



# Hymenoptera Specimens from the Caño Negro Wetland, of the National Museum Collection, Costa Rica

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## Abstract

Caño Negro is a Ramsar Wetland that has been extensively studied for botanical and vertebrate species, but with a significant deficiency in insect and other invertebrate taxonomy. To contribute to diminishing this important information gap, a rapid assessment was conducted to establish a baseline taxonomic inventory, referencing specimens housed in the collection of the National Museum of Costa Rica, as well as those collected during three field expeditions. A total of 415 species, across 37 families, were found. The ecological roles of many of these species are vital for assessing their conservation status, ranging from mutualistic interactions with plant species to their role in nutrient cycling. Hymenoptera constitute one of the most important faunal groups for consideration in ecosystem assessments, particularly in the context of a Ramsar wetland.

**Keywords:** Ants; Bees; RAMSAR; Wasps

## Abbreviations

GBIF: Global Biodiversity Information Facility; MNCR: National Museum of Costa Rica; MNCR-A: Arthropod specimen from the National Museum of Costa Rica collection; SINAC: National System of Conservation Areas.

## Introduction

The Caño Negro National Wildlife Refuge (RNVSCN), located in northern Costa Rica (Caño Negro, San Carlos, Alajuela), constitutes one of Mesoamerica's most critical wetland ecosystems. Designated as a Ramsar Site in 1991 (Site No. 540) due to its international importance, this complex of seasonal lagoons and *Raphia taedigera* palm swamps serves as a vital carbon sink and a sanctuary for exceptional biodiversity, harboring endangered species such

as the tropical gar (*Atractosteus tropicus*) and the jabiru (*Jabiru mycteria*) [1,2]. Its pulsatile hydrology, dictated by the Frío River, defines flood cycles that regulate the ecosystem's trophic structure.

Recently, the scientific focus has expanded towards the wetland's entomofauna, recognizing insects as bioindicators of environmental health. Recent entomological studies have revealed significant richness in key functional groups. For instance, research on the diversity of frugivorous butterflies (Nymphalidae) has demonstrated how surrounding habitat fragmentation impacts species composition within the refuge, highlighting the necessity of biological corridors [3]. Similarly, Odonata (dragonflies and damselflies) inventories have been fundamental for assessing water quality, identifying species sensitive to agricultural eutrophication originating from adjacent pineapple crops [4], underscoring

the wetland's vulnerability to external anthropogenic pressures.

However, a substantial record to serve as a baseline for the study of various Hymenoptera groups is still lacking. Therefore, the present work was undertaken to generate such a record, which can then be used as a reference for subsequent studies of the site.

## Methodology

### Species List

To establish a reference baseline, a thorough search of the MNCR's database was conducted to extract a list of Hymenoptera taxa originating from the Caño Negro Wetland, it can be accessed by the following link: <https://biodiversidad.museocostarica.go.cr/>

Taxonomic data from the GBIF database for the area was also extracted to generate a comparison illustrating the representation percentage of taxa in the heritage collection.

### SINAC Permits

Several field expeditions were carried out during which specimens were collected using various methods including traps, Malaise traps, sweep nets, light screens, and scent traps. Collections were conducted under collection permit SINAC-SE-DE-R-0154-2025 and scientific passport: SINAC-SE-DE-LC-0042-2025 for the expeditions from October 27-31.

### Results

A total of 415 species (Table 1), present in the National Museum of Costa Rica's collection, were found, distributed across 37 families. However, with the exception of the recent addition of *Centris festiva*, all others correspond to records from between 1992 and 1994, without other recent samplings.

Among these records are 17 endemic species, one of which is the bee *Melipona costarricensis*, and the rest are parasitic wasps from the families Braconidae and Ichneumonidae.

Familia	Identificación	Testigo	Endemismo
Agaonidae	No Id	MNCR-A 2041789	Non endemic
Apidae	<i>Apis (Apis) mellifera</i>	MNCR-A 3971707	Non endemic
Apidae	<i>Bombus (Fervidobombus) pullatus</i>	MNCR-A 1976891	Non endemic
Apidae	<i>Centris (Heterocentris) analis</i>	MNCR-A 2216965	Non endemic
Apidae	<i>Centris (Ptilocentris) festiva</i>	Registro 2025	Non endemic
Apidae	<i>Centris (Heterocentris) labrosa</i>	MNCR-A 739313	Non endemic
Apidae	<i>Centris (Heterocentris) vittata</i>	MNCR-A 739317	Non endemic
Apidae	<i>Centris (Trachina) longimana</i>	MNCR-A 739265	Non endemic
Apidae	<i>Epicharis (Hoplepicharis) lunulata</i>	MNCR-A 2012436	Non endemic
Apidae	<i>Euglossa ignita</i>	MNCR-A 1706467	Non endemic
Apidae	<i>Euglossa imperialis</i>	MNCR-A 1302581	Non endemic
Apidae	<i>Euglossa townsendi</i>	MNCR-A 1745805	Non endemic
Apidae	<i>Eulaema (Apeulaema) nigrita</i>	MNCR-A 1985717	Non endemic
Apidae	<i>Eulaema (Eulaema) meriana</i>	MNCR-A 1302590	Non endemic
Apidae	<i>Exaerete dentata</i>	MNCR-A 2401008	Non endemic
Apidae	<i>Exaerete frontalis</i>	MNCR-A 1302585	Non endemic
Apidae	<i>Exaerete smaragdina</i>	MNCR-A 1302583	Non endemic
Apidae	<i>Lestrimelitta danuncia</i>	MNCR-A 902175	Non endemic
Apidae	<i>Melipona (Melikerria) beecheii</i>	MNCR-A 1706432	Non endemic
Apidae	<i>Melipona (Michmelia) costarricensis</i>	MNCR-A 1767851	Endemic
Apidae	<i>Nannotrigona perilampoides</i>	MNCR-A 980350	Non endemic

Apidae	<i>Partamona orizabaensis</i>	MNCR-A 3973634	Non endemic
Apidae	<i>Trigona (Frieseomelitta) paupera</i>	MNCR-A 1335905	Non endemic
Apidae	<i>Trigona (Tetragona) zieglerei</i>	MNCR-A 1193301	Non endemic
Apidae	<i>Trigona (Trigona) muzoensis</i>	MNCR-A 3971616	Non endemic
Apidae	<i>Trigona (Trigona) nigerrima</i>	MNCR-A 1873944	Non endemic
Apidae	<i>Trigona (Trigona) silvestriana</i>	MNCR-A 988730	Non endemic
Apidae	<i>Trigona corvina</i>	MNCR-A 1333102	Non endemic
Apidae	<i>Trigona fulviventris</i>	MNCR-A 1980820	Non endemic
Apidae	<i>Trigona fuscipennis</i>	MNCR-A 3973737	Non endemic
Apidae	<i>Exomalopsis sp.</i>	MNCR-A 1335904	Non endemic
Apidae	<i>Florilegus sp.</i>	MNCR-A 882365	Non endemic
Apidae	<i>Melissoptila sp.</i>	MNCR-A 1980874	Non endemic
Apidae	<i>Melitoma sp.</i>	MNCR-A 980144	Non endemic
Apidae	<i>Osiris sp.</i>	MNCR-A 3973531	Non endemic
Apidae	<i>Paratetrapedia sp.</i>	MNCR-A 1976948	Non endemic
Apidae	<i>Rathymus sp.</i>	MNCR-A 1292404	Non endemic
Apidae	<i>Xylocopa sp.</i>	MNCR-A 696725	Non endemic
Argidae	<i>Didymia unifasciata</i>	MNCR-A 2116859	Non endemic
Argidae	<i>Eriglenum crudum</i>	MNCR-A 1767826	Non endemic
Argidae	<i>Scobina lepida</i>	MNCR-A 439391	Non endemic
Argidae	<i>Scobina notaticollis</i>	MNCR-A 980215	Non endemic
Bethylidae	<i>Anisepyris bifidus</i>	MNCR-A 2495774	Non endemic
Bethylidae	<i>Anisepyris franciscanus</i>	MNCR-A 911706	Non endemic
Bethylidae	<i>Bakeriella sp.</i>	MNCR-A 1706431	Non endemic
Bethylidae	<i>Goniozus sp.</i>	MNCR-A 1803512	Non endemic
Bethylidae	<i>Rhabdepyris vesculus</i>	MNCR-A 2334131	Non endemic
Bethylidae	<i>Apenesia sp.</i>	MNCR-A 1704175	Non endemic
Bethylidae	<i>Dissomphalus sp.</i>	MNCR-A 2495751	Non endemic
Bethylidae	<i>Epyris sp.</i>	MNCR-A 1704182	Non endemic
Bethylidae	<i>Holepyris sp.</i>	MNCR-A 1706540	Non endemic
Bethylidae	<i>Pseudisobrachium sp.</i>	MNCR-A 911663	Non endemic
Braconidae	<i>Acanthorhogas costaricensis</i>	MNCR-A 1980758	Non endemic
Braconidae	<i>Alabagrus albispina</i>	MNCR-A 696957	Non endemic
Braconidae	<i>Alabagrus arawak</i>	MNCR-A 902096	Non endemic
Braconidae	<i>Alabagrus maculipes</i>	MNCR-A 2125388	Non endemic
Braconidae	<i>Alabagrus masneri</i>	MNCR-A 897393	Non endemic
Braconidae	<i>Alabagrus watsoni</i>	MNCR-A 1931972	Non endemic
Braconidae	<i>Aleiodes vaughani</i>	MNCR-A 2167754	Non endemic
Braconidae	<i>Epsilogaster tico</i>	MNCR-A 1746455	Endemic

Braconidae	<i>Hypomicrogaster zonaria</i>	MNCR-A 1864054	Non endemic
Braconidae	<i>Masonbeckia towesi</i>	MNCR-A 911701	Non endemic
Braconidae	<i>Semirhytus crassivena</i>	MNCR-A 911674	Non endemic
Braconidae	<i>Stantonia pallidus</i>	MNCR-A 943970	Non endemic
Braconidae	<i>Triraphis eumekes</i>	MNCR-A 1745869	Non endemic
Braconidae	<i>Triraphis guarusa</i>	MNCR-A 1745871	Non endemic
Braconidae	<i>Yelicones gavinbroadi</i>	MNCR-A 2012394	Non endemic
Braconidae	<i>Yelicones nigrocaputus</i>	MNCR-A 2012393	Non endemic
Braconidae	<i>Zelomorpha miza</i>	MNCR-A 1176632	Endemic
Braconidae	<i>Zelomorpha petila</i>	MNCR-A 1980816	Endemic
Braconidae	<i>Bassus sp.</i>	MNCR-A 938720	Non endemic
Braconidae	<i>Bracon sp.</i>	MNCR-A 897372	Non endemic
Braconidae	<i>Campsobracon sp.</i>	MNCR-A 781521	Non endemic
Braconidae	<i>Campsobraconoides sp.</i>	MNCR-A 1745862	Non endemic
Braconidae	<i>Chelonus sp.</i>	MNCR-A 1980706	Non endemic
Braconidae	<i>Choreborogas sp.</i>	MNCR-A 2109099	Non endemic
Braconidae	<i>Clinocentrus sp.</i>	MNCR-A 1746641	Non endemic
Braconidae	<i>Cotesia sp.</i>	MNCR-A 1746821	Non endemic
Braconidae	<i>Cystomastax sp.</i>	MNCR-A 1762943	Non endemic
Braconidae	<i>Diachasmimorpha sp.</i>	MNCR-A 2123948	Non endemic
Braconidae	<i>Digonogastra sp.</i>	MNCR-A 696958	Non endemic
Braconidae	<i>Diospilus sp.</i>	MNCR-A 1980768	Non endemic
Braconidae	<i>Dolichogenidea sp.</i>	MNCR-A 1746867	Non endemic
Braconidae	<i>Exasticolus Sp.</i>	MNCR-A 1980601	Non endemic
Braconidae	<i>Fornicia Sp.</i>	MNCR-A 1746494	Non endemic
Braconidae	<i>Glyptapanteles sp.</i>	MNCR-A 1746585	Non endemic
Braconidae	<i>Gnaptodon sp.</i>	MNCR-A 1746562	Non endemic
Braconidae	<i>Helcon sp.</i>	MNCR-A 1980799	Non endemic
Braconidae	<i>Hemibracon sp.</i>	MNCR-A 1863671	Non endemic
Braconidae	<i>Heterospilus sp.</i>	MNCR-A 2495763	Non endemic
Braconidae	<i>Hormius sp.</i>	MNCR-A 897319	Non endemic
Braconidae	<i>Labagathis sp.</i>	MNCR-A 739353	Non endemic
Braconidae	<i>Macrocentrus sp.</i>	MNCR-A 1941718	Non endemic
Braconidae	<i>Myosoma sp.</i>	MNCR-A 2334373	Non endemic
Braconidae	<i>Notiospathius sp.</i>	MNCR-A 1704196	Non endemic
Braconidae	<i>Opius sp.</i>	MNCR-A 1980691	Non endemic
Braconidae	<i>Orgilus sp.</i>	MNCR-A 1746768	Non endemic
Braconidae	<i>Phanerotoma sp.</i>	MNCR-A 1980626	Non endemic
Braconidae	<i>Prasmodon sp.</i>	MNCR-A 1746432	Non endemic

Braconidae	<i>Pseudognaptodon sp.</i>	MNCR-A 1864370	Non endemic
Braconidae	<i>Rhygoplitis sp.</i>	MNCR-A 897387	Non endemic
Braconidae	<i>Rhysipolis sp.</i>	MNCR-A 980670	Non endemic
Braconidae	<i>Sacirema sp.</i>	MNCR-A 696959	Non endemic
Braconidae	<i>Sendaphne sp.</i>	MNCR-A 1746952	Non endemic
Braconidae	<i>Vipio sp.</i>	MNCR-A 1980602	Non endemic
Braconidae	<i>Xanthomicrogaster sp.</i>	MNCR-A 1746668	Non endemic
Braconidae	<i>Zacremnops sp.</i>	MNCR-A 696850	Non endemic
Ceraphronidae	<i>No Id.</i>	MNCR-A 897360	Non endemic
Chalcididae	<i>Conura annulipes</i>	MNCR-A 1863690	Non endemic
Chalcididae	<i>Conura carinata</i>	MNCR-A 1746676	Non endemic
Chalcididae	<i>Conura carinifea</i>	MNCR-A 1941695	Non endemic
Chalcididae	<i>Conura contribula</i>	MNCR-A 1746862	Non endemic
Chalcididae	<i>Conura delicata</i>	MNCR-A 2012367	Non endemic
Chalcididae	<i>Conura dimidiata</i>	MNCR-A 1302612	Non endemic
Chalcididae	<i>Conura discolor</i>	MNCR-A 911722	Non endemic
Chalcididae	<i>Conura elongata</i>	MNCR-A 1874417	Non endemic
Chalcididae	<i>Conura flava</i>	MNCR-A 739407	Non endemic
Chalcididae	<i>Conura fulvovariegata</i>	MNCR-A 2123938	Non endemic
Chalcididae	<i>Conura maculipennis</i>	MNCR-A 1746852	Non endemic
Chalcididae	<i>Conura marcosensis</i>	MNCR-A 1864359	Non endemic
Chalcididae	<i>Conura nigriiformis</i>	MNCR-A 938676	Non endemic
Chalcididae	<i>Conura rufodorsalis</i>	MNCR-A 2117078	Non endemic
Chalcididae	<i>Conura segoviae</i>	MNCR-A 739447	Non endemic
Chalcididae	<i>Conura transitira</i>	MNCR-A 911675	Non endemic
Chalcididae	<i>Haltichella sp.</i>	MNCR-A 2495757	Non endemic
Chalcididae	<i>Melanosmicra flavicollis</i>	MNCR-A 2123902	Non endemic
Chalcididae	<i>Melanosmicra variventris</i>	MNCR-A 1746861	Non endemic
Chrysididae	<i>Cleptidea panamensis</i>	MNCR-A 1193300	Non endemic
Chrysididae	<i>Caenochrysis sp.</i>	MNCR-A 1193303	Non endemic
Colletidae	<i>Ptiloglossa eximia</i>	MNCR-A 2038286	Non endemic
Colletidae	<i>Ptiloglossa mexicana</i>	MNCR-A 1754241	Non endemic
Crabronidae	<i>Cerceris sp.</i>	MNCR-A 1943598	Non endemic
Crabronidae	<i>Liris sp.</i>	MNCR-A 739288	Non endemic
Crabronidae	<i>Stigmus sp.</i>	MNCR-A 2249396	Non endemic
Crabronidae	<i>Trypoxylon sp.</i>	MNCR-A 781402	Non endemic
Cynipidae	<i>No Id</i>	MNCR-A 1705950	Non endemic
Diapriidae	<i>Acanthopria sp.</i>	MNCR-A 2334468	Non endemic
Diapriidae	<i>Basalys sp.</i>	MNCR-A 897395	Non endemic

Diapriidae	<i>Coptera sp.</i>	MNCR-A 2041812	Non endemic
Diapriidae	<i>Doliopria sp.</i>	MNCR-A 1193186	Non endemic
Diapriidae	<i>Entomacis sp.</i>	MNCR-A 1941669	Non endemic
Diapriidae	<i>Idiotypa sp.</i>	MNCR-A 1746487	Non endemic
Diapriidae	<i>Monelata sp.</i>	MNCR-A 2334460	Non endemic
Diapriidae	<i>Paramesius sp.</i>	MNCR-A 897307	Non endemic
Diapriidae	<i>Spilomicrus sp.</i>	MNCR-A 2334401	Non endemic
Diapriidae	<i>Trichopria sp.</i>	MNCR-A 897300	Non endemic
Dryinidae	No Id	MNCR-A 1746479	Non endemic
Elasmidae	No Id	MNCR-A 1802967	Non endemic
Encyrtidae	<i>Ooencyrtus sp.</i>	MNCR-A 1193217	Non endemic
Encyrtidae	<i>Syrphophagus sp.</i>	MNCR-A 1762792	Non endemic
Eucharitidae	<i>Oraesema costaricensis</i>	MNCR-A 1746776	Non endemic
Eulophidae	<i>Elachertus complex</i>	MNCR- 938724	Non endemic
Eulophidae	<i>Horismenus sp.</i>	MNCR-A 2334386	Non endemic
Eulophidae	<i>Tetrastichus sp.</i>	MNCR-A 1864090	Non endemic
Eupelmidae	No Id	MNCR-A 1941706	Non endemic
Eurytomidae	<i>Conoaxima sp.</i>	MNCR-A 2109101	Non endemic
Eurytomidae	<i>Eurytoma sp.</i>	MNCR-A 938700	Non endemic
Eurytomidae	<i>Rileyia sp.</i>	MNCR-A 1803545	Non endemic
Evaniidae	<i>Evania sp.</i>	MNCR-A 1704253	Non endemic
Evaniidae	<i>Evaniella sp.</i>	MNCR-A 739390	Non endemic
Evaniidae	<i>Hyptia sp.</i>	MNCR-A 1864123	Non endemic
Evaniidae	<i>Semaeomyia sp.</i>	MNCR-A 911684	Non endemic
Figitidae	<i>Acantheucoela sp.</i>	MNCR-A 2123924	Non endemic
Figitidae	<i>Balna sp.</i>	MNCR-A 1980594	Non endemic
Figitidae	<i>Kleidotoma sp.</i>	MNCR-A 1193181	Non endemic
Figitidae	<i>Penteucoila sp.</i>	MNCR-A 1803521	Non endemic
Figitidae	<i>Prosaspicera sp.</i>	MNCR-A 739497	Non endemic
Figitidae	<i>Rhabdeucoela sp.</i>	MNCR-A 1762828	Non endemic
Figitidae	<i>Tropideucoila sp.</i>	MNCR-A 1746674	Non endemic
Figitidae	<i>Zaeucoila sp.</i>	MNCR-A 1980625	Non endemic
Formicidae	<i>Acanthoponera minor</i>	MNCR-A 1704228	Non endemic
Formicidae	<i>Acromyrmex octospinosus</i>	MNCR-A 1704227	Non endemic
Formicidae	<i>Apterostigma sp.</i>	MNCR-A 2334143	Non endemic
Formicidae	<i>Atta cephalotes</i>	MNCR-A 1333097	Non endemic
Formicidae	<i>Azteca sp.</i>	MNCR-A 2334328	Non endemic
Formicidae	<i>Camponotus atriceps</i>	MNCR-A 1728194	Non endemic
Formicidae	<i>Camponotus claviscapus</i>	MNCR-A 944122	Non endemic

Formicidae	<i>Camponotus planatus</i>	MNCR-A 2125208	Non endemic
Formicidae	<i>Camponotus trapezoides</i>	MNCR-A 897476	Non endemic
Formicidae	<i>Cephalotes minutus</i>	MNCR-A 2193276	Non endemic
Formicidae	<i>Cephalotes multispinosus</i>	MNCR-A 944075	Non endemic
Formicidae	<i>Cephalotes porrasi</i>	MNCR-A 1295389	Non endemic
Formicidae	<i>Crematogaster carinata</i>	MNCR-A 2400995	Non endemic
Formicidae	<i>Crematogaster crinosa</i>	MNCR-A 897536	Non endemic
Formicidae	<i>Crematogaster curvispinosa</i>	MNCR-A 1864023	Non endemic
Formicidae	<i>Crematogaster distans</i>	MNCR-A 944136	Non endemic
Formicidae	<i>Crematogaster evallans</i>	MNCR-A 1705976	Non endemic
Formicidae	<i>Crematogaster limata</i>	MNCR-A 1863909	Non endemic
Formicidae	<i>Crematogaster sp.</i>	MNCR-A 1706015	Non endemic
Formicidae	<i>Cyphomyrmex cornutus</i>	MNCR-A 1706561	Non endemic
Formicidae	<i>Dolichoderus sp.</i>	MNCR-A 2334341	Non endemic
Formicidae	<i>Eciton burchellii</i>	MNCR-A 2041835	Non endemic
Formicidae	<i>Eciton dulcium</i>	MNCR-A 1295332	Non endemic
Formicidae	<i>Ectatomma ruidum</i>	MNCR-A 986470	Non endemic
Formicidae	<i>Gnamptogenys regularis</i>	MNCR-A 2193326	Non endemic
Formicidae	<i>Gnamptogenys sulcata</i>	MNCR-A 989070	Non endemic
Formicidae	<i>Hypoponera sp.</i>	MNCR-A 2463764	Non endemic
Formicidae	<i>Labidus coecus</i>	MNCR-A 2167745	Non endemic
Formicidae	<i>Lachnomyrmex scrobiculatus</i>	MNCR-A 911872	Non endemic
Formicidae	<i>Leptothorax sp.</i>	MNCR-A 1706504	Non endemic
Formicidae	<i>Myrmelachista sp.</i>	MNCR-A 2334317	Non endemic
Formicidae	<i>Neivamyrmex pilosus</i>	MNCR-A 1358448	Non endemic
Formicidae	<i>Nomamyrmex esenbeckii</i>	MNCR-A 2012440	Non endemic
Formicidae	<i>Nomamyrmex hartigii</i>	MNCR-A 1292748	Non endemic
Formicidae	<i>Odontomachus bauri</i>	MNCR-A 2334150	Non endemic
Formicidae	<i>Odontomachus chelifer</i>	MNCR-A 1295327	Non endemic
Formicidae	<i>Odontomachus laticeps</i>	MNCR-A 1333152	Non endemic
Formicidae	<i>Pachycondyla obscuricornis</i>	MNCR-A 1704224	Non endemic
Formicidae	<i>Pachycondyla villosa</i>	MNCR-A 1706461	Non endemic
Formicidae	<i>Paraponera clavata</i>	MNCR-A 1292744	Non endemic
Formicidae	<i>Paratrechina sp.</i>	MNCR-A 2334350	Non endemic
Formicidae	<i>Pheidole sp.</i>	MNCR-A 897608	Non endemic
Formicidae	<i>Procryptocerus belti</i>	MNCR-A 2334199	Non endemic
Formicidae	<i>Procryptocerus pictipes</i>	MNCR-A 897404	Non endemic
Formicidae	<i>Pseudomyrmex sp.</i>	MNCR-A 2495732	Non endemic
Formicidae	<i>Pyramica sp.</i>	MNCR-A 2125215	Non endemic

Formicidae	<i>Sericomyrmex amabilis</i>	MNCR-A 1704213	Non endemic
Formicidae	<i>Solenopsis sp.</i>	MNCR-A 2401006	Non endemic
Formicidae	<i>Stenammas sp.</i>	MNCR-A 2123832	Non endemic
Formicidae	<i>Strumigenys ludia</i>	MNCR-A 2193269	Non endemic
Formicidae	<i>Tapinoma sp.</i>	MNCR-A 1874227	Non endemic
Formicidae	<i>Tetramorium bicarinatum</i>	MNCR-A 1193132	Non endemic
Formicidae	<i>Wasmannia auropunctata</i>	MNCR-A 2167679	Non endemic
Halictidae	<i>Augochlora sp.</i>	MNCR-A 1980837	Non endemic
Halictidae	<i>Augochlorella sp.</i>	MNCR-A 439385	Non endemic
Halictidae	<i>Augochloropsis sp.</i>	MNCR-A 2012390	Non endemic
Halictidae	<i>Lasioglossum sp.</i>	MNCR-A 739518	Non endemic
Halictidae	<i>Megalopta centralis</i>	MNCR-A 1947526	Non endemic
Halictidae	<i>Neocorynura sp.</i>	MNCR-A 2012401	Non endemic
Halictidae	<i>Pereirapis semiauratus</i>	MNCR-A 988796	Non endemic
Ichneumonidae	<i>Acrotaphus latifasciatus</i>	MNCR-A 2422006	Non endemic
Ichneumonidae	<i>Apechoneura valerieae</i>	MNCR-A 2130456	Endemic
Ichneumonidae	<i>Baryceros sp.</i>	MNCR-A 2598817	Non endemic
Ichneumonidae	<i>Brachycyrtus veriatrix</i>	MNCR-A 2130309	Endemic
Ichneumonidae	<i>Carinodes sp.</i>	MNCR-A 781417	Non endemic
Ichneumonidae	<i>Casinaria sp.</i>	MNCR-A 2041829	Non endemic
Ichneumonidae	<i>Castrosion renei</i>	MNCR-A 2109258	Non endemic
Ichneumonidae	<i>Cratichneumon sp.</i>	MNCR-A 980734	Non endemic
Ichneumonidae	<i>Cryptanura sp.</i>	MNCR-A 3973529	Non endemic
Ichneumonidae	<i>Diapetimorpha sp.</i>	MNCR-A 980206	Non endemic
Ichneumonidae	<i>Digonocryptus sp.</i>	MNCR-A 2598822	Non endemic
Ichneumonidae	<i>Diradops diora</i>	MNCR-A 1980773	Endemic
Ichneumonidae	<i>Dusona sp.</i>	MNCR-A 1941717	Non endemic
Ichneumonidae	<i>Eiphosoma dentator</i>	MNCR-A 1706451	Non endemic
Ichneumonidae	<i>Eiphosoma laphygmae</i>	MNCR-A 1706434	Non endemic
Ichneumonidae	<i>Eiphosoma macrum</i>	MNCR-A 2130461	Non endemic
Ichneumonidae	<i>Eiphosoma nigrovittatum</i>	MNCR-A 1762948	Non endemic
Ichneumonidae	<i>Eiphosoma tantali</i>	MNCR-A 2130462	Non endemic
Ichneumonidae	<i>Eiphosoma vitticolle</i>	MNCR-A 1762946	Non endemic
Ichneumonidae	<i>Enicospilus chiriquensis</i>	MNCR-A 1980843	Non endemic
Ichneumonidae	<i>Enicospilus flavoscutellatus</i>	MNCR-A 902306	Non endemic
Ichneumonidae	<i>Enicospilus glabratus</i>	MNCR-A 1745853	Non endemic
Ichneumonidae	<i>Enicospilus trilineatus</i>	MNCR-A 943763	Non endemic
Ichneumonidae	<i>Enicospilus sp.</i>	MNCR-A 902307	Non endemic
Ichneumonidae	<i>Epirhyssa theloides</i>	MNCR-A 1762925	Non endemic

Ichneumonidae	<i>Eusterinx sp.</i>	MNCR-A 1704167	Non endemic
Ichneumonidae	<i>Grotea vanessae</i>	MNCR-A 1762903	Non endemic
Ichneumonidae	<i>Hyposoter sp.</i>	MNCR-A 2598799	Non endemic
Ichneumonidae	<i>Joppa sp.</i>	MNCR-A 1358447	Non endemic
Ichneumonidae	<i>Joppocryptus sp.</i>	MNCR-A 911635	Non endemic
Ichneumonidae	<i>Labena tarsata</i>	MNCR-A 1980761	Non endemic
Ichneumonidae	<i>Lathrolestes irenea</i>	MNCR-A 1746436	Non endemic
Ichneumonidae	<i>Lissaspis sp.</i>	MNCR-A 1941705	Non endemic
Ichneumonidae	<i>Listrodromus sp.</i>	MNCR-A 2495778	Non endemic
Ichneumonidae	<i>Lobaegis sp.</i>	MNCR-A 781459	Non endemic
Ichneumonidae	<i>Lymeon sp.</i>	MNCR-A 2598810	Non endemic
Ichneumonidae	<i>Megastylus sp.</i>	MNCR-A 1980628	Non endemic
Ichneumonidae	<i>Mesochorus sp.</i>	MNCR-A 911596	Non endemic
Ichneumonidae	<i>Neotheronia bostrandae</i>	MNCR-A 1976913	Endemic
Ichneumonidae	<i>Neotheronia lineata</i>	MNCR-A 911630	Non endemic
Ichneumonidae	<i>Neotheronia tacubaya</i>	MNCR-A 1745894	Non endemic
Ichneumonidae	<i>Neotheronia tolteca</i>	MNCR-A 1704251	Non endemic
Ichneumonidae	<i>Odontopimpla sp.</i>	MNCR-A 781387	Non endemic
Ichneumonidae	<i>Orthocentrus sp.</i>	MNCR-A 2167697	Non endemic
Ichneumonidae	<i>Pimpla azteca</i>	MNCR-A 1746435	Non endemic
Ichneumonidae	<i>Pimpla croceiventris</i>	MNCR-A 2125443	Non endemic
Ichneumonidae	<i>Pimpla perssoni</i>	MNCR-A 1745877	Non endemic
Ichneumonidae	<i>Pimpla sumichrasti</i>	MNCR-A 1980719	Non endemic
Ichneumonidae	<i>Polycyrtus acerbus</i>	MNCR-A 943663	Non endemic
Ichneumonidae	<i>Polycyrtus alexisi</i>	MNCR-A 1704248	Endemic
Ichneumonidae	<i>Polycyrtus areolaris</i>	MNCR-A 2598819	Non endemic
Ichneumonidae	<i>Polycyrtus condylobus</i>	MNCR-A 1745848	Non endemic
Ichneumonidae	<i>Polycyrtus duplaris</i>	MNCR-A 2334174	Non endemic
Ichneumonidae	<i>Polycyrtus eneyae</i>	MNCR-A 781388	Endemic
Ichneumonidae	<i>Polycyrtus erythrosterus</i>	MNCR-A 3973448	Non endemic
Ichneumonidae	<i>Polycyrtus furvus</i>	MNCR-A 943765	Non endemic
Ichneumonidae	<i>Polycyrtus josei</i>	MNCR-A 980224	Endemic
Ichneumonidae	<i>Polycyrtus juani</i>	MNCR-A 911631	Endemic
Ichneumonidae	<i>Polycyrtus maculatus</i>	MNCR-A 781404	Non endemic
Ichneumonidae	<i>Polycyrtus marcoi</i>	MNCR-A 980203	Endemic
Ichneumonidae	<i>Polycyrtus melanoleucus</i>	MNCR-A 781365	Non endemic
Ichneumonidae	<i>Polycyrtus semialbus</i>	MNCR-A 781457	Non endemic
Ichneumonidae	<i>Polycyrtus triangularis</i>	MNCR-A 2444897	Non endemic
Ichneumonidae	<i>Polycyrtus tubulifera</i>	MNCR-A 1762951	Non endemic

Ichneumonidae	<i>Polycyrtus univittatus</i>	MNCR-A 1333091	Non endemic
Ichneumonidae	<i>Polycyrtus wilsoni</i>	MNCR-A 2598814	Endemic
Ichneumonidae	<i>Sphelodon phoxopteridis</i>	MNCR-A 1941711	Non endemic
Ichneumonidae	<i>Tetragonochora sp.</i>	MNCR-A 1746448	Non endemic
Ichneumonidae	<i>Thyreodon rufothorax</i>	MNCR-A 1176635	Non endemic
Ichneumonidae	<i>Trathala sp.</i>	MNCR-A 1980704	Non endemic
Ichneumonidae	<i>Xiphosomella nigroornata</i>	MNCR-A 2130453	Non endemic
Ichneumonidae	<i>Xiphosomella ozne</i>	MNCR-A 2130308	Endemic
Leucospidae	<i>No Id</i>	MNCR-A 943857	Non endemic
Megachilidae	<i>Coelioxys (Leuraspidia) azteca</i>	MNCR-A 696966	Non endemic
Megachilidae	<i>Coelioxys (Rhinocoelioxys) zapoteca</i>	MNCR-A 1704244	Non endemic
Megachilidae	<i>Megachile sp.</i>	MNCR-A 739294	Non endemic
Mutillidae	<i>Ephuta championi</i>	MNCR-A 1763003	Non endemic
Mutillidae	<i>Pseudomethoca sp.</i>	MNCR-A 2600527	Non endemic
Mutillidae	<i>Timulla sp.</i>	MNCR-A 2600521	Non endemic
Mymaridae	<i>No Id</i>	MNCR-A 1803526	Non endemic
Pergidae	<i>No Id</i>	MNCR-A 988839	Non endemic
Perilampidae	<i>Perilampus platigaster</i>	MNCR-A 1193264	Non endemic
Platygastridae	<i>No Id</i>	MNCR-A 911660	Non endemic
Pompilidae	<i>Ageniella sp.</i>	MNCR-A 1980510	Non endemic
Pompilidae	<i>Allaporus sp.</i>	MNCR-A 1746605	Non endemic
Pompilidae	<i>Anoplus sp.</i>	MNCR-A 1976921	Non endemic
Pompilidae	<i>Aporus sp.</i>	MNCR-A 938820	Non endemic
Pompilidae	<i>Auplopus sp.</i>	MNCR-A 902168	Non endemic
Pompilidae	<i>Caliadurgus sp.</i>	MNCR-A 1980599	Non endemic
Pompilidae	<i>Epipompilus sp.</i>	MNCR-A 1762918	Non endemic
Pompilidae	<i>Hemipepsis sp.</i>	MNCR-A 1168829	Non endemic
Pompilidae	<i>Minagenia sp.</i>	MNCR-A 1762919	Non endemic
Pompilidae	<i>Notocyphus sp.</i>	MNCR-A 1976915	Non endemic
Pompilidae	<i>Paracyphononyx sp.</i>	MNCR-A 911521	Non endemic
Pompilidae	<i>Pepsis festiva</i>	MNCR-A 1754251	Non endemic
Pompilidae	<i>Pepsis grossa</i>	MNCR-A 980698	Non endemic
Pompilidae	<i>Poecilopompilus sp.</i>	MNCR-A 1945745	Non endemic
Pompilidae	<i>Priochilus sp.</i>	MNCR-A 739243	Non endemic
Pompilidae	<i>Priocnemella sp.</i>	MNCR-A 1980700	Non endemic
Pompilidae	<i>Tachypompilus sp.</i>	MNCR-A 1704229	Non endemic
Pteromalidae	<i>Alticornis sp.</i>	MNCR-A 1864129	Non endemic
Pteromalidae	<i>Catolaccus sp.</i>	MNCR-A 1803522	Non endemic
Pteromalidae	<i>Chrysoglyphe sp.</i>	MNCR-A 1864128	Non endemic

Pteromalidae	<i>Erotolepsia sp.</i>	MNCR-A 2334487	Non endemic
Pteromalidae	<i>Heteroschema sp.</i>	MNCR-A 1864083	Non endemic
Pteromalidae	<i>Lelaps sp.</i>	MNCR-A 2495770	Non endemic
Pteromalidae	<i>Lyracus sp.</i>	MNCR-A 980799	Non endemic
Pteromalidae	<i>Neocatolaccus sp.</i>	MNCR-A 2495734	Non endemic
Pteromalidae	<i>Netomocera sp.</i>	MNCR-A 2334470	Non endemic
Pteromalidae	<i>Parurios sp.</i>	MNCR-A 1746634	Non endemic
Pteromalidae	<i>Propodeia sp.</i>	MNCR-A 2193445	Non endemic
Pteromalidae	<i>Pteromalus sp.</i>	MNCR-A 980843	Non endemic
Pteromalidae	<i>Spalangia cameroni</i>	MNCR-A 2036608	Non endemic
Pteromalidae	<i>Spalangia chontalensis</i>	MNCR-A 2041806	Non endemic
Pteromalidae	<i>Spalangia imitator</i>	MNCR-A 1706557	Endemic
Pteromalidae	<i>Spalangia nigroaenea</i>	MNCR-A 943997	Non endemic
Rhopalosomatidae	No ID	MNCR-A 1176636	Non endemic
Scelionidae	<i>Anteroides sp.</i>	MNCR-A 938732	Non endemic
Scelionidae	<i>Baryconus sp.</i>	MNCR-A 943996	Non endemic
Scelionidae	<i>Calliscelio sp.</i>	MNCR-A 2334528	Non endemic
Scelionidae	<i>Chromoteleia sp.</i>	MNCR-A 911657	Non endemic
Scelionidae	<i>Cremastobaeus sp.</i>	MNCR-A 1803497	Non endemic
Scelionidae	<i>Duta sp.</i>	MNCR-A 911679	Non endemic
Scelionidae	<i>Dyscritobaeus sp.</i>	MNCR-A 2193433	Non endemic
Scelionidae	<i>Grynooides sp.</i>	MNCR-A 938694	Non endemic
Scelionidae	<i>Gryon sp.</i>	MNCR-A 2334422	Non endemic
Scelionidae	<i>Idris spectabilis</i>	MNCR-A 2125251	Non endemic
Scelionidae	<i>Macroteleia sp.</i>	MNCR-A 2334402	Non endemic
Scelionidae	<i>Odontacolus sp.</i>	MNCR-A 1193225	Non endemic
Scelionidae	<i>Oethecoctonus sp.</i>	MNCR-A 911691	Non endemic
Scelionidae	<i>Opisthacantha sp.</i>	MNCR-A 2334396	Non endemic
Scelionidae	<i>Parascelio sp.</i>	MNCR-A 1941650	Non endemic
Scelionidae	<i>Probaryconus sp.</i>	MNCR-A 1704171	Non endemic
Scelionidae	<i>Psilanteris sp.</i>	MNCR-A 2193394	Non endemic
Scelionidae	<i>Scelio sp.</i>	MNCR-A 2193413	Non endemic
Scelionidae	<i>Telenomus sp.</i>	MNCR-A 911711	Non endemic
Scelionidae	<i>Trimorus sp.</i>	MNCR-A 1980665	Non endemic
Scelionidae	<i>Triteleia sp.</i>	MNCR-A 980828	Non endemic
Scoliidae	<i>Campsomeris dorsata</i>	MNCR-A 1706460	Non endemic
Sphecidae	<i>Ammophila sp.</i>	MNCR-A 1952987	Non endemic
Sphecidae	<i>Eremnophila opulenta</i>	MNCR-A 1706474	Non endemic
Sphecidae	<i>Isodontia sp.</i>	MNCR-A 1952981	Non endemic

Sphecidae	<i>Sceliphron sp.</i>	MNCR-A 696851	Non endemic
Sphecidae	<i>Sphex dorsalis</i>	MNCR-A 1976895	Non endemic
Sphecidae	<i>Sphex ichneumoneus</i>	MNCR-A 1302594	Non endemic
Tenthredinidae	<i>Waldheimia amazonica</i>	MNCR-A 1976972	Non endemic
Tenthredinidae	<i>Waldheimia ochra</i>	MNCR-A 902147	Non endemic
Tiphiidae	<i>Krombeinia sp.</i>	MNCR-A 1864386	Non endemic
Tiphiidae	<i>Myzinum sp.</i>	MNCR-A 439406	Non endemic
Tiphiidae	<i>Paratiphia sp.</i>	MNCR-A 988811	Non endemic
Tiphiidae	<i>Pterombrus sp.</i>	MNCR-A 1704203	Non endemic
Tiphiidae	<i>Tiphia sp.</i>	MNCR-A 781508	Non endemic
Torymidae	<i>Torymus sp.</i>	MNCR-A 1980783	Non endemic
Vespidae	<i>Agelaia areata</i>	MNCR-A 3374672	Non endemic
Vespidae	<i>Agelaia cajennensis</i>	MNCR-A 781470	Non endemic
Vespidae	<i>Agelaia centralis</i>	MNCR-A 3374673	Non endemic
Vespidae	<i>Agelaia melanopyga</i>	MNCR-A 3373202	Non endemic
Vespidae	<i>Agelaia myrmecophila</i>	MNCR-A 2167746	Non endemic
Vespidae	<i>Alphamenes sp.</i>	MNCR-A 2012419	Non endemic
Vespidae	<i>Apoica pallens</i>	MNCR-A 2217107	Non endemic
Vespidae	<i>Apoica pallida</i>	MNCR-A 882304	Non endemic
Vespidae	<i>Apoica thoracica</i>	MNCR-A 439409	Non endemic
Vespidae	<i>Brachygastra mellifica</i>	MNCR-A 2216939	Non endemic
Vespidae	<i>Hypancistrocerus sp.</i>	MNCR-A 2123887	Non endemic
Vespidae	<i>Mischocyttarus angulatus</i>	MNCR-A 439404	Non endemic
Vespidae	<i>Mischocyttarus basimacula</i>	MNCR-A 439400	Non endemic
Vespidae	<i>Mischocyttarus costaricensis</i>	MNCR-A 882364	Non endemic
Vespidae	<i>Mischocyttarus basimacula</i>	MNCR-A 439403	Non endemic
Vespidae	<i>Omicron sp.</i>	MNCR-A 2334189	Non endemic
Vespidae	<i>Pachodynerus sp.</i>	MNCR-A 980721	Non endemic
Vespidae	<i>Parachartergus apicalis</i>	MNCR-A 1947520	Non endemic
Vespidae	<i>Parachartergus fraternus</i>	MNCR-A 1333101	Non endemic
Vespidae	<i>Polistes erythrocephalus</i>	MNCR-A 1767862	Non endemic
Vespidae	<i>Polistes major major</i>	MNCR-A 1767854	Non endemic
Vespidae	<i>Polybia bribri</i>	MNCR-A 739342	Endemic
Vespidae	<i>Polybia diguetana</i>	MNCR-A 3374674	Non endemic
Vespidae	<i>Polybia emaciata</i>	MNCR-A 2012386	Non endemic
Vespidae	<i>Polybia flavitincta</i>	MNCR-A 1985696	Non endemic
Vespidae	<i>Polybia occidentalis</i>	MNCR-A 739347	Non endemic
Vespidae	<i>Polybia occidentalis nigratella</i>	MNCR-A 1980842	Non endemic
Vespidae	<i>Polybia rejecta</i>	MNCR-A 696968	Non endemic

Vespidae	<i>Protopolybia chartergoides</i>	MNCR-A 1976908	Non endemic
Vespidae	<i>Protopolybia exigua</i>	MNCR-A 938863	Non endemic
Vespidae	<i>Stenodynerus sp.</i>	MNCR-A 1754249	Non endemic
Vespidae	<i>Synoeca septentrionalis</i>	MNCR-A 1333220	Non endemic

**Table 1:** Species from the National Museum of Costa Rica's collection.

## Discussion

As an internationally significant Ramsar site in Costa Rica, Caño Negro has been historically monitored. Official reports and management plans have focused their conservation efforts almost exclusively on charismatic vertebrates, highlighting exhaustive inventories of birds, reptiles, fish, and mammals.

However, a critical gap exists in the ecological information of this ecosystem: insects. Despite constituting the largest biomass and being fundamental for trophic webs and pollination, entomological groups are systematically overlooked in official assessments. This omission in Caño Negro reflects a concerning trend that limits our comprehensive understanding of wetland health.

Below are some of the most relevant data related to the reported species for the wetland:  
Impact of *Oreasema costaricensis* on the Myrmecofauna of Galápagos:

The introduction of *Oreasema costaricensis* (Eucharitidae) to the Galápagos Islands poses a considerable ecological challenge. This parasitoid wasp of the family Eucharitidae possesses a specialized life cycle obligatorily dependent on ants of the genus *Pheidole*. Taxonomic and ecological investigations have confirmed its presence in the archipelago and its direct association with the endemic ant *Pheidole williamsi*, acting as a pressure factor on its populations [5].

The parasitism mechanism is highly specific: the wasp's planidium larvae utilize foraging workers as vehicles to infiltrate the colony, where they ultimately consume the host ant pupae. Studies on the interaction between formacids and their parasitoids in the islands suggest that the decline of *P. williamsi* due to this parasitism could create ecological vacuums. These empty niches are frequently exploited by more aggressive invasive species, such as the tropical fire ant (*Solenopsis geminata*), altering the structure of the native invertebrate community [6,7]. The monitoring of *O. costaricensis* is, therefore, a key component in invasive species management plans of the Charles Darwin Foundation and the Galápagos National Park Directorate.

## The Relevance of Ants in Site Conservation

Ants, members of the family Formicidae, represent a taxonomically and functionally dominant component in most terrestrial ecosystems, particularly in tropical regions [8]. Their omnipresence and the intricate ecological interactions they establish make them organisms of fundamental interest for biodiversity conservation, primarily in the following aspects:

### Ecosystem Engineers and Key Regulators

A prominent group in terms of ecological impact are leaf-cutter ants of the genera *Atta* and *Acromyrmex*. Species such as *Atta cephalotes* and *Acromyrmex octospinosus* are recognized as ecosystem engineers due to their capacity to significantly modify the physical and biological environment [8,9]. Their foraging and nest-building activity profoundly influences:

**Nutrient cycling:** They transport vast quantities of plant biomass underground, where the decomposition of organic matter in their fungal garden chambers enriches the soil with plant-available nutrients [10].

**Soil structure:** The excavation of their complex nests alters soil hydrology, aeration, and granular composition [11].

**Vegetation dynamics:** They act as significant herbivores, affecting vegetation composition, distribution, and regeneration [12]. Their presence and the integrity of their colonies are, therefore, indicators of the health and functionality of tropical ecosystems.

Army ants (*Eciton burchellii*, *Eciton dulcium*, *Labidus coecus*, *Neivamyrmex pilosus*, *Nomamyrmex esenbeckii*, *Nomamyrmex hartigii*) are apex predators with cascading trophic impacts [13,14]. Their massive foraging columns exert considerable predatory pressure on other invertebrates, and occasionally small vertebrates, regulating their populations. Furthermore, their activity influences the behavior of other species, such as birds that follow the columns to capture fleeing prey [15]. The need for large extents of intact habitat to sustain their colonies makes them sensitive indicators of forest quality and extent [16].

### Critical Mutualisms and Habitat Specialists

Several ant species establish obligate mutualistic relationships with plants, being essential for the latter's persistence. The genera *Azteca* and *Pseudomyrmex* are paradigmatic examples. *Azteca* species form well-documented mutualisms with trees of the genus *Cecropia*, defending their host plants from herbivores and competing vines in exchange for shelter (domatia) and food (Müllerian bodies and nectar) [17,18]. Similarly, many *Pseudomyrmex* species are obligate mutualists of acacias and other myrmecophytic plants, offering protection against herbivores and competitors [19]. The presence of *Myrmelachista* sp. on the list is also relevant, as some species are known for creating "devil's gardens" by eliminating competing vegetation around their host plants, favoring their growth [20]. The conservation of these ants is intrinsically linked to that of their mutualistic plants, forming a complex of co-dependent species: Minor fungus-growing ants (*Apterostigma* sp., *Cyphomyrmex cornutus*, *Lachnomyrmex scrobiculatus*, *Sericomyrmex amabilis*) are essential components of nutrient cycling in leaf litter and soil. Unlike *Atta* and *Acromyrmex*, many of these species are more specialized in their fungal cultivation substrates and the microhabitats they occupy [21]. Their sensitivity to changes in leaf litter humidity and composition makes them potential bioindicators of understory integrity [22].

Turtle ants (*Cephalotes minutus*, *Cephalotes multispinosus*, *Cephalotes porrasi*, *Procryptocerus belti*, *Procryptocerus pictipes*) are highly specialized arboreal ants, both in their flattened morphology and habits [23]. They inhabit bark crevices, decaying wood, and domatia, contributing to canopy biodiversity. Their presence often denotes mature and well-structured forests, as they depend on specific resources and microhabitats associated with dead wood and arboreal architecture [24].

The bullet ant (*Paraponera clavata*) is a formidable forest floor predator, but its relevance is not limited to its trophic role. Its participation in the seed dispersal for certain plants has been documented, contributing to forest regeneration [25,26]. Its dependence on primary and undisturbed forests makes it a habitat quality indicator.

### Functional Diversity and Specialization

Genera with high species diversity and varied ecological roles, such as *Camponotus*, *Pheidole*, *Odontomachus*, *Gnamptogenys*, *Strumigenys*, *Pyramica*, and *Hypoponera*, are crucial for biodiversity:

*Pheidole* is one of the most diverse ant genera globally, with species occupying niches as granivores, scavengers, and

predators [27]. High *Pheidole* diversity in an ecosystem is an indicator of species richness and complexity of trophic interactions.

*Odontomachus* (trap-jaw ants) and *Gnamptogenys* (specialized predators) are important for controlling populations of other invertebrates [28,29].

*Strumigenys ludia* and other *Pyramica* sp. are microscopic and highly specialized predators of microarthropods in leaf litter; fundamental for decomposition processes and soil community maintenance [30]. The richness and abundance of these groups reflect the health of the invertebrate community and ecosystem integrity.

### Invasive Species and Threats to Biodiversity

Finally, conservation relevance lies not only in beneficial native species but also in those that pose a significant threat. Species such as *Wasmannia auropunctata* (electric ant or little fire ant) are considered among the 100 most damaging invasive species globally [31]. Its presence on the list is of extreme conservation concern. *Wasmannia auropunctata* aggressively displaces native ant species and other invertebrates, reduces arthropod diversity, affects fruit production in some crops, and can sting small vertebrates, drastically altering community structure and ecological processes [32,33]. Although *Solenopsis* sp. includes native species, the mention of *Solenopsis invicta* (red imported fire ant) or other invasive *Solenopsis* species would also indicate a critical threat to native biodiversity [34]. The management and control of these invasive species are crucial for protecting ecosystems and biological diversity.

### Ecological Role of Present Bee Species

#### *Melipona beecheii* and Meliponiculture in the Caño Negro Biological Corridor

The presence of *Melipona* species, such as *M. beecheii*, in the region surrounding the Caño Negro Wetland underscores the importance of stingless bees for the pollination of native flora and local crops. Although *M. beecheii* is more associated with dry forests, the genus's importance in pollinating humid forests and agroforestry systems near the wetland is undeniable. González et al. [35] point out that traditional meliponiculture in Costa Rica, including areas near natural reserves, is vital for the conservation of these bees, which face pressure from habitat loss due to agricultural expansion and agrochemical use in the areas adjacent to Caño Negro. The deforestation of riparian forests bordering the wetland reduces nesting sites and resource sources, compromising the viability of *Melipona* populations and, consequently, the resilience of pollination in this key ecosystem.

### **Euglossini (*Euglossa* & *Eulaema*) and Caño Negro Wetland Connectivity**

Orchid bees are crucial pollinators in the humid tropical forests surrounding and comprising much of the Caño Negro ecosystem. Their ability to fly long distances, documented by Janzen [36], makes them essential “genetic connectors” for plants found dispersed or in habitat fragments. In a mosaic of wetlands, rivers, and forest patches like Caño Negro, these bees maintain the gene flow of vital plant species for the ecosystem’s structure, including lianas and trees with specialized flowers. Habitat degradation and loss of floral diversity in the wetland’s buffer zones directly threaten these intricate pollination networks, affecting not only orchids but also the overall health of the forest [37].

### ***Trigona corvina* and Resource Dynamics in Caño Negro**

The genus *Trigona*, with species like *Trigona corvina*, is omnipresent and ecologically dominant in the Neotropics, including the Caño Negro Wetland. These stingless bees are known for their aggressive foraging strategies and their ability to monopolize nectar and pollen sources. In the rich environment of Caño Negro, where floral resources can fluctuate seasonally with water levels and mass flowering events, the presence of *T. corvina* significantly influences resource partitioning among the pollinator community [38]. Its dominance can displace smaller or less competitive bee species from abundant floral patches, thus shaping interactions and coexistence within the pollinator guild and potentially limiting effective pollination for some plants.

### ***Centris analis* and Floral Specialization in the Wetland Margins**

Bees of the genus *Centris*, such as *Centris analis*, are specialists in collecting floral oils, a vital resource for their reproduction. In the diverse habitats of Caño Negro’s margins, where plant species like Malpighiaceae exist, these bees play an irreplaceable role. The oils are not only a nutritive lipid source for larvae but are also used to line brood cells, protecting them from humidity and pathogens in a typically humid environment. Vinson, et al. [39] highlighted the specificity of this interaction. The conservation of *Centris* populations in Caño Negro is directly linked to the presence and health of their host oil-producing plants. The alteration of native flora along the wetland’s edges, either by drainage or invasive species, directly threatens this coevolved mutualism and, therefore, the reproduction of these key bees.

### **Nocturnal Pollination in the Canopy’s Gloom**

The presence of *Megalopta centralis* in the Caño Negro

ecosystem reveals the sophistication of its pollination networks. This halictid bee is one of the few truly nocturnal bees, specialized in exploiting floral resources available during crepuscular and nocturnal hours. Its compound eyes, adapted for high light sensitivity, allow it to navigate and forage in the low light of the tropical understory [40]. In Caño Negro, *M. centralis* complements the activity of diurnal pollinators, ensuring the reproduction of plants that open their flowers at dusk, an ecological strategy to avoid diurnal competition. This temporal niche reduces pressure on resources and contributes to wetland resilience by expanding the pollination window, which is vital for maintaining the area’s high plant biodiversity.

### **Solitary Bees of Caño Negro**

Unlike their social relatives, solitary bees constitute the vast majority of bee species and operate individually, with each female building and provisioning her own nest. In the Caño Negro Wetland, genera present in your list such as *Megachile* (leaf-cutter bees), *Xylocopa* (carpenter bees), *Lasioglossum* (sweat bees), and various species of *Centris* and *Ptiloglossa* play irreplaceable ecological roles.

These bees exhibit an impressive diversity of nesting strategies adapted to Caño Negro’s varied microhabitats. *Xylocopa* bees excavate galleries in dead or soft wood, common in flooded forest areas and river margins, efficiently pollinating plants with poricidal anthers via vibration (buzz pollination). *Megachile* nest in pre-existing cavities, using leaf or petal pieces to construct larval cells, being important pollinators of legumes. Many species of *Lasioglossum*, *Exomalopsis*, and *Ptiloglossa* nest in the ground, preferably in bare soils or with sparse vegetation, utilizing trail edges and forest clearings. The presence of *Ptiloglossa eximia* and *P. mexicana* suggests specialization in collecting pollen from plants like Malpighiaceae, often during crepuscular hours, complementing the work of other diurnal pollinators [41].

The importance of these solitary bees for Caño Negro’s ecological resilience lies in their pollination efficiency and their complementarity with social species. Their diversity ensures that a wide range of plants, from shrubs to canopy trees, are effectively pollinated. However, their nesting specificity makes them particularly vulnerable to habitat degradation. The removal of dead wood, soil alteration by surrounding agricultural activities, and pesticide use directly affect their populations by eliminating their nesting sites and food sources [42]. The conservation of landscape heterogeneity in Caño Negro, including patches of native vegetation and decaying wood, is crucial for maintaining the diversity and pollination services of these solitary bees.

## Conclusions

### Critical Information Gap on Hymenoptera

Despite being an internationally significant Ramsar Site and the crucial role of insects in trophic networks and pollination, a “critical gap” exists in the ecological information regarding Hymenoptera in Caño Negro. Current studies have disproportionately focused on charismatic vertebrates, leaving insects “systematically overlooked” in official assessments. This lack of current and comprehensive records (with most dating from 1992-1994) hinders a comprehensive understanding of wetland health and impedes the formulation of data-driven conservation strategies for this vital group.

### Hymenoptera as Ecosystem Engineers and Pillars of the Trophic Network

The bees and ants of Caño Negro are not mere components but “fundamental” to the ecosystem’s structure and function. Bees act as irreplaceable pollinators (Meliponini, Euglossini, Centris, solitary bees), ensuring plant reproduction. Ants, for their part, are “ecosystem engineers” (e.g., Atta, Acromyrmex modifying soils and cycling nutrients), “apex predators” (e.g., Eciton regulating populations), and establish “critical mutualisms” with plants (e.g., Azteca, Pseudomyrmex). Their functional diversity is essential for wetland resilience.

### Sensitive Bioindicators of Environmental Health and Anthropogenic Threats

Hymenoptera, along with other insects like Odonata, are “bioindicators of the environmental health” of the wetland. The presence and diversity of species such as fungus-growing ants (sensitive to leaf litter and humidity) or “turtle ants” (indicators of mature forests) reflect habitat integrity. Their vulnerability to “surrounding habitat fragmentation,” “agricultural eutrophication” from adjacent pineapple crops, and pesticide use demonstrates how the well-being of these insects is a direct thermometer of the “external anthropogenic pressures” impacting Caño Negro.

### Extreme Vulnerability to Habitat Degradation and Microhabitat Loss

The specificity of Hymenoptera makes them particularly susceptible to environmental alteration. Solitary bees (Xylocopa, Megachile, Lasioglossum) depend on resources such as dead wood, pre-existing cavities, or specific soil types for nesting. Orchid bees (Euglossa, Eulaema) require habitat connectivity for their foraging flights. The “removal of dead wood” or “soil alteration” directly impacts these populations, highlighting the need to conserve “landscape heterogeneity”

within and on the periphery of the wetland.

### Critical Threat from Invasive Hymenoptera Species

The presence of invasive Hymenoptera represents a “conservation concern.” The case of *Oreasema costaricensis* in Galápagos, though outside Caño Negro, illustrates the devastating potential of parasitoid species. More directly, the mention of species like *Wasmannia auropunctata* (electric ant) and potentially invasive *Solenopsis* species (fire ant) in the list of Hymenoptera found in Costa Rica, indicates an “extreme” threat. These species “aggressively displace” native species, “reduce arthropod diversity,” and “drastically alter community structure,” demanding rigorous “monitoring” and “management” in Caño Negro.

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