odonata with other orders, such as Lepidoptera (butterflies and moths) and with Diptera (flies and mosquitoes), may be related to a series of shared general characteristics among the groups, such as being colorful, having wings, and showing certain levels of seasonality.

The relationship they establish by indicating that dragonflies are part of birds and, at a generic level, of "flying" animals is noteworthy, a view shared by the North American Cheyenne Indians, who considered dragonflies and other winged insects as species of birds rather than insects (Green, 2012). Dragonflies, especially Anisoptera, stand out for their incomparable mastery of flight,

Fig. 8. Treemap of perception of the differences between dragonflies and damselflies. The size of the boxes indicates the frequency of the answers. Each participant provided more than one answer. Perceptions of the residents of the Tapajós-Arapiuns Resex, Brazilian Amazon.

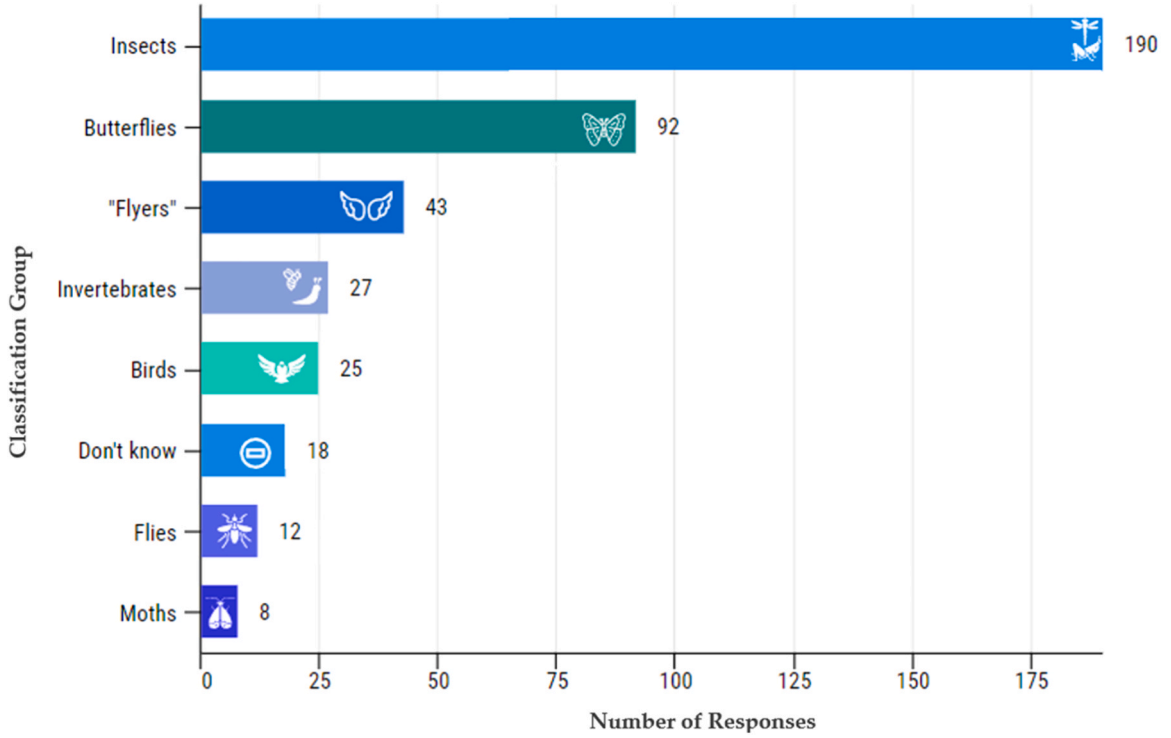

Fig. 9. Group of animals in which dragonflies and damselflies are classified. Perceptions of the residents of the Tapajós-Arapiuns Resex, Brazilian Amazon.

exhibiting highly developed morphological adaptations for aerial food searching; these abilities can only be equaled by some birds of prey (Corbet, 1999).

3.2.6. The occurrence environments of Odonata and the associated environmental conditions

According to indigenous and non-indigenous residents, the three main environments where dragonflies occur are forests and jungles (*n*=238), riverbanks (*n*=213), and stream edges (*n*=128) (Fig. 10a). Regarding the environmental conditions associated with the presence of Odonata, it was found that many of the interviewees (*n*=167; 40.24 %) indicated being unaware of such association (Fig. 10b). 21.20 % (*n*=88) reported that dragonflies are related to preserved environments, 19.76 % (*n*=82) linked them to bodies of water or water resources, 15.19 % (*n*=63) associated them with sunny locations or high temperatures, and 3.61 % (*n*=15) associated

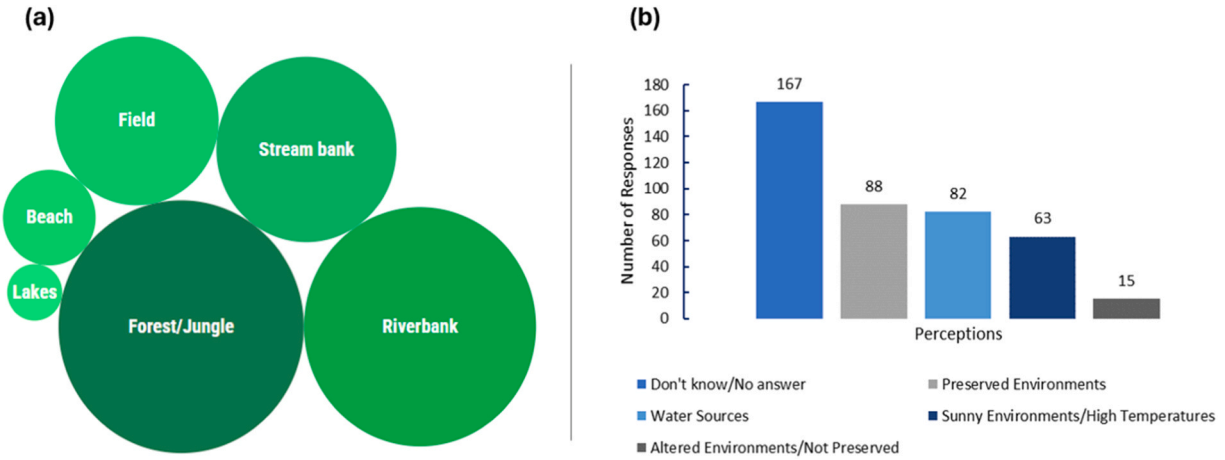

Fig. 10. **(a)** Word cloud of the types of environments where dragonflies occur. The size of the spheres indicates the frequency with which the environments were mentioned. Each participant provided more than one answer, **(b)** Perceptions about the environmental conditions associated with the presence of dragonflies. Perceptions of the residents of the Tapajós-Arapiuns Resex, Brazilian Amazon.

them with altered or unpreserved environments.

This reflects the participants' familiarity with this group of insects in relation to the environments they inhabit. Odonates live in all types of freshwater environments (rivers, streams, lakes, and ponds), and some can even be found in brackish water, with their composition varying according to environmental conditions (Juen et al., 2014; Pinto, 2024). Dragonflies, for example, prefer shaded areas and generally inhabit streams with dense forested areas, so their richness is expected to be higher in preserved environments. In contrast, damselflies, being heliophilic, require areas with greater solar incidence, such as ponds, fields, or open areas, so their richness is expected to be higher in environments with low vegetation cover or impacted areas (Corbet, 1999; Juen et al., 2014; Oliveira-Junior and Juen, 2019; Pinto, 2024).

These eco-physiological characteristics make Odonata excellent indicators of environmental conditions in aquatic habitats, as their presence or absence reveals the conservation status of these ecosystems (Carvalho et al., 2013; Monteiro-Júnior et al., 2013). Since most participants claimed to be unaware of the relationship between dragonfly occurrence and environmental alterations, there is a need to raise awareness among local populations about the importance of these organisms in assessing the environmental quality of Amazonian streams. This can be done simultaneously through the development of community-based ecotourism and the ICMBio National Biodiversity Monitoring Program, as described in previous paragraphs (Brasil et al., 2020).

3.2.7. Uses of dragonflies and damselflies

55.18 % indicated that dragonflies have no utility, and 17.83 % stated that they were unaware of their uses for humans (Fig. 11). However, both indigenous and non-indigenous participants reported some uses such as announcing the arrival of summer (16.63 %), controlling pests (4.58 %), and treating diseases (2.41 %).

The use of Odonata as an indicator of the arrival of summer by traditional communities is associated with the perception of an increase in their abundance during the dry season, which usually occurs between the months of May and September (Nobre et al., 2009; Fisch et al., 1998). They affirm that "they can be observed more frequently", "it seems that they reproduce more", "they concentrate more on the riverbanks", "they are found everywhere, there are many", "sometimes there are so many that they enter the house". This converges with Japanese culture, for whom dragonflies symbolize the arrival of summer (Laurent, 2000).

These observations could be well-founded. Seasonal environmental factors such as photoperiods, rainfall, and temperature influence larval development and adult activity, thus having a significant impact on the number of generations produced by various species, as well as on the occurrence and distribution of odonates (Corbet, 1999; Corbet et al., 2006; Hassall and Thompson, 2008). Accordingly, species adapted to the dry season, possibly belonging to the Suborder Anisoptera due to their generalist habits and high tolerance to solar radiation (Oliveira-Júnior and Juen, 2019), could be more frequently visible in the Tapajós-Arapiuns RESEX at the beginning of summer.

On the other hand, odonates are also used for crop pest control or biocontrol. According to Corbet (1999), odonates, both in their larval and adult stages, are major predators of other insects, thus playing a crucial role in controlling crop pests and disease vectors. Studies such as May (2019) show records of Odonata feeding on soybean and rice pests. Although many farmers do not recognize

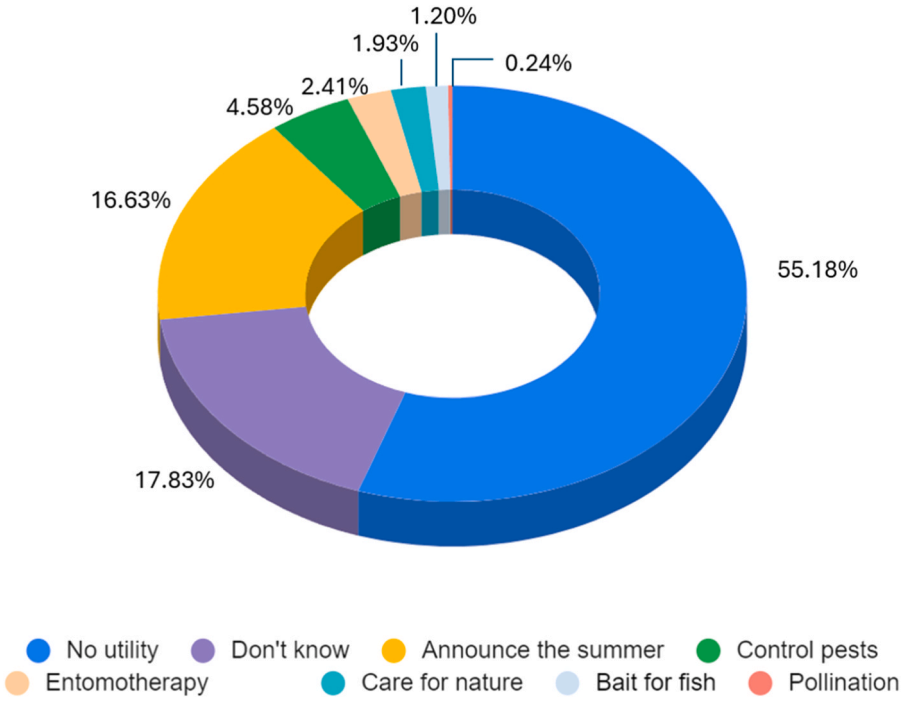

Fig. 11. Description of the uses of dragonflies and damselflies in the Tapajós-Arapiuns Resex, Brazilian Amazon.

beneficial predators for their crops (Gurung, 2003), this is not the case for residents of the reserve, who have identified this valuable ecosystem service provided by odonates, which is essential for their main economic activity, family farming.

Finally, the medicinal use of insects or entomotherapy has been recorded in many regions of the world. According to Costa-Neto (2005), insects themselves or substances extracted from them have been widely used as medicinal resources by various human cultures. In response to this, traditional communities reported using odonates for wart removal, solving speech problems in children (stuttering), and treating cancer and diabetes. The procedure described by them for removing warts involves capturing the largest dragonflies (Anisoptera) and placing them directly on the wart, according to them, "the dragonflies eat the warts until they disappear completely". To treat stuttering, the largest specimens of Anisoptera are captured and placed directly on the tongue so that after several bites, the child "loosens the tongue and speaks normally". This process must be repeated in several sessions until the child's speech improves. Finally, to treat cancer and diabetes, a dragonfly must be captured and placed in an infusion with hot water for a period of two hours, then the insect must be removed, and the liquid should be consumed.

In the literature, other medicinal uses associated with Odonata were found, such as treatment for snakebites, yellow fever, inflammations (Costa-Neto, 2006), stomach pain, hypertension, kidney problems, toothache, dizziness, gas, hypertension (Gurung, 2003), sore throat, asthma, fever, cough, and tumor problems (Siddiqui et al., 2023). However, no records were found of their uses for treating warts, speech problems, and diabetes, making this the first record in the literature regarding these uses.

3.2.8. Observation and collection of dragonflies

When asked if they had ever gone out to observe and collect dragonflies, the majority (76.39 %) reported that they had not, while the remaining (23.61 %) indicated that they had (Fig. 12). Those who responded affirmatively were asked about the collection methods used, with 96.44 % indicating that they did so manually, and the remaining 3.56 % using a sieve. The purpose of this collection was predominantly for playing with them (95.50 %) and for observing them up close (4.5 %).

They stated that when they were children, they competed among themselves to see who had more skill in catching them with their hands because "they are very agile", contrasting with the use of the sieve, which "was for the novices". The use of the sieve had already been described by Ulysséa et al. (2010), who recorded that the inhabitants of a community in Santa Catarina (Brazil) made a type of net to catch odonates using a coffee strainer and a bamboo branch.

Since the main purpose of these collections was recreational, they would capture an adult dragonfly, tie a thread or string to its abdomen, and guide its flight through the thread or take them "for a walk through the forest". According to the information provided, each child had a collection of odonates of different colors, which were exchanged for other specimens. In some cases, the dragonflies ended up dying due to exhaustion or because in their attempt to "escape", the knot of the thread tightened even more, ultimately "splitting their bodies in two".

In response to this, several of the interviewees reported that this recreational activity is no longer practiced. Authors such as Alves et al. (2015) and Ulysséa et al. (2010) also reported this game in the northeast and south regions of the country, which is known as "little airplane". However, the development of recreational activities with insects is not exclusive to Brazil; games such as cricket fights, mantis battles, and beetle races have been reported in different parts of the world, which highlights the various levels of interaction between human beings and insects.

3.2.9. Level of skills and knowledge about Odonata

When asked to indicate their level of skill and knowledge about Odonata, the majority of the interviewees selected a low level (n=252; 60.72 %) or very low level (n=95; 22.89 %) (Fig. 13).

A similar result has been reported in Lemelin's study (2009). Although this perception highlights the need to design and implement educational programs and public awareness campaigns about odonates, we cannot overlook the profound knowledge displayed by

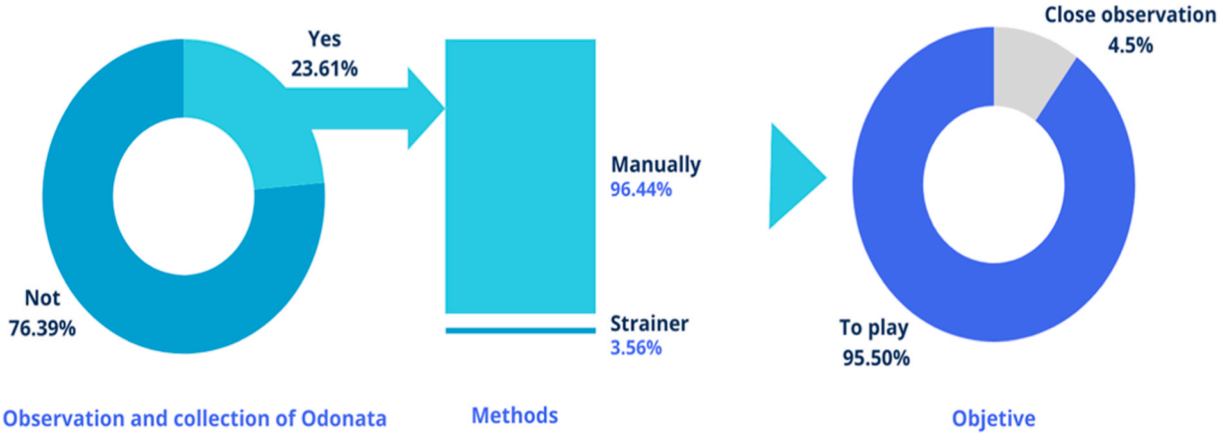

Fig. 12. Observation and collection of dragonflies and damselflies, methods employed and purposes. Perceptions of the residents of the Tapajós-Arapiuns Resex, Brazilian Amazon.

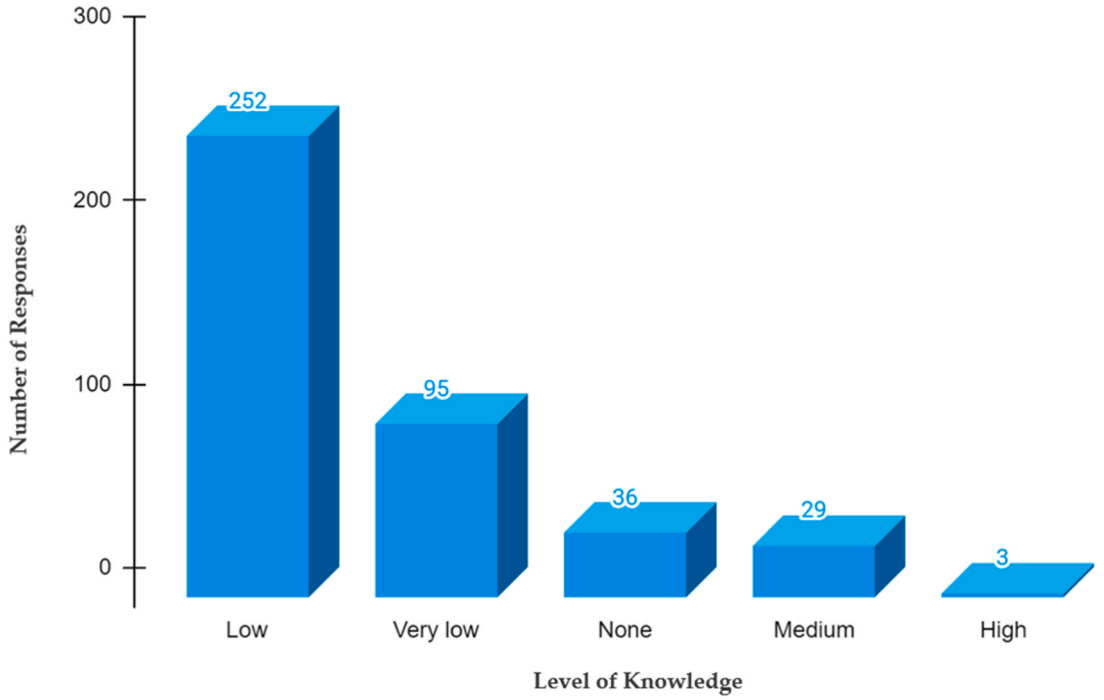

Fig. 13. Perception of the level of knowledge and skills about the local odonatofauna. Perceptions of the residents of the Tapajós-Arapiuns Resex, Brazilian Amazon.

local indigenous and non-indigenous communities during the interviews. They described specific morphological and behavioral traits of these insects, information that is not common knowledge among the general population.

This stems from the fact that these traditional ecological knowledge systems are built in coexistence and interconnectedness with the environment, based on empirical experiences and observations of nature accumulated over millennia, which are transmitted across generations (Berkes et al., 2000). All this knowledge is relevant for the conservation, management, and sustainable use of biological diversity, as it enables a more holistic and contextualized understanding of species interactions, natural cycles, and environmental changes, providing tools to respond to them (Berkes et al., 2000; Levis et al., 2024). Additionally, it promotes the participation of local communities in decision-making processes, ensuring that their needs and perspectives are considered, thereby strengthening the legitimacy and effectiveness of conservation policies (Armitage et al., 2020).

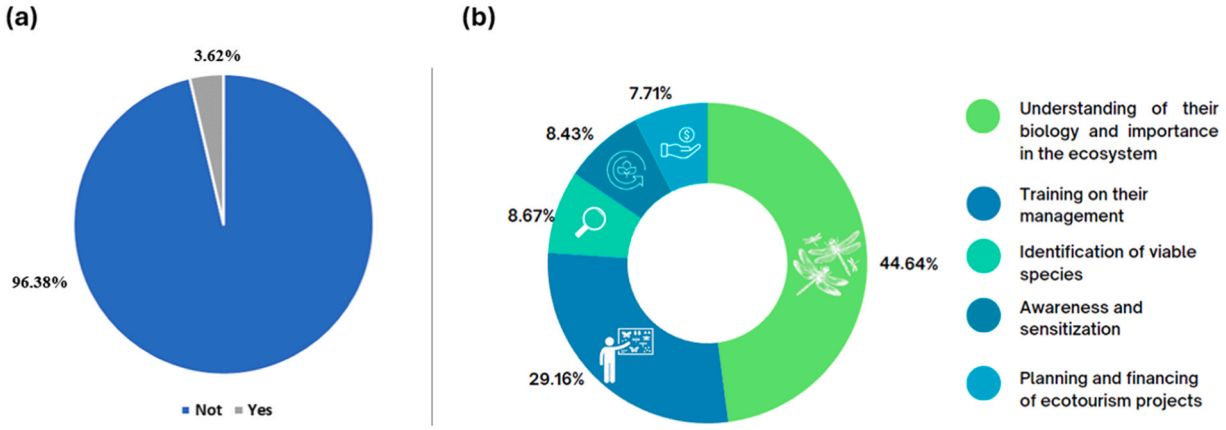

Fig. 14. Perceptions of the residents about **(a)** Incorporation of information about invertebrates into current ecotourism activities; and **(b)** Considerations for including invertebrates in ecotourism activities at the Tapajós-Arapiuns Resex, Brazilian Amazon.

3.3. Ecotouristic potential of dragonflies and damselflies

3.3.1. Inclusion of information about invertebrates in ecotourism activities in the Tapajós-Arapiuns Resex

A 96.38 % (n=400) of the participants reported that in the ecotourism activities currently developed in the Tapajós-Arapiuns Resex, no information about invertebrates is included, while the remaining 3.62 % (n=15) reported that it is included, but exclusively about bees (Fig. 14a).

Although the inclusion of insects in ecotourism activities is not common in the reserve, initiatives such as beekeeping (sting bees) and meliponiculture (stingless bees) are becoming increasingly popular among communities (PSA, 2015). Among the services offered are visits to the hives and the sale of products such as honey, pollen, and propolis. The breeding of native stingless bees has been developed in communities such as Amorim, Aminã, Anã, Vila Franca, and Suruacá, benefiting multiple families (De Almeida et al., 2022).

Furthermore, when asked about what they consider important for including invertebrates in ecotourism activities, the majority stated that it is crucial to understand their biology and importance in the ecosystem (44.64 %), to receive training on their management (29.16 %), and to learn to identify species suitable for inclusion in entomotourism activities (8.67 %) (Fig. 14b). In response to this, several authors emphasize that one of the main obstacles to the development of entomotourism is the lack of training for the individuals who will lead the insect tourism activities, as well as the absence of appropriate literature for this purpose (Gómez and Gasca, 2022; Guerrero-Moreno and Oliveira-Junior, 2024b).

Suh and Samways (2001) add that it is vital for reserves, natural parks, or sanctuaries to inform the public about which species can be observed and the likelihood of seeing a particular species at a certain time of the year, as this allows visitors to recognize and become familiar with the local insect fauna. This also requires the recognition of insect diversity in the region with the support of entomologists and experts in the field to facilitate their identification. In this regard, the ICMBio Monitora program and research such as that of Oliveira-Junior et al. (2022) are crucial for the development of entomotourism with Odonata in the protected area, as they enable the identification of different odonate species, which may be of interest to various tourists.

3.3.2. Seeing, observing, and collecting Odonata as an ecotourism attraction

A significant portion of the participants indicated that seeing (n=413; 99.52 %) and observing (n=411; 99.04 %) dragonflies could be a viable and attractive ecotourism attraction for visitors (Fig. 15). This is aligned with the most common activity in entomotourism, "wild watching," which provides visitors and tourists with the opportunity to contemplate, photograph, and interact with biodiversity in its natural habitat through interpretive programs (Guerrero-Moreno and Oliveira-Junior, 2024b; Rykken and Farrell, 2012). This practice becomes an extremely enriching experience as it promotes awareness and environmental education.

The collection of dragonflies as an ecotourism attraction was one of the most controversial aspects among the interviewees, as while 69.40 % (n=288) indicated being in favor, 30.60 % (n=127) vehemently opposed it, stating that "collecting them without a scientific purpose is not right," "they should only be admired, there is no need to manipulate them," "they belong to the forest and should stay in the forest," and "collection should only be authorized for study purposes, unless they are collected solely for observation and subsequently released." This result coincides with Lemelin's study (2009), in which the majority of interviewees stated that specimens should be collected and preserved solely for scientific and conservation purposes. This is aligned with the National System of Nature Conservation Units (SNUC- *Sistema Nacional de Unidades de Conservação da Natureza*), which manages the protected areas and establishes criteria and norms for species collection in Brazil, specifying that collections must be authorized in advance by ICMBio and

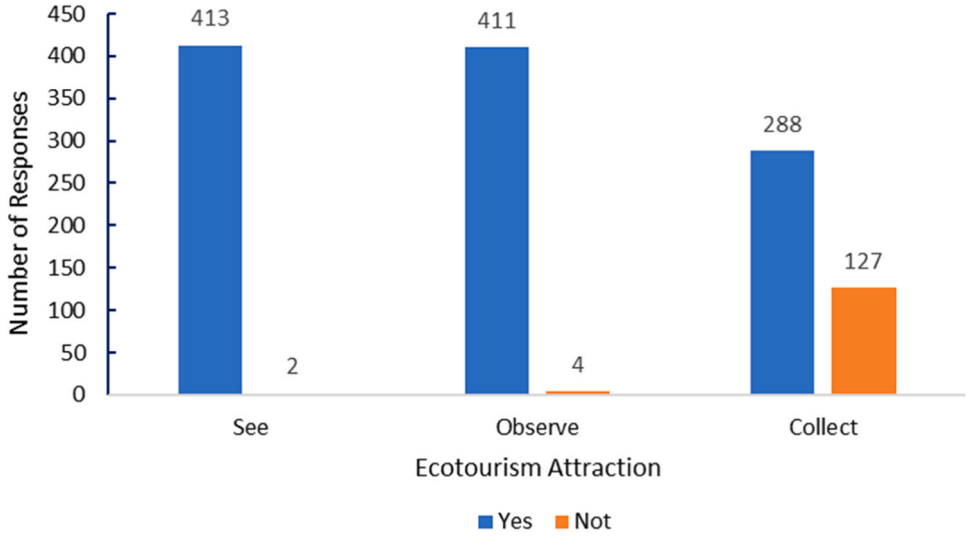

Fig. 15. Perception about seeing, observing, and collecting dragonflies as a tourist attraction. Perceptions of the residents of the Tapajós-Arapiuns Resex, Brazilian Amazon.

their purpose must be exclusively scientific (Brasil, 2000).

3.3.3. Best environments and schedules to observe dragonflies in the Tapajós-Arapiuns Resex

According to local indigenous and non-indigenous communities in the protected area, the best places to observe dragonflies are on the riverbanks (38.65 %), in the forest (26.60 %), and on the edges of the igarapé (25.04 %) (Table 3). Larvae and adults of Odonata inhabit a range of habitats, from phytotelmata (water-filled plant structures such as bromeliads or tree holes) to streams, rivers, and lakes, where they are easily observable, making them model organisms for behavioral, ecological, and evolutionary research (Corbet, 1999; Córdoba-Aguilar, 2008). According to Samways (2020), freshwater bodies are where odonates are most frequently seen and closely interact with human cultures. Their striking coloration, abundance, size, and biology make them highly suitable for habitat quality monitoring through citizen science and serve as key organisms for conservation initiatives (Bried et al., 2020; Bried et al., 2020; Samways, 2020).

Additionally, they indicated that the best times to observe dragonflies are from 9h00 to 10h00 (16.19 %), from 15h00 to 16h00 (23.93 %), and from 17h00 to 18h00 (19.20 %) (Table 3). Which suggests that these times would be the best to be included in the reserve's community-based ecotourism programs. According to the study by Batista et al. (2021), the best time to observe and collect odonates in tropical streams occurs between 12:00 and 14:00 hours. However, it is noteworthy that odonate activity is subject to variations in environmental characteristics such as luminosity, temperature, and humidity, which influence community dynamics (Calvão et al., 2018). Considering this information, it is important to identify which species are more frequently observed in the morning and which in the afternoon. This will allow the alignment of visiting hours with the particular interests of tourists, especially if they have preferences for certain species. Due to the ecophysiological needs of the suborders, it is more likely to find a greater number of Zygoptera species in the morning when solar intensity is lower, and Anisoptera species in the afternoon when solar intensity is higher (Corbet, 1999; Oliveira-Júnior and Juen, 2019).

3.3.4. Reasons why entomotourism with Odonata could attract tourists to the Tapajós-Arapiuns Resex

Being eye-catching (n=237; 41.87 %), beautiful (n=162; 28.62 %), and arousing curiosity (n=62; 10.95 %) are the main reasons why tourists might be attracted to participate in ecotourism activities involving Odonata, according to the perception of traditional communities (Fig. 16). These perceptions align with studies by authors such as (Lawal and Banjo, 2007; Lemelin, 2009) and Samways (2012), who highlight the attractiveness of dragonflies in the realm of tourism and recreation due to their striking characteristics, size, colors, flight capabilities, and diurnal habits, which collectively make them highly popular and recognizable. Thanks to these characteristics, they attract thousands of tourists to protected areas, such as the Nakamura Dragonfly Reserve in Japan, initiatives that generate funds and support for biodiversity conservation (Lemelin, 2007; Samways, 2012).

In addition to aesthetic motivations, participants also stated that the biodiversity of the Tapajós-Arapiuns Resex (n=46; 8.13 %), regional exclusivity (n=37; 6.54 %), and widespread interest in Amazonian fauna (n=22; 3.89 %) could attract visitors. Studies such as Oliveira-Junior et al. (2022) corroborate the significant richness and abundance of Odonata insects within the Resex, which constitutes an ecotourism incentive. According to Kalkman et al. (2008), the highest diversity of dragonflies is found in the waters of tropical rainforests, with the Oriental and Neotropical regions being critical areas for Odonata diversification. Both the Amazon ecosystem and its biodiversity, the vast stretches of white sand beaches, the Tapajós and Arapiuns rivers, and cultural diversity represent great potential for ecotourism development (PSA, 2015).

3.3.5. Environmental, cultural, and economic importance of Odonata

When community members and villagers were asked if they considered Odonata important for the environment, the vast majority responded affirmatively (99.52 %) (Fig. 17). Respondents mainly associated their importance with the fact that "they exist in nature for

Table 3
Perception of leaders and residents of the Tapajós-Arapiuns Resex regarding the best places and times to observe dragonflies. Frequency = Number of times the word is mentioned. Percentages are calculated on the total number of responses in each criterion. Each participant provided more than one answer.

	Frequency	Percentage (%)
Better environment		
Riverbank	247	38.65
Forest/Jungle/Nature	170	26.60
Stream bank	160	25.04
Field	25	3.91
Lakes	23	3.60
Beach	14	2.19
Better schedule		
7h00 to 8h00	109	15.62
9h00 to 10h00	113	16.19
11h00 to 12h00	101	14.47
13h00 to 14h00	74	10.60
15h00 to 16h00	167	23.93
17h00 to 18h00	134	19.20

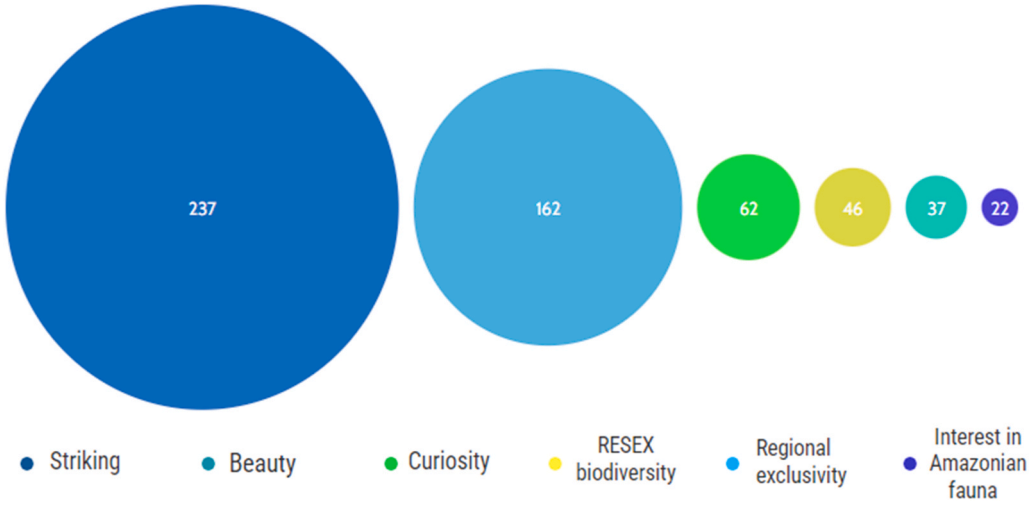

Fig. 16. Perceptions about the reasons why odonate entomotourism could attract tourists. The size of the circles indicates the frequency of the responses. Each participant provided more than one answer. Perceptions of the residents of the Tapajós-Arapiuns Resex, Brazilian Amazon.

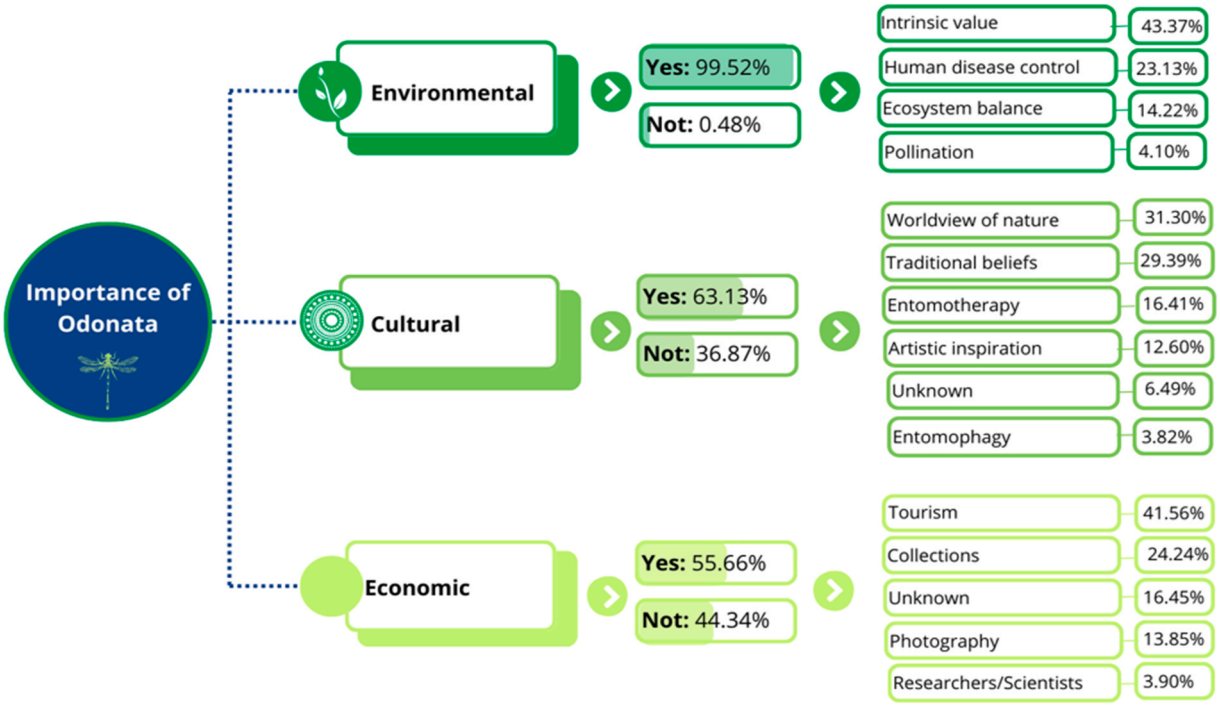

Fig. 17. Tree of perceptions about the environmental, cultural, and economic importance of Odonata. Perceptions of the residents of the Tapajós-Arapiuns Resex, Brazilian Amazon.

a reason" and that "they are as important as any other living organism" (43.37 %), reflecting their intrinsic value. They also highlighted their importance in controlling pests (23.13 %) because "they feed on mosquitoes and other pests dangerous to humans" and contribute to ecosystem balance (14.22 %) by "serving as food for other animals such as birds and frogs".

These perceptions are crucial as they not only reaffirm the environmental importance of Odonata but also reinforce their value from a non-anthropocentric perspective, where biodiversity has value, regardless of human interests. This aligns with the connection that traditional communities have had with nature, which is framed within an ecocentric worldview (Levis et al., 2024). According to Piccolo (2017), recognition of intrinsic value is a fundamental aspect of biodiversity conservation, as it implies an obligation to do what is right above particular interests or purely utilitarian reasons.

Furthermore, the biological control of pests by Odonata has already been documented. Both larvae and adults prey on significant

percentages of dipterans (flies and mosquitoes), which can transmit diseases such as malaria, Zika, chikungunya, or dengue (Maxwell et al., 2016; Quiroz-Martínez and Rodríguez-Castro, 2007; Vatandoost, 2021), resulting in benefits for human health. Their importance in the food chain is also highlighted as they are important prey for birds, spiders, reptiles, amphibians, mammals, and even other insects (Corbet, 1999).

63.13 % affirmed that dragonflies and damselflies are important at a cultural level. On one hand, they indicated that their importance lies in being part of their worldview (31.30 %) as they have coexisted with them for decades, making them part of their daily lives and their spiritual world, often acting as "messengers." They also stated that they are part of traditional beliefs (29.39 %) since there are legends associated with them, and their presence inside houses indicates the arrival of an unexpected visitor or is a sign of good luck; very few mentioned that odonates were an omen of bad luck and that they could even be a sign of death. Cultural value was also related to the medicinal use of dragonflies (16.41 %), which was described in detail in the section related to the uses of Odonata. In turn, they mentioned their importance associated with artistic inspiration (12.60 %).

This coincides with other studies such as Cudera et al. (2020) and Green (2012), who highlighted the role of dragonflies in the worldview, mythology, ceremonies, and rituals of different cultures. Dragonflies have served as inspiration for artistic creation, including poems, books, manuscripts, paintings, and engravings (May, 2019; Simaika and Samways, 2008). They have also represented good omens or served as a protective amulet against death (Green, 2012). However, albeit to a lesser extent, they have also been associated with death or bad luck, also related to their common names such as "devil's darning needle" or "devil's needle" (Lemelin, 2009).

The economic importance of this order was recognized by 55.66 % of the indigenous and non-indigenous interviewees. Within the economic perspective, they included tourism (41.56 %) as a potential source of income, Odonata collections (24.24 %), the sale of photographic material (13.85 %), and the income that visits by researchers and scientists interested in these insects can generate (3.90 %). In general, entomotourism as a subsector of ecotourism allows tourists from all over the world to participate in activities such as photography, observation, entomophagy, and other forms of direct interaction with various types of insects, generating profits (Hvenegaard, 2016). However, it has been found that, in most cases, local communities are not considered in the planning and execution of ecotourism; instead, private external companies operating within conservation areas receive all the benefits (Phuong et al., 2022). This highlights the need for tourism to be managed and administered directly by traditional communities in a sustainable manner, which can be achieved through community-based ecotourism (CBET), aligning with the Public Use Plan of the Tapajós-Arapiuns Resex (ICMbio, 2022).

3.3.6. The meaning of dragonflies for traditional communities

When asked if odonates held any significance for them, the majority affirmed that they did (n=365; 87.95 %) (Fig. 18). Among the most common meanings are the beauty of nature (24.38 %), transformation (10.68 %), and freedom (9.58 %). These results highlight the deep connection that participants have with these insects, attributing them various symbolic meanings, all with positive connotations. The perception related to beauty underscores the strong aesthetic value of Odonata, which, along with other ecological attributes, easily qualifies them as flagship species in various environmental education programs for the protection of aquatic ecosystems (Clausnitzer et al., 2017). Symbolism related to transformation is also common among butterflies and is related to the process of metamorphosis, which in the case of dragonflies is incomplete (hemimetabolous), meaning they only have three stages (egg, larva, and adult), showing significant changes between each state during the process (Corbet, 1999). Lastly, the meaning associated with freedom is likely linked to their incredible flight capacity, which stands out for its maneuverability, speed, and visual guidance control, as well as its ability to cover long distances (May, 2019; Pinto, 2024).

3.3.7. Availability to support ecotourism activities with dragonflies

Finally, 89.88 % of the respondents indicated a desire to participate in the development of ecotourism activities involving Odonata in the Tapajós-Arapiuns Resex (Fig. 19).

The high interest expressed by participants reflects a significant opportunity to promote biodiversity conservation, sustainable development, social justice, and community empowerment through CBET (Mtapuri and Giampiccoli, 2018). The inclusion of dragonflies and damselflies in ecotourism activities fosters greater awareness and effort to conserve these insects and their habitats (Samways, 2012), and their protection, in turn, can contribute to the well-being of other species within the reserve. Additionally, there are economic benefits that can help improve the quality of life of local communities, as well as the valorization of their cultures and traditional knowledge (Benites and Mamede, 2020; Levis, 2024).

4. Conclusions

The present study reveals the significant potential of Odonata as a key organism for promoting community-based ecotourism in the Tapajós-Arapiuns Resex in the Brazilian Amazon. The hypothesis that local communities would have a positive perception of the integration of Odonata into ecotourism activities was corroborated. The results indicate that the interviewed traditional communities possess extensive knowledge about Odonata at both environmental and cultural levels, which not only contributes to their conservation but also enriches future ecotourism experiences by offering visitors the opportunity to learn about the relationship between local communities and odonatofauna and biodiversity in general.

There is a highly appreciative attitude and favorable aesthetic perception towards odonates, attributing them with strong intrinsic value. Emblematic taxa, such as dragonflies and damselflies, with high popularity profiles, can foster interest from audiences of all ages towards other invertebrates, which is vital given the current loss of biodiversity. The importance of dragonflies in local cosmology,

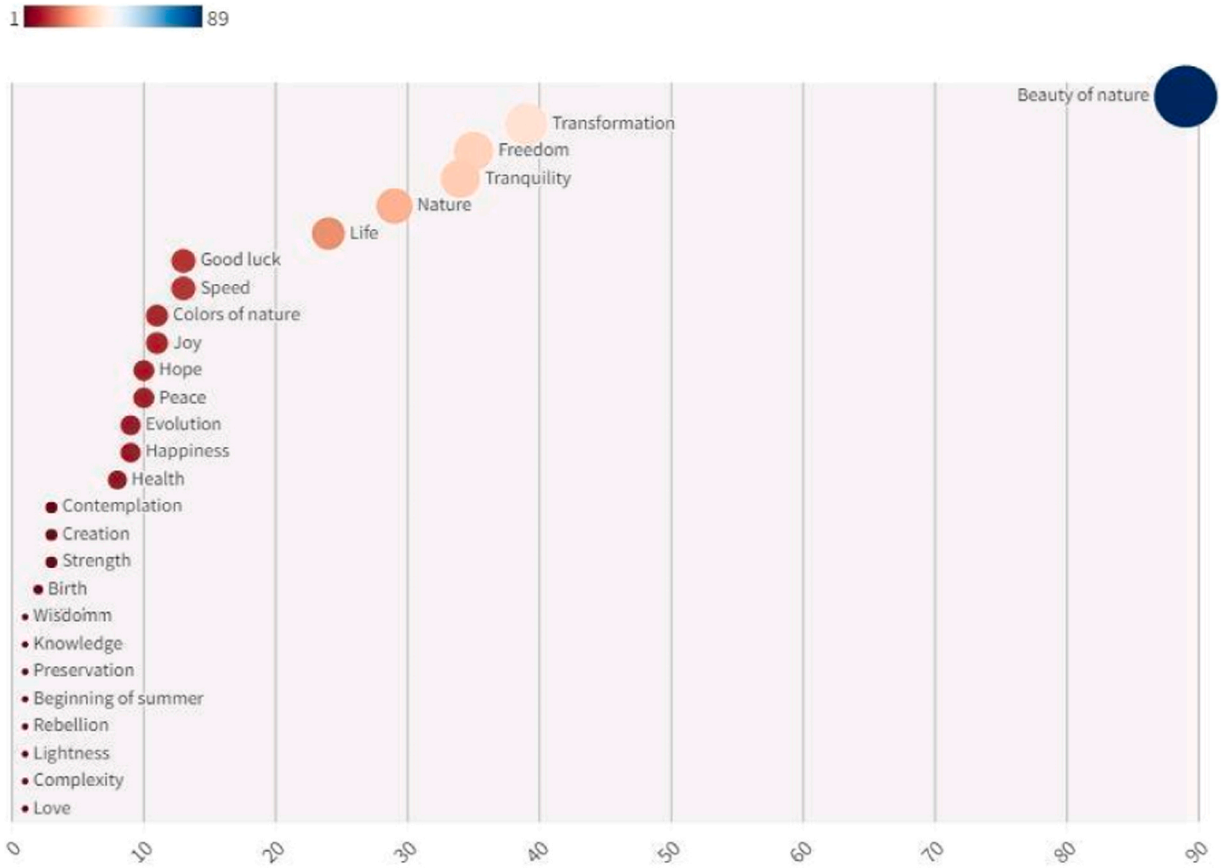

Fig. 18. Scatter Plot of what dragonflies and damselflies symbolize for the traditional communities of the Tapajós-Arapiuns Resex, Brazilian Amazon. The size and color of the points indicate the frequency.

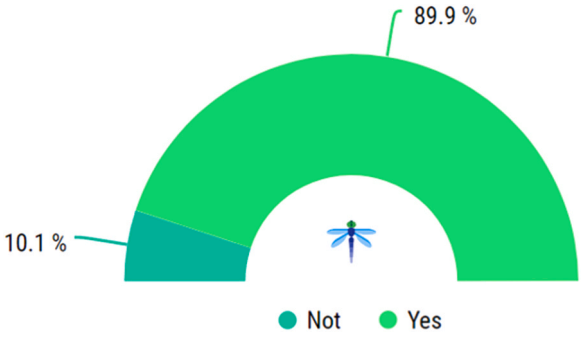

Fig. 19. Interest in participating in the development of ecotourism activities with Odonata in the reserve. Perceptions of the residents of the Tapajós-Arapiuns Rersex, Brazilian Amazon.

along with their striking appearance, behavior, and ecological significance, makes Odonata a highly attractive order for the development of CBET initiatives, especially when their inclusion in ecotourism is still in its infancy globally.

Community-based ecotourism, centered on Odonata, not only has the potential to attract tourists but also to promote the participation and empowerment of indigenous and non-indigenous populations inhabiting the reserve. This approach can improve the quality of life of traditional communities through economic benefits, cultural valorization, and recognition of their traditional knowledge. Concurrently with the development of CBET, communities can utilize Odonata to infer the environmental quality of streams in the Tapajós-Arapiuns Resex through ICMBio's Monitoring Program, enabling early identification of changes in water sources on which their livelihoods depend and the implementation of appropriate conservation measures. This synergy between environmental monitoring and CBET will contribute not only to biodiversity preservation but also to environmental education for

visitors and the strengthening of ecological knowledge among local communities.

Finally, there is a need to design and implement educational and training programs on Odonata alongside local communities. This includes delving into their biology, ecological importance, handling techniques, and identification of potential species, which can facilitate the inclusion of these insects in CBET. Funding and the development of public policies supporting these initiatives are crucial to ensure their success and sustainability.

We anticipate that this research will serve as a diagnostic tool for local communities to evaluate the inclusion of Odonata as key organisms for the development of community-based ecotourism within protected areas. This strategy aims at local biodiversity conservation, income generation, and community empowerment. The results will be shared with the traditional communities of the Resex Tapajós-Arapiuns and made available on the ICMBio platform to facilitate the design of training and technical assistance programs that aligned with the specific needs, capacities, and demands of the communities, thus promoting a collaborative management model.

5. Future perspectives

A key aspect of the sustainable success of Community-Based Ecotourism (CBET) is the continuous commitment to local communities. Therefore, it is crucial to implement a robust community engagement plan that includes ongoing support and the facilitation of participatory workshops. These spaces will allow for the co-creation of strategies that reflect the needs, expectations, and concerns of traditional communities. Feedback from these meetings will be fundamental for adapting initiatives to local realities.

Additionally, it is essential to develop specific training programs on Odonata that address their biology, ecological roles, and sustainable management techniques. Such programs will complement the invaluable traditional ecological knowledge possessed by communities and enhance their capacity to manage CBET initiatives autonomously and effectively.

On another note, it is important to establish participatory monitoring mechanisms that enable communities to evaluate the impact of CBET activities over time. These mechanisms will ensure that local voices are heard and facilitate the adaptation of strategies based on observed results. By integrating these elements, it is expected that CBET initiatives will not only economically benefit communities but also contribute to biodiversity conservation, promote cultural appreciation, and encourage community leadership in the long term.

Furthermore, it is essential to recognize the crucial role of public policies in this context. These policies must ensure that communities have the necessary resources to develop and maintain sustainable initiatives like CBET, which in turn contributes to the protection of natural areas. This includes not only access to funding but also technical and training support that enables them to manage their projects effectively. By creating a favorable institutional framework, long-term sustainability is promoted, and the capacity of communities to face environmental and socio-economic challenges is enhanced.

An integrated approach that combines all these elements will allow for the construction of a more equitable and sustainable future for traditional communities, ensuring that their development goes hand in hand with environmental conservation and the strengthening of their cultural identity.

Ethics statement

Not applicable: This manuscript does not include human or animal research.

If this manuscript involves research on animals or humans, it is imperative to disclose all approval details.

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CRediT authorship contribution statement

M.A.G.-M.: Writing – original draft, Writing – review & editing, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **L.J.:** Writing – review & editing, Methodology, Formal analysis, Conceptualization. **M.P.-C.:** Writing – review & editing, Methodology, Formal analysis. **M.A.T.:** Writing – review & editing, Methodology, Formal analysis. **J.M.B.O.-J.:** Writing – original draft, Writing – review & editing, Project administration, Methodology, Formal analysis, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

No AI tool used in this research.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

No data was used for the research described in the article.

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Ethics approval statement, patient consent statement, permission to reproduce material from other sources, and clinical trial registration

Not applicable.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.gecco.2024.e03230.

References

Aguilar-Barojas, S., 2005. Fórmulas para el cálculo de la muestra en investigaciones de salud. Salud En. Tabasco v. 11, 333–338.
Albert, C., Luque, G.M., Courchamp, F., 2018. The twenty most charismatic species. PloS One v. 13 (n. 7). https://doi.org/10.1371/journal.pone.0199149.
Allan, J., Castillo, M., 2007. Structure and function of running waters. Stream Ecology. Springer.
Armitage, D., et al., 2020. Governance principles for community-centered conservation in the post-2020 global biodiversity framework. Conserv. Sci. Pract. v. 2 (n. 2). https://doi.org/10.1111/csp2.160.
Baquero, J., Parrado, A., 2021. Percepción y conocimiento ambiental como base para una estrategia de ecoturismo en un área protegida urbana de Bogotá (Colombia). Tur. Y. Soc. v. 29, 293–314. https://doi.org/10.18601/01207555.n29.13.
Barua, M., et al., 2012. Selecting flagships for invertebrate conservation. Biodivers. Conserv. v. 21 (n. 6), 1457–1476. https://doi.org/10.1007/s10531-012-0257-7.
Batista, J.D., et al., 2021. Sampling efficiency of a protocol to measure Odonata diversity in tropical streams. PloS One v. 16 (n. 3). https://doi.org/10.1371/journal.pone.0248216.
Benites, M., Mamede, S., 2020. Ecoturismo de Base Comunitária na Comunidade Quilombola Furnas da Boa Sorte, Corguinho (MS): Planejamento e Sustentabilidade. Rev. Bras. De. Ecotur. v. 13. https://doi.org/10.34024/rbecotur.2020.v13.6778.
Berkes, F., Colding, J., Folke, C., 2000. Rediscovery of traditional ecological knowledge as adaptive management, 1 out Ecol. Appl. v. 10 (n. 5), 1251–1262. https://doi.org/10.1890/1051-0761(2000)010[1251:roteka]2.0.co;2, 1 out.
Bonada, N., Fornells, N.P., Resh, V.H., Statzner, B., 2006. Developments in Aquatic Insect Biomonitoring: A Comparative Analysis of Recent Approaches. Annu. Rev. Entomol. v. 51, 495–523. https://doi.org/10.1146/annurev.ento.51.110104.151124.
Brasil. Decreto de 6 de novembro de 1998. Diário Oficial da República Federativa do Brasil, Brasília, 6 de novembro de 1998; Presidência da República Brasil: Brasília, Brasil, 1998.
Brasil. Lei nº 9.985, de 18 de julho de 2000. Diário Oficial [da] República Federativa do Brasil, Brasília, 2000.
Brasil, L.; Dantas, D.; Polaz, C.; Raseira, M.; Juen, L. Bergamini, L. Monitoramento participativo em igarapés de unidades de conservação da Amazônia brasileira utilizando Odonata. Hetaerina, Boletín de la Sociedad de Odonatología Latinoamericana, v. 2, n.1, p. 8-13. 2020. Disponível em: https://www.researchgate.net/publication/339230632_Monitoramento_participativo_em_igarapes_de_unidades_de_conservacao_da_Amazonia_brasileira_utilizando_Odonata. Accesso em: 06 mai. 2024.
Brasil, L.S., Vilela, D.S., 2019. Peculiaridades regionais na percepção de brasileiros sobre libélulas: nomenclatura popular e conservação. Hetaerina, Boletín de la Sociedad de Odonatología Latinoamericana, 1 (1), 15–20. Disponível em: https://www.researchgate.net/publication/330597999_Peculiaridades_regionais_na_percepcao_de_brasileiros_sobre_libelulas_nomenclatura_popular_e_conservacao. Accesso em: 29 abr. 2024.
Bried, J., Ries, L., Smith, B., et al., 2020. Towards global volunteer monitoring of Odonate abundance. BioScience (10), 914–923. https://doi.org/10.1093/biosci/biaa092.
Calvão, L.B., et al., 2018. Land use modifies Odonata diversity in streams of the Brazilian Cerrado. J. Insect Conserv. v. 22 (n. 5-6), 675–685. https://doi.org/10.1007/s10841-018-0093-5.
Cardoso, P., et al., 2020. Scientists' warning to humanity on insect extinctions. Biol. Conserv. v. 242, 108426. https://doi.org/10.1016/j.biocon.2020.108426.
Carvalho, F.G., et al., 2013. Effects of marginal vegetation removal on Odonata communities. Acta Limnol. Bras. v. 25 (n. 1), 10–18. https://doi.org/10.1590/s2179-975x2013005000013.
Ceballos, G., Ehrlich, P.R., Dirzo, R., 2017. Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines. Proc. Natl. Acad. Sci. USA v. 114. https://doi.org/10.1073/pnas.1704949114.

Clausnitzer, V., et al., 2017. Dragonflies as flagships for sustainable use of water resources in environmental education. Appl. Environ. Educ. Commun. v. 16 (n. 3), 196–209. https://doi.org/10.1080/1533015x.2017.1333050.
Corbet, P., 1999. Dragonflies: Behaviour and Ecology of Odonata. 1st Ed. ; Harley Book.: Colch., UK. https://doi.org/10.1111/j.1365-2427.2001.00664.x.
Corbet, P.S., Suhling, F., Soendgerath, D., 2006. Voltinism of Odonata: a review. Int. J. Odonatol. v. 9 (n. 1), 1–44. https://doi.org/10.1080/13887890.2006.9748261.
Córdoba-Aguilar, A.. Dragonflies and Damselflies: Model Organisms for Ecological and Evolutionary Research. Oxford, Oxford University Press, XII, p 290, 2008. https://doi.org/10.1093/acprof:oso/9780199230693.001.0001.
Costa-Neto, E.M., 2002. Manual de Etnoentomologia. Ed. Zaragoza, Soc. Entomol. ógica Aragón.,V. 100, 104.
Costa-Neto, E.M., 2005. Entomotherapy, or the Medicinal Use of Insects. J. Ethnobiol. v. 25 (n. 1), 93–114. https://doi.org/10.2993/0278-0771(2005)25[93:eotmuo]2.0.co;2.
Costa-Neto, E.M., Pino, J.M., Ramos-Elorduy, J., 2006. Los insectos medicinales de Brasil: primeros resultados. Boletín. De. la SEA (n. 38), 395–414.
Cudera, R., Razon, B.C., Millondaga, K.J., 2020. Cultural and ecological significance of Odonata (Insecta) to the T'boli of Lake Sebu, Mindanao, Philippines. Biodiversitas v. 21 (n. 6). https://doi.org/10.13057/biodiv/d210627.
De Almeida, E., et al., 2022. Agroextrativismo nas comunidades ribeirinhas do Baixo Tapajós. In: O rio que nos une: Uso & Gestão na Floresta Nacional do Tapajós e Reserva Extrativista Tapajós-Arapiuns. Bras. ília; ICMBio 171–192.
De Andrade, V., Da Silva, H.C., 2021. As denominações para libélula, no atlas linguístico do brasil: um estudo sobre a motivação dos signos. . Alfa v. 65. https://doi.org/10.1590/1981-5794-13455.
Fisch, G., Marengo, J., Nobre, C., 1998. Uma revisão geral sobre o clima da Amazônia. Acta Amaz. 28, 101. https://doi.org/10.1590/1809-43921998282126.
Fukano, Y., Soga, M., 2023. Evolutionary psychology of entomophobia and its implications for insect conservation. Curr. Opin. Insect Sci. v. 59, 101100. https://doi.org/10.1016/j.cois.2023.101100.
Garrison, R.W.; Von Ellenrieder, N.; Louton, J. A. Dragonfly Genera of the New World: An Illustrated and Annotated Key to the Anisoptera. Baltimore: Johns Hopkins University Press, 2006.
Gómez, M., Gasca, L., 2022. Entomoturismo: Los insectos como atractivo turístico. En: Turismo, patrimonio y procesos socio ambientales en Chiapas. Univ. Intercult. De. Chiapas 171–190.
Gonçalves, A. Da língua Tupy, chamada de língua geral indígenas do Brasil. Lipsia, 1958.
Green, R.Susweca, 2012. The dragonfly motif in plains Indian art. Whisp. Wind v. 41 (n. 3), 4–7.
Guerrero-Moreno, M.A., Oliveira-Junior, J.M., 2024b. A global bibliometric analysis of the scientific literature on entomotourism: Exploring trends, patterns and research gaps. Biodivers. Conserv. (IN PROCESS OF PUBLICATION).
Guerrero-Moreno, M.A., Oliveira-Junior, J.M., 2024a. Approaches, trends and gaps in community-based ecotourism research: a bibliometric analysis of publications between 2002 and 2022. Sustainability v. 16 (n. 7), 2639. https://doi.org/10.3390/su16072639.
Gurung, A.B., 2003. Insects – a mistake in God's creation? Tharu farmers' perception and knowledge of insects: A case study of Gobardiha Village Development Committee, Dang-DEUKHURI, N. Agric. Hum. Values v. 20 (n. 4), 337–370. https://doi.org/10.1023/b:ahum.0000005149.30242.7f.
Harvey, J.A., et al., 2020. International scientists formulate a roadmap for insect conservation and recovery. Nat. Ecol. Evol. v. 4 (n. 2), 174–176. https://doi.org/10.1038/s41559-019-1079-8.
Hassall, C., Thompson, D.J., 2008. The effects of environmental warming on Odonata: a review. Int. J. Odonatol. v. 11 (n. 2), 131–153. https://doi.org/10.1080/13887890.2008.9748319.
Horwitz, P., Recher, H., Majer, J., 1999. Putting invertebrates on the agenda: political and bureaucratic challenges. En. Royal Zoological Society of New South Wales eBooks, pp. 398–406. https://doi.org/10.7882/RZSNSW.1999.065.
Huntly, P.M., Van Noort, S., Hamer, M., 2005. Giving increased value to invertebrates through ecotourism: research article. South Afr. J. Wildl. Res. v. 35 (1), 53–62.
Hurtienne, T., 2005. Agricultura familiar e desenvolvimento rural sustentável na Amazônia. Novos Cad. NAEA v. 8 (n. 1). https://doi.org/10.5801/ncn.v8i1.47.
Hvenegaard, G.T., 2016. Insect festivals in North america: Patterns and purposes. Am. Èntomol. v. 62, 235–240. https://doi.org/10.1093/ae/tmw078.
IBGE, Instituto Brasileiro de Geografia e Estatística. Censo Demográfico 2022; IBGE: Rio de Janeiro, Brasil, 2022. Disponível em: http://www.ibge.gov.br. Acesso em: 29 abr. 2024.
ICMBio, 2014. Instituto Chico Mendes de Conservação da Biodiversidade. Plano de Manejo: Reserva Extrativista Tapajós-Arapiuns. Diagn. óstico Vol.1.
ICMbio, 2022. Instituto Chico Mendes de Conservação da Biodiversidade. Plano de Uso Público da Reserva Extrativista Tapajós-Arapiuns. St. éM., Par. á Vol.1.
Ilahi, I., 2019. The role of odonate nymphs in ecofriendly control of mosquitoes and sensitivity of odonate nymphs to inorganic nutrient pollutants (jan). Appl. Ecol. Environ. Res. v. 17 (n. 3), 1. https://doi.org/10.15666/aeer/1703_61716188 (jan).
Jervis, L.L., Boland, M.E., Fickenscher, A., 2010. American Indian Family Caregivers' Experiences with Helping Elders. J. Cross-Cult. Gerontol. v. 25 (n. 4), 355–369. https://doi.org/10.1007/s10823-010-9131-9.
Juen, L., et al., 2014. Composição e riqueza de Odonata (Insecta) em riachos com diferentes níveis de conservação em um ecótone Cerrado-Floresta Amazônica. Acta Amaz. v. 44 (n. 2), 223–233. https://doi.org/10.1590/s0044-59672014000200008.
Kadoya, T., Suda, S., Washitani, I., 2004. Dragonfly species richness on man-made ponds: effects of pond size and pond age on newly established assemblages. Ecol. Res. v. 19, 461–467. https://doi.org/10.1111/j.1440-1703.2004.00659.x.
Kalkman, V., Clausnitzer, V., Dijkstra, K., et al., 2008. Global diversity of dragonflies (Odonata) in freshwater. Hydrobiologia 595, 351–363. https://doi.org/10.1007/s10750-007-9029-x.
Kellert, S., 1993. Values and Perceptions of Invertebrates. Conserv. Biol. v. 7, 845–855. https://doi.org/10.1046/j.1523-1739.1993.740845.x.
Laurent, E.L., 2000. Children, 'insects' and play in Japan. In: Podberscek, In.A.L., Paul, E.S., Serpell, J.A. (Eds.), Companion animals and us. Cambridge University Press, pp. 61–89.
Lawal, O., Banjo, A., 2007. Survey for the usage of arthropods in traditional medicine in southwestern Nigeria. J. Entomol. v. 4, 104–112. https://doi.org/10.3923/je.2007.104.112.
Lemelin, H., 2009. Goodwill hunting: dragon hunters, dragonflies and leisure. Curr. Issues Tour. v. 12 (5-6), 553–571. https://doi.org/10.1080/13683500802346169.
Lemelin, R.H., 2007. Finding beauty in the dragon: The role of dragonflies in recreation and tourism. J. Ecotourism v. 6 (2), 139–145. https://doi.org/10.2167/joe161.0.
Levis, C., et al., 2024. Contributions of human cultures to biodiversity and ecosystem conservation. Nat. Ecol. Evol. https://doi.org/10.1038/s41559-024-02356-1.
Lockwood, J., 2013. The infested mind: why humans fear, loathe, and love insects. Oxford University Press, UK.
Loxdale, H., 2016. Insect science - a vulnerable discipline? Èntomol. Exp. Et. Appl. v. 159, 121–134. https://doi.org/10.1111/eea.12421.
Maxwell, S., Fuller, R., Brooks, T., et al., 2016. Biodiversity: The ravages of guns, nets and bulldozers. Nature v. 536, 143–145. https://doi.org/10.1038/536143a.
May, M.L., 2019. Odonata: Who they are and what they have done for us lately: Classification and ecosystem services of dragonflies. Insects v. 10 (n. 3), 62. https://doi.org/10.3390/insects10030062.
Medeiros, H.M.N., et al., 2021. Alternative Tourism and Environmental Impacts: Perception of Residents of an Extractive Reserve in the Brazilian Amazonia. Sustainability v. 13 (n. 4), 2076. https://doi.org/10.3390/su13042076.
Monteiro-Júnior, C., et al., 2013. Effect of vegetation removal for road building on richness and composition of Odonata communities in Amazonia, Brazil. Int. J. Odonatol. v. 16 (n. 2), 135–144. https://doi.org/10.1080/13887890.2013.764798.
Morais, R., et al., 2018. Caça: subsídios para gestão de unidades de conservação e manejo de espécies. I. CMBio.
Mtapuri, O., Giampiccoli, A., 2018. Tourism, Community-based tourism and ecotourism: a definitional problematic. South Afr. Geogr. J. v. 101, 1–14. https://doi.org/10.1080/03736245.2018.1522598.
Nascimento, M.G., 1998. Migrações nordestinas para a Amazônia. Rev. De. Educ. ção, Cult. e meio Ambient. v. 2, 1–13.
Nobre, C., et al., 2009. Understanding the climate of Amazonia: Progress from LBA. Geophys. Monogr. 145–157. https://doi.org/10.1029/2009gm000903.

Nóbrega-Spinola, J., et al., 2022. Atuação do poder público no território do rio que nos une. In: O rio que nos une: Uso & Gestão na Floresta Nacional do Tapajós e Reserva Extrativista Tapajós-Arapiuns, 193-145 Bras. ília; ICMBio.
Oliveira-Júnior, J., Silva, E., Rocha, T., Juen, L., 2022. Odonata (Insecta) da Floresta Nacional do Tapajós e da Reserva Extrativista Tapajós- Arapiuns. Cap 20.
Oliveira-Júnior, J.M.B., Juen, L., 2019. The Zygoptera/Anisoptera Ratio (Insecta: Odonata): a New Tool for Habitat Alterations Assessment in Amazonian Streams. Neotrop. Entomol. v. 48 (n. 4), 552–560. https://doi.org/10.1007/s13744-019-00672-x.
Oliveira-Júnior, J.M.B., Shimano, Y., Gardner, T.A., Hughes, R.M., De Marco, P., Juen, L., 2015. Neotropical dragonflies (Insecta: Odonata) as indicators of ecological condition of small streams in the eastern Amazon. Austral Ecol. v. 40, 733–744. https://doi.org/10.1111/aec.12242.
Olmos-Martínez, E., Romero-Schmidt, H.L., Blázquez, M.C., Arias-González, C., Ortega-Rubio, A., 2022. Human Communities in Protected Natural Areas and Biodiversity Conservation. Diversity v. 14, 441. https://doi.org/10.3390/d14060441.
Omuse, E.R., et al., 2024. The global atlas of edible insects: analysis of diversity and commonality contributing to food systems and sustainability. Sci. Rep. v. 14 (n. 1), 29. https://doi.org/10.1038/s41598-024-55603-7.
Phuong, N., Ba, D., Dieu, L., 2022. Assessing the potential of community-based ecotourism toward sustainable development: a case study in Tua Chua Karst Plateau – Dien Bien – Viet Nam. Geoj. Tour. Geosites 44, 1300–1305. https://doi.org/10.30892/gtg.44414-946.
Piccolo, J.J., 2017. Intrinsic values in nature: Objective good or simply half of an unhelpful dichotomy? J. Nat. Conserv. v. 37, 8–11. https://doi.org/10.1016/j.jnc.2017.02.007.
Pinto, Â.P., 2024. Odonata Fabricius, 1793. En. Insetos do Brasil: Diversidade e Taxonomia. 2ª ed. Editora INPA, pp. 187–233. https://doi.org/10.61818/56330464c15.
Primack, R.B., Kobori, H., Mori, S., 2000. Dragonfly pond restoration promotes conservation awareness in Japan. Conserv. Biol. v. 14 (n. 5), 1553–1554. https://doi.org/10.1046/j.1523-1739.2000.99549.x.
Prum, R.O., Cole, J.A., Torres, R.H., 2004. Blue integumentary structural colors in dragonflies (Odonata) are not produced by incoherent Tyndall scattering. J. Exp. Biol. v. 207 (n. 22), 3999–4009. https://doi.org/10.1242/jeb.01240.
Quiroz-Martínez, H., Rodríguez-Castro, A., 2007. Aquatic insects as predators of mosquito larvae (n). J. Am. Mosq. Control Assoc. v. 23, 11. https://doi.org/10.2987/8756-971x(2007)23[110:aiapom]2.0.co;2.
Relyea, R.A., Hoverman, J.T., 2008. Interactive effects of predators and a pesticide on aquatic communities. Oikos v. 117 (n. 11), 1647–1658. https://doi.org/10.1111/j.1600-0706.2008.16933.x.
Rykken, J., Farrell, B., 2012. Discovering the microwilderness in parks and protected areas. In: Lemelin, In.R. (Ed.), The Management of Insects in Recreation and Tourism. Oxford University, pp. 306–322. https://doi.org/10.1017/CBO9781139003339.023.
Sacchi, A.C., 2023. Mulheres indígenas e organização política: união, luta, força e resistência. Rev. Anthr. ógicas v. 33 (n. 2), 164. https://doi.org/10.51359/2525-5223.2022.256854.
Sampieri, R., 2014. Metodol. De. la Invest. óN. Sexta edicióN.
Samways, M., 2002. Strategy for the national red-listing of invertebrates based on experiences with Odonata in South Africa. Afr. Entomol. v. 10, 43–52 https://hdl.handle.net/10520/EJC31895.
Samways, M., 2012. Dragonflies: Their lives, our lives, from ponds to reserves. In: Lemelin, R.H. (Ed.), The Management of Insects in Recreation and Tourism. Cambridge University Press, pp. 108–120. https://doi.org/10.1017/CBO9781139003339.
Samways, M., 2020. Insect conservation: a global synthesis. CAB Int. v. 1.
PSA. Projeto Saúde e Alegria. Coleção Prazer em Conhecer: Comunidades da Reserva Extrativista Tapajós-Arapiuns. CEAPS. 2015.
Scudder, G. The importance of insects. In: Insect Biodiversity: Science and Society. R. Footit and P. Adler. Oxford: Blackwell Publishing, 1st edn, 7–32, 2009. https://doi.org/10.1002/9781118945568.ch2.
Siddiqui, S.A., Li, C., Aidoo, O.F., Fernando, I., Haddad, M.A., Pereira, J.A.M., Blinov, A., Golik, A., Câmara, J.S., 2023. Unravelling the potential of insects for medicinal purposes – a comprehensive review. Heliyon 9, e15938. https://doi.org/10.1016/j.heliyon.2023.e15938.
Signor, C., et al., 2022. Turismo em unidades de conservação: Contexto histórico e regional sobre a Floresta Nacional do Tapajós e a Reserva Extrativista Tapajós-Arapiuns. In: O rio que nos une: Uso & Gestão na Floresta Nacional do Tapajós e Reserva Extrativista Tapajós-Arapiuns. Bras. ília; ICMBio 193–203.
Silveira, B., 1987. Vocabulário Tupi-Guarani-Português. Bras., 5 Ed.
Simaika, J.P.; Samways, M.J. Valuing dragonflies as service providers. En: Oxford University Press e Books, p. 109-124, 2008. https://doi.org/10.1093/acprof:oso/9780199230693.003.0009.
Soares, M., et al., 2022. Histórico de criação e implementação da Floresta Nacional do Tapajós e da Reserva Extrativista Tapajós-Arapiuns. In: O rio que nos une: Uso & Gestão na Floresta Nacional do Tapajós e Reserva Extrativista Tapajós-Arapiuns. Bras. ília; ICMBio 21–31.
Soga, M., et al., 2023. The vicious cycle of biophobia. Trends Ecol. Evol. v. 38 (n. 6), 512–520. https://doi.org/10.1016/j.tree.2022.12.012.
Souza, T.D., et al., 2018. Economic impacts of tourism in protected areas of Brazil. J. Sustain. Tour. v. 27 (n. 6), 735–749. https://doi.org/10.1080/09669582.2017.1408633.
Stork, N.E., 2018. How Many Species of Insects and Other Terrestrial Arthropods Are There on Earth? Annu. Rev. Entomol. v. 63 (n. 1), 31–45. https://doi.org/10.1146/annurev-ento-020117-043348.
Suárez-Tovar, C.M., et al., 2022. Dragon colors: the nature and function of Odonata (dragonfly and damselfly) coloration. J. Zool. v. 317 (n. 1), 1–9. https://doi.org/10.1111/jzo.12963.
Suh, A.N., Samways, M.J., 2001. Development of a dragonfly awareness trail in an African botanical garden. Biol. Conserv. v. 100, 345–353. https://doi.org/10.1016/S0006-3207(01)00038-6.
Tedesco, J.C. Agricultura familiar: realidades e perspectivas. Passo Fundo, UPF. 2001.
Thomas, A.L.R., et al., 2004. Dragonfly flight: free-flight and tethered flow visualizations reveal a diverse array of unsteady lift-generating mechanisms, controlled primarily via angle of attack. J. Exp. Biol. v. 207 (n. 24), 4299–4323. https://doi.org/10.1242/jeb.01262.
Tilman, D., et al., 2001. Forecasting agriculturally driven global environmental change. Science v. 292, 281–284. https://doi.org/10.1126/science.1057544.
Ulysséa, M.A., Hanazaki, N., Lopes, B.C., 2010. Percepção e uso dos insetos pelos moradores da comunidade do Ribeirão da Ilha, Santa Catarina, Brasil. Biotemas v. 23 (n. 3), 191–202. https://doi.org/10.5007/2175-7925.2010v23n3p191.
Vasconcellos, F., Castley, J.G., 2014. Ecotourism as a conservation tool and its adoption by private protected areas in Brazil. J. Sustain. Tour. v. 22 (n. 4), 604–625. https://doi.org/10.1080/09669582.2013.875550.
Vatandoost, H., 2021. Dragonflies as an important aquatic predator insect and their potential for control of vectors of different diseases. J. Mar. Sci. v. 3 (n. 3). https://doi.org/10.30564/jms.v3i3.3121.
Viscogliosi, C., et al., 2020. Importance of Indigenous elders' contributions to individual and community wellness: results from a scoping review on social participation and intergenerational solidarity. Can. J. Public Health v. 111 (n. 5), 667–681. https://doi.org/10.17269/s41997-019-00292-3.
West, P., Igoe, J., Brockington, D., 2006. Parks and Peoples: The Social Impact of Protected Areas. Annu. Rev. Anthropol. v. 35, 251–277. https://doi.org/10.1146/annurev.anthro.35.081705.123308.
Williams, P., et al., 2004. Comparative biodiversity of rivers, streams, ditches and ponds in an agricultural landscape in Southern England. Biol. Conserv. v. 115, 329–341. https://doi.org/10.1016/S0006-3207(03)00153-8.