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Review - Biological and Applied Sciences

Conserving the Invisible Common: Advances and Challenges of the Insect Conservation in Brazil

Carlos Alberto dos Santos Souza[1]*
https://orcid.org/0000-0002-4838-4117

Isabelle da Rocha Silva Cordeiro[1]
https://orcid.org/0000-0003-2762-1379

Oséias Martins Magalhães[1]
https://orcid.org/0000-0003-4988-7119

Paula Ferreira Grossi[1]
https://orcid.org/0000-0001-9108-7428

Jarbas Marçal Queiroz[2]
https://orcid.org/0000-0002-4175-1834

[1]Federal Rural University of Rio de Janeiro, Institute of Biological and Health Sciences, Postgraduate Program of Animal Biology, Seropédica, Rio de Janeiro, Brazil; [2]Federal Rural University of Rio de Janeiro, Institute of Forests, Department of Environmental Sciences, Seropédica, Rio de Janeiro, Brazil.

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*Correspondence: seteorus@yahoo.com.br; Tel.: +55-24-99818-2560 (C.A.S.S.).

HIGHLIGHTS

- Most Brazilian entomology has focused on the Atlantic Forest biome.
- Research on the Amazon and Pantanal biomes should be increased given their biodiversity.
- The Hymenoptera is the most studied taxon in Brazil for conservation.
- Aquatic insects are widely used in official monitoring and conservation programs.
- Insect recovery programs should provide effective conservation.

Abstract: In 2019, B. Jarvis paraphrased E. Wilson in that “insects are a case study in terms of the invisible importance of the common”. However, threats to insect diversity are rapidly increasing worldwide, and there is a significant challenge to halt or reverse this process. This is especially true in tropical regions where insect diversity is large, but resources are scarce and conservation policy is poorly developed. In Brazil, studies into insect conservation have grown over the last 30 years and, in this contribution, we use available literature to ask: i) what advances have been made; ii) where are the major knowledge gaps and iii) what are the priorities for action? Brazilian studies into insect conservation reflect international trends with respect to levels of ecological organization and a focus on taxonomic conservation. In general, research is restricted to the main Brazilian hotspots and to the states with better infrastructure. Hymenoptera, Diptera, Coleoptera and Lepidoptera are the main orders studied. Work on Ephemeroptera, Plecoptera, Trichoptera and Odonata has increased in recent years and currently are the main insect orders covered by official management initiatives

due to their role as indicators of water quality. Priority areas for future work include the promotion of species conservation and ways to increase resource contribution from the private sector through legal instruments that can support integrative public policies for insect species conservation.

Keywords: Conservation strategies; entomofauna; systematic review.

INTRODUCTION

It is a fact that the conservation of the insects is necessary [1], because of its importance to the functioning of ecosystems [2], issues of ethic nature [3] and maintenance of the diversity in face of the decline or extinction of species [4]. However, the conservation of the insects is a complex issue considering the threats by which they are exposed [1,5] and because of many challenges that worry scientists and authorities.

Globally, the challenges on insect conservation are related, mainly in the tropics [6], to the mega diversity, to the insufficiency of biological knowledge about the majority of the species (*sensu lato*), to the difficulties on the monitoring of the cryptic species and to the limited value society puts on insects [3,7].

In Brazil, other challenges also threaten the preservation of insects, such as: (a) territorial extension and the existence of under sampled areas [8,9]; (b) limited number of specialists [10]; (c) great species richness [11], even in urban areas [9]; (d) incomplete entomological collections, non-catalogued or collections that are not registered in computers [12]; (e) biopiracy [13]; (f) lack of public policies to the insect conservation [14]; and (g) flexibilization of the laws for the use of pesticides [15].

This scenario has contributed, at least in part, to researchers [9] to propose different strategies to the conservation of land invertebrates' species in Brazil, but little of it is put into practice as policies or priorities for the government to the conservation of native insects. It is important to highlight that all the initiatives adopted as public instruments to the prospection of the insect conservation and their habitats evolved with a basis on researches and experiences with other taxa, but what changed after the first publications about the conversation of insects in Brazil?

In this context, this study aims to systematically review what the scientific community has produced about the insect conservation in the last decades in Brazil (i.e., 1997 a 2018) and identify tendencies, limitations and/or knowledge gaps to answer the following questions: (a) What are the limitations and the trends of the published studies about the insect conservation? (b) Can the knowledge produced until now inspire new strategies of insect conservation (i.e. more realistic approaches)? By the end of this paper, we suggest how the future researches can reduce uncertainties and stimulate more efficiently the actions to the conversation of the species of insects.

What is covered by research on insect conservation in Brazil?

A total of 93 publications were analyzed among 308 selected by the Scopus base using the words: insect and Brazil and conservation. The yearly production from 1997 and 2007 registered a small increase (1.2 ± 1 publication/year), in contrast to the period from 2008 to 2018 (7.3 ± 3 publication/year). The total of publications about insect conservation is equivalent to 1.5% when compared to the total of studies published about insects in Brazil in the same period (i.e., 6.113 publications).

Most insect conservation studies in Brazil dealt with communities (93.4% of the publications), while studies about populations or species represented together a total of 6.5% of the analyzed publications. In addition, 52.6% of the publications indicated direct conservation and 47.3% indirect conservation. To sum up, recommendations to direct conservation were strict author's indication to the conservation of the community, population or species of insects being analyzed; while the recommendations to the indirect conservation pointed to the need to preserve the habitats and the entirety of the ecosystems to reach the taxa conservation.

It is important to highlight that the studies with communities of insects that pointed to direct conservation, in general, present deficiencies regarding the identification of the key-species or umbrella species [16,17], as well as a lack of indication regarding the management or conservation of the species (48.3% of the publications). In this last case, it has already been criticized by other studies [18], which argued that it would be fundamental to produce scientific information which is applicable to the management of communities or species of insects.

The preference for studies with insect communities and habitat conservation is linked to the evolution of the concepts and experiences acquired in years of research about insect conservation [3,19], and also

represents more manageable financial strategies to the conservation and management of the mega diversity of insects.

Even though it seems logic to preserve the habitats or the entirety of ecosystems to preserve a large number of species, one cannot discard the fact that species with reduced dispersion, reduced distribution or the ones that have philopatric tendencies to specific habitats deserve special attention, as already considered in other research [5] about the evaluation of the priorities and conservation of unique species or special status.

The geographical and ecological distribution of the studies about insect conservation in Brazil

The Brazilian production about insect conservation is focused on the Southeast, (37.7%, 48 publications) and Northeast (24.4%, 31 publications) (Figure 1). The other regions (Central-West, South and North) together have 37.7% of the Brazilian production (48 publications). The pattern on the distribution of the publications about insect conservation in Brazil reiterates the maintenance of a historic view of knowledge about the Brazilian entomofauna and the regionalization of the publications [10]. Nevertheless, the current position occupied by the northeast of Brazil is surprising, because the geographic and biogeographic distribution of the knowledge of the land invertebrates was considered the worst one among all the other Brazilian regions [20].

The two largest Brazil regions (North – 3.853.6767.9 km² and Central-West – 1.606.403.5 km²: [21]) are too deprived of studies about insect conservation, as well as of knowledge of its own insect diversity [10]. Moreover, it is important to highlight that the Central-West and North regions still concentrate the smallest amount of public research institutions [22], collections [23], researchers [10] and probably resources in comparison to the Southeast, South and Northeast regions.

In the Southeast, Minas Gerais was the state with the highest regional production (41.6%, 20 publications), whereas the state of Rio de Janeiro registered the lowest volume of publications about the theme for this same region (12.5%, 6 publications). On the Northeast, the State of Bahia registered the highest regional production (35.4%, 11 publications), while the State of Maranhão did not register any research about insect conservation among the publications analyzed (Figure 1).

The Brazilian Central-West registered 18 publications distributed among the states of Mato Grosso do Sul (33.3%, 6 publications), Mato Grosso (27.7%, 5 publications), Distrito Federal (22.2%, 4 publications) and Goiás (16.6%, 3 publications). On the South, the State of Rio Grande do Sul concentrated 52.6% (10 publications) of the regional publications; while the states of Paraná and Santa Catarina registered respectively: 31.7% and 15.7%. The North region registered 11 publications, with the prominent position being occupied by Amazonas (54.5%, 6 publications). In addition, the States of Amapá, Rondônia, Roraima and Tocantins did not register any publications (Figure 1).

In general, the distribution of research among the states reiterates the tendencies of concentrating scientific production about the insect conservation regarding the Brazilian regions. Approximately 15 years ago, the production profile of information to Hexapoda was already heavily biased, presenting the States of São Paulo, Minas Gerais and Rio de Janeiro as the main responsible for concentrating together 67.0% of the national production [10] (Figure 1).

Among biomes, the Atlantic Forest and the Brazilian savannah (Cerrado) concentrated more than a half of the national production about the insect conservation, respectively 46.5% (47 publications) and 23.8% (24 publications), but the relation between these pieces of information and the percentage of the protected areas among the biomes in Brazil is too divergent. For instance, the Amazon biome has 28.6% of legally protected area; the Brazilian savannah (Cerrado), Caatinga and Atlantic Forest have, respectively, 8.6%, 9.0% and 10.4%; while the Pantanal and Pampa have less than 5.0% of protected areas (i.e., respectively, 4.5% and 3.2%) [24] (Figure 1).

Despite the region or biome, 79.5% of the publications refer to studies developed in terrestrial environments and only 20.4% on aquatic environments. Specifically, the forest habitats were preferably studied regarding insect conservation (78.2% of the publications) in comparison to other habitats (e.g., fields, plantations, creeks, river/small streams and floodplains). Among the aquatic habitats, 65.9% of the studies were developed in rivers/small streams, while creeks and floodplains registered, respectively, 30.0% and 5.0% of the studies.

The predominance of studies in land habitats in comparison to the aquatic habitats suggest that the easy access, logistics and investments to research [8] are responsible for the differences on the amount of information, despite the continuous publication of researches on aquatic bioindicators [25,26].

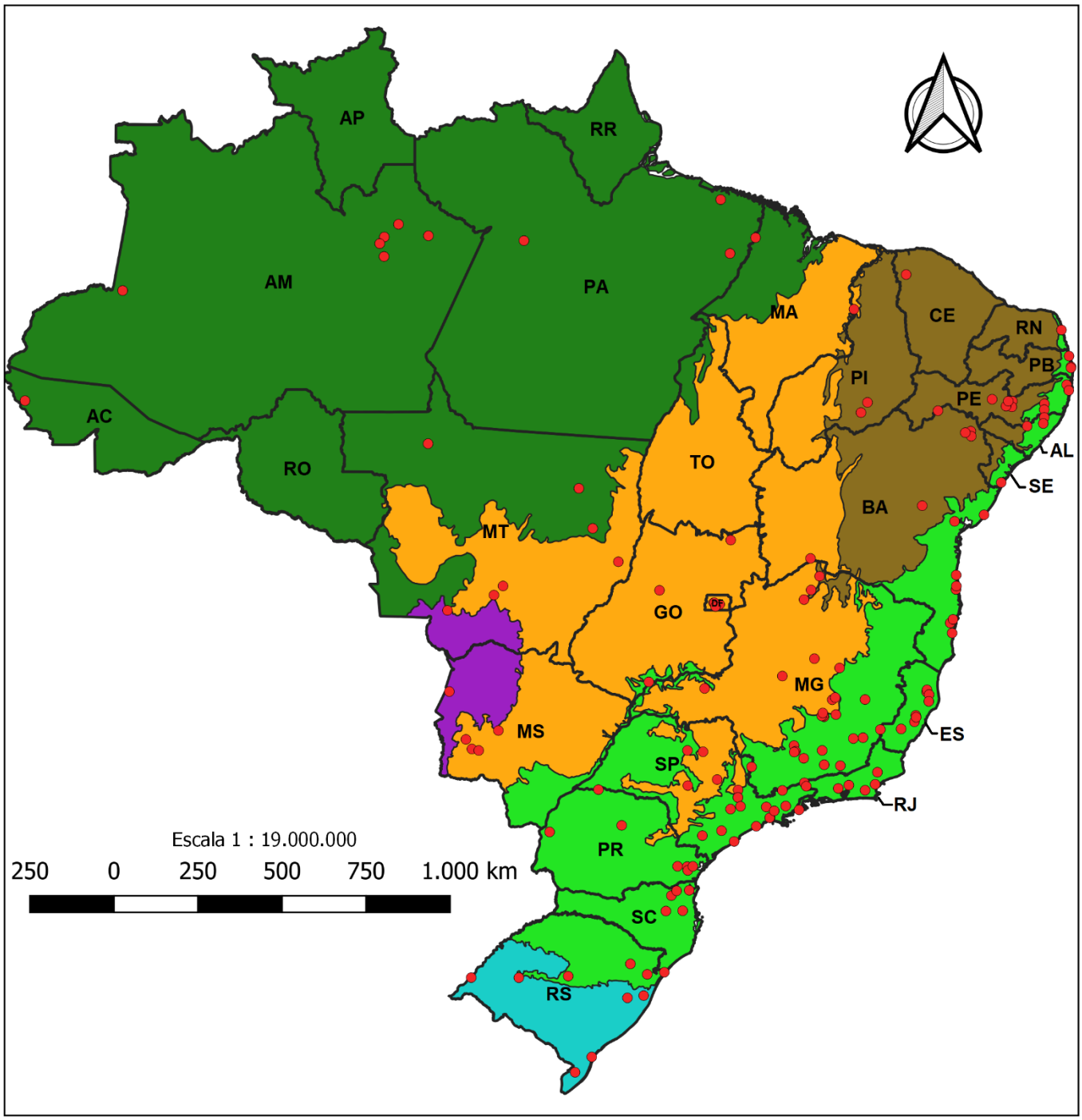

Figure 1. Distribution of research among Brazilian regions, states and biomes. Polygons – Amazon (dark green), Caatinga (brown), Cerrado (orange), Atlantic Forest (light green), Pampa (blue) and Pantanal (purple); Dots - searched locations (red). *Datum* SIRGAS 2000.

What are the main taxa related to insect conservation in Brazil?

In total, 19 orders and 226 families of insects were mentioned in the publications (Table 1). The orders Hymenoptera, Diptera, Coleoptera and Lepidoptera were the main references of insect conservation in Brazil. At least two publications did not inform which orders of insects were analyzed, and the orders Embioptera, Zoraptera, Psocoptera, Phthiraptera, Mecoptera, Siphonaptera e Strepsiptera were not registered.

In Brazil, the taxonomic knowledge of orders and families of insects is not equally distributed, in part because of the differences in the number of specialists in activity [10]. The concentration of studies of Hymenoptera, Diptera, Coleoptera e Lepidoptera can also be explained by the whole amount of species richness registered in Brazil for each taxon, since some authors [11], the orders who present largest species

richness in Brazil are Coleoptera (28.000 spp.), Lepidoptera (26.000 spp.), Hemiptera (10.200 spp.), Hymenoptera (10.000 spp.) and Diptera (8.700 spp.).

The ranking of the main orders studied requires reflections about the few public policies and/or criteria implemented for the insect conservation on Brazil territory. For instance, Hymenoptera and Coleoptera together have only 6.0% of species included in a threat of extinction category [27], that is to say, what is the relevance of this number for the conservation of the species from both orders? Another issue refers to the insufficient efforts for the inclusion of hymenopterans, especially Formicidae and Apoidae, which knowledge of taxa was considered sufficient to carry out programs of conservation, evaluation and monitoring of the environmental quality of the habitats [9]. On the other hand, the actual position occupied by Diptera can be considered surprising, because for a long time the taxon has been related to studies of medical or economical interest [9].

In terms of insect conservation in Brazil, Lepidoptera has always been a reference on the topic. Until December 2018, in the scientific journals specialized on insect conservation (e.g., Journal of Insect Conservation and Insect Diversity and Conservation), Brazil was ranked among the countries with high number of studies about Lepidoptera. At the beginning of the century, many studies have already suggested Lepidoptera as an important flagship group [9,28], but only some species were officially included as instruments to conservation [29] or are under broader protection [30].

The orders Ephemeroptera, Plecoptera Trichoptera and Odonata also deserve attention regarding the insect conservation in Brazil, due to the increasing number of studies that discuss the relation of the taxa with the environmental quality of the waters [31,32]. Apparently, these issues have been influencing the increasing focus of the authorities regarding the applications in official programs of management and monitoring of watersheds [33] and reinforce the protection for the species in threat of extinction [27].

Table 1. Literature review on insect conservation in Brazil.

Ref.	Location/Ecological scale				Cited taxons	
	State	Biome	Env	Habitat	Order	Family
[34]	PA	Am	T	Fo	L	Erebidae
[35]	PA	Am	A	Ri	Di	Chironomidae
[36]	RJ, SP, SC, PR	MA	T	Fo	L	Sphingidae
[37]	RS	Pm	T	Fo	Di	Muscidae
[38]	SP	MA	T	Fo, FP	Bl_1, C, De, Di, He, Hy, I, L, Or	Formicidae
[39]	PE	Ca	T	Fo	Hy	Formicidae
[40]	MT, MS	Pn	T	Fo	Hy	Apidae, Crabronidae, Mutillidae, Pompilidae, Scoliidae, Sphecidae, Tiphiidae, Vespidae
[41]	PE	Ca	T	Fo	Hy	Formicidae
[42]	ES	MA	A	Ri	C, Di, Ep, He, L, Od, Pl, Tr	Baetidae, Calamoceratidae, Calopteterygidae, Ceratopogonidae, Chironomidae, Elmidae, Empididae, Gerridae, Glossosomatidae, Gomphidae, Helichopsychidae, Hydroptilidae, Hydropsychidae, Leptoceridae, Leptohyphidae, Leptophlebiidae, Libellulidae, Megapodagrionidae, Naucoridae, Odontoceridae, Perlidae, Philopotamidae, Polycentropodidae, Psephenidae, Psychodidae, Pyralidae, Simuliidae, Tipulidae, Veliidae
[43]	MG	MA	T	FP	Hy	Vespidae
[44]	RJ, MG, BA	MA, Ce	T	Fo	-	-
[45]	PR	MA	T	FP	Di	Syrphidae

Cont. Table 1

[46]	GO	Ce	A	Ri	Tr	-
[47]	RJ	MA	T	Fo	Di	Asilidae
[48]	SP	MA	T	Fo	L	Sphingidae
[49]	RS	MA	A	Ri	C	Elmidae
[50]	RS	MA	T	Fo	C	Anobiidae, Anthribidae, Biphyllidae, Cerylonidae, Ciidae, Clambidae, Colydiidae, Corylophidae, Cryptophagidae, Elateridae, Endomychidae, Erotylidae, Latridiidae, Leiodidae, Melandryidae, Nitidulidae, Phalacridae, Ptiliidae, Staphylinidae, Tenebrionidae
[51]	PA	Am	A	St	Bl_1, C, Di, Ep, He, Me, Od, Pl, Tr	Aeshnidae, Baetidae, Blaberidae, Caenidae, Calamoceratidae, Calopterygidae, Ceratopogonidae, Chironomidae, Coenagrionidae, Corduliidae, Corixidae, Corydalidae, Coryphoridae, Crambidae, Dicteriadidae, Dolichopodidae, Dryopidae, Dytiscidae, Ecnomidae, Elmidae, Empididae, Entomobryidae, Euthyplociidae, Gerridae, Glossosomatidae, Gomphidae, Gyrinidae, Helicopsychidae, Hydraenidae, Hydrochidae, Hydrophilidae, Hydroptilidae, Hydropsychidae, Paronellidae, Leptoceridae, Leptohyphidae, Leptophebiidae, Libellulidae, Limnichidae, Megapodagrionidae, Naucoridae, Noteridae, Odontoceridae, Perilestidae, Perlidae, Philopotamidae, Polycentropodidae, Polymitarcyidae, Polythoridae, Ptilodactylidae, Protoneuridae, Sialidae, Simuliidae, Scirtidae, Staphylinidae, Stratiomyidae, Tabanidae, Tipulidae, Veliidae
[52]	CE	Ca	T	Fo	Hy	Apidae, Chrysididae, Crabronidae, Ichneumonidae, Leucospidae, Megachilidae, Pompilidae, Sphecidae, Vespidae
[53]	MG	Ce	T	Fo	Di	Psychodidae
[54]	MG	MA	T	Fo	Hy	Vespidae
[55]	SP	MA	T	FP	Bl_2, C, De, Di, He, Hy, I, L, N, Or, Th	Acrididae, Aetalionidae, Agromyzidae, Aphididae, Apidae, Asilidae, Blatellidae, Carabidae, Cercopidae, Chrysopidae, Chrysomelidae, Coreidae, Culicidae, Curculionidae, Cydnidae, Dolichopodidae, Drosophilidae, Elateridae, Forficulidae, Formicidae, Gryllidae, Hemerobiidae, Hesperiidae, Labiduridae, Muscidae, Mycetophilidae, Noctuidae, Passalidae, Phoridae, Pieridae, Piophilidae, Psychodidae, Reduviidae, Rhizophagidae, Scarabaeidae, Sciaridae, Sphaeroceridae, Staphylidae, Tachinidae, Termitidae, Ulidiidae, Vespidae
[56]	RS	MA, Pm	T	Fo	Di	Syrphidae
[57]	AL	MA	T	Fo	Hy	Formicidae
[58]	MG, SP, GO	Ce	A	St	Ep, Pl, Tr	-
[59]	MS	Ce	A	St	C, Di, Ep, L, Od, Tr	Aeshinidae, Caenidae, Calamoceratidae, Calopterygidae, Ceratopogonidae, Coenagrionidae, Dryopidae, Ecnomidae, Elmidae, Empididae, Ephemeridae, Gomphidae, Gyrinidae, Helicopsychidae, Hydropsychidae, Hydrophilidae, Hydroptilidae, Leptoceridae, Leptohyphidae, Leptophlebiidae, Libellulidae, Lutrochidae, Nymphalidae, Papilionidae, Philopotamidae, Pieridae, Polycentropodidae, Protoneuridae, Pyralidae, Riodinidae, Scarabaeidae, Scirtidae, Simuliidae, Staphylinidae, Stratyomidae, Tabanidae, Tipulidae, Xiphocentronidae

Cont. Table 1

[60]	BA, PE, PI	Ca	T	Fo	Di	Drosophilidae
[61]	MG, SE	Ce, Ca	T	Fo	C, He, Or, Ph	Acanaloniidae, Achilidae, Buprestidae, Cerambycidae, Cercopidae, Chrysomelidae, Cicadellidae, Cixiidae, Coreidae, Curculionidae, Dictyopharidae, Fulgoridae, Lygaeidae, Membracidae, Miridae, Proscopiidae, Psyllidae, Rhopalidae, Tettigonidae, Thyreocoridae, Tingidae
[62]	BA, PE, PI	Ca	T	Fo	Di	Drosophilidae
[63]	BA	Ce	T	Fo	-	-
[64]	DF	Ce	T	Fo	L	Elachistidae, Gelechiidae, Oecophoridae, Pyralidae, Tortricidae
[65]	BA	MA	T	Fo, FP	C, He	Achilidae, Achilixiidae, Aetalionidae, Anobiidae, Cerambycidae, Chrysomelidae, Cicadellidae, Cicadidae, Cixiidae, Curculionidae, Cydnidae, Derbidae, Elateridae, Issidae, Lygaeidae, Membracidae, Miridae, Phasmidae, Psyllidae, Pyrrhocoridae, Tingidae
[66]	GO	Ce	A	Ri	Ep, Pl, Tr	-
[67]	MS	Ce	T	Fi	C	Scarabaeidae
[68]	MT	Am	T	Fo	Hy	Mutillidae
[69]	AM	Am	A	Ri	C, Di, Ep, Me, Pl, Tr	Chironomidae, Corydalidae, Dryopidae, Lutrochidae, Odontoceridae
[70]	BA, MG	Ce, Ca	T	Fo	Hy	Apidae
[71]	MT	Am	T	Fo	Hy	Formicidae
[72]	MG	MA	A	St	Ep, Pl, Tr	-
[73]	MS	Ce, Pn	T	Fo	L	Hesperiidae, Lycaenidae, Papilionidae, Pieridae, Riodinidae
[26]	PA	Am	T	Fo	Od	Aeshnidae, Gomphidae, Libellulidae
[74]	RS	Pm	A	Ri	C, Di, Ep, Me, Od, Pl, Tr	Baetidae, Caenidae, Calopterygidae, Ceratopogonidae, Chironomidae, Coenagrionidae, Corduliidae, Corydalidae, Dytiscidae, Elmidae, Empididae, Gomphidae, Gypopterygidae, Helicopsychidae, Hydropsychidae, Hydrophilidae, Hydroptilidae, Leptohyphidae, Leptophlebiidae, Libellulidae, Perlidae, Philopotamidae, Polycentropodidae, Psephenidae, Tricorythidae
[75]	ES	MA	T	Fo	Hy	Apidae
[76]	PR	MA	T	Fo	Hy	Apidae, Crabronidae, Pompilidae
[77]	PE	MA	T	Fo	C	Scarabaeidae
[78]	AL, PE	MA	T	Fo	Hy	Apidae
[79]	MS	Ce, Pn	A	Ri	C, Di, Ep, Tr	Chironomidae, Dryopidae, Ecnomidae, Elmidae, Leptoceridae, Leptophlebiidae
[80]	BA	MA	T	Fo	Hy	Apidae
[81]	MS	Ce	A	Ri	Ep	Leptophlebiidae
[82]	MG	Ce, MA	T	Fo	Hy	Apidae

Cont. Table 1

[83]	PI	Ce	T	FP	Bl_2, C, De, Di, He, Hy, I, Le, Ma, N, Or, Th	Acrididae, Apidae, Blattidae, Brassolidae, Carabidae, Coccinelidae, Corizidae, Culicidae, Curculionidae, Cydnidae, Dolichopodidae, Elateridae, Formicidae, Gryllidae, Hesperiidae, Ichneumonidae, Lampyridae, Mantidae, Mutillidae, Myrmeleontidae, Noctuidae, Pompilidae, Proscopiidae, Pyralidae, Sarcophagidae, Scarabaeidae, Tenebrionidae, Termitidae
[84]	AM	Am	T	Fo	Hy	Mutillidae
[85]	BA	MA	T	Fo	Hy	Apidae
[86]	BA	MA	T	Fo	Hy	Apidae
[87]	BA	MA	T	Fo	Hy	Apidae
[88]	RJ	MA	A	Ri	Ep, Pl, Tr	Chironomidae
[89]	ES	MA	T	Fo	Hy	Apidae
[90]	RS	Pm	A	Ri	Di	Chironomidae
[91]	RS	Pm	A	Ri	Di	Chironomidae
[92]	AM	Am	T	Fo	C, Di	Scarabaeidae, Scathophagidae
[93]	MG	Ce	T	Fi	L	Hesperiidae, Lycaenidae, Nymphalidae, Papilionidae, Pieridae, Riodinidae
[25]	AM	Am	A	St	C, Di, E, Pl, Tr	Chironomidae, Baetidae
[94]	SP	Ce	T	Fo	Hy	Formicidae
[95]	SP	MA	T	Fo	L	Nymphalidae
[96]	SP	MA	T	Fi	C	Chrysomelidae, Curculionidae, Dryopidae, Dytiscidae, Elmidae, Hydraenidae
[97]	MT	Ce	A	Ri	Od	Coenagrionidae
[98]	SP	MA	T	Fo, Fi	Hy	Braconidae
[99]	RS	Pm, MA	A	FP	Di, E, Od, Tr	Aeshnidae, Baetidae, Caenidae, Calamoceratidae, Chironomidae, Coenagrionidae, Gomphidae, Hydroptilidae, Leptoceridae, Leptophlebiidae, Letisdae, Libellulidae, Polymitarcyidae
[100]	SP	MA	T	Fi	C, He, Hy, N, Od, Or	Acrididae, Braconidae, Cercopidae, Chrysopidae, Chrysomelidae, Cicadellidae, Coccinelidae, Coenagrionidae, Curculionidae, Delphacidae, Eulophidae, Figitidae, Libellulidae, Lygaeidae, Pentatomidae, Phalacridae, Pyrricoridae, Platygastridae, Tettigonidae
[101]	RS	Pm	T	Fi	L	Hesperiidae, Lycaenidae, Nymphalidae, Papilionidae, Pieridae, Riodinidae
[102]	MG	Ce	T	Fo, FP	C	Scarabaeidae

Cont. Table 1

103]	PR	MA	T	Fo	C	Anthicidae, Carabidae, Cerambycidae, Cerylonidae, Chrysomelidae, Clambidae, Cneoglossidae, Coccinellidae, Corylophidae, Curculionidae, Dytiscidae, Elateridae, Endomychidae, Erotylidae, Eucinetidae, Hydraenidae, Hydrophilidae, Laemophloeidae, Lagriidae, Lampyridae, Languridae, Leiodidae, Limnichidae, Lycidae, Melandryidae, Nitidulidae, Ptiliidae, Ptilodactylidae, Scarabaeidae, Scirtidae, Scydmaenidae, Staphylinidae, Tenebrionidae, Trogossitidae, Zopheridae
[104]	RN	MA	T	Fi	Hy	Apidae
[105]	MG	Ce	T	Fo	Hy	Vespidae
[106]	AC	Am	T	Fo	Hy	Chalcididae, Crabronidae, Eucharididae, Evaniidae, Mutillidae, Pompilidae, Vespidae
[107]	ES	MA	T	Fo		Scarabaeidae
[108]	DF	Ce	T	Fo	Di	Drosophilidae
[109]	SP, SC, RJ, AL, BA, PE, PR, SE, ES	MA	T	Fo	Hy	Apidae
[110]	PB	MA	T	Fo	Hy	Apidae
[111]	MG	MA	T	Fo, FP	Hy	Trichogrammatidae
[112]	MG	MA	T	Fo	L	Hesperiidae, Lycaenidae, Nymphalidae, Papilionidae, Pieridae, Riodinidae
[113]	ES	MA	T	Fo	Bl_2	Blaberidae
[114]	SP	Ce	T	Fo	Di, L	Cecidomyidae, Tephritidae
[115]	AM	Am	T	Fo	C	Scarabaeidae
[116]	MG	MA	T	Fo	C	Aderidae, Aphodiidae, Biphlyllidae, Cerambycidae, Cetoniidae, Curculionidae, Elateridae, Histeridae, Laemophloeidae, Lampyridae, Melolonthidae, Nitidulidae, Nosodendridae, Rutelidae, Scolytidae, Staphylinidae, Tenebrionidae
[117]	MG	MA	T	Fo	Hy, Or	Formicidae, Mogoplistidae, Phalangopsidae, Trigoniidae
[118]	SP	MA	A	St	C, Di, E, He, Le, Od, Pl, Tr	Baetidae, Caenidae, Calamoceratidae, Calopterygidae, Ceratopogonidae, Chironomidae, Coenagrionidae, Corduliidae, Curculionidae, Dixidae, Dytiscidae, Elmidae, Empididae, Gomphidae, Gripopterygidae, Haliplidae, Hydrophilidae, Leptoceridae, Leptophlebiidae, Libellulidae, Aeshnidae, Megapotagrionidae, Odontoceridae, Perlidae, Philopotamidae, Polycentropodidae, Psychodidae, Pyralidae, Simuliidae, Tricorythidae, Vellidae
[119]	MG, SP	MA	T	FP, Fi	He	Anthocoridae
[28]	PB, PE, MT, DF, MG, RJ, SP, PR, ES, SC	MA	T	Fo	L	Lycaenidae, Nymphalidae, Papilionidae, Pieridae
[120]	AM	Am	T	Fo	Hy	Formicidae
[121]	MG	MA	T	Fo	Bl_2, C, He, Or, Ph	Acrididae, Chrysomelidae, Cerambycidae, Cercopidae, Cicadelidae, Cicadidae, Curculionidae, Delphacidae, Distyopharidae, Fulgoridae, Membracidae, Pentatomidae, Scutelleridae, Tettigonidae, Tingidae

Cont. Table 1

[122]	MG	MA	T	Fi	L	Hesperiidae, Nymphalidae
[123]	DF	Ce	T	Fo, FP	L	Actiidae, Apatelodidae, Blastobasidae, Crambridae, Dalceridae, Gelechidae, Geometridae, Hedylidae, Hesperiidae, Lasiocampidae, Limacodidae

Legends: Biome – (Am) Amazon, (Ca) Caatinga, (Ce) Cerrado, (MA) Atlantic Forest, (Pn) Pantanal and (Pm) Pampa; Type of Environment – (A) Aquatic and (T) Terrestrial; Habitat – (Fi) Field, (FP) Flood Plain, (Fo) Forest, (Pl) Plantation, (St) Stream, (Ri) River/Stream; Order – (Bl_1) Blattaria, (Bl_2) Blattodea, (C) Coleoptera, (Di) Diptera, (De) Dermaptera, (E) Ephemeroptea, (He) Hemiptera, (Hy) Hymenoptera, (I) Isoptera, (L) Lepidoptera, (Ma) Mantodea, (Me) Mecoptera, (N) Neuroptera, (Od) Odonata, (Or) Orthoptera, (Ph) Phasmida, (Pl) Plecoptera, (Th) Thysanura and (Tr) Trichoptera,

Different perspectives to the insect conservation: implications and opportunities for its management

In the last few years, different suggestions to the approach on the insect conservation were prominent because they pointed to new directions and priorities to the conservation of the diversity of insects worldwide [1,3]. In addition, the efficient insect conservation cannot be reached in the same way as the conservation of vertebrates [124]. Likewise, the politics for the insect conservation cannot be restricted to the lists of species in threat of extinction or on the creation of new protected environmental reserves.

In Brazil, the different views on the insect conservation require some teamwork from the scientist and the authorities and also the establishment of short-term, medium-term and long-term priorities. That is to say, in a context in which there is limited financing and a lack of plans for the national conservation for all the groups, how can we come up with priorities for the insect conservation?

The decentralization of research among the Brazilian regions is a priority that can be reached through resources delivered by public funding, so the government can finance research in underexplored areas, such as “Complexo Pantaneiro” [8,20], “Amazonia” [9] and “Campos Sulinos” [10]. Certainly, the perspectives that come from this action would be a cheaper alternative when compared to the possibility of opening and doing the maintenance of new university campuses, because the amount of studies production among regions is highly influenced by the geographic proximity to universities and research institutes.

Another important aspect regarding the increase of researches about the insect conservation, discovery of new species and, consequently, decentralization of researches refers to the need of improving the means for obtaining financial resources in the private sector. Based on the experiences from the last 10 years, the description of new species of cave invertebrates increased significantly in different areas of Brazil, because of the companies’ demands created on the process of environmental licensing [125].

On the other hand, it is important to highlight that the inclusion of insects in the official programs of diversity monitoring (e.g., aquatic insects: [33]; frugivorous lepidopterans: [29]) arises as emerging initiatives on the evaluation of the environmental quality and the biodiversity in general. However, it is expected that other insects as flaghship species [9] have an opportunity to integrate these programs after the development of technical protocols to the environmental analysis. Furthermore, future national plans to the insect conservation must adopt a broader and more functional approach [126], once the representative conservation of diversity cannot be based on rare, charismatic or umbrella species [124].

Recently, reviews on insect conservation [3] mentioned that the efficient reach of the insect conservation, in terms of development of public policies, does not limit itself to the development and validation of studies, but on its alignment with the human needs, being essential to understand how society evaluates (e.g., positive and negative experiences) and relates the insect conservation with well-being and life quality (i.e., Citizen Science).

In Brazil, the development of programs to promote the conservation of insects (e.g., Rede Brasileira de Interações Planta Polinizador – REBIPP; Associação Brasileira de Estudo das Abelhas – A.B.E.L.H.A; Iniciativa Brasileira dos Polinizadores – IBP) and the representation of insects in cartoons [127] emerge with the potential to boost the public opinion through an easy dialogue between studies and different levels of society. By all means, these approaches could lead to the implementation of many integrative practices for the insect conservation, aiming to insert and instrumentalise society, while the scientists would correct the existent practices (e.g. generation of taxonomic information; identification of important species for the conservation. Rare, endemic, key, umbrella and flagship species; expansion of studies of under sampled biomes; development and testing of technical protocols of sampling for different taxons) and would explore new research horizons. Moreover, the participation of the government and research institutions would improve mechanisms in favor of conservation through strategies to organize actions, policies and resources

regarding the full service of Aichi Biodiversity Targets, adopted by the Parties to the Convention on Biological Diversity (CBD) in October 2010.

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