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Diversity of the myrmecophilous communities associated with the ectatommine ant genus *Ectatomma*



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The genus *Ectatomma* F. Smith

- ✓ Hunting ants which prey on a diversity of arthropods, scavenge on dead prey, and exploit sugar sources.
- ✓ As for the majority of poneromorph and ectaheteromorph ants, they are aggressive and considered as poor candidates for associations with possible guests.
- ✓ The genus contains few species (15 valid + 3 cryptic), exclusively neotropical but widely distributed. Some of them are considered as dominants.
- ✓ In the last decades various cases of associated invertebrates have been occasionally reported during the nest excavation of various *Ectatomma* species.
- ✓ Until now, no systematic, exhaustive review of the associations with the genus *Ectatomma* had been attempted.



Methods

- ✓ We evaluated the organisms present within the nests or attended by the foragers through exhaustive colony sampling and observations of two species of *Ectatomma* (*E. tuberculatum* and *E. brunneum*) and one species complex (*E. ruidum*) over more than thirty five years of colony sampling.
- ✓ We revised as much literature as we could find on all the species of this genus.



1. Parasitoids of *Ectatomma*

- Only reports for which true primary parasitoidism has been proven (or highly suspected) have been considered.
- We found at least 28 associations involving parasitoids from 3 classes of invertebrates (Insecta, Arachnida, Nematoda) belonging to, at least, 23 different taxa from 5 families in 5 orders: Diptera - Hymenoptera - Coleoptera - Mesostigmata - Mermithida.



1. Parasitoids of *Ectatomma*




Taxon	Associate	Host	Target	References
Insecta: Diptera: Phoridae 	<i>Apocephalus catholicus</i> <i>Apocephalus comosus</i> <i>Apocaphalus glabiventris</i> <i>Apocephalus lobicauda</i> <i>Apocephalus paraponerae</i> <i>Apocephalus</i> sp. ? Unidentified sp. Unidentified sp.	<i>E. goninion</i> <i>E. tuberculatum</i> <i>E. ruidum</i> <i>E. tuberculatum</i> <i>E. tuberculatum</i> <i>E. lugens</i> <i>E. ruidum</i> <i>E. tuberculatum</i> <i>E. lugens</i> <i>E. brunneum</i> <i>E. ruidum</i>	adult adult adult adult adult adult adult adult adult adult larva	Brown 2000 Brown 2000 Brown 2000 Brown 2000 Brown 2000 Brown 2000 Morehead & Feener 2000 Brown & Feener 1991; Brown 2000 Souza & Moura 2004 Giannotti & Machado 1992; Lapolla et al. 2003 Lachaud & Pérez-Lachaud 2015
Insecta: Hymenoptera: Eucharitidae (Eucharitinae) 	<i>Dicoelothorax platycerus</i> <i>Dilocantha lachaudii</i> <i>Galearia latreillei</i> <i>Isomerala coronata</i> <i>Kapala iridicolor</i> <i>Kapala izapa</i> <i>Kapala</i> sp.1 <i>Kapala</i> sp.2 <i>Kapala</i> sp. <i>Lasiokapala spiralicornis</i> Unidentified sp.	<i>E. brunneum</i> <i>E. tuberculatum</i> <i>E. brunneum</i> <i>E. tuberculatum</i> <i>E. ruidum</i> sp. 1 <i>E. ruidum</i> sp. 2 <i>E. ruidum</i> sp. 2 <i>E. brunneum</i> <i>E. tuberculatum</i> <i>E. ruidum</i> sp. 4 <i>E. brunneum</i> <i>E. ruidum</i> sp. 3	larva/pupa larva/pupa larva/pupa larva/pupa larva/pupa larva/pupa larva/pupa larva/pupa larva/pupa larva/pupa larva/pupa larva/pupa	Torréns y Heraty 2012; Torrén's 2013 Heraty 1998; Lachaud et al. 1998 Torrén's 2013 Cook 1905; Pérez-Lachaud et al. 2006b Howard et al. 2001; Pérez-Lachaud et al. 2006a Pérez-Lachaud et al. 2006a Pérez-Lachaud et al. 2006a Lachaud et al. 2012a Pérez-Lachaud et al. 2006b Pérez-Lachaud & Lachaud, unpubl. data Torrén's et al. 2016 Pérez-Lachaud & Lachaud, unpubl. data
Insecta: Coleoptera: Cleridae 	<i>Phyllobaenus obscurus</i> Unidentified sp.	<i>E. ruidum</i> sp. 3 <i>E. ruidum</i> sp. 4	larva larva	Pérez-Lachaud & Lachaud, unpubl. data Pérez-Lachaud & Lachaud, unpubl. data
Arachnida: Mesostigmata: Macrotrichidae 	<i>Macrotrichus sellnicki</i>	<i>E. ruidum</i> sp. 2	larva/pupa	Pérez-Lachaud et al. 2019
Nematoda: Mermithida: Mermithidae 	<i>Meximermis ectatommi</i> <i>Meximermis</i> sp. Unidentified sp.	<i>E. ruidum</i> sp. 2 <i>E. tuberculatum</i> <i>E. ruidum</i> sp. 3	all stages all stages all stages	Weber 1946; Poinar et al. 2006 Wheeler 1930; Pérez-Lachaud et al. 2011 Pérez-Lachaud & Lachaud, unpubl. data

2. Mimetics

- 7 associations involving mimetics from 2 classes of invertebrates (Arachnida, Insecta) belonging to 7 different taxa from 4 families in 3 orders: Araneae - Diptera - Hemiptera.



2. Mimetics

Taxon	Associate	Host	Location	References
Arachnida: Araneae: Unidentified family	Unidentified sp.	<i>E. tuberculatum</i>	outside nest	Lachaud unpubl. data
Arachnida: Araneae: Corinnidae 	<i>Mazax pax</i> <i>Myrmecium</i> cf. <i>bifasciatum</i>	<i>E. ruidum</i> <i>E. lugens</i>	outside nest outside nest	Reiskind 1977 Oliveira 1988
Insecta: Diptera: Micropezidae 	<i>Plocoscelus arthriticus</i> <i>Plocoscelus camptomerus</i> (or <i>P. podragricus</i>)	<i>E. tuberculatum</i> Unidentified sp.	outside nest outside nest	Wheeler 1924 Eberhard 1999
Insecta: Hemiptera: Alydidae 	<i>Hyalimenus tarsatus</i> <i>Hyalimenus limbativentris</i>	<i>E. brunneum</i> <i>E. brunneum</i> <i>E. tuberculatum</i>	outside nest outside nest outside nest	Oliveira 1985 Oliveira 1985 Oliveira 1985



3. Nesting association

- At least 21 associations involving organisms from 1 class of invertebrates (Insecta) belonging to, at least, 10 different taxa from 2 families in 2 orders: Blattodea - Hymenoptera.



4. Predators

- 6 associations involving predators from 2 classes of invertebrates (Arachnida, Insecta) belonging to, at least, 5 different taxa from 5 families in 5 orders: Araneae - Coleoptera - Diptera - Hemiptera - Hymenoptera.



4. Predators

Taxon	Associate	Host	Location	References
Arachnida: Araneae: Therididae	<i>Latrodectus geometricus</i>	<i>E. tuberculatum</i>	outside nest	Nascimento 2006
Insecta: Coleoptera: Carabidae	Unidentified sp.	<i>E. ruidum</i> sp. 2 <i>E. ruidum</i> sp. 4	inside nest* inside nest*	Pérez-Lachaud & Lachaud unpubl. data Lachaud & Pérez-Lachaud unpubl. data
Insecta: Diptera: Syrphidae	<i>Microdon</i> sp.	<i>E. ruidum</i>	inside nest	Weber 1946
Insecta: Hemiptera: Rhyparochromidae	<i>Xenydrium formiciforme</i>	<i>E. ruidum</i>	outside nest*	Poppius & Bergroth 1920
Insecta: Hymenoptera: Formicidae (Dorylinae)	<i>Acanthosticus quirozi</i>	<i>E. ruidum</i> sp. 2	inside nest	Lachaud & Pérez-Lachaud unpubl. data



5. Trophobionts


- At least 126 associations involving trophobionts from 1 class of invertebrates (Insecta) belonging to, at least, 98 different taxa from 14 families in 1 order: Hemiptera.



5. Trophobionts

Taxon	Associate	Host	Location	References
Insecta: Hemiptera: Membracidae (Membracinae)    	<i>Enchenopa dubia</i>	<i>E. ruidum</i>	outside nest	Wood 1984
	<i>Enchenopa gracilis</i>	<i>E. tuberculatum</i> <i>E. brunneum</i> <i>E. ruidum</i>	outside nest outside nest outside nest	Wood 1984 Azevedo 2006; Ibarra Isassi & Oliveira 2017 Cavalleri et al. 2010; Cavalleri 2012
	<i>Enchenopa ignidorsum</i>	<i>E. ruidum</i> <i>E. tuberculatum</i>	outside nest outside nest	Wood 1984 Wood 1984
	<i>Enchenopa monoceros</i>	<i>E. brunneum</i>	outside nest	Azevedo 2006
	<i>Enchenopa</i> sp.	<i>E. tuberculatum</i> Unidentified sp.	outside nest outside nest	Godoy et al. 2006 Blüthgen et al. 2000; Flórez-V. et al. 2015
	<i>Enchenopa squamigera</i>	<i>E. ruidum</i> <i>E. tuberculatum</i>	outside nest outside nest	Wood 1984 Godoy et al. 2006
	<i>Enchophyllum dubium</i>	<i>E. ruidum</i> <i>E. tuberculatum</i> <i>E. brunneum</i>	outside nest outside nest outside nest	Wood 1984 Wood 1984 Azecedo 2006
	<i>Enchophyllum quinquemaculatum</i>			
	<i>Erechtia sallaei</i>	<i>E. tuberculatum</i>	outside nest	Wood 1984
	<i>Erechtia</i> sp. 1	<i>E. tuberculatum</i>	outside nest	Argoti Ávila 2011
	<i>Erechtia</i> sp. 2	<i>E. tuberculatum</i>	outside nest	Argoti Ávila 2011
	<i>Erechtia</i> sp. 3	<i>E. tuberculatum</i>	outside nest	Argoti Ávila 2011
	<i>Erechtia</i> sp. 4	<i>E. tuberculatum</i>	outside nest	Argoti Ávila 2011
	<i>Erechtia</i> sp. 8	<i>E. tuberculatum</i>	outside nest	Argoti Ávila 2011
	<i>Gayaquila</i> sp.	<i>E. ruidum</i> <i>E. tuberculatum</i> <i>E. edentatum</i>	outside nest outside nest outside nest	Godoy et al. 2006 Godoy et al. 2006 Del-Claro & Oliveira 1999
	<i>Guayaquila xiphias</i>	<i>E. planidens</i>	outside nest	Del-Claro & Oliveira 1999
	<i>Membracis dorsata</i>	<i>E. tuberculatum</i>	outside nest	Godoy et al. 2006
	<i>Membracis fuscata</i>	<i>E. ruidum</i> <i>E. tuberculatum</i>	outside nest outside nest	Wood 1984 Wood 1984; Loye 1992; Godoy et al. 2006
	<i>Membracis tectigera</i>	<i>E. ruidum</i> <i>E. tuberculatum</i>	outside nest outside nest	Wood 1984 Wood 1984
	<i>Notocera bituberculata</i>	<i>E. tuberculatum</i>	outside nest	Loye 1992
<i>Phyllotropis cingulata</i>	<i>E. tuberculatum</i>	outside nest	https://twitter.com/search?q=Phyllotropis&src=typp	
<i>Phyllotropis</i> sp.	Unidentified sp.	outside nest	Flórez-V. et al. 2015	
<i>Potnia granadensis</i>	<i>E. ruidum</i>	outside nest	Loye 1992; Godoy et al. 2006	
<i>Talipes</i> sp.	<i>E. tuberculatum</i>	outside nest	Argoti Ávila 2011	
<i>Todea cimicoides</i>	<i>E. tuberculatum</i>	outside nest	Argoti Ávila 2011	
<i>Tritropidia nimbata</i>	<i>E. tuberculatum</i>	outside nest	Argoti Ávila 2011	
Unidentified sp.	<i>E. brunneum</i> <i>E. tuberculatum</i>	outside nest outside nest	Fernández 1991 Fernández 1991; Blüthgen et al. 2000	

5. Trophobionts

Taxon	Associate	Host	Location	References
Insecta: Hemiptera: Pseudococcidae 	<i>Dysmicoccus boninsis</i> <i>Dysmicoccus brevipes</i> <i>Planococcus citri</i> <i>Pseudococcus sp. 1</i> <i>Saccharicoccus sacchari</i>	<i>E. ruidum</i> <i>E. ruidum</i> <i>E. tuberculatum</i> Unidentified sp. Unidentified sp. <i>E. ruidum</i>	outside nest outside nest outside nest outside nest outside nest outside nest	Kondo et al. 2008 Velez et al. 2002 De Medeiros et al. 1995 Franco et al. 2003 Franco et al. 2003 Kondo et al. 2008
Insecta: Hemiptera: Psyllidae	Unidentified sp.	<i>E. ruidum</i>	outside nest	Pratt 1989



6. Scavengers

- 16 associations involving scavengers from 4 classes of invertebrates (Diplopoda, Insecta, Malacostraca, Mollusca) belonging to, at least, 7 different taxa from 6 families in 4 orders: Polydesmida - Zygentoma - Isopoda - Gastropoda.



6. Scavengers

Taxon	Associate	Host	Location	References
Diplopoda: Polydesmida: Polydesmidae	Unidentified sp.	<i>E. ruidum</i> sp. 2	inside nest*	Quevedo Vega 2015; Pérez-Lachaud & Lachaud unpubl. data
Insecta: Zygentoma: Lepismatidae or Nicoletiidae	Unidentified sp.	<i>E. ruidum</i> sp. 1 <i>E. ruidum</i> sp. 2 <i>E. ruidum</i> sp. 3 <i>E. tuberculatum</i>	inside nest inside nest inside nest inside nest	Lachaud unpubl. data Quevedo Vega 2015; Lachaud unpubl. data Lachaud unpubl. data Cook 1905; Pérez-Lachaud et al. 2011
Malacostraca: Isopoda: Oniscidae	<i>Oniscus</i> sp. Unidentified sp.	<i>E. ruidum</i> <i>E. ruidum</i> sp. 2 <i>E. ruidum</i> sp. 4 <i>E. brunneum</i> <i>E. opaciventre</i>	inside nest inside nest inside nest inside nest inside nest	Weber 1946 Lachaud unpubl. data Lachaud unpubl. data Lapola et al. 2003; Lachaud unpubl. data Antionalli-Junior & Giannotti 1997
Malacostraca: Isopoda: Platyarthridae	Unidentified sp.	<i>E. ruidum</i> sp. 1 <i>E. ruidum</i> sp. 2 <i>E. tuberculatum</i>	inside nest inside nest inside nest	Lachaud unpubl. data Lachaud unpubl. data Lachaud unpubl. data
Malacostraca: Isopoda: Philosciidae	<i>Philoscia muscorum</i>	<i>E. ruidum</i>	inside nest	Pratt 1989
Mollusca: Gastropoda: Unidentified family	Unidentified sp.	<i>E. ruidum</i> sp. 2 <i>E. tuberculatum</i>	inside nest inside nest	Lachaud et al. unpubl. data Cook 1904, 1905; Lachaud et al. unpubl. data




7. Cleptoparasites

- 8 associations involving cleptoparasites from 1 class of invertebrates (Insecta) belonging to 8 different taxa from 2 families in 1 order: Hymenoptera.



7. Cleptoparasites

Taxon	Associate	Host	Location	References
Insecta: Hymenoptera: Ampulicidae	<i>Ampulex</i> sp.	<i>E. ruidum</i>	outside nest	Kronauer 2004
Insecta: Hymenoptera: Formicidae (Ectatomminae) 	<i>Ectatomma brunneum</i> <i>Ectatomma muticum</i> <i>Ectatomma ruidum</i> sp. 1 <i>Ectatomma ruidum</i> sp. 2 <i>Ectatomma permagnum</i> <i>Ectatomma tuberculatum</i>	<i>E. brunneum</i> <i>E. muticum</i> <i>E. ruidum</i> sp. 1 <i>E. ruidum</i> sp. 2 <i>E. permagnum</i> <i>E. tuberculatum</i>	inside nest inside nest inside nest inside nest inside nest inside nest	Lachaud & Corbara unpubl. data Fénéron in lit. Breed et al. 1990; Lachaud et al. unpubl. data De Carli et al. 1998; Lachaud et al. unpubl. data Paiva & Brandão 1989 Lachaud & Pérez-Lachaud unpubl. data
Insecta: Hymenoptera: Formicidae (Myrmicinae)	<i>Crematogaster limata</i>	<i>E. tuberculatum</i>	outside nest	Wheeler 1986; Richard et al. 2004

8. Mutualists, symbionts, symphiles and inquilines

- 30 associations involving organisms from 2 classes of invertebrates (Entognatha, Insecta) belonging to 24 different taxa from 5 families in 3 orders: Collembola - Hymenoptera - Lepidoptera.



8. Mutualists, symbionts, symphiles and inquilines

Taxon	Associate	Host	Location	References
Entognatha: Collembola: Unidentified family	Unidentified sp.	<i>E. ruidum</i>	symphile	Weber 1946
Insecta: Hymenoptera: Formicidae (Ectatomminae)	<i>Ectatomma parasiticum</i>	<i>E. tuberculatum</i>	inquiline	Hora et al. 2005; Feitosa et al. 2008
Insecta: Lepidoptera: Lycaenidae (Theclinae)	<i>Allosmaitia strophius</i> <i>Arawacus lincoides</i> <i>Parrhasius polibetes</i> <i>Rekoa marius</i> <i>Rekoa palegon</i> <i>Terenthina terentia</i> <i>Tmolus echion</i>	<i>E. tuberculatum</i> <i>E. ruidum</i> <i>E. tuberculatum</i> <i>E. edentatum</i> <i>E. tuberculatum</i> <i>E. tuberculatum</i> <i>E. ruidum</i> <i>E. tuberculatum</i> Unidentified sp.	oviposition facilitation mutualistic mutualistic oviposition facilitation mutualistic oviposition facilitation mutualistic mutualism mutualistic*	Bächtold et al. 2016; 2017 Robbins & Aiello 1982; Robbins 1991 Robbins & Aiello 1982; Robbins 1991 Oliveira & Del-Claro 2005; Kaminski 2010 Oliveira & Del-Claro 2005; Kaminski 2010 Bächtold et al. 2016 Lachaud unpubl. data Pomerantz 2015 Robbins & Aiello 1982
Insecta: Lepidoptera: Nymphalidae (Ithomiinae)	<i>Mechanitis isthmia</i>	<i>E. ruidum</i>	mutualistic	Young 1978
Insecta: Lepidoptera: Riodinidae (Riodiniinae)	<i>Adelotypa annulifera</i> <i>Aricoris domina</i> <i>Calospila cilissa</i> <i>Calospila emylius</i> <i>Eurybia elvina</i> <i>Eurybia lycisca</i> <i>Eurybia sp. nr. hyacinthina</i> <i>Nymphidium sp.</i> <i>Synargis abaris</i> <i>Synargis calyce</i> <i>Synargis galena</i> <i>Synargis gela</i> <i>Synargis mycone</i> <i>Thisbe irenea</i>	<i>E. tuberculatum</i> <i>E. tuberculatum</i> <i>E. ruidum</i> <i>E. tuberculatum</i> <i>E. ruidum</i> <i>E. tuberculatum</i> <i>E. ruidum</i> <i>E. tuberculatum</i> <i>E. tuberculatum</i> Unidentified sp. <i>E. tuberculatum</i> <i>E. tuberculatum</i> <i>E. tuberculatum</i> <i>E. tuberculatum</i> <i>E. ruidum</i> <i>E. tuberculatum</i> <i>E. ruidum</i> <i>E. tuberculatum</i>	symbiont symbiont mutualistic mutualistic symbiont symbiont symbiont symbiont symbiont symbiont mutualistic symbiont symbiont symbiont symbiont symbiont symbiont mutualistic	Torres & Pomerantz 2016 Robbins & Aiello 1982 DeVries et al. 1992 DeVries et al. 1992 DeVries et al. 1992; Travassos et al. 2008 DeVries et al. 1992; Travassos et al. 2008 DeVries et al. 1992 DeVries et al. 1992 DeVries et al. 1992 DeVries et al. 1992 DeVries et al. 1992 Kursar et al. 2006 DeVries et al. 1992 Alves-Silva et al. 2018 Kaminski 2017 DeVries et al. 1992 DeVries et al. 1992 DeVries et al. 1992 DeVries 1988; DeVries & Baker 1989; DeVries 1991; DeVries et al. 1992 DeVries 1988; DeVries & Baker 1989; DeVries 1991; DeVries et al. 1992



9. Parasites

- 7 associations involving parasites from 3 classes (Insecta, Alphaproteobacteria, Sordariomycetes) belonging to 5 different taxa from 4 families in 3 orders: Thysanoptera - Rickettsiales - Hypocreales.



9. Parasites

Taxon	Associate	Host	Target	References
Insecta: Thysanoptera: Heterothripidae	<i>Aulacothrips minor</i>	<i>E. ruidum</i>	outside nest (indirect)	Cavalleri et al. 2010
Alphaproteobacteria: Rickettsiales: Anaplasmataceae	<i>Wolbachia</i> spp.	<i>E. brunneum</i> <i>E. edentatum</i> <i>E. tuberculatum</i>	all stages all stages all stages	Werren et al. 1995; Baccaro 2009; Marchesin et al. 2015
Sordariomycetes: Hypocreales: Cordycipitaceae	<i>Beauveria bassiana</i>	Unidentified sp.	adults	Quevillon & Hughes 2018
Sordariomycetes: Hypocreales: Ophiocordycipitaceae	<i>Ophiocordyceps australis</i> <i>Ophiocordyceps</i> sp.	<i>E. tuberculatum</i> <i>E. tuberculatum</i>	adults adults	Baccaro et al. 2014 https://pbase.com/ctranter/image/144565029



10. Potpourri

- 14 associations involving organisms from 3 classes of invertebrates (Arachnida, Diplopoda, Insecta) belonging to, at least, 7 different taxa from 7 families in 4 orders: Mesostigmata - unknown Diplopoda order - Coleoptera - Phasmida.



10. Potpourri

Taxon	Associate	Host	Interaction	References
Arachnida: Mesostigmata: Oplitidae	<i>Oplitis</i> sp.	<i>E. ruidum</i> sp. 2	phoretic or ectoparasitic	Quevedo Vega 2015; Pérez-Lachaud & Lachaud unpubl. data
Arachnida: Mesostigmata: Unidentified family	Unidentified sp.	<i>E. brunneum</i> <i>E. tuberculatum</i> <i>E. ruidum</i> sp. 4	phoretic or ectoparasitic	Lapolla et al. 2003 Weber 1946 Pérez-Lachaud & Lachaud unpubl. data
Diplopoda: Unidentified order: Unidentified family	Unidentified spp.	<i>E. opaciventre</i> <i>E. ruidum</i> sp. 2 <i>E. tuberculatum</i> <i>E. vizottoi</i>	unknown unknown unknown unknown	Antonialli-Junior & Giannotti 1997 Lachaud unpubl. data Cook 1905 Vieira & Antonialli Jr. 2007
Insecta: Coleoptera: Anobiidae	Unidentified sp.	<i>E. planidens</i>	unknown	Antonialli-Junior & Giannotti 1997
Insecta: Coleoptera: Histeridae	<i>Euxenister breyeri</i> Unidentified sp.	<i>E. brunneum</i> <i>E. tuberculatum</i>	unknown unknown	Bruch 1931; Dégallier 1998 Pérez-Lachaud et al. 2011
Insecta: Coleoptera: Staphylinidae	Unidentified sp.	<i>E. ruidum</i> sp. 2 <i>E. ruidum</i> sp. 3	unknown unknown	Quevedo Vega 2015 Pérez-Lachaud & Lachaud unpubl. data
Insecta: Phasmida: Diapheromeridae	<i>Calynda bicuspis</i>	<i>E. brunneum</i>	eggs dispersion	Windsor et al. 1996



Conclusions

- ✓ Despite the reduced number of species concerned, the small size of their colonies, and their aggressiveness, the genus *Ectatomma* exhibits an amazing variety of associates ranging from facultative mutualists to true primary parasitoids, fungi and bacteria.
- ✓ A conservative list of 194 species belonging to 49 families from 18 orders are involved in, at least, 263 associations.
- ✓ 48% of them concern trophobiotic associations with Hemiptera, but most of the associates are rare, specific, and exhibit specialized biology and a wide range of interactions.
- ✓ Out of the 18 species of *Ectatomma* reviewed (15 valid + 3 undescribed cryptic species), less than a third part has been studied. It is likely that such communities might be much more important than previously expected and that numerous new associations are still waiting for being discovered.
- ✓ Considering the risks of biodiversity degradation (habitat loss and habitat fragmentation), it is urgent to perform detailed inventories of the numerous species poorly studied until now and to improve our knowledge on the other, better known species.



