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Floral associations of cyclocephaline scarab beetles

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Abstract

The scarab beetle tribe Cyclocephalini (Coleoptera: Scarabaeidae: Dynastinae) is the second largest tribe of rhinoceros beetles, with nearly 500 described species. This diverse group is most closely associated with early diverging angiosperm groups (the family Nymphaeaceae, magnoliid clade, and monocots), where they feed, mate, and receive the benefit of thermal rewards from the host plant. Cyclocephaline floral association data have never been synthesized, and a comprehensive review of this ecological interaction was necessary to promote research by updating nomenclature, identifying inconsistencies in the data, and reporting previously unpublished data. Based on the most specific data, at least 97 cyclocephaline beetle species have been reported from the flowers of 58 plant genera representing 17 families and 15 orders. Thirteen new cyclocephaline floral associations are reported herein. Six cyclocephaline and 25 plant synonyms were reported in the literature and on beetle voucher specimen labels, and these were updated to reflect current nomenclature. The valid names of three unavailable plant host names were identified. We review the cyclocephaline floral associations with respect to inferred relationships of angiosperm orders. Ten genera of cyclocephaline beetles have been recorded from flowers of early diverging angiosperm groups. In contrast, only one genus, *Cyclocephala*, has been recorded from dicot flowers. Cyclocephaline visitation of dicot flowers is limited to the New World, and it is unknown whether this is evolutionary meaningful or the result of sampling bias and incomplete data. The most important areas for future research include: 1) elucidating the factors that attract cyclocephalines to flowers including floral scent chemistry and thermogenesis, 2) determining whether cyclocephaline dicot visitation is truly limited to the New World, and 3) inferring evolutionary relationships within the Cyclocephalini to rigorously test vicarance hypotheses, host plant shifts, and mutualisms with angiosperms.

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Keywords: Cantharophily, Scarabaeidae, Dynastinae, Araceae, Arecaceae, Annonaceae, Nymphaceae
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Introduction

The Cyclocephalini (Coleoptera: Scarabaeidae: Dynastinae) is the second largest rhinoceros beetle tribe, currently containing 15 genera and nearly 500 described beetle species (Jameson et al. 2002; Ratcliffe 2003; Smith 2006). Cyclocephalines have a pantropical distribution, though the majority of the group's generic and species diversity is concentrated in the New World (Ratcliffe 2003; Ratcliffe and Cave 2006). Most genera are sexually dimorphic, with males having enlarged protarsal claws and females having expanded elytral epipleura (Moore 2012). Cyclocephalines are important economically and ecologically as root pests (larvae) and pollinators (adults) (Ratcliffe 2003; Ratcliffe and Paulsen 2008). Adult cyclocephaline beetles can be found within the inflorescences of early diverging angiosperm groups (the family Nymphaeaceae, magnoliid clade, and monocots; Figure 1) and have been shown to contribute to pollination in the Annonaceae, Araceae, Arecaceae, Cyclanthaceae, Magnoliaceae, and Nymphaeaceae (Cramer et al. 1975; Beach 1982; Beach 1984; Young 1986; Young 1988b; Gottsberger 1989; Dieringer et al. 1999; Hirthe and Porembski 2003; Maia et al. 2012). Studies of these interactions indicate that some early diverging angiosperm groups offer rewards to cyclocephalines in the form of mating sites, food, and metabolic boosts associated with floral thermogenicity in return for pollination services (Gottsberger 1986; Young 1986; Seymour et al. 2009). Cyclocephaline visitation of dicot flowers is poorly known and little studied.

Cyclocephaline floral associations have been reported in journals, books, and monographs since the late 18th century. However, the prevalence, geographic scope, and biological importance of these records are difficult to gauge because publications summarizing cyclocephaline floral visitation are somewhat dated and report floral visitation only for specific plant families, geographic areas, or vegetation types (Henderson 1986; Gibernau 2003; Gottsberger and Silberbauer-Gottsberger 2006; Gibernau 2011). The fragmentary nature of these data and the citation of unpublished observations have hampered the ability to identify floral association trends within cyclocephaline genera and species.

The phylogeny of the Cyclocephalini was investigated for the first time by Clark (2011), and the generic-level relationships within the tribe remain an area of active research by M. R. Moore. Tribal circumscription of the Cyclocephalini is subject to change based on ongoing phylogenetic analyses. This research will provide an evolutionary framework for interpreting patterns of floral visitation. Compilation and synthesis of a checklist of floral associations is needed in order to understand the ecology of the Cyclocephalini within a phylogenetic context.

This checklist synthesizes data (plant and beetle species, geographic locality, and original citation) for the floral associations of adult

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cyclocephaline beetles. Invalid nomenclature in the surveyed literature is identified and corrected; conflicting data, sources of error, and uncertainty in the data are identified; and unpublished floral association data from examined voucher specimens are added. The aim of this work is to promote future research of these ecological interactions by providing a comprehensive data set of the taxonomic and geographic scope of floral visitation for cyclocephaline beetles.

Materials and Methods

Literature was surveyed from 1758 (Linnaeus) to 2012. Keyword searches for all cyclocephaline genera (*sensu* Ratcliffe and Cave 2006; Clark 2011) were conducted in the following databases: BioOne® (www.bioone.org), BIOSIS Previews® (http://apps.webofknowledge.com/), JSTOR (www.jstor.org), and Biodiversity Heritage Library (www.biodiversitylibrary.org). Every host plant reference from Pike et al. (1976) was checked for floral association data.

All reported cyclocephaline species names from the literature were verified by referencing the original species description and monographic treatments of the Dynastinae (Endrödi 1985; Ratcliffe 2003; Ratcliffe and Cave 2006). Synonyms or misspelled cyclocephaline species names in the literature were updated to reflect current nomenclature. All reported host plant names were verified using the peer-reviewed botanical taxonomic databases Tropicos (www.tropicos.org) and The Plant List (www.plantlist.org). Synonyms or misspelled plant names were updated to reflect current nomenclature based on The Plant List (2010). In some cases, scientific names in the literature could not be identified as valid or invalid (e.g., unavailable manuscript names or conflicting synonyms). Some unverified plant names were reported according to the original citation for the floral association, and the name was noted as unresolved. Occasionally, host plant and beetle species were not assigned an author in the reference for an association. This caused problems due to the prevalence of synonyms and homonyms in the plant and insect literature. Resulting ambiguities were rectified to the extent possible and explained in the remarks column (Appendix 1).

Borrowed specimens of cyclocephaline species allowed for direct evaluation of species-level identifications that were reported by several authors. Particularly, this included specimens of *Cyclocephala sexpunctata* Laporte (1840) and *C. brevis* Höhne (1847) collected by George Schatz, Helen Young (La Selva Biological Station, Costa Rica), Alberto Seres, and Nelson Ramirez (Henri Pittier National Park, Venezuela), with floral association data that were subsequently published or unpublished. Identifications of these specimens (or specimen vouchers) were critically examined (Moore 2011). Exemplar material borrowed from the University of Nebraska State Museum (authoritatively identified by B. C. Ratcliffe) and monographic treatments (Ratcliffe 2003; Ratcliffe and Cave 2006) served as the basis for evaluating species identifications as well as detailed images of some type specimens. The operating assumption was that the collectors and authors were consistent with their species-level determinations. Identifications deemed incorrect based on current taxonomy were updated and noted accordingly. Unpublished host plant data were also found with cyclocephaline specimens in collections. These specimens were collected by M. R. Moore and deposited at Wichita State University, Wichita, Kansas, USA, or loaned from the following institutions:

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INBC: Instituto Nacional de Biodiversidad, Santo Domingo de Herédia, Costa Rica (Angel Solís)
MLUH: Zentralmagazin Naturwissenschaftlicher Sammlungen, Martin Luther Universität Halle-Wittenberg, Halle, Saxony-Anhalt, Germany (Karla Schneider)
MNHN: Muséum national d'Histoire naturelle, Paris, France (Olivier Montreuil)
SEMC: Snow Entomological Museum, University of Kansas, Lawrence, KS (Zach Falin and Jennifer Thomas)
UNSM: University of Nebraska State Museum, Lincoln, NE (Brett Ratcliffe and Matt Paulsen)
USNM: U.S. National Museum, Washington, D.C. (currently housed at the University of Nebraska State Museum for off-site enhancement) (Floyd Shockley and Dave Furth)
UVGC: Universidad del Valle de Guatemala, Guatemala City, Guatemala (Jack Schuster and Enio Cano)
WICH: Wichita State University, Wichita, KS (Mary Liz Jameson)
ZMHB: Museum für Naturkunde der Humboldt Universität zu Berlin, Berlin, Germany (Johannes Frisch and Joachim Willers)

Concrete and anecdotal evidence of floral associations were also included in the checklist. The nature of the published association occasionally needed clarification or elaboration (e.g., cyclocephalines reported near flowers but not on them or museum specimens covered in resin and pollen). These clarifications were provided in the remarks column of Appendix 1. A large amount of unpublished and inaccessible data exists with regard to cyclocephaline floral visitation. These records provide ambiguous data for plant species, cyclocephaline species, locality, and associated voucher information. For example, Schatz (1990, Table 7.3) recorded known and predicted (without distinguishing the two) plant taxa pollinated by dynastines in the Neotropics. Schatz (1990, Table 7.4) recorded cyclocephaline plant visitation at La Selva Biological Station, but a large amount of data could not be extracted because of the non-specific nature of the record (i.e., the data were reported at the tribal-level rather than at the species-level). These inaccessible data are important because they report certain associations that are not recorded elsewhere in the literature. Repetitive data from these types of records were omitted from the checklist. Only unique generic or species-level plant associa-

Table 1. Previously unpublished cyclocephaline beetle floral association data.

Scarab Taxa	Plant Taxa	Locality	Collector	Depository
Cyclocephala atripes Bates, 1888	*Dieffenbachia tonduzii* Croat & Grayum	COSTA RICA: Herédia (La Selva Biol. Stat.)	M. Grayum	3 vouchers in INBC
Cyclocephala brevis Höhne, 1847 *incertae cedis* (*Cyclocephala* morphospecies 3 *sensu* Moore 2011)	*Dieffenbachia seguine* (Jacq.) Schott	VENEZUELA: Aragua (Henri Pittier National Park)	A. Seres and N. Ramirez	1 voucher in USNM
	Philodendron ligulatum Schott	COSTA RICA: Herédia (La Selva Biol. Stat.)	H. Young	1 voucher in INBC
Cyclocephala brevis Höhne, 1847 *incertae cedis* (*Cyclocephala* morphospecies 4 *sensu* Moore 2011)	*Philodendron* sp.	PANAMA: Colón (1 km E Rio Guanche Bridge)	B. Ratcliffe and M. Jameson	1 voucher in UNSM
Cyclocephala octopunctata Burmeister, 1847	*Annona dioica* A. St.-Hil.	BOLIVIA: Santa Cruz	uncredited	1 voucher in UNSM
Cyclocephala ovulum Bates, 1888	*Inga* sp.	ECUADOR: Napo (Yasuni Research Station)	M. Jameson	1 plant voucher in WICH
Cyclocephala rustica (Olivier, 1789)	Arecaceae	BRAZIL: Manaus (Reserva Ducke)	S. Vidal	2 vouchers in UNSM
	Dieffenbachia seguine (Jacq.) Schott	FRENCH GUIANA: Dept 973 (Nouragues)	M. Gibernau	5 vouchers in UNSM
Cyclocephala santaritae Ratcliffe, 1992a	*Oenocarpus* sp.	ECUADOR: Napo	H. Balslev and A. Henderson	3 vouchers in UNSM
Cyclocephala sexpunctata Laporte, 1840 *incertae sedis* (*Cyclocephala* morphospecies 2 *sensu* Moore 2011)	*Alocasia macrorrhizos* (L.) G. Don	COSTA RICA: San José (Parque del Este)	Uncredited (likely collected by C. Valerio, see Valerio 1984)	8 vouchers in UNSM
Cyclocephala undata (Olivier, 1789)	*Duguetia asterotricha* (Diels) R. E. Fr.	BRAZIL: Manaus	G. Gottsberger	1 voucher in UNSM
Erioscelis proba Sharp, 1877	*Dieffenbachia seguine* (Jacq.) Schott	FRENCH GUIANA (Nouragues Field Station)	M. Gibernau	28 vouchers in UNSM
Mimeoma signatoides (Höhne, 1923)	*Socratea* sp.	VENEZUELA (Henri Pittier National Park)	A. Seres and N. Ramirez	1 voucher in USNM

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tions were reported for the beetle tribe from these data sets. These non-specific records are reported at the end the checklist with the intention that they be reevaluated with the addition of more data.

Results

Based on species-specific records from the literature and voucher label data, at least 97 cyclocephaline species from nine or 10 genera (depending on the identity of the cyclocephaline reported by Gibbs et al. (1977)) were recorded in association with the flowers of at least 161 species representing 58 genera, 17 families, and 15 orders (Appendix 1). Examined voucher specimens occasionally had unique, unpublished, floral association data. Thirteen new plant associations are provided in Table 1. Examined voucher specimens that did not have unique data are noted in Appendix 1. The most specific data are summarized at the generic-level for the plant association (plant classification according to the Angiosperm Phylogeny Group III (2009)) in Table 2 and are provided in full detail (lowest-level taxonomy, geographic data, and references) in Appendix 1. Cyclocephaline beetle genera and their associations with angiosperm plant lineages were mapped onto the APG III angiosperm phylogeny (Figure 1).

Five of the 15 cyclocephaline genera were not reported as floral visitors in any of the surveyed literature: *Acrobolbia* Ohaus (1912), *Ancognatha* Erichson (1847), *Harposcelis* Burmeister (1847), *Stenocrates* Burmeister (1847), and *Surutu* Martínez (1955). Preliminary phylogenetic analysis of the Cyclocephalini indicated that the Neotropical genus *Parapucaya* Prell (1934) (Dynastinae: Pentodontini) and the Indonesian archipelago genus *Neohyphus* Heller (1896) (Dynastinae: Oryctoderini) fall within a potential newly

Table 2. Generic-level summary of floral association records for the Cyclocephalini (group names in parentheses are based on APG III (2009)) [? indicates a potentially dubius record, see Appendix 1].

Plant Taxa	Scarab Genera
NYMPHAELES	
Nymphaeaceae	
Nymphaea	*Cyclocephala* Dejean
	Ruteloryctes Arrow
Victoria	*Arriguttia* Martínez
	Chalepides Casey
	Cyclocephala
MAGNOLIALES	
Annonaceae	
Annona	*Cyclocephala*
	Dyscinetus Harold (?)
Cymbopetalum	*Cyclocephala*
Duguetia	*Cyclocephala*
Malmea	*Cyclocephala*
Porcelia	*Cyclocephala*
Magnoliaceae	
Magnolia	*Augoderia* Burmeister (?)
	Cyclocephala
ALISMATALES	
Araceae	
Alocasia	*Cyclocephala*
Amorphophallus	*Peltonotus* Burmeister
Caladium	*Cyclocephala*
Colocasia	*Cyclocephala*
Dieffenbachia	*Cyclocephala*
	Erioscelis Burmeister
Epipremnum	*Peltonotus*
Gearum	*Cyclocephala*
Monstera	*Cyclocephala*
Montrichardia	*Aspidolea* Bates
	Cyclocephala
	Erioscelis
Philodendron	*Cyclocephala*
	Erioscelis
Rhodospatha	*Cyclocephala*
Syngonium	*Cyclocephala*
	Erioscelis
Taccarum	*Cyclocephala*
Xanthosoma	*Cyclocephala*
	Erioscelis
Araceae undetermined	*Arriguttia* Martínez
PANDANALES	
Cyclanthaceae	
Asplundia	*Cyclocephala*
Carludovica	*Cyclocephala*
Cyclanthus	*Cyclocephala*
ARECALES	
Arecaceae	
Acrocomia	*Cyclocephala*
Aphandra	*Cyclocephala*
Astrocaryum	*Cyclocephala*
	Mimeoma Casey
Attalea	*Cyclocephala*
Bactris	*Cyclocephala*
	Mimeoma
Cryosophila	*Cyclocephala*
Elaeis	*Cyclocephala*

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Table 2. Continued.

Oenocarpus	*Aspidolea*
	Cyclocephala
Phytelephas	*Cyclocephala*
Socratea	*Cyclocephala*
	Mimeoma
Syagrus	*Cyclocephala*
Wettinia	*Cyclocephala*
FABALES	
Fabaceae	
Acacia	*Cyclocephala*
Pithecellobium	*Cyclocephala*
Inga	*Cyclocephala*
ROSALES	
Moraceae	
Ficus	*Cyclocephala*
MALPIGHIALES	
Calophyllaceae	
Kielmeyera	*Cyclocephala*
MYRTALES	
Myrtaceae	
Psidium	*Cyclocephala*
MALVALES	
Malvaceae	
Hibiscus	*Cyclocephala*
CARYOPHYLLALES	
Cactaceae	
Cereus	*Cyclocephala*
Echinopsis	*Cyclocephala*
Opuntia	*Cyclocephala*
ERICALES	
Lecythidaceae	
Corythophora	*Cyclocephala*
Eschweilera	*Cyclocephala*
Lecythis	*Cyclocephala*
Sapotaceae	
Pouteria	*Cyclocephala*
ASTERALES	
Asteraceae	
Helianthus	*Cyclocephala*
Verbesina	*Cyclocephala*
SOLANALES	
Solanaceae	
Brugmansia	*Cyclocephala*
Datura	*Cyclocephala*
GENTIANALES	
Apocynaceae	
Hancornia	*Cyclocephala*
Mandevilla	*Cyclocephala*
Tabernaemontana	*Cyclocephala*

defined Cyclocephalini (Clark 2011). These genera were included in the systematic literature searches but yielded no floral association records. The results of Clark (2011) hypothesized that the genus *Erioscelis* Burmeister (1847) is sister to all remaining genera of the Cyclocephalini + *Neohyphyus* + *Parapucaya*. *Erioscelis* was included in this checklist because of its documented visitation of several genera in the Araceae (also visited by other cyclocephalines) and its historical inclusion in the Cyclocephalini.

Floral associations that are less specific or ambiguous (non-specific records) were also reported (Appendix 1). For example, Listabarth (1996) reported dynastine scarabs, with no further species identification, on three species of *Bactris* palms (Arecales). These data include records for Scarabaeidae, Dynastinae, and beetles on flowers that fit the general pattern of cyclocephaline floral visitation (nocturnal visitation of bowl-shaped, thermogenic inflorescences). Non-specific records were included in the checklist with the hope that they may be reevaluated with additional data.

Gathering and interpreting floral association data were complicated by the prevalancy of synonyms, invalid names, and unavailable names in the literature. Based on The International Code of Zoological Nomenclature (ICZN 1999), an unavailable name is a name that is excluded from use due to the requirements of the code. For example, the unavailable name *Cyclocephala inpunctata* was reported in the surveyed literature (Gottsberger 1986, 1988). *C. inpunctata* has never been described in the literature. This name is unavailable and was likely reported in error. Based on published locality data for the floral association, images of the beetle (Gottsberger 1988; Figure 4a, 5 a–d), and subsequently published records, we consider this species to be *Cyclocephala quatuordecimpunctata* Mannerheim (1829) (personal communication with B. C. Ratcliffe, April 2011). Synonyms of six cyclocephaline genus or species names were

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reported in the surveyed literature; these invalid names were updated based on current nomenclature (Appendix 2). Synonyms of 25 plant genus or species names were reported in the surveyed literature and on voucher specimen label data; these invalid names were updated based on current nomenclature (Appendix 3).

Seven unresolved or unavailable plant names were reported from label data and in the surveyed literature (Appendix 4). According to The Plant List (2010), unresolved names are those for which "it is not yet possible to assign a status of either 'accepted' or 'synonym.'" Two of these names, *Philodendron atlanticum* and *Dieffenbachia longivaginata*, were unavailable manuscript names (place-holder names for species that were later described) of Thomas Croat and Michael Grayum (Missouri Botanical Garden, St. Louis, Missouri, USA). These species were identified as *Philodendron ligulatum* Schott and *Dieffenbachia tonduzii* Croat and Grayum, respectively (personal communication with T. Croat and M. Grayum, April 2011). *Xanthosoma macrorrhizas* is an unavailable name that was reported by Valerio (1984). This species may be the cultivated, naturalized, non-native species *Alocasia macrorrhizos* (L.) G. Don (personal communication with T. Croat, April 2011).

Certain cyclocephaline species were commonly reported as floral visitors. For example, *Cyclocephala sexpunctata* had over 20 floral visitation records in the surveyed literature (Appendix 1). *C. sexpunctata* is externally nearly identical to *C. brevis* (*sensu* Ratcliffe 2003; Ratcliffe and Cave 2006). Research on these two species showed that they represent four, or potentially five, morphospecies (Moore 2011). This conclusion was based on male genitalic characters, the form of the female epipleuron, and extensive range and spatial data (Moore 2011). The taxonomy of the species *C. sexpunctata* and *C. brevis* remains unresolved (a possible species complex), and their floral associations were reported in detail (Moore 2011). Some voucher specimens for reported floral associations of *C. sexpunctata* and *C. brevis* remain to be examined, and some data will require reinterpretation after the examination of type specimens.

Discussion

Examination of cyclocephaline floral associations with respect to inferred relationships of angiosperm orders revealed that 10 of the 15 genera of cyclocephaline beetles have been recorded from flowers of early diverging angiosperm groups (the family Nymphaeaceae, magnoliid clade, and monocots; Figure 1). In contrast, only one genus, *Cyclocephala*, has been recorded from dicot flowers (Figure 1). Experimental and observational studies have demonstrated that cyclocephalines can act as pollinators in Nymphaeales, Magnoliales, Arecales, Pandanales, and Alismatales (Figure 1; Table 2) (Cramer et al. 1975; Beach 1982; Beach 1984; Young 1986; Young 1988b; Gottsberger 1989; Dieringer et al. 1999; Hirthe and Porembski 2003; Maia et al. 2012). In these early diverging plant groups, a wide set of floral traits and floral pollination syndromes indicate a correlation with cyclocephaline beetles (large pollen grains with sticky exudates, sturdy and funnel-shaped inflorescences or large disc-shaped flowers, timing of anthesis, and thermogenesis) (Thien et al. 2009; Gibernau et al. 2010). These angiosperm orders offer rewards to cyclocephalines in the form of mating sites, food, and heat resources associated with floral thermogenicity (Young 1986; Seymour et al. 2009).

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Some cyclocephaline/flower associations are mutualistic (Cramer et al. 1975; Beach 1982; Beach 1984; Young 1986; Young 1988b; Gottsberger 1989; Dieringer et al. 1999; Hirthe and Porembski 2003; Maia et al. 2012). Ervik and Knudsen (2003) provide a compelling argument that scarab pollination of the Nymphaeaceae (Nymphales) is a mutualistic relationship that dates to the early Cretaceous. Whether this represents an example of coevolution is unclear, and only one study has addressed this hypothesis (Schiestl and Dötterl 2012). Schiestl and Dötterl (2012) argued that volatile organic compound production/detection systems arose in the Scarabaeoidea during the Jurassic, whereas floral volatile organic compounds arose in the Cretaceous/Paleocene. This was taken as evidence that early diverging angiosperm plant/scarab associations evolved due to a preexisting sensory bias in scarabs rather than as a result of coevolution (Schiestl and Dötterl 2012). However, coevolution could not be ruled out for the mutualism between cyclocephaline scarabs and aroid flowers (Schiestl and Dötterl 2012).

Floral visitation of the core eudicot clade (Figure 1) by cyclocephalines is poorly described and, in certain cases, differs significantly from a pollination mutualism. Such cases involve feeding and mating within flowers in which cyclocephalines have no apparent pollinating function and may destroy the reproductive capability of the plant. For example, in the Brazilian dicot *Opuntia monocantha* Haw. (Caryophyllales), *Cyclocephala* have been observed mating within the flowers and feeding on stamens (Lenzi and Inácio Orth 2011). Observations made on *Echinopsis ancistrophora* Speg. subsp. *ancistrophora* (Caryophyllales) flowers indicate that *Cyclocephala* visitors display destructive feeding behavior and do not contribute to reproduction (Schlumpberger et al. 2009). *Cyclocephala metrica* Steinheil (1874) was observed feeding on seeds in flower heads of *Verbesina encelioides* (Cav.) Benth. and Hook. f. ex A. Gray (Asterales) in Argentina (Hayward 1946). Seed predation in phytophagous scarabs is rare, the only other known example being some members of the subtribe Anisopliina (Scarabaeidae: Rutelinae: Anomalini) that feed on grass seeds (Poaceae) (Jameson et al. 2007).

In contrast to apparent destructive associations with dicots, only one detailed account provides evidence of a cyclocephaline beetle pollinating a eudicot. Prance (1976) observed male and female *Cyclocephala verticalis* Burmeister (1847) occupying the inflorescences of *Lecythis*, *Corythophora*, and *Eschweilera* (Ericales) in Amazonas, Brazil. *C. verticalis* was strong enough to lift the closed androphore flap of Lecythidaceae (Ericales) inflorescences and displayed selective feeding of floral parts, eating only staminode tissue at the apex of the androphore and leaving fertile stamens untouched (Prance 1976). Based on these observations, *C. verticalis* was considered a likely pollinator of some Lecythidaceae genera, though this hypothesis was not tested (Prance 1976).

Gottsberger (1986) considered cyclocephaline floral visitation of the dicot families Apocynaceae (Gentianales), Calophyllaceae (Malpighiales), and Sapotaceae (Ericales) to be opportunistic. In the absence of early diverging angiosperm host flowers, Gottsberger (1986) hypothesized that cyclocephalines would visit strongly scented flowers of other groups. Cyclocephalines have been shown to aggregate based on floral scent compounds alone (Gottsberger et al. 2012). Cyclocephaline species (and populations) likely are biased towards a wide range of floral scent

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compounds. Eudicot species with geographically variable floral scent profiles may evolve scents that incidentally stimulate cyclocephaline aggregation by randomly sampling the sensory bias range of scarabs present in that area (e.g., Schlumpberger and Raguso 2008; Schlumpberger et al. 2009). This scenario, if accurate, would lend support to the hypothesis of Schiestl and Dötterl (2012) that preexisting sensory biases in cyclocephalines have an important role in determining the host flower profile of a given cyclocephaline species.

Based on the assembled data (Appendix 1), cyclocephaline visitation of eudicots is limited to the New World. It is unknown whether this shift represents an evolutionary event that occurred in New World cyclocephalines. Observations of cyclocephalines on dicot flowers (Figure 1) have largely been made by chance and have not been the subject of rigorous experimentation or sampling protocols. Thus, it is quite possible that Old World cyclocephalines (*Ruteloryctes*, *Peltonotus*, and potentially *Neohyphus*) visit both early diverging angiosperm groups and dicot groups, but dicot associations have not been recorded. However, it is certain that the known diversity of host flowers lineages is much higher for New World cyclocephalines (15 orders, 17 families, and 58 genera) compared to Old World cyclocephalines (two orders, two families, and three genera) (Appendix 1). This correlation may indicate that the radiation of the cyclocephalines in the New World was accompanied by a subsequent increase in the diversity of their floral associations.

Cyclocephaline species are generally oligophagous or polyphagous. For cyclocephaline species with multiple host records, only seven species have been recorded from a single host plant genus (monophagous), 23 species have been reported from multiple host plant genera within a family (oligophagous), and 27 species have been recorded from multiple host plant families (polyphagous) (Appendix 1). Single inflorescences often contain multiple cyclocephaline species, and an extreme example is *Dieffenbachia nitidipetiolata* Croat and Grayum (Alismatales), which was visited by at least nine *Cyclocephala* species at La Selva Biological Station, Costa Rica (Young 1990; see Croat 2004 for plant identification). These multi-species aggregations might be explained if floral scents are serving as sex pheromones for multiple cyclocephaline species (Schatz 1990). This hypothesis may be supported by the observations of Gottsberger et al. (2012) that *Cyclocephala literata* Burmeister will aggregate due to floral scent compounds alone.

The consequences of polyphagous and oligophagous cyclocephalines for pollination efficiency have been experimentally addressed, indicating that cyclocephaline floral visitors are differentially important as pollinators due to an interaction between their relative abundance and specific behavior (Young 1986, 1988a, b, 1990). It is less clear how cyclocephalines species, which often mate inside inflorescences, maintain sexual isolation in close proximity to multiple congenerics. A single infloresence may host large crowds of beetles, often more then 30 individuals (Maia et al. 2012). Sexual isolation may be maintained due to interspecific mating morphology (Moore 2012). Sexually dimorphic cyclocephaline species have enlarged protarsal claws (males), and the elytral epipleuron variably expanded into a shelf or flange (females). Morphological differences among epipleural expansions are useful for species-level identification in the Cyclocephalini (Ratcliffe 2003). Females have sclerotized patches, sometimes with setae, on the ventral portion of epipleural expansions (Moore

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2012). It is hypothesized that the interaction between the male protarsal claw, the female epipleural expansions, and the ventral portion of the female elytra serves as a pre-copulatory sexual isolation mechanism. Further sexual isolation between species is accomplished by species-specific differences in male genitalic structure (Moore 2012). The male protarsal claw and the female epipleuron may also be involved in intraspecific mate competition. For example, male *Cyclocephala gravis* Bates were observed clinging tightly to the epipleural structures of a female (guarding behavior), thus limiting the mating access of other *C. gravis* males (Moore 2012). Cyclocephaline beetles exhibit some similarity to hopliine scarabs (Scarabaeidae: Rutelinae: Hopliini), which are generalist flower visitors in South Africa (Ahrens et al. 2011). Sexual dimorphism has evolved independently several times within the Hopliini (Ahrens et al. 2011). Evolution of sexual dimorphism in hopliines could be tied to the group's biology, as they feed and compete for mates within inflorescences (Midgeley 1992; Ahrens et al. 2011). Sexual dimorphism in cyclocephalines and hopliines may be analogous, driven by selection pressures related to oligophagous and polyphagous flower feeding, mating behavior, and host visitation.

Cyclocephaline beetles and floral associations provide an ideal system for investigating ecology (pollination, competition) and evolution (sexual selection, mutualisms). A well-founded phylogenetic framework for the Cyclocephalini is needed to advance this work. While ecological associations between beetles and early diverging angiosperm groups is fairly well-established, additional research is necessary to understand the ecological and historical associations of cyclocephaline beetles and dicots. Specifically, research is needed to address the apparent cyclocephaline diversification on New World dicots. Research on cryptic species of host plants and beetles is fundamental to understanding this system. This includes the role of floral volatile compounds in attracting cyclocephaline beetles and patterns of pollination, herbivory, and interspecific competition within floral hosts.

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References

Aguirre A, Guevara R, Dirzo R. 2011. Effects of forest fragmentation on assemblages of pollinators and floral visitors to male- and female-phase inflorescences of *Astrocaryum mexicanum* (Arecaceae) in a Mexican rain forest. *Journal of Tropical Ecology* 27: 25–33.

Ahrens D, Scott M, Vogler AP. 2011. The phylogeny of monkey beetles based on mitochondrial and ribosomal RNA genes (Coleoptera: Scarabaeidae: Hopliini). *Molecular Phylogenetics and Evolution* 60: 408–415.

Downloaded From: https://complete.bioone.org/journals/Journal-of-Insect-Science on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

Anderson AB, Overal WL, Henderson A. 1988. Pollination ecology of a forest-dominant palm (*Orbignya phalerata* Mart.) in northern Brazil. *Biotropica* 20: 192–205.

Anderson RS, Gómez-Pignataro LD. 1997. *Systenotelus*, a remarkable new genus of weevil (Coleoptera: Curculionidae) associated with *Carludovica* (Cyclanthaceae) in Costa Rica and Panamá. *Revista de Biología Tropical* 45: 887–904.

Angiosperm Phylogeny Group III (APG III). 2009. An update of The Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. *Botanical Journal of the Linnean Society* 161: 105–121.

Arrow GJ. 1902. Notes and descriptions of some Dynastidae from tropical America, chiefly supplementary to the 'Biologia Centrali-Americana.' *Annals and Magazine of Natural History* (series 7) 10: 137–147.

Arrow GJ. 1903. Description of a few new species of Coleoptera from Sapucay, Paraguay. *Proceedings of the Zoological Society of London* 2: 255–258.

Arrow GJ. 1910. On the lamellicorn beetles of the genus *Peltonotus* with descriptions of four new species. *Annals and Magazine of Natural History* (series 8) 5: 153–157.

Arrow GJ. 1911. Notes on the coleopterous subfamily Dynastinae, with descriptions of new genera and species. *Annals and Magazine of Natural History* (series 8) 8: 151–176.

Balslev H, Henderson A. 1987. A new *Ammandra* (Palmae) from Ecuador. *Systematic Botany* 12: 501–504.

Bates HW. 1888. Pectinicornia and Lamellicornia, Family Dynastidae. In: Godman FD, Salvin O, Editors. *Biologia Centrali-Americana*. *Insecta*, *Coleoptera*, volume 2, part 2. pp. 296–342.

Bates HW. 1891. Coleoptera. In: Whymper E, Editor. *Supplementary Appendix to Travels Amongst the Great Andes of the Equator*. pp. 7–39. John Murray.

Bawa KS, Bullock SH, Perry DR, Coville RE, Grayum MH. 1985b. Reproductive biology of tropical lowland rainforest trees. II. Pollination systems. *American Journal of Botany* 72: 346–356.

Bawa KS, Perry DR, Beach JH. 1985a. Reproductive biology of tropical lowland rainforest trees. I. Sexual systems and incompatibility mechanisms. *American Journal of Botany* 72: 331–345.

Beach JH. 1982. Beetle pollination of *Cyclanthus bipartitus* (Cyclanthaceae). *American Journal of Botany* 69: 1074–1081.

Beach JH. 1984. The reproductive biology of the peach or "pejibaye" palm (*Bactris gasipaes*) and a wild congener (*B. porschiana*) in the Atlantic lowlands of Costa Rica. *Principes* 28: 107–119.

Beath DN. 1998. *Pollination Ecology of the Araceae*. International Aroid Society, Inc. Available online: http://www.aroid.org/pollination/beath/index.php

Beath DN. 1999. Dynastine scarab beetle pollination in *Dieffenbachia longispatha* (Araceae) on Barro Colorado Island (Panama) compared with La Selva Biological Station (Costa Rica). *Aroideana* 22: 63–71.

Downloaded From: https://complete.bioone.org/journals/Journal-of-Insect-Science on 28 Mar 2024
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Bernal R, Ervik F. 1996. Floral biology and pollination of the dioecious plam *Phytelephas seemannii* in Colombia: an adaptation to staphylinid beetles. *Biotropica* 28: 682–696.

Bogner J. 2008. The genus *Bognera* Mayo & Nicolson (Araceae). *Aroideana* 31: 3–14.

Bullock SH. 1981. Notes on the phenology of inflorescences and pollination of some rain forest palms in Costa Rica. *Principes* 25: 101–105.

Burmeister H. 1847. *Handbuch der Entomologie*, volume 5. T. C. F. Enslin.

Búrquez A, Sarukhán KJ, Pedroza AL. 1987. Floral biology of a primary rainforest palm, *Astrocaryum mexicanum* Liebm. *Botanical Journal of the Linnean Society* 94: 407–419.

Casey TL. 1915. A review of the American species of Rutelinae, Dynastinae and Cetoniinae. *Memoirs on the Coleoptera* 11: 1–347.

Cavalcante TRM. 2000. *Polinização manual e natural da gravioleira (Annona muricata L.)*. MS dissertation. Universidad Federal de Viçosa, Viçosa, Brazil.

Cavalcante TRM, Naves RV, Franceschinelli EV, da Silva RP. 2009. Polinização de frutos em araticum. *Bragantia, Campinas* 68: 13–21.

Chen HY, Yeng WS, Boyce PC, Hung WM, Yok MCK. 2011. Studies of Homalomeneae (Araceae) of Borneo VII: *Homalomena debilicrista*, a new species from Malaysian Borneo, and observations of its pollination mechanics. *Plant Diversity and Evolution* 129: 77–87.

Clark DR. 2011. *Phylogenetic analysis of the scarab beetle tribe Cyclocephalini (Coleoptera: Scarabaeidae: Dynastinae) based on adult morphological characters*. Masters Thesis, Wichita State University. Wichita, KS, USA.

Cockerell TDA. 1897. Biological notes on some Coleoptera from New Mexico. *Journal of the New York Entomological Society* 5: 149–150.

Cook OF. 1927. New genera and species of ivory palms from Colombia, Ecuador and Peru. *Journal of the Washington Academy of Sciences* 17: 218–230.

Cramer JM, Meese ADJ, Tuenissen PA. 1975. A note on the pollination of nocturnally flowering species of *Nymphaea. Acta Botanica Neerlandica* 24: 489–490.

Croat TB. 1981. A revision of *Syngonium* (Araceae). *Annals of the Missouri Botanical Garden* 68: 565–651.

Croat TB. 1997. A revision of *Philodendron* subgenus *Philodendron* (Araceae) for Mexico and Central America. *Annals of the Missouri Botanical Garden* 84: 311–704.

Croat TB. 2004. Revision of "*Dieffenbachia*" (Araceae) of Mexico, Central America, and the West Indies. *Annals of the Missouri Botanical Garden* 91: 668–772.

de Oliveira HN, Ávila CJ. 2011. Ocorréncia de *Cyclocephala forsteri* em *Acronomia aculeata*. *Pesquisa Agropecuária Tropical* 41: 293–295.

Dechambre RP. 1979. Missions Entomologiques en Guyane et au Brésil

Downloaded From: https://complete.bioone.org/journals/Journal-of-Insect-Science on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

(Coleoptera, Dynastidae). *Revue Française d'Entomologie* 1: 160–168.

Dechambre RP. 1980. Six nouvelles espèces de *Cyclocephala*. *Revue Francaise d'Entomologie* (Nouvelle-Serie) 2: 42–49.

Dejean PFMA. 1821. *Catalogue de la collection de Coléoptères de M. le Baron Dejean*. Paris, France.

Dieringer G, Delgado L. 1994. Notes on the biology of *Cyclocephala jalapensis* (Coleoptera: Scarabaeidae): an endemic of eastern Mexico. *The Southwestern Entomologist* 19: 309–311.

Dieringer G, Espinosa JE. 1994. Reproductive Ecology of *Magnolia schiedeana* (Magnoliaceae), a threatened cloud forest tree species in Veracruz, Mexico. *Bulletin of the Torrey Botanical Club* 121: 154–159.

Dieringer G, Cabrera R L, Lara M, Loya L, Reyes-Castillo P. 1999. Beetles pollination and floral thermogenicity in *Magnolia tamaulipana* (Magnoliaceae). *International Journal of Plant Sciences* 160: 64–71.

Dieringer G, Reyes-Castillo P, Lara M, Cabrera RL, Loya L. 1998. Endothermy and floral utilization of *Cyclocephala caelestis* (Coleoptera: Scarabaeoidae: Melolonthidae): a cloud forest endemic beetle. *Acta Zoologica Mexicana* 73: 145–153.

Endrödi S. 1963. Neue *Cyclocephala*-Arten. *Annales Historico-Naturales Musei Nationalis Hungarici (pars Zoologica*) 55: 323–333.

Endrödi S. 1964. Eine Reihe von neuen *Cyclocephala*-Arten (Col., Melolonthidae, Dynastinae). *Folia Entomologica Hungarica* 17: 433–470.

Endrödi S. 1966. Monographie der Dynastinae (Coleoptera, Lamellicornia). I. Teil. *Entomologische Abhandlungen* 33: 1–460.

Endrödi S. 1969. Einige neue Cyclocephalini und Pentodontini. *Acta Zoologica Hungarica* 15: 21–42.

Endrödi S. 1975. *Cyclocephala hardyi* sp. n. *Folia Entomologica Hungarica* (N.S.) 28: 281–284.

Endrödi S. 1980. Sechs neue Dynastinen-Arten aus Amerika und Borneo (Coleoptera: Dynastinae). *Folia Entomologica Hungarica* 41: 37–42.

Endrödi S. 1985. *The Dynastinae of the World*. Dr. W. Junk Publishers.

Erichson WF. 1847. Conspectus insectorum coleopterorum quae in Republica Peruana observata sunt. *Archiv für Naturgeschichte* 13: 67–185.

Ervik F. 1993. Notes on the phenology and pollination of the dioecious palms *Mauritia flexuosa* (Calamoideae) and *Aphandra natalia* (Phytelephantoideae) in Ecuador. In: Barthlott W, Naumann CM, Schmidt-Loeske K, Schuchmann KL, Editors. *Animal-plant interactions in tropical environments: results of the annual meeting of the German Society for Tropical Ecology held at Bonn, Germany, February 13-16, 1992*. pp. 7–12.

Ervik F, Knudsen JT. 2003. Water lilies and scarabs: faithful partners for 100 million years? *Biological Journal of the Linnean Society* 80: 539–543.

Ervik F, Tollsten L, Knudsen JT. 1999. Floral scent chemistry and pollination ecology in

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Terms of Use: https://complete.bioone.org/terms-of-use

phytelephantoid palms (*Arecaceae*). *Plant Systematics and Evolution* 217: 279–297.

Fabricius JC. 1775. *Systema Entomologiae*. Leipzig, Germany.

Fabricius JC. 1781. *Species Insectorum*, Volume 1. Kiel, Germany.

Fabricius JC. 1798. *Supplementum Entomologiae Systematicae*. Proft et Storch, Hafniae.

García-Robledo C, Kattan G, Murcia C, Quintero-Marín P. 2004. Beetle pollination and fruit predation of *Xanthosoma daguense* (Araceae) in an Andean cloud forest in Colombia. *Journal of Tropical Ecology* 20: 459–469.

García-Robledo C, Quintero-Marín P, Mora-Kepfer F. 2005. Geographic variation and succession of arthropod communities in inflorescences and infructescences of *Xanthosoma* (Araceae). *Biotropica* 37: 650–656.

Gessner F. 1962. A abertura das flôres de *Victoria regia*, em relação à luz. *Boletim do Museu Paranense Emílio Goeldi* 17: 1–13.

Gibernau M. 2003. Pollinators and visitors of aroid inflorescences. *Aroideana* 26: 66–83.

Gibernau M. 2011. Pollinators and visitors of aroid inflorescences: an addendum. *Aroideana* 34: 70–83.

Gibernau M, Barabé D. 2002. Pollination ecology of *Philodendron squamiferum* (Araceae). *Canadian Journal of Botany* 80: 316–320.

Gibernau M, Barabé D, Labat B. 2000. Flowering and pollination of *Philodendron melinonii* (Araceae) in French Guiana. *Plant Biology* 2: 331–334.

Gibernau M, Barabé D, Cerdan P, Dejean A. 1999. Beetle pollination of *Philodendron solimoesense* (Araceae) in French Guiana. *International Journal of Plant Science* 160: 1135–1143.

Gibernau M, Barabé D, Labat D, Cerdan P, Dejean A. 2003. Reproductive Biology of *Montrichardia arborescens* (Araceae) in French Guiana. *Journal of Tropical Ecology* 19: 103–107.

Gibernau M, Chartier M, Barabé D. 2010. Recent advances towards an evolutionary comprehension of Araceae pollination. In: Seberg O, Petersen G, Barfod AS, Davis JI, Editors. *Diversity, phylogeny, and evolution in the Monocotyledons*. pp. 101–114. Aarhus University Press.

Gibbs PE, Semir J, da Cruz ND. 1977. Floral biology of *Talauma ovata* St. Hil. (Magnoliaceae). *Ciéncia e Cultura* 29: 1437–1441.

Goldwasser LP. 1987. *I. Branching patterns, generating rules, and astrogenetic trajectories in Bugula (Cheilostomata, Bryozoa). II. Mutualism and its ecological and evolutionary consequences.* PhD Dissertation, University of California-Berkeley. Berkely, CA, USA.

Goldwasser L. 2000. Scarab beetles, elephant ear (*Xanthosoma robustum*), and their associates. In: Natkarni NM, Wheelwright NT, Editors. *Monteverde. Ecology and Conservation of a Tropical Cloud Forest*. pp. 268–271. Oxford University Press.

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Terms of Use: https://complete.bioone.org/terms-of-use

Gonçalves EG, Maia ACD. 2006. New evidence of pollination in *Gearum brasiliense* (Araceae: Spathicarpeae). *Aroideana* 29: 148–151.

Gottsberger G. 1986. Some pollination strategies in Neotropical Savannas and Forests. *Plant Systematics and Evolution* 152: 29–45.

Gottsberger G. 1988. The reproductive biology of primitive angiosperms. *Taxon* 37: 630–643.

Gottsberger G. 1989. Beetle pollination and flowering rhythm of *Annona* spp. (Annonaceae) in Brazil. *Entwicklungsgeschichte und Systematik der Planzen* 167: 165–187.

Gottsberger G. 1991. Pollination of some species of the Carludovicoideae, and remarks on the origin and evolution of Cyclanthaceae. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie* 113: 221–235.

Gottsberger G. 1999. Pollination and evolution in neotropical Annonaceae. *Plant Species Biology* 14: 143–152.

Gottsberger G, Amaral A. 1984. Pollination strategies in Brazilian *Philodendron* species. *Berichte der Deutschen Botanischen Gesellschaft* 97: 391–410.

Gottsberger G, Webber AC, Hildenbrand M. 1998. Nutritious tissues in flowers of Annonaceae. *Annonaceae Newsletter* 12: 25–26.

Gottsberger G, Silberbauer-Gottsberger I. 1988. Pollination strategies of *Annona* species from the cerrado vegetation in Brazil. *Lagascalia* 15: 665–672.

Gottsberger G, Silberbauer-Gottsberger I. 1991. Olfactory and visual attraction of *Erioscelis emarginata* (Cyclocephalini, Dynastinae) to the inflorescences of *Philodendron selloum* (Araceae). *Biotropica* 23: 23–28.

Gottsberger G, Silberbauer-Gottsberger I. 2006. *Life in the Cerrado: a South American Tropical Seasonal Ecosystem. Volume 2. Pollination and Seed Dispersal*. Reta Verlag.

Gottsberger G, Silberbauer-Gottsberger I, Seymour RS, Dötterl S. 2012. Pollination ecology of *Magnolia ovata* may explain the overall large flower size of the genus. *Flora-Morphology, Distribution, Functional Ecology of Plants* 207: 107–118.

Grayum MH. 1984. *Palynology and phylogeny of the Araceae*. Botany PhD Dissertation, University of Massachusetts. Amherst, MA, USA.

Grayum MH. 1986. Correlations between pollination biology and pollen morphology in the Araceae, with some implications for angiosperm evolution. In: Blackmore S, Ferguson IK, Editors. *Pollen and Spores*: *Form and Function.* pp. 313–327. Linnean Society Symposium Series No. 12. Academic Press.

Grayum MH. 1990. Evolution and phylogeny of the Araceae. *Annals of the Missouri Botanical Garden* 77: 628–697.

Grayum MH. 1996. Revision of *Philodendron* subgenus *Pteromischum* (Araceae) for Pacific and Caribbean Tropical America. *Systematic Botany Monographs* 47: 1–233.

Downloaded From: https://complete.bioone.org/journals/Journal-of-Insect-Science on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

Grimm R. 2009. *Peltonotus nasutus* Arrow, 1910 und *Phaeochrous*-Arten als Bestäuber von *Amorphophallus paeoniifolius* (Araceae) in Thailand (Coleoptera: Scarabaeidae). *Entomologische Zeitschrift mit Insekten-Börse* 119: 167–168.

Hardon JJ. 1969. Interspecific hybrids in the genus *Elaeis* II. Vegetative growth and yield of F_1 hybrids *E. guineensis* x *E. oleifera*. *Euphytica* 18: 380–388.

Hay A, Gottschalk M, Holguin A. 2012. *Huanduj: Brugmansia*. Kew Publishing.

Hayward KJ. 1946. Departamento de Entomología. *Revista Industrial y Agrícola de Tucumán* 36: 60–72.

Heller KM. 1896. Neue Käfer von Celebes. *Abhandlungen der der Berichte des Königlichen Zoologischen und Anthropologisch-Ethnographischen Museums zu Dresden* 3: 12–14.

Henderson A. 1984. Observations on pollination of *Cryosophila albida*. *Principes* 28: 120–126.

Henderson A. 1986. A review of pollination studies in the Palmae. *Botanical Review* 52: 221–259.

Henderson A, Pardini R, dos Santos JF, Rebello, Vanin S, Almeida D. 2000. Pollination of *Bactris* (Palmae) in an Amazon Forest. *Brittonia* 52: 160–171.

Herbst JFW. 1790. Pauli J, Editor. Natursystem aller bekannten in- und ausländischen Insekten, als eine Fortsetzung der von Büffonschen Naturgeschichte. Nach dem System des Ritters von Linné und Fabricius zu bearbeitet angefangen von Carl Gustav Jablonsky. Der Käfer zweyter Theil. 3: 1–324.

Heyne A, Taschenberg O. 1907. *Die Exotischen Käfer in Wort und Bild.* G. Reusche.

Hirthe G, Porembski S. 2003. Pollination of *Nymphaea lotus* (Nymphaeaceae) by rhinoceros beetles and bees in the northeastern Ivory Coast. *Plant Biology* 5: 670–676.

Höhne W. 1923. Neue Cyclocephalen (Col. Dyn.). *Deutsche Entomologische Zeitschrift* 1923: 345–373.

International Commission on Zoological Nomenclature (ICZN). 1999. *International Code of Zoological Nomenclature. 4th edition*. International Trust for Zoological Nomenclature.

Jameson ML, Micó E, Galante E. 2007. Evolution and phylogeny of the scarab subtribe Anisopliina (Coleoptera: Scarabaeidae: Rutelinae: Anomalini). *Systematic Entomology* 32: 429–449.

Jameson ML, Ratcliffe BC, Maly V. 2002. Review of the genus *Acrobolbia* with remarks on its classification, and a key to the world genera of Cyclocephalini (Coleoptera: Scarabaeidae: Dynastinae). *Folia Heyrovskyana* 10: 1–15.

Jameson ML, Wada K. 2004. Revision of the genus *Peltonotus* Burmeister (Coleoptera: Scarabaeidae: Dynastinae) from southeastern Asia. *Zootaxa* 502: 1–66.

Kirsch TFW. 1870 [1871]. Beiträge zur Käferfauna von Bogotá. *Berliner*

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Entomologische Zeitschrift 14(1870): 337–378 (pages misnumbered, first one as 353).

Knuth PEOW, Appel O, Loew E. 1904. *Handbuch der Blütenbiologie, unter Zugrundelegung von Herman Müllers Werk: "Die Befruchtung der Blumen durch Insekten."* Volume 3. W. Engelmann.

Krell F-T, Hirthe G, Seine R, Porembski S. 2003. Rhinoceros beetles pollinate water lilies in Africa (Coleoptera: Scarabaeidae: Dynastinae; Magnoliidae: Nymphaeceae). *Ecotropica* 9: 103–106.

Kress WJ, Beach JH. 1994. Flowering plant reproductive systems. In: McDade L, Bawa KS, Hespenheide, HA, Hartshorn GS, Editors. *La Selva*: *Ecology and Natural History of a Neotropical Rainforest*. pp. 161–182. The University of Chicago Press.

Küchmeister HA, Webber C, Silberbauer-Gottsberger I, Gottsberger G. 1998. A Polinização e sua relação com a termogênese em espécies de Arecaceae e Annonaceae da Amazônia central. *Acta Amazonica* 28: 217–245.

Küchmeister H, Gottsberger G, Silberbauer-Gottsberger I. 1993. Pollination biology of *Orbignya spectabilis*, a 'monoecious' Amazonian palm. In: Barthlott W, Naumann CM, Schmidt-Loske K, Schuchmann KL, Editors. *Animal-plant interactions in tropical environments: results of the annual meeting of the German Society for Tropical Ecology held at Bonn, Germany, February 13-16, 1992*. pp. 67–76.

Lachance M-A, Starmer WT, Rosa CA, Bowles JM, Stuart J, Baker F, Janzen DH. 2001. Biogeography of the yeasts of ephemeral flowers and their insects. *FEMS Yeast Research* 1: 1–8.

Laporte FL. 1840. *Histoire Naturelle des Insectes Coleoptérès. Avec une introduction Renferment l'Anatomie et la Physiologie des Animaux articulés, par M. Brullé,* Volume 2. P. Duménil.

Lenzi M, Orth A. 2011. Visitantes florais de *Opuntia monacantha* (Cactaceae) em restingas de Florianópolis, SC, Brasil. *Acta Biológica Paranaense* 40: 19–32.

Linnaeus C. 1758. *Systema Naturae*, edito decima. Leipzig, Germany.

Linnaeus C. 1767. *Systema Naturae*, Volume 1, pars 2, edito duodecima reformata. Stockholm, Sweden.

Linsley EG. 1960. Observations on some matinal bees at flowers of *Cucurbita*, *Ipomoea* and *Datura* in desert areas of New Mexico and southeastern Arizona. *Journal of the New York Entomological Society* 68: 13–20.

Listabarth, C. 1992. A survey of pollination strategies in the Bactrinidinae (Palmae). *Bulletin de l'Institut Francais d'Études Andines* 21: 699–714.

Listabarth, C. 1996. Pollination of *Bactris* by *Phyllotrox* and *Epurea*. Implications of the palm breeding beetles on pollination at the community level. *Biotropica* 28: 69–81.

Luederwalt, H. 1926. *Cyclocephala cribrata* Burm. (Lamellicornidae, Dynastinae). Habitant legal das Bromeliaceas. *Revista do Museu Paulista* 14: 129–132.

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Maas PJM, Westra LYT, Chatrou LW. 2003. *Duguetia* (Annonaceae). *Flora Neotropica* 88: 1–274.

Madison M. 1979. Protection of developing seeds in neotropical Araceae. *Aroideana* 2: 52–61.

Madison M. 1981. Notes on *Caladium* (Araceae) and its allies. *Selbyana* 5: 342–377.

Maia ACD, Schlindwein C. 2006. *Caladium bicolor* (Araceae) and *Cyclocephala celata* (Coleoptera, Dynastinae): A well-established pollination system in the northern Atlantic rainforest of Pernambuco, Brazil. *Plant Biology* 8: 529–534.

Maia ACD, Schlindwein C, Navarro DMAF, Gibernau M. 2010. Pollination of *Philodendron acutatum* (Araceae) in the Atlantic forest of northeastern Brazil: a single scarab beetle species guarantees high fruit set. *International Journal of Plant Science* 171: 740–748.

Maia ACD, Gibernau M, Carvalho AT, Gonçalves EG, Schlindwein C. 2012. The cowl does not make the monk: scarab beetle pollination of the Neotropical aroid *Taccarum ulei* (Araceae, Spathicarpeae). *Biological Journal of the Linnean Society* 108: 22–34. doi: 10.1111/j.1095-8312.2012.01985.x.

Mannerheim CV. 1829. Description de quarante nouvelles espèces de scarabéides du Brésil avec figures. *Nouveaux Mémoires de la Société Impériale des Naturalistes de Moscou* 1: 29–80.

Martínez A. 1955. Un nuevo genero y especie de escarabeido dinastino (Col. Scarabaeidae, Dynatinae). *Mitteilungen der Münchener Entomologischen Gesellschaft* 45: 242–249.

Martínez A. 1968. Notas sobre Cyclocephalini Americanos con descripción de dos nuevas especies (Col. Scarab., Dynast.). *Ciencia* 26: 185–191.

Midgeley J. 1992. Why do some hopliinid beetles have large hind-legs? *Journal of the Entomological Society of Southern Africa* 55: 157–159.

Momose K, Yumoto T, Nagamitsu T, Kato M, Nagamasu H, Sakai S, Harrison RD, Itioka T, Hamid AA, Inoue T. 1998. Pollination biology in a lowland dipterocarp forest in Sarawak, Malaysia. I. Characteristics of the plant-pollinator community in a lowland dipterocarp forest. *American Journal of Botany* 85: 1477–1501.

Moore I. 1937. A list of beetles of San Diego County, California. *San Diego Society of Natural History-Occasional Papers* 2: 1–109.

Moore MR. 2011. *Disentangling the phenotypic variation and pollination biology of the Cyclocephala sexpunctata species complex (Coleoptera: Scarabaeidae: Dynastinae)*. Masters Thesis, Wichita State University. Wichita, KS, USA.

Moore MR. 2012. A new female elytron character for the tribe Cyclocephalini (Coleoptera: Scarabaeidae: Dynastinae) and an observation of its possible function. *The Coleopterists Bulletin* 66: 200–202.

Mora-Urpí J, Solís EM. 1980. Polinización en *Bactris gasipaes* H. B. K. (Palmae). *Revista de Biología Tropical* 28: 153–174.

Mora-Urpí J. 1982. Polinización en *Bactris gasipaes* H. B. K. (Palmae): Nota Adicional. *Revista de Biología Tropical* 30: 174–176.

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Morón MA. 1977. Descripción del macho de *Cyclocephala picta* Burm. 1847 (Coleoptera: Melolonthidae, Dynastinae). *Anales del Instituto de Biología de la Universidad Nacional Autónoma de México (serie Zoología)* 48: 133–140.

Morón MA. 1997. Notas sobre *Cyclocephala* Latreille (Coleoptera: Melolonthidae, Dynastinae) associadas con *Xanthosoma* Schott (Araceae) en Chiapas, México. *Giornale Italiano di Entomologia* 8: 399–407.

Murray NA. 1993. Revision of *Cymbopetalum* and *Porcelia* (Annonaceae). *Systematic Botany Monographs* 40: 1–3, 5–87, 89–121.

Núñez LA, Bernal R, Knudsen JT. 2005. Diurnal palm pollination by mystropine beetles: is it weather-related? *Plant Systematics and Evolution* 254: 149–171.

Núñez-Avellaneda LA, Rojas-Robles R. 2008. Biología reproductiva y ecología de la polinización de la palma milpesos *Oenocarpus bataua* en los Andes Colombianos. *Caldasia* 30: 101–125.

Núñez-Avellaneda LA, Neita JC. 2009. Rol de los escarabajos Cyclocephalini (Dynastinae: Scarabaeidae) en la polinización de palmas silvestres en Colombia. In: Hernández-Ortiz V, Deloya C, Castillo PR, Editors. *Memorias VIII Reunión Latinoamericana de Escarabaeidología* (*Coleoptera: Scarabaeoidea*). pp. 16–17. Jalapa, Mexico.

Ohaus F. 1910. Neue südamerikanische Dynastiden (Col.). *Deutsche Entomologische Zeitschrift* 1910: 671–690.

Ohaus F. 1912. Beiträge zur Kenntnis der Ruteliden. X. *Stettiner Entomologische Zeitung* 1912: 273–319.

Olivier AG. 1789. *Entomologie, ou Historie Naturelle des Insectes, avec leurs Caractèrs Génériques et Specifiques, leur Description, leur Synonymie, et leur Figure Enluminée. Coleoptérès*, volume 1 (genera separately paged). Jean Francois Baudouin.

Pardo-Locarno LC, Arroyo JE, Quiñónez F. 2008. Observaciones de los escarabajos copronecrófagos y sapromelífagos de San Luis Robles, Nariño. *Boletín Científico Centro de Museos: Meseo de Historia Natural* 8: 113–139.

Pellmyr O. 1985. *Cyclocephala*: visitor and probable pollinator of *Caladium bicolor* (Araceae). *Acta Amazonica* 15: 269–272.

Pike KS, Rivers RL, Ratcliffe BC, Oseto CY, Mayo ZB. 1976. A world bibliography of the genus *Cyclocephala* (Coleoptera: Scarabaeidae). *Miscellaneous publication of the University of Nebraska Agricultural Experiment Station* 32: 1–36.

Ponchel Y. 2006. The Dynastidae of the world. Biologie et collecte de quelques dynastides. Available online: http://dynastidae.voila.net/biologie.html

Ponchel Y. 2010. Note sur *Cyclocephala virgo* Dechambre, 1999 et mise point sur trios espèces de Dynastidae récemment decrites de Guyane (Coleoptera Dynastidae). *L'Entomologiste* 66: 171–172.

Prance GT. 1976. The pollination and androphore structure of some Amazonian Lecythidaceae. *Biotropica* 8: 235–241.

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Prance GT, Anderson AB. 1976. Studies of the floral biology of neotropical Nymphaeaceae 3. *Acta Amazonica* 6: 163–170.

Prance GT, Arias JR. 1975. A study of the floral biology of *Victoria amazonica* (Poepp.) Sowerby (Nymphaeaceae). *Acta Amazonica* 5: 109–139.

Prance GT. 1980. A note on the pollination of *Nymphaea amazonum* Mart. and Zucc. (Nymphaeaceae). *Brittonia* 32: 505–507.

Prell H. 1934. Beiträge zur Kenntnis der Dynastinen (XII). *Beschreibungen und Bemerkungen. Entomologische Zeitschrift* 47: 162–164, 186–188, 194–195.

Raguso RA, Henzel C, Buchmann SL, Nabhan GP. 2003. Trumpet flowers of the Sonoran desert: floral biology of *Peniocereus* cacti and sacred *Datura*. *International Journal of Plant Sciences* 164: 877–892.

Ramírez N. 1989. Biologia de polinizacion en una comunidad arbustiva tropical de la alta Guayana Venezolana. *Biotropica* 21: 319–330.

Ramírez N. 1992. Especificidad de los sistemas de polinizacion en una comunidad arbustiva de la Guyana Venezolana. *Ecotropicos* 5: 1–19.

Ramirez N, Brito Y. 1992. Pollination biology in a palm swamp community in the Venezuelan central plains. *Botanical Journal of the Linnean Society* 110: 277–302.

Ratcliffe BC. 1977. Four new species of Neotropical Cyclocephalini (Coleoptera: Scarabaeidae). *Acta Amazonica* 7: 429–434.

Ratcliffe BC. 1992a. Nine new species and 11 country records of *Cyclocephala* (Coleoptera: Scarabaeidae: Dynastinae) from Panama and Costa Rica. *The Coleopterists Bulletin* 46: 216–235.

Ratcliffe BC. 1992b. New species and country records of Brazilian *Cyclocephala* (Coleoptera: Scarabaeidae: Dynastinae). *Tidschrift voor Entomologie* 136: 179–190.

Ratcliffe BC. 2003. The Dynastine scarab beetles of Costa Rica and Panama (Coleoptera: Scarabaeidae: Dynastinae). *Bulletin of the University of Nebraska State Museum* 16: 1–506.

Ratcliffe BC, Delgado L. 1990. New species and notes of *Cyclocephala* from Mexico (Coleoptera: Scarabaeidae: Dynastinae). *Folia Entomologica Mexicana* 80: 41–57.

Ratcliffe BC, Morón MA. 1997. Dynastinae. In: Morón MA, Ratcliffe BC, Deloya C, Editors. *Atlas de los Escarabajos de México. Coleoptera: Lamellicornia. Volume 1. Familia Melolonthidae.* pp. 53–98. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO) and Sociedad Mexicana de Entomologia.

Ratcliffe BC, Paulsen MJ. 2008. The scarabaeoid beetles of Nebraska. *Bulletin of the University of Nebraska State Museum* 22: 1–569.

Ratcliffe BC, Cave RD. 2002. New species of *Cyclocephala* from Honduras and El Salvador. *The Coleopterists Bulletin* 56: 152–157.

Ratcliffe BC, Cave RD. 2006. The Dynastine scarab beetles of Honduras, Nicaragua, and El Salvador (Coleoptera: Scarabaeidae:

Downloaded From: https://complete.bioone.org/journals/Journal-of-Insect-Science on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

Dynastinae). *Bulletin of the University of Nebraska State Museum* 21: 1–424.

Rickson FR, Cresti M, Beach JH. 1990. Plant cells which aid in pollen digestion within a beetle's gut. *Oecologia* 82: 424–426.

Rosa CA, Morais PB, Santos SR, Peres Neto RR, Mendonça-Hagler LC, Hagler AN. 1995. Yeast communities associated with different plant resources in sandy coastal plains of southeastern Brazil. *Mycological Research* 99: 1047–1054.

Rosa CA, Lachance M-A, Starmer WT, Barker JSF, Bowles JM, Schlag-Edler B. 1999. *Kodamaea nitidulidarum*, *Candida restingae* and *Kodamaea anthophila*, three new related yeast species from ephemeral flowers. *International Journal and Systematic Bacteriology* 49: 309–318.

Saylor LW. 1945. Synoptic revision of the United States scarab beetles of the subfamily Dynastinae, No. 1: Tribe Cyclocephalini. *Journal of the Washington Academy of Sciences* 35: 378–386.

Scariot AO, Lieras E, Hay JD. 1991. Reproductive biology of the palm *Acrocomia aculeata* in central Brazil. *Biotropica* 23: 12–22.

Schatz GE. 1985. A new *Cymbopetalum* (Annonaceae) from Costa Rica and Panama with observations on natural hybridization. *Annals of the Missouri Botanical Graden* 72: 535–538.

Schatz GE. 1987. *Systematic and ecological studies of Central American Annonaceae*. PhD Thesis, University of Wisconsin-Madison. Madison, WI, USA.

Schatz GE. 1990. Some aspects of pollination biology in Central American forests. In: Bawa KS, Hadley M, Editors. *Reproductive Ecology of Tropical Forest Plants*. pp. 69–84. UNESCO and The Parthenon Publishing Group.

Schiestl FP, Dötterl S. 2012. The evolution of floral scent and olfactory preferences in pollinators: coevolution or pre-existing bias? *Evolution* 66(7): 2042_2055. doi:10.1111/j.1558-5646.2012.01593.x

Schrottky C. 1908. Blumen und Insekten in Paraguay. *Zeitschrift für wissenschlaftliche Insektenbiologie* 4: 22–26.

Schrottky C. 1910. Die Befruchtung von *Philodendron* und *Caladium* durch einen Käfer (*Erioscelis emarginata*). *Zeitschrift für wissenschlaftliche Insektenbiologie* 6: 67–68.

Schlumpberger BO, Cocucci AA, Moré M, Sérsic AN, Raguso RA. 2009. Extreme variation in floral characters and its consequences for pollinator attraction among populations of an Andean cactus. *Annals of Botany* 103: 1489–1500.

Schlumpberger BO, Raguso RA. 2008. Geographic variation in floral scent of *Echinopsis ancistrophora* (Cactaceae); evidence for constraints on hawkmoth attraction. *Oikos* 117: 801–814.

Seres A, Ramírez N. 1995. Biologia floral y polinizacion de algunas Monocotiledoneas de un Bosque Nublado Venezolano. *Annals of the Missouri Botanical Garden* 82: 61–81.

Seymour RS, Matthews PDG. 2006. The role of thermogenesis in the pollination biology of the Amazon waterlily *Victoria amazonica*. *Annals of Botany* 98: 1129–1135.

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Seymour RS, White CR, Gibernau M. 2009. Endothermy of dynastine scarab beetles (*Cyclocephala colasi*) associated with pollination biology of a thermogenic arum lily (*Philodendron solimoesense*). *The Journal of Experimental Biology* 212: 2960–2968.

Sharp D. 1877. Description of some new species of beetles (Scarabaeidae) from Central America. *Journal of the Linnean Scoiety of London (Zoology)* 13: 129–138.

Silberbauer-Gottsberger I. 1990. Pollination and evolution in palms. *Phyton* 30: 213–233.

Silberbauer-Gottsberger I, Gottsberger G, Webber AC. 2003. Morphological and functional flower characteristics of New and Old World Annonaceae with respect to their mode of pollination. *Taxon* 52: 701–718.

Silberbauer-Gottsberger I, Gottsberger RA, Gottsberger G. 1997. Flowering rhythm and pollination in a hybrid population of *Annona* in a small cerrado area in Mato Grosso, Brazil. *Annonaceae Newsletter* 11: 55–60.

Smith ABT. 2006. A review of the family-group names for the superfamily Scarabaeoidea (Coleoptera) with corrections to nomenclature and a current classification. *The Coleopterists Bulletin* 60: 144–204.

Stechauner-Rohringer R, Pardo-Locarno LC. 2010. Redescripción de inmaduros, ciclo de vida, distribución e importancia agrícola de *Cyclocephala lunulata* Burmeister (Coleóptera: Melolonthidae: Dynastinae) en Colombia. *Boletin Cientifico Centro de Museos, Museo de Historia Natural* 14: 203–220.

Steinheil E. 1874. Symbolae ad historiam Coleopterorum Argentiniae meridionales, ossia enumerazione dei coleotteri raccolti dal Prof. P. Strobel nell' Argentina meridionale, e descrizione dell specie nuove. II Centuria. *Atti della Societa Italiana de Scienze Naturali e del Museo Civico di Storia Naturale di Milano* 15: 554–578.

The Plant List. 2010. Version 1. Available online: http://www.theplantlist.org

Thien LB, Bernhardt P, Devall MS, Chen Z-D, Luo Y-B, Fan J-H, Yuan L-C, Williams JH. 2009. Pollination biology of basal angiosperms (ANITA grade). *American Journal of Botany* 96(1): 1–17.

Tropicos. Missouri Botanical Garden. Available online: http://www.tropicos.org

Valla JJ, Cirino DR. 1972. Biologia floral del Irupé, *Victoria cruziana* D.'Orb (Nymphaeaceae). *Darwiniana* 17: 477–500.

Valerio CE. 1984. Insect visitors of the inflorescence of the aroid *Dieffenbachia oerstedii* (Araceae) in Costa Rica. *Brenesia* 22: 139–146.

Valerio CE. 1988. Notes on phenology and pollination of *Xanthosoma wendlandii* (Araceae) in Costa Rica. *Revista de Biología Tropical* 36: 55–61.

Villalta R. 1988. *Estudio de la biologia floral e identificacion de agentes polinizadores de guanábana (Annona muricata L.) en la zona atlantica de Costa Rica*. Thesis. Heredia, Costa Rica, Universidad Nacional.

Voeks RA. 2002. Reproductive ecology of the piassava palm (*Attalea funifera*) of Bahia,

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Brazil. *Journal of Tropical Ecology* 18: 121–136.

von Bayern T. 1897. *Meine Reise in die Brasilianischen Tropen*. D. Remmer.

Webber AC. 1981. *Biologia floral de algumas Annonaceae na região de Manaus AM*. Masters Thesis, Instituto Nascional de Pesquiras da Amazonia, Manaus, AM, Brazil.

Webber AC, Gottsberger G. 1993. Floral biology and pollination of *Cymbopetalum euneurum* in Manaus, Amazonia. *Annonaceae Newsletter* 9: 25–28.

Warming E. 1883. Tropische Fragmente. I. Die Bestäubung von *Philodendron bipinnatifidum* Schott. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie* 4: 328–340.

Wiersema JH. 1987. A monograph of the *Nymphaea* subgenus *Hydrocallis* (Nymphaeaceae). *Systematic Botany Monographs* 16: 1–112.

Young HJ. 1986. Beetle pollination of *Dieffenbachia longispatha* (Araceae). *American Journal of Botany* 73: 931–944.

Young HJ. 1987. Aroid observations: *Philodendron rothschuhianum*. *Aroideana* 10: 22.

Young HJ. 1988a. Differential importance of beetle species pollinating *Dieffenbachia longispatha* (Araceae). *Ecology* 69: 832–844.

Young HJ. 1988b. Neighborhood size in a beetle pollinated tropical aroid: effects of low density and asynchronous flowering. *Oecologia* 76: 461–466.

Young HJ. 1990. Pollination and reproductive biology of an understory neotropical aroid. In: Bawa KS, Hadley M, Editors. *Reproductive Ecology of Tropical Forest Plants*. pp. 151–164. UNESCO and The Parthenon Publishing Group.

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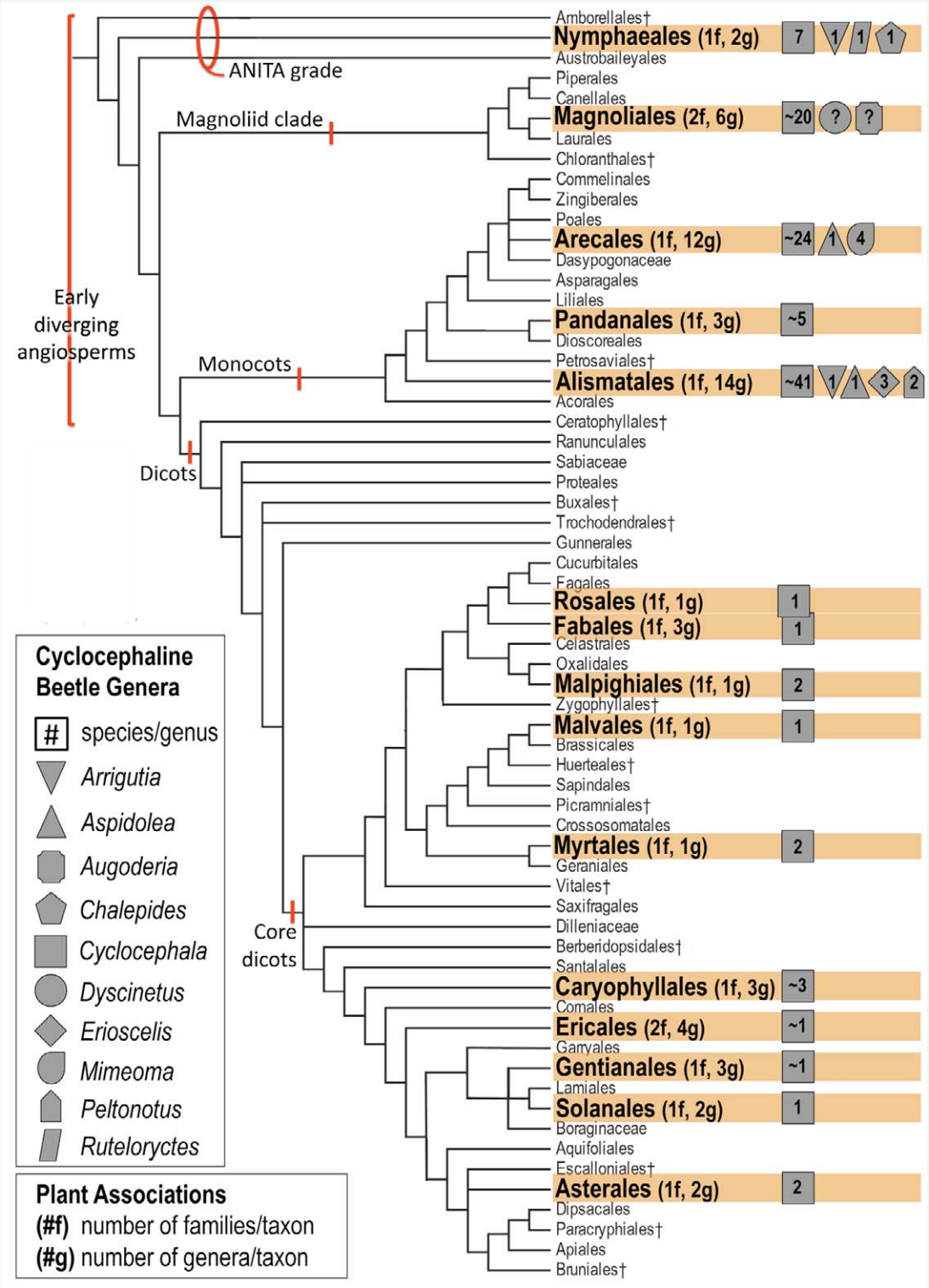


Figure 1. Cyclocephaline beetle genera and their associations with angiosperm plant lineages (plant phylogeny from APGIII 2009). Icons denote beetle genera that are associated with angiosperm plant lineages. Numbers in the icons indicate the number of species for each beetle genus. If the number of beetle species is unresolved due to conflict in the literature, this is indicated with ~ symbol (the number may be X ± 1 species). If the beetle genus has not been satisfactorily associated with the plant lineage, it is denoted with a ? symbol. For each angiosperm plant lineage, the number of families and genera that the beetles are associated with is denoted with #f (number of families) and #g (number of genera). See Appendix 1 for data. High quality figures are available online.

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Appendix 1. Checklist of floral associations for the Cyclocephalini (Scarabaeidae: Dynastinae).

Beetle Taxon	Plant Taxon	Geographic Locality	References	Remarks
Arriguttia brevissima (Arrow, 1911)	Araceae	FRENCH GUIANA	Ponchel 2006	–
	Victoria amazonica (Poepp.) J. C. Sowerby	BRAZIL: Pará	Martínez 1968	–
Aspidolea fuliginea Burmeister, 1847	*Oenocarpus bataua* Mart.	COLOMBIA: Antioquia, Chocó, Meta	Nunez-Avellaneda and Rojas-Robles 2008	–
Aspidolea quadrata Endrödi, 1980	*Montrichardia arborescens* (L.) Schott	FRENCH GUIANA: Kourou, Sinnamary	Gibernau *et al.* 2003; Ponchel 2006	–
Augoderia nitidula Burmeister, 1847 *or* *Cyclocephala nr. emarginata* Endrödi, 1966 *or* *Cyclocephala literata* Burmeister, 1847	*Magnolia ovata* (A. St.-Hil.) Spreng.	BRAZIL: Minas Gerais, São Paulo	Gibbs *et al.* 1977	Gibbs *et al.* (1977) stated that the scarab was *A. nitidula*, but the figure legend reported the scarab species as *Cyclocephala* nr. *emarginata* Endrödi, 1966. Gottsberger (1986) reported the scarab species as *C. literata*.
Chalepides dilatatus (Mannerheim, 1829)	NO DATA	BRAZIL	Mannerheim 1829	–
Chalepides sp.	*Victoria cruziana* A. D. Orb.	ARGENTINA: Corrientes	Valla and Cirino 1972	–
Cyclocephala abrelata Ratcliffe and Cave, 2002	NO DATA	HONDURAS: Yoro (Parque Nacional Pico Bonito)	Ratcliffe and Cave 2002; Ratcliffe and Cave 2006	Ten specimens of *C. abrelata* were collected in the flowers of an unidentified aroid or palm (Ratcliffe and Cave 2002).
Cyclocephala aequatoria Endrödi, 1963	*Phytelephas aequatorialis* Spruce	ECUADOR: Cañar, Cotopaxi, Esmeraldas, Manabí, Pichincha	Balslev and Henderson 1987; Ervik *et al.* 1999	–
Cyclocephala alazonia Ratcliffe, 2003	NO DATA	COSTA RICA: Alajuela (Reserva Biologica Monteverde, Estacion Eladios, Peñas Blancas Refuge)	Ratcliffe 2003	The two known specimens of *C. alazonia* are covered with pollen, suggesting feeding inside of a flower (Ratcliffe 2003).
Cyclocephala amazona (Linnaeus, 1767)	*Annona muricata* L.	COSTA RICA	Villalta 1988	–
	Astrocaryum alatum Loomis	PANAMA	Ratcliffe 2003	–
	Attalea butyracea (Mutis ex. L.f.) Wess. Boer	COLOMBIA	Núnez-Avellaneda and Neita 2009	–
	Bactris coloradonis L. H. Bailey	COSTA RICA: Herédia (La Selva Biological Station)	Beach 1984; Ratcliffe 2003, citing pers. comm. from J. Beach and H. Young	–
	Bactris gasipaes Kunth	COSTA RICA: Herédia (La Selva Biological Station); Limon (Guápiles, Estación Experimental de Los Diamantes)	Mora-Urpí and Solís 1980; Mora-Urpí 1982; Beach 1984; Gottsberger 1986; Rickson *et al.* 1990; Ratcliffe 2003, citing pers. comm. from J. Beach and H. Young	–
	Bactris hondurensis Standl.	COSTA RICA: Herédia (La Selva Biological Station)	Bullock 1981	–
	Cryosophila williamsii P. H. Allen	COSTA RICA: Herédia (La Selva Biological Station)	Henderson 1984; Silberbauer-Gottsberger 1990	–
	Cyclanthus bipartitus Poit. ex A. Rich.	COSTA RICA: Herédia (La Selva Biological Station)	Beach 1982	Beach (1982) reported the scarab as *C.* nr. *amazona*. Ratcliffe (2003) recorded *C. amazona* from La Selva Biological Station, thus this is probably a correct identification.
	Cymbopetalum lanugipetalum Schery	PANAMA: Colón	Murray 1993	–
	Cymbopetalum longipes Benth. ex Diels	PERU: San Martín	Murray 1993	–
	Montrichardia arborescens (L.) Schott	FRENCH GUIANA	Ponchel 2006	–
	Phytelephas seemannii O. F. Cook	COLOMBIA: Chocó	Bernal and Ervik 1996; Ervik *et al.* 1999	The scarab was reported as *Cyclocephala amazonica* (L.) (= *C. amazona* (L.)).
	Phytelephas sp.	COLOMBIA: Nariña (Tumaco)	Pardo-Locarno *et al.* 2008	–

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Appendix 1. Continued.

Cyclocephala amblyopsis Bates, 1888	*Dieffenbachia nitidipetiolata* Croat & Grayum	COSTA RICA: Herédia (La Selva Biological Station) PANAMA	Young 1986; Young 1988a; Young 1988b; Young 1990; Beath 1999; Ratcliffe 2003	The plant was reported as *D. longispatha* (Croat 2004).
	Philodendron anisotomum Schott	COSTA RICA: Herédia (La Selva Biological Station)	Croat 1997, citing pers. comm. from H. Young	–
	Philodendron platypetiolatum Madison	COSTA RICA: Herédia (La Selva Biological Station)	Beath 1998	–
	Philodendron pterotum K. Koch and Augustin	COSTA RICA: Herédia (La Selva Biological Station)	Croat 1997, citing pers. comm. from H. Young	–
	Philodendron radiatum Schott	COSTA RICA: Herédia (La Selva Biological Station)	Croat 1997, citing pers. comm. from H. Young	–
	Philodendron rothschuhianum (Engl.) Croat & Grayum	COSTA RICA: Herédia (La Selva Biological Station)	Croat 1997, citing pers. comm. from H. Young	–
	Philodendron tripartitum (Jacq.) Schott	COSTA RICA: Herédia (La Selva Biological Station)	Croat 1997, citing pers. comm. from H. Young	–
	Syngonium sp.	COSTA RICA: (Northern low lands)	Valerio 1984	–
	Xanthosoma daguense Engl.	COLOMBIA: Risaralda (Sanctuario de Fauna y Flora Otún-Quimbaya)	García-Robledo *et al.* 2004; García-Robledo *et al.* 2005	–
	Xanthosoma robustum Schott	MEXICO: Chiapas (Socunusco)	Morón 1997	–
	Xanthosoma sagittifolium (L.) Schott	MEXICO: Chiapas (Socunusco)	Morón 1997	–
	Xanthosoma sp.	COLOMBIA: Nariña (Tumaco)	Pardo-Locarno *et al.* 2008	–
	Xanthosoma wendlandii (Schott) Standl.	COSTA RICA: San José (Granadilla de Curridabat) MEXICO: Chiapas (Cacahoatán)	Valerio 1988; Morón 1997	–
Cyclocephala ampliata Bates, 1888	*Dieffenbachia nitidipetiolata* Croat & Grayum	COSTA RICA: Herédia (La Selva Biological Station)	Young 1990	The plant was reported as *D. longispatha* (Croat 2004).
	Philodendron pterotum K. Koch and Augustin	COSTA RICA: Herédia (La Selva Biological Station)	Croat 1997, citing pers. comm. from H. Young	–
	Philodendron radiatum Schott	COSTA RICA: Herédia (La Selva Biological Station)	Croat 1997, citing pers. comm. from H. Young; Beath 1998; Beath 1999	The scarab was reported as *Cyclocephala ampliota* [*sic*] (Beath 1999).
	Philodendron sp.	COSTA RICA	Ratcliffe 2003, citing pers. comm. from H. Young	The plant could possibly be *P. pterotum* or *P. radiatum* as reported by Croat (1997).
Cyclocephala atripes Bates, 1888	*Cyclanthus bipartitus* Poit. ex A. Rich.	COSTA RICA: Herédia (La Selva Biological Station)	Beach 1982; Ratcliffe 1992a	–
	Dieffenbachia nitidipetiolata Croat & Grayum	COSTA RICA: Herédia (La Selva Biological Station) PANAMA: Colón	Young 1986; Young 1988a; Young 1990; Ratcliffe 2003	The plant was reported as *D. longispatha* (Croat 2004).
	Dieffenbachia spp.	COSTA RICA: Herédia (La Selva Biological Station)	Beach 1982	Beach (1982) noted *C. atripes* on two *Dieffenbachia* spp. (possibly *D. nitidipetiolata* as described by Young (1986; 1988a; 1988b)) or *D. tonduzii* herein.
	Dieffenbachia tonduzii Croat & Grayum	COSTA RICA: Herédia (La Selva Biological Station)	Label data of M. Grayum	Three vouchers examined from INBC
	Annona aurantiaca Barb. Rodr.	BRAZIL: Maranhão	Gottsberger 1986; Gottsberger 1989; Gottsberger and Silberbauer-Gottsberger 2006	–
	Annona coriacea Mart.	BRAZIL: Maranhão; Minas Gerais (Indianópolis); São Paulo	Gottsberger 1986; Gottsberger and Silberbauer-Gottsberger 1988; Gottsberger 1989;Gottsberger 1999; Silberbauer-Gottsberger et al. 2003; Gottsberger and Silberbauer-Gottsberger 2006	–

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Appendix 1. Continued.

	Annona cornifolia A. St.-Hil.	BRAZIL: Minas Gerais (Indianópolis); São Paulo (Botucatu)	Gottsberger 1986; Gottsberger 1988; Gottsberger and Silberbauer-Gottsberger 1988; Gottsberger 1989; Gottsberger and Silberbauer-Gottsberger 2006	–
Cyclocephala atricapilla Mannerheim, 1829	*Annona crassiflora* Mart.	BRAZIL: Brasília (Chapada dos Veadeiros, north of Brasilia); Goiás (Vila Propício); Minas Gerais (Indianópolis); São Paulo (Botucatu)	Gottsberger 1988; Gottsberger and Silberbauer-Gottsberger 1988; Gottsberger 1989; Gottsberger 1999; Gottsberger and Silberbauer-Gottsberger 2006; Cavalcante *et al.* 2009	–
	Annona dioica A. St.- Hil.	BRAZIL: Minas Gerais (Indianópolis); São Paulo (Botucatu)	Gottsberger 1986, citing pers. obs. by Silberbauer-Gottsberger; Gottsberger 1988; Gottsberger 1989; Gottsberger 1999; Gottsberger and Silberbauer-Gottsberger 2006	–
	Annona monticola Mart.	BRAZIL: Brasília; Minas Gerais (Indianópolis)	Gottsberger 1989; Gottsberger and Silberbauer-Gottsberger 2006	–
	Annona tomentosa R. E. Fr.	BRAZIL: Brasília; Minas Gerais (Indianópolis)	Gottsberger 1989; Gottsberger and Silberbauer-Gottsberger 2006	–
	Annona warmingiana Mello-Silva & Pirani	BRAZIL: Brasília	Gottsberger 1986; Gottsberger 1989; Gottsberger and Silberbauer-Gottsberger 2006	–
	Caladium sp.	BRAZIL: Maranhão	Gottsberger 1986	–
	Colocasia esculenta (L.) Schott	BRAZIL: São Paulo	Gottsberger 1986	The scarab was reported from cultivated *C. esculenta*.
	Philodendron ptarianum Steyerm. var. *rugosum* Bunt.	VENEZUELA: Bolívar (Canaima National Park)	Ramírez 1992	–
	Philodendron mello-barretoanum Burle-Marx ex G. M. Barroso	BRAZIL: Minas Gerais (Indianópolis)	Gottsberger and Silberbauer-Gottsberger 2006	–
	Xanthosoma striatipes (Kunth & C. D. Bouché) Madison	BRAZIL: São Paulo	Gottsberger 1986	–
Cyclocephala boulardi Dechambre, 1979	*Bactris hirta* Mart.	BRAZIL: Amazonas	Küchmeister *et al.* 1998	–
Cyclocephala brevis Höhne, 1847 *incertae sedis* (*Cyclocephala* morphospecies 3 *sensu* Moore 2011)	*Dieffenbachia seguine* (Jacq.) Schott	VENEZUELA: Aragua (Henri Pittier National Park)	Label data of A. Seres and N. Ramirez	A single voucher examined from USNM
	Philodendron ligulatum Schott	COSTA RICA: Herédia (La Selva Biological Station)	Label data of H. Young	A single voucher examined from INBC
	Socratea sp.	VENEZUELA (Henri Pittier National Park)	Seres and Ramírez 1995	Based on other observed specimens collected by Seres and Ramirez from this locality this scarab was reported as *C. sexpunctata* and is *Cyclocephala* morphospecies 3 *sensu* Moore 2011
	Xanthosoma sp.	VENEZUELA (Henri Pittier National Park, Rancho Grande)	Label data of A. Seres and N. Ramirez	A single voucher examined from USNM
	Xanthosoma undipes (K. Koch & C. D. Bouché) K. Koch	VENEZUELA (Henri Pittier National Park, Rancho Grande)	Seres and Ramirez 1995; Label data of A. Seres and N. Ramirez	The scarab was identified and reported as *C. sexpunctata* (Seres and Ramirez 1995). A single voucher examined from USNM

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Cyclocephala brevis Höhne, 1847 *incertae sedis* (*Cyclocephala* morphospecies 4 *sensu* Moore 2011)	*Cymbopetalum languipetalum* Schery	PANAMA: Colón	Murray 1993	Reported as *C. sexpunctata* (Murray 1993).
	Cymbopetalum sp.	PANAMA: Colón (Btwn. Gatun and Pina)	Label data of N. A. Murray; Ratcliffe 2003	A single voucher examined from UNSM
	Philodendron sp.	PANAMA: Colón (1 km E Rio Guanche Bridge)	Label data of B. Ratcliffe and M. Jameson	A single voucher examined from UNSM
Cyclocephala brevis Höhne, 1847 *incertae sedis* (ambiguous records)	*Dieffenbachia longispatha* Engl. and K. Krause	PANAMA (Barro Colorado Island)	Beath 1999	The scarab was reported as *C. sexpunctata* which is not recorded from Barro Colorado Island (Ratcliffe 2003).
	Dieffenbachia nitidipetiolata Croat and Grayum	COSTA RICA: Herédia (La Selva Biological Station)	Young 1990; Beath 1999	The scarab was reported as *C. sexpunctata* which is not recorded from La Selva (Ratcliffe 2003). The plant was reported as *D. longispatha*, which does not occur in La Selva (Croat 2004).
	Dieffenbachia oerstedii Schott	COSTA RICA: San José (Granadilla de Curridabat)	Valerio 1984	–
	Dieffenbachia sp.	PANAMA	Ratcliffe 2003	–
	Philodendron fragrantissimum (Hook.) G. Don	PANAMA (Barro Colorado Island)	Beath 1998	The scarab was reported as *C. sexpunctata* which is not recorded on Barro Colorado Island (Ratcliffe 2003).
	Philodendron platypetiolatum Madison	COSTA RICA: Herédia (La Selva Biological Station)	Beath 1998	The scarab was reported as *C. sexpunctata* which is not recorded on Barro Colorado Island (Ratcliffe 2003).
	Philodendron pterotum K. Koch and Augustin	COSTA RICA: Herédia (La Selva Biological Station)	Croat 1997, citing pers. comm. with H. Young	The scarab was reported as *C. sexpunctata* which is not recorded in La Selva (Ratcliffe 2003).
	Xanthosoma helleborifolium (Jacq.) Schott	PANAMA (Barro Colorado Island)	Beath 1998	The scarab was reported as *C. sexpunctata* which is not recorded at Barro Colorado Island (Ratcliffe 2003).
	Xanthosoma mexicanum Liebm.	PANAMA (Barro Colorado Island)	Beath 1998	–
	Xanthosoma sp.	ECUADOR	Ohaus 1910	–
	Xanthosoma wendlandii (Schott) Standl.	COSTA RICA: San José (Granadilla)	Valerio 1988	–
Cyclocephala brittoni Endrödi, 1964	*Annona muricata* L.	COSTA RICA: Limón	Villalta 1988; Ratcliffe 1992a	–
	Bactris hondurensis Standl.	COSTA RICA: Herédia (La Selva Biological Station)	Bullock 1981; Ratcliffe 1992a	–
	Rhodospatha sp.	COSTA RICA: Limón	Ratcliffe 1992a	–
Cyclocephala caelestis Ratcliffe and Delgado, 1990	*Magnolia tamaulipana* Vazquez	MEXICO: Tamaulipas (El Cielo Reserve)	Dieringer *et al.* 1998; Dieringer *et al.* 1999	–
Cyclocephala camachicola Ohaus, 1910	*Xanthosoma* sp.	ECUADOR (west side of Cordillera)	Ohaus 1910	–
Cyclocephala carbonaria Arrow, 1911	*Philodendron wendlandii* Schott	NO DATA	Ratcliffe 2003, citing pers. comm. from H. Young	–
	Dieffenbachia longispatha Engl. and K. Krause	PANAMA (Barro Colorado Island)	Beath 1999	–
	Xanthosoma helleborifolium (Jacq.) Schott	PANAMA (Barro Colorado Island)	Beath 1998	–
	Xanthosoma mexicanum Liebm.	PANAMA (Barro Colorado Island)	Beath 1998	–
Cyclocephala castanea (Olivier, 1789)	*Nymphaea glandulifera* Rodschied	SURINAME	Cramer *et al.* 1975	–
	Nymphaea rudgeana G. Mey.	BRAZIL: Amazonas (Manaus) SURINAME	Cramer *et al.* 1975; Prance and Anderson 1976	–
	Victoria amazonica (Poepp.) J. C. Sowerby	BRAZIL: Amazonas	von Bayern 1897; Knuth *et al.* 1904; Gessner 1962	–

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Cyclocephala celata Dechambre, 1980	*Caladium bicolor* (Aiton) Vent.	BRAZIL: Pernambuco (Goiana)	Maia and Schlindwein 2006	–
	Gearum brasiliense N. E. Br.	BRAZIL: Tocantins (Arraias)	Gonçalves and Maia 2006	–
	Philodendron acutatum Schott	BRAZIL: Pernambuco (Goiana, Igarassu)	Maia *et al.* 2010	–
	Taccarum ulei Engl. and K. Krause	BRAZIL: Pernambuco	Maia *et al.* 2010, citing unpublished data of A. C. D. Maia, C. Schlindwein and M. Gibernau; Maia *et al.* 2012	–
Cyclocephala cearae Höhne, 1923	*Taccarum ulei* Engl. and K. Krause	BRAZIL: Pernambuco	Maia et al. 2012	–
Cyclocephala colasi Endrödi, 1964	Araceae	FRENCH GUIANA	Ponchel 2006	–
	Montrichardia arborescens (L.) Schott	FRENCH GUIANA: Kourou, Sinnamary	Gibernau *et al.* 2003; Ponchel 2006	–
	Montrichardia linifera (Arruda) Schott	FRENCH GUIANA	Ponchel 2006	–
	Philodendron melinonii Brongn. ex Regel	FRENCH GUIANA: Kourou	Gibernau *et al.* 2000; Ponchel 2006	–
	Philodendron solimoesense A. C. Sm.	FRENCH GUIANA (between Kourou and Sinnamary)	Gibernau *et al.* 1999; Ponchel 2006; Seymour *et al.* 2009	–
Cyclocephala conspicua Sharp, 1877	*Cyclanthus bipartitus* Poit. ex A. Rich.	COSTA RICA: Herédia (La Selva Biological Station)	Beach 1982	–
	Dieffenbachia nitidipetiolata Croat & Grayum	COSTA RICA: Herédia (La Selva Biological Station)	Young 1988a; Young 1990	The plant was reported as *D. longispatha* (Croat 2004).
	Dieffenbachia spp.	COSTA RICA: Herédia (La Selva Biological Station)	Beach 1982	Beach (1982) noted *C. conspicua* on two *Dieffenbachia* spp. (possibly *D. nitidipetiolata* as described by Young [1986; 1988a; 1988b]). The plant was reported as *D. longispatha* (Croat 2004).
	Philodendron correae Croat	PANAMA: Bocas del Toro (near continental divide)	Croat 1997	–
Cyclocephala cribrata Burmeister, 1847	*Astrocaryum aculeatissimum* (Schott) Burret	BRAZIL: São Paulo	Luederwalt 1926	–
	Philodendron bipinnatifidum Schott ex Endl.	BRAZIL: São Paulo (Botucatu)	Gottsberger and Amaral 1984; Gottsberger 1986	–
	Philodendron sp.	BRAZIL: São Paulo	Luederwalt 1926	–
Cyclocephala discicollis Arrow, 1902	*Bactris major* Jacq.	COLOMBIA	Núnez-Avellaneda and Neita 2009	–
Cyclocephala discolor (Herbst, 1790)	*Aphandra natalia* (Balslev & A. J. Henderson) Barfod	COLOMBIA: Chocó ECUADOR: Morona-Santiago, Napo, Pastaza	Ervik *et al.* 1999	–
	Arecaceae	PERU	Ponchel 2006	–
	Oenocarpus bataua Mart.	COLOMBIA: Antioquia, Chocó, Meta	Nunez-Avellaneda and Rojas-Robles 2008; Núnez-Avellaneda and Neita 2009	–
Cyclocephala distincta Burmeister, 1847	*Attalea funifera* Mart.	BRAZIL: Bahia	Voeks 2002	–
Cyclocephala emarginata Endrödi, 1966	Araceae	FRENCH GUIANA	Ponchel 2006	–
	Philodendron solimoesense A. C. Sm.	FRENCH GUIANA	Gibernau *et al.* 1999	–
Cyclocephala epistomalis Bates, 1888	*Nymphaea amazonum* Mart. & Zucc.	BRAZIL: Mato Grosso (near Fazenda Jofre)	Prance 1980	–
Cyclocephala fasciolata Bates, 1888	*Asplundia* sp.	MEXICO	Ratcliffe and Morón 1997	–
	Astrocaryum mexicanum Liebm. ex Mart.	MEXICO: Veracruz (Los Tuxtlas)	Búrquez *et al.* 1987; Aguirre *et al.* 2011	–
	Astrocaryum sp.	MEXICO	Ratcliffe and Morón 1997	The plant was reported as *Astrocaryon* [*sic*] sp.
	Monstera sp.	MEXICO	Ratcliffe and Morón 1997	–

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Cyclocephala forsteri Endrödi, 1963	*Acrocomia aculeata* (Jacq.) Lodd. ex Mart.	BRAZIL: Distrito Federal (Planaltina Area), Mato Grosso do Sul COLOMBIA	Scariot *et al.* 1991; Núnez-Avellaneda and Neita 2009; de Oliveira and Ávila 2011	–
Cyclocephala gravis Bates, 1888	Araceae	GUATEMALA: Sololá (Las Tarrales Reserve)	Label data of M. Moore	Nine vouchers deposited in WICH
	Colocasia sp.	HONDURAS: Francisco Morazán (El Zamorano)	Ratcliffe and Cave 2006	Nine vouchers deposited in WICH
	Dieffenbachia longispatha Engl. and K. Krause	PANAMA (Barro Colorado Island)	Beath 1999	–
	Dieffenbachia nitidipetiolata Croat & Grayum	COSTA RICA: Herédia (La Selva Biological Station) PANAMA: Colón	Young 1986; Young 1988a; Young 1988b; Young 1990; Beath 1999; Ratcliffe 2003	The plant was reported as *D. longispatha* (Croat 2004).
	Montrichardia arborescens (L.) Schott	VENEZUELA: Guárico State (near Calabozo)	Ramirez and Brito 1992	–
	Philodendron grandipes K. Krause	COSTA RICA: Herédia (La Selva Biological Station) PANAMA: San Blas (Nusagandi)	Young 1986; Croat 1997; Croat 1997, citing pers. comm. with H. Young	–
	Xanthosoma helleborifolium (Jacq.) Schott	PANAMA (Barro Colorado Island)	Beath 1998	–
	Xanthosoma mexicanum Liebm.	PANAMA (Barro Colorado Island)	Beath 1998	–
Cyclocephala gregaria Heyne and Taschenberg, 1907	*Xanthosoma daguense* Engl.	COLOMBIA: Risaralda (Sanctuario de Fauna y Flora Otún-Quimbaya)	García-Robledo *et al.* 2004; García-Robledo *et al.* 2005	–
Cyclocephala guianae Endrödi, 1969	*Oenocarpus bacaba* Mart.	BRAZIL: Amazonas	Küchmeister *et al.* 1998	–
Cyclocephala hardyi Endrödi, 1975	*Victoria amazonica* (Poepp.) J. C. Sowerby	BRAZIL: Amazonas GUAYANA: Upper Takutu-Upper Essequibo (Karanambu Ranch)	Endrödi 1975; Prance and Arias 1975; Seymour and Matthews 2006	– –
Cyclocephala iani Ratcliffe, 1992b	*Annona nitida* Mart.	BRAZIL: Amazonas	Ratcliffe 1992b	–
Cyclocephala inca Endrödi, 1966	*Attalea insignis* (Mart.) Drude	COLOMBIA	Núnez-Avellaneda and Neita 2009	–
Cyclocephala jalapensis Casey, 1915	*Magnolia schiedeana* Schltl.	MEXICO: Veracruz (Xalapa area)	Dieringer and Delgado 1994; Dieringer and Espinosa 1994	–
Cyclocephala kaszabi Endrödi, 1964	*Dieffenbachia nitidipetiolata* Croat & Grayum	COSTA RICA: Herédia (La Selva Biological Station)	Young 1986; Young 1988a; Young 1990	The plant was reported as *D. longispatha* (Croat 2004).
	Philodendron radiatum Schott	NO DATA	Croat 1997	–
	Philodendron rothschuhianum (Engl.) Croat & Grayum	COSTA RICA: Herédia (La Selva Biological Station)	Young 1987	–
	Philodendron tripartitum (Jacq.) Schott	COSTA RICA: Herédia (La Selva Biological Station)	Croat 1997, citing pers. comm. from H. Young	–
	Xanthosoma daguense Engl.	COLOMBIA: Risaralda (Sanctuario de Fauna y Flora Otún-Quimbaya)	García-Robledo *et al.* 2004; García-Robledo *et al.* 2005	–
Cyclocephala laminata Burmeister, 1847	*Cereus pernambucensis* Lem.	BRAZIL: Rio de Janeiro	Rosa *et al.* 1995; Rosa *et al.* 1999; Lachance *et al.* 2001	–
Cyclocephala latericia Höhne, 1923	*Annona crassilflora* Mart.	BRAZIL: Goiás (Vila Propício)	Cavalcante *et al.* 2009	–
	Araceae	BRAZIL: Pará	Martínez 1968	The scarab was reported as *Cyclocephala lateritia* [*sic*].

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Cyclocephala ligyrina Bates, 1888	*Dieffenbachia nitidipetiolata* Croat & Grayum	COSTA RICA: Herédia (La Selva Biological Station)	Young 1986; Young 1988a; Young 1990	The plant was reported as *D. longispatha* (Croat 2004).
	Philodendron cretosum Croat & Grayum	COSTA RICA: Herédia (La Selva Biological Station)	Ratcliffe 2003	–
	Philodendron jodavisianum G. S. Bunting	PANAMA: Panamá	Croat 1997	–
	Philodendron pterotum K. Koch and Augustin	PANAMA (Former Canal Zone)	Croat 1997	–
	Philodendron radiatum Schott	NO DATA	Croat 1997	–
	Philodendron rothschuhianum (Engl.) Croat & Grayum	COSTA RICA: Herédia (La Selva Biological Station)	Ratcliffe 2003	–
Cyclocephala literata Burmeister, 1847	*Annona crassilflora* Mart.	BRAZIL: São Paulo	Gottsberger 1986; Gottsberger 1989; Gottsberger and Silberbauer-Gottsberger 2006	–
	Magnolia ovata (A. St.-Hil.) Spreng.	BRAZIL: São Paulo	Gottsberger 1986; Gottsberger 1989; Gottsberger et al. 2012	–
Cyclocephala lunulata Burmeister, 1847	*Acacia pennata* (L.) Willd.	NO DATA	Ratcliffe and Morón 1997	–
	Ficus sp.	NO DATA	Morón 1997	–
	Hibiscus rosa-sinensis L.	NO DATA	Ratcliffe and Morón 1997	–
	Psidium sp.	NO DATA	Morón 1997	–
	Pithecellobium dulce (Roxb.) Benth.	NO DATA	Ratcliffe and Morón 1997	The plant was reported as *Pitecellobium* [*sic*] *dulce*.
	Pithecellobium sp.	COLOMBIA: Valle del Cauca	Stechauner-Rohringer and Pardo-Locarno 2010	–
Cyclocephala lutea Endrödi, 1966	Cactaceae	BRAZIL: Pará	Martínez 1968	–
Cyclocephala mafaffa Burmeister, 1847	Araceae	GUATEMALA: Solóla (Las Tarrales Reserve)	Label data of M. Moore	Four vouchers deposited in WICH
	Malmea depressa (Baill.) R. E. Fr.	MEXICO: Michoacán	Murray 1993	–
	Philodendron jodavisianum G. S. Bunting	PANAMA: Panamá	Croat 1997	–
	Philodendron giganteum Schott	Guadeloupe archipelago	Ponchel 2006	–
	Xanthosoma robustum Schott	MEXICO: Chiapas (Cacahoatán and Chiapa de Corzco)	Morón 1997; Morón 1997, citing pers. comm. from Beutelspacher); Ratcliffe and Morón 1997	–
	Xanthosoma wendlandii (Schott) Standl.	COSTA RICA: Guanacaste (Nicoya)	Valerio 1988	–
Cyclocephala marginalis Kirsch, 1870 [1871]	*Attalea butyracea* (Mutis ex. L.f.) Wess. Boer	COLOMBIA	Núnez-Avellaneda and Neita 2009	–
	Attalea microcarpa Mart.	BRAZIL: Amazonas	Küchmeister *et al.* 1998	–
Cyclocephala mecynotarsis Höhne, 1923	*Acrocomia aculeata* (Jacq.) Lodd. ex Mart.	BRAZIL: Distrito Federal (Planaltina Area)	Scariot *et al.* 1991	–
	Attalea geraensis Barb. Rodr.	BRAZIL	Gottsberger and Silberbauer-Gottsberger 2006	–
Cyclocephala melanae Bates, 1888	*Philodendron schottianum* H. Wendl. ex Schott	COSTA RICA: Cartago	Croat 1997	–

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Cyclocephala melanocephala (Fabricius, 1775)	*Annona coriacea* Mart.	BRAZIL: São Paulo	Gottsberger 1986	–
	Brugmansia arborea (L.) Steud. or *Brugmansia* x *candida* Pers. or *Brugmansia suaveolens* (Humb. & Bonpl. ex Willd.) Bercht. & J. Presl	BRAZIL: São Paulo ECUADOR	Ohaus 1910; Gottsberger 1986	The plant was reported as *Datura arborea* without assigning authorship. The name *D. arborea* was used by three authors and is a synonym of the species listed to the left. The identity of the association with *Brugmansia* sp. is ambiguous.
	Brugmansia insignis (Barb. Rodr.) Lockwood ex R. E. Schult.	COLOMBIA	Hay *et al.* 2012	–
	Cactaceae	FRENCH GUIANA	Ponchel 2006	–
	Datura innoxia Mill.	USA: New Mexico	Cockerell 1897	–
	Datura sp.	USA: Arizona, California, New Mexico	Moore 1937; Saylor 1945; Linsley 1960	–
	Datura wrightii Regel	USA: Arizona	Raguso *et al.* 2003	–
	Kielmeyera variabilis Mart. & Zucc.	BRAZIL: São Paulo	Gottsberger 1986	–
	Magnolia ovata (A. St.-Hil.) Spreng.	BRAZL: São Paulo	Gottsberger 1986	–
	Mandevilla longiflora (Desf.) Pichon	BRAZIL: São Paulo	Gottsberger 1986	–
	Porcelia magnifructa (Schery) R.E. Fr.	PANAMA: Veraguas	Murray 1993	–
Cyclocephala metrica Steinheil, 1874	*Verbesina encelioides* (Cav.) Benth. & Hook.f. ex A. Gray	ARGENTINA: Salta	Hayward 1946	Reported to feed on the seeds of *V. encelioides*.
Cyclocephala munda Kirsch, 1870 [1871]	*Xanthosoma poeppigii* Schott	PERU: Loreto (Estación Biológica Madre Selva)	García-Robledo *et al.* 2005	–
Cyclocephala nigerrima Bates, 1888	*Monstera adansonii* Schott var. *adansonii*	COSTA RICA: Puntarenas (Monteverde)	Ratcliffe 2003, citing pers. comm. from A. Smith	–
	Philodendron brenesii Standl.	COSTA RICA: San José (vicinity of Vara Blanca)	Croat 1997	–
	Philodendron sp.	NO DATA	Valerio 1984	–
	Philodendron tysonii Croat	PANAMA: Chiriquí (near continental divide)	Croat 1997	–
	Xanthosoma undipes (K. Koch & C. D. Bouché) K. Koch	COSTA RICA: Guanacaste (Peñas Blancas), Puntarenas (Monteverde)	Goldwasser 1987; Goldwasser 2000; García-Robledo et al. 2005, citing pers. comm. with T. Croat	The plant was reported as *Xanthosoma robustum* Schott (García-Robledo et al. 2005, citing pers. comm. with T. Croat).
Cyclocephala ohausiana Höhne, 1923	*Annona coriacea* Mart.	BRAZIL: Minas Gerais, São Paulo	Gottsberger 1986; Gottsberger 1988; Gottsberger and Silberbauer-Gottsberger 1988; Gottsberger 1989; Gottsberger and Silberbauer-Gottsberger 2006	–
	Xanthosoma striatipes (Kunth & C. D. Bouché) Madison	BRAZIL: São Paulo	Gottsberger 1986; Gottsberger 1989	–
Cyclocephala octopunctata Burmeister, 1847	*Annona crassilflora* Mart.	BRAZIL: Goiás (Goiána and Vila Propício)	Cavalcante *et al.* 2009	–
	Annona dioica A. St.- Hil.	BOLIVIA: Santa Cruz	Label data of uncredited collector	Single voucher examined from UNSM
Cyclocephala ovulum Bates, 1888	*Helianthus* sp. (girsasol)	ARGENTINA	Hayward 1946	–
	Inga sp.	ECUADOR: Napo (Yasuni Research Station)	Label data of Mary Liz Jameson	Plant voucher examined from WICH
Cyclocephala paraguayensis Arrow, 1903	*Annona coriacea* Mart.	BRAZIL: São Paulo	Gottsberger 1989	–
	Kielmeyera variabilis Mart. & Zucc.	BRAZIL: São Paulo	Gottsberger 1986	–

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Appendix 1. Continued.

Cyclocephala picipes (Olivier, 1789)	*Annona montana* Macfad.	BRAZIL: Amazonas (Manaus)	Webber 1981	The scarab was reported from cultivated *A. montana*.
	Annona muricata L.	BRAZIL: Amazonas (Manaus)	Webber 1981	The scarab was reported from cultivated *A. muricata*.
	Annona nitida Mart.	BRAZIL: Amazonas (Manaus)	Webber 1981	–
Cyclocephala picta Burmeister, 1847	*Xanthosoma robustum* Schott	MEXICO: Veracruz	Morón 1977	–
Cyclocephala prolongata Arrow, 1902	*Attalea amygdalina* Kunth	COLOMBIA	Núnez-Avellaneda and Neita 2009	–
Cyclocephala nr. *putrida* Burmeister, 1847	*Nymphaea lasiophylla* Mart. & Zucc.	BRAZIL (northeastern)	Wiersema 1987	–
Cyclocephala quadripunctata Höhne, 1923	*Aphandra natalia* (Balslev & A. J. Henderson) Barfod	COLOMBIA: Chocó ECUADOR: Morona-Santiago, Napo, Pustaza	Ervik *et al.* 1999	–
	Attalea insignis (Mart.) Drude	COLOMBIA	Núnez-Avellaneda and Neita 2009	–
	Phytelephas macrocarpa Ruiz & Pav.	COLOMBIA: Chocó ECUADOR: Napo	Ervik *et al.* 1999	–
Cyclocephala quatuordecimpunctata Mannerheim, 1829	*Annona aurantiaca* Barb. Rodr.	BRAZIL: Mato Grosso	Silberbauer-Gottsberger *et al.* 1997	Anecdotal, citing Gottsberger (1989) and Gottsberger and Silberbauer-Gottsberger (1988). This association was not verifiable in cited literature.
	Annona coriacea Mart.	BRAZIL: Mato Grosso, Minas Gerais, São Paulo	Gottsberger 1986; Gottsberger 1989; Silberbauer-Gottsberger et al. 1997; Gottsberger and Silberbauer-Gottsberger 2006	The scarab was reported as *C. inpunctata* (Gottsberger 1986)
	Annona cornifolia A. St.-Hil.	BRAZIL: Minas Gerais (Indianópolis); São Paulo (Botucatu)	Gottsberger 1986; Gottsberger 1988; Gottsberger and Silberbauer-Gottsberger 1988; Gottsberger 1989; Gottsberger 1999; Gottsberger and Silberbauer-Gottsberger 2006	The scarab was reported as *C. inpunctata* (Gottsberger 1986; Gottsberger 1988)
	Annona crassiflora Mart.	BRAZIL: Brasília (Chapada dos Veadeiros, north of Brasilia); Goiás; Minas Gerais (Indianópolis); São Paulo (Botucatu)	Gottsberger 1989; Gottsberger and Silberbauer-Gottsberger 2006	–
	Annona dioica A. St.- Hil.	BRAZIL: Mato Grosso; Minas Gerais (Indianópolis); São Paulo (Botucatu)	Gottsberger 1986, citing pers. obs. by Silberbauer-Gottsberger; Gottsberger 1988; Gottsberger 1989; Silberbauer-Gottsberger et al. 1997; Gottsberger and Silberbauer-Gottsberger 2006	The scarab was reported as *C. inpunctata* (Gottsberger 1986)
	Annona hybrid forms 1 & 3	BRAZIL: Mato Grosso	Silberbauer-Gottsberger *et al.* 1997	–
	Annona malmeana R. E. Fr. x *Annona coriacea* Mart.	BRAZIL: Mato Grosso	Gottsberger and Silberbauer-Gottsberger 2006	–
	Annona monticola Mart.	BRAZIL: Minas Gerais	Gottsberger and Silberbauer-Gottsberger 2006	–
	Annona tomentosa R. E. Fr.	BRAZIL: Brasília; Minas Gerais (Indianópolis)	Gottsberger 1989; Gottsberger 1999; Gottsberger and Silberbauer-Gottsberger 2006	–
	NO DATA	BRAZIL	Mannerheim 1829	–
Cyclocephala quercina Burmeister, 1847	*Montrichardia arborescens* (L.) Schott	FRENCH GUIANA	Ponchel 2006	–
	Nymphaeaceae	FRENCH GUIANA	Ponchel 2006	–
Cyclocephala rondoniana Ratcliffe, 1992b	*Attalea attaleoides* (Barb. Rodr.) Wess. Boer	BRAZIL: Amazonas	Küchmeister *et al.* 1998	–

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Appendix 1. Continued.

Cyclocephala rubescens Bates, 1891	*Philodendron grayumii* Croat	PANAMA: Coclé (near El Copé)	Croat 1997	*C. rubescens* is not recorded in Panama (Ratcliffe 2003).
Cyclocephala rufovaria Arrow, 1911	Araceae	FRENCH GUIANA	Ponchel 2006	–
Cyclocephala rustica (Olivier, 1789)	Araceae	BRAZIL: Manaus (Reserva Ducke) FRENCH GUIANA	Label data of I. Gottsberger; Ponchel 2006	A single voucher examined from UNSM
	Arecaceae	BRAZIL: Manaus (Reserva Ducke)	Label data of S. Vidal	Two vouchers examined from deposited UNSM
	Caladium bicolor (Aiton) Vent.	SURINAME FRENCH GUIANA: Karou	Pellmyr 1985; Label data of M. Gibernau	Two vouchers examined from in UNSM
	Dieffenbachia seguine (Jacq.) Schott	FRENCH GUIANA (Nouragues)	Label data of M. Gibernau	Five voucher specimens examined from UNSM
	Philodendron callosum K. Krause	NO DATA	Croat 1997	–
	Philodendron ptarianum Steyerm.	NO DATA	Croat 1997	The plant voucher is listed as Ramirez 1163 by Croat (1997). In the Tropicos database Ramirez 1163 is a specimen of *Philodendron callosum* K. Krause.
Cyclocephala santaritae Ratcliffe, 1992a	*Attalea insignis* (Mart.) Drude	COLOMBIA	Núnez-Avellaneda and Neita 2009	–
	Oenocarpus sp.	ECUADOR: Napo	Label data of H. Balslev and A. Henderson	Three voucher specimens examined from UNSM
Cyclocephala sarpedon Ratcliffe, 1992b	*Oenocarpus bacaba* Mart.	BRAZIL: Amazonas	Küchmeister *et al.* 1998	–
Cyclocephala sexpunctata Laporte, 1840 *incertae sedis* (*Cyclocephala* morphospecies 1 *sensu* Moore 2011)	Araceae	GUATEMALA: Sololá (Las Tarrales Reserve); Huehuetenago (Zapote) MEXICO: Veracruz (Catemaco, Pipipan, Parque de la Flora y Fauna Silvestre Tropical)	Label data of M. Moore; Label data of F. Capistran; Bates 1888	Two specimens deposited in WICH. A single voucher examined from UVGC (Capistran).
	Xanthosoma robustum Schott	MEXICO: Chiapas (Cacahoatán); Guerrero (Mochitlán, Achauizolta)	Morón 1997; Label data of L. Delgado	A single voucher examined from UVGC. Morón (1997) reported this beetle as *C. sexpunctata*.
	Xanthosoma sagittifolium (L.) Schott	MEXICO: Chiapas (Cacahoatán)	Morón 1997	–
	Xanthosoma sp.	GUATEMALA: Quetzaltenango (El Palmar near Finca El Faro)	Label data of E. Cano	A single voucher examined from UVGC.
	Xanthosoma wendlandii (Schott) Standl.	MEXICO: Chiapas (Cacahoatán)	Morón 1997	–
Cyclocephala sexpunctata Laporte, 1840 *incertae sedis* (*Cyclocephala* morphospecies 2 *sensu* Moore 2011)	*Alocasia macrorrhizos* (L.) G. Don	COSTA RICA: San José (Parque del Este)	Label data of uncredited collector; Valerio 1984	Eight voucher specimens examined from UNSM
	Araceae	PANAMA: Chiriquí (La Fortune, Quebrada Al Trail)	Label data of J. Ashe & A. Brooks	A single voucher examined from KSEM
	Philodendron tripartitum (Jacq.) Schott	COSTA RICA: San José (Parque del Este)	Label data of uncredited collector	Two vouchers examined from UNSM
	Xanthosoma sp.	COSTA RICA: Alajuela (San Ramon, Rio S. Lorencito)	Label data of A. Solís	A single voucher examined from INBC

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Appendix 1. Continued.

Cyclocephala sexpunctata Laporte, 1840 *incertae sedis* (ambiguous records)	*Philodendron grandipes* K. Krause	NO DATA	Croat 1997	–
	Philodendron grayumii Croat	PANAMA: Coclé (near El Copé)	Croat 1997	–
	Philodendron sagittifolium Liebm.	PANAMA: Panamá	Croat 1997	–
	Philodendron solimoesense A. C. Sm.	FRENCH GUIANA	Gibernau *et al.* 1999	–
	Xanthosoma poeppigii Schott	PERU: Loreto (Estación Biológica Madre Selva)	García-Robledo *et al.* 2005	–
	Xanthosoma undipes (K. Koch & C. D. Bouché) K. Koch	COSTA RICA: Cartago (San Ramón de la Unión), Guanacaste (Peñas Blancas), Puntarenas (Monteverde)	Goldwasser 1987; Seres and Ramírez 1995; Goldwasser 2000; García-Robledo *et al.* 2005	Goldwasser (1987; 2000) reported the plant as *Xanthosoma robustum* Schott (García-Robledo *et al.* 2005, citing pers. comm. with T. Croat).
	Xanthosoma wendlandii (Schott) Standl.	COSTA RICA: Herédia (Santo Domingo); Alajuela (Alajuela)	Valerio 1988	–
Cyclocephala simulatrix Höhne, 1923	*Philodendron solimoesense* A. C. Sm.	FRENCH GUIANA	Ponchel 2006	–
	Philodendron squamiferum Poepp.	FRENCH GUIANA: Kourou	Gibernau and Barabé 2002	–
Cyclocephala sparsa Arrow, 1902	*Annona purpurea* Moç & Sessé ex Dunal	MEXICO: Michoacán	Murray 1993	–
	Cymbopetalum baillonii R. E. Fr.	MEXICO: Veracruz	Murray 1993	–
	Cymbopetalum costaricense (Donn. Sm.) R. E. Fr.	COSTA RICA: Herédia (La Selva Biological Station)	Schatz 1985	–
	Cymbopetalum gracile R. E. Fr.	MEXICO: Guerrero	Murray 1993	–
	Cymbopetalum hintonii Lundell	MEXICO: Jalisco	Murray 1993	–
	Cymbopetalum torulosum G. E. Schatz	COSTA RICA: Herédia (La Selva Biological Station)	Bawa *et al.* 1985a; Bawa *et al.* 1985b; Schatz 1985; Kress and Beach 1994	–
	Malmea aff. *depressa* (Baill.) R. E. Fr.	MEXICO: Veracruz (Estacíon Biológica Los Tuxtlas)	Schatz 1987	–

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Appendix 1. Continued.

Cyclocephala spp.	*Annona montana* Macfad.	BRAZIL: Amazonas (Amazonia)	Webber 1981	The scarab was reported from cultivated *A. montana*.
	Annona muricata L.	BRAZIL: Amazonas (Manaus)	Webber 1981	The scarab was reported from cultivated *A. muricata*.
	Annona sp. ex aff. *Annona paludosa* Aubl.	BRAZIL (Amazonia, near Paricatuba)	Gottsberger 1989	–
	Annona Section *Pilannona*	NO DATA	Schatz 1987	–
	Aphandra natalia (Balslev & A. J. Henderson) Barfod	ECUADOR: Morona-Santiago (20 km south of Sucua)	Ervik 1993	–
	Attalea spectabilis Mart.	BRAZIL: Amazonas (Ducke Forest Reserve)	Küchmeister *et al.* 1993	–
	Bactris gasipaes Kunth	PERU: Huánaco (Pachitea)	Listabarth 1992	–
	Bactris hirta var. *pectinata* (Mart.) Govaerts	BRAZIL: Manaus (Reserve 1501 of Biological Dynamics of Forest Fragments Project)	Henderson *et al.* 2000	–
	Bactris sp.	PERU: Huanaco (Pachitea)	Listabarth 1992	–
	Carludovica drudei Mast.	COSTA RICA: Puntarenas	Anderson and Gómez-P. 1997	–
	Carludovica palmata Ruiz & Pav.	COSTA RICA: Puntarenas	Anderson and Gómez-P. 1997	–
	Cymbopetalum stenophyllum Donn. Sm.	MEXICO: Chiapas	Murray 1993	–
	Dieffenbachia pittieri Engl. & K. Krause	NO DATA	Pellmeyr 1985, citing pers. comm. from J. Beach	The plant was reported as *D. piltieri* [*sic*].
	Duguetia spixiana Mart.	PERU: Madre de Dios (Tambopata)	Maas *et al.* 2003	–
	Echinopsis ancistrophora Speg. subsp. *ancistrophora*	ARGENTINA	Slumpberger *et al.* 2009	–
	Elaeis oleifera (Kunth) Cortés	NO DATA	Hardon 1969, citing unpublished data of J. J. Hardon	–
	Hancornia speciosa Gomes	BRAZIL: Minas Gerais	Gottsberger 1986	–
	Magnolia ovata (A. St.-Hil.) Spreng.	BRAZL: São Paulo	Gottsberger 1986	–
	Oenocarpus bacaba Mart.	BRAZIL: Amazonas	Küchmeister *et al.* 1998	–
	Opuntia monacantha Haw.	BRAZIL: Santa Catarina (Florianópolis)	Lenzi and Inácio Orth 2011	–
	Philodendron aurantiifolium subsp. *aurantiifolium* Schott	COSTA RICA: Herédia (La Selva Biological Station)	Grayum 1996	–
	Philodendron ptarianum Steyerm. var. *rugosum* Bunt.	VENEZUELA: Bolívar (Canaima National Park)	Ramírez 1989	Two unidentified *Cyclocephala* species came to *P. ptarianum*. One scarab species was indentified as *C. atricopilla* [*sic*] (= *C. atricapilla*) in Ramírez 1992.
	Porcelia spp.	NO DATA	Schatz 1987, citing pers. comm. from P. J. M. Maas	–
	Pouteria sp.	BRAZIL: Minas Gerais	Gottsberger 1986	–
	Syagrus sancona (Kunth) H. Karst.	COLOMBIA	Núnez-Avellaneda and Neita 2009	–
	Syngonium triphyllum Birdsey ex Croat	COSTA RICA	Croat 1981, citing pers. comm. from T. Ray	–
	Tabernaemontana sp.	BRAZIL: Minas Gerais	Gottsberger 1986	–
	Wettinia quinaria (O. F. Cook & Doyle) Burret	COLOMBIA: Chocó (El Amargal Biological Station)	Núñez *et al.* 2005	–
	Xanthosoma undipes (K. Koch and C. D. Bouché) K. Koch	VENEZUELA (Henri Pittier National Park)	Seres and Ramírez 1995	–
	Xanthosoma wendlandii (Schott) Standl.	COSTA RICA: Guanacaste (Carmona de Nandayure)	Valerio 1988	–

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Appendix 1. Continued.

Cyclocephala stictica Burmeister, 1847	*Astrocaryum alatum* Loomis	COSTA RICA: Herédia (La Selva Biological Station)	Bullock 1981	–
	Annona muricata L.	COSTA RICA	Villalta 1988; Ratcliffe 2003	–
	Bactris coloradonis L. H. Bailey	COSTA RICA	Ratcliffe 2003	–
	Bactris hondurensis Standl.	COSTA RICA: Herédia (La Selva Biological Station)	Bullock 1981	–
	Oenocarpus bataua Mart.	COLOMBIA: Antioquia, Chocó, Meta	Nunez-Avellaneda and Rojas-Robles 2008	–
	Xanthosoma sagittifolium (L.) Schott	MEXICO: Chiapas (Cacahoatán)	Morón 1997	–
	Xanthosoma wendlandii (Schott) Standl.	MEXICO: Chiapas (Cacahoatán)	Morón 1997	–
Cyclocephala tutilina Burmeister, 1847	*Cyclanthus bipartitus* Poit. ex A. Rich.	VENEZUELA (Henri Pittier National Park)	Seres and Ramírez 1995	–
	Dieffenbachia nitidipetiolata Croat & Grayum	COSTA RICA: Herédia (La Selva Biological Station)	Young 1986; Young 1988a; Young 1990	*C. tutilina* is not recorded in Costa Rica (Ratcliffe 2003). The plant was reported as *D. longispatha* (Croat 2004).
	Dieffenbachia seguine (Jacq.) Schott	VENEZUELA: Aragua (Henri Pittier National Park)	Ratcliffe and Cave 2006; Label data of A. Seres and N. Ramirez	The plant was reported as *D. seguinum* [*sic*] (Ratlcliffe and Cave 2006). A single voucher was examined from USNM
	Dieffenbachia sp.	VENEZUELA (Henri Pittier National Park)	Seres and Ramírez 1995	–
	Philodendron macroglossum Schott	VENEZUELA (Henri Pittier National Park)	Seres and Ramírez 1995	–
	Xanthosoma sp.	ECUADOR VENEZUELA (Henri Pittier National Park)	Ohaus 1910; Label data of A. Seres and N. Ramirez	A single voucher examined from USNM
	Xanthosoma undipes (K. Koch and C. D. Bouché) K. Koch	VENEZUELA (Henri Pittier National Park)	Seres and Ramírez 1995	–
Cyclocephala tylifera Höhne, 1923	*Philodendron squamiferum* Poepp.	FRENCH GUIANA: Kourou	Gibernau and Barabé 2002; Ponchel 2006	–
Cyclocephala undata (Olivier, 1789)	*Annona foetida* Mart.	BRAZIL: Amazonas (Manaus)	Gottsberger 1999, citing unpublished data of A. C. Weber and G. Gottsberger	–
	Annona montana Macfad.	NO DATA	Gottsberger *et al.* 1998	–
	Bactris hirta Mart.	BRAZIL: Amazonas	Küchmeister *et al.* 1998	–
	Cymbopetalum euneurum N. A. Murray	BRAZIL: Amazonas (Ducke Forest Reserve)	Webber and Gottsberger 1993	–
	Duguetia asterotricha (Diels) R. E. Fr.	BRAZIL: Manaus	Label data of G. Gottsberger	A single voucher examined from UNSM
	Duguetia riparia Huber	BRAZIL: Amazonas	Küchmeister *et al.* 1998	–
	Duguetia ulei (Diels) R. E. Fr.	BRAZIL: Amazonas	Küchmeister *et al.* 1998	–
	Malmea manausensis Maas & Miralha	NO DATA	Gottsberger *et al.* 1998	–
	Montrichardia arborescens (L.) Schott	FRENCH GUIANA	Ponchel 2006	–
Cyclocephala variabilis Burmeister, 1847	*Attalea geraensis* Barb. Rodr.	BRAZIL: São Paulo	Gottsberger 1986	–
Cyclocephala varians Burmeister, 1847	*Montrichardia arborescens* (L.) Schott	FRENCH GUIANA: Kourou, Sinnamary	Gibernau *et al.* 2003; Ponchel 2006	–
	Montrichardia linifera (Arruda) Schott	FRENCH GUIANA	Ponchel 2006	–
	Nymphaeaceae	FRENCH GUIANA	Ponchel 2006	–
Cyclocephala variolosa Burmeister, 1847	*Philodendron bipinnatifidum* Schott ex Endl.	BRAZIL: São Paulo (Botucatu)	Gottsberger and Amaral 1984; Gottsberger 1986	–
	Philodendron sp.	BRAZIL: São Paulo (Botucatu)	Gottsberger and Amaral 1984	–
Cyclocephala vestita Höhne, 1923	*Annona muricata* L.	BRAZIL (northeastern)	Cavalcante 2000; Maia *et al.* 2010, citing unpublished data of Maia, Schlindwein and Gibernau	–
	Montrichardia arborescens (L.) Schott	FRENCH GUIANA: Kourou, Sinnamary	Gibernau *et al.* 2003; Ponchel 2006	–

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Cyclocephala verticalis Burmeister, 1847	*Corythophora rimosa* W. A. Rodrigue	BRAZIL: Amazonas (Manaus)	Prance 1976	–
	Eschweilera decolorans Sandwith	BRAZIL: Amazonas (Manaus)	Prance 1976	–
	Eschweilera sp.	BRAZIL: Amazonas (Manaus)	Prance 1976	–
	Lecythis lurida (Miers) S. A. Mori	BRAZIL: Amazonas (Manaus)	Prance 1976	–
	Nymphaea amazonum Mart. & Zucc.	SURINAME	Cramer *et al.* 1975	–
	Nymphaea conardii Wiersema	VENEZUELA: Barinas (Sosa)	Wiersema 1987	–
	Nymphaea rudgeana G. Mey.	BRAZIL: Pará (Belém) SURINAME	Cramer *et al.* 1975; Prance and Anderson 1976	–
	Victoria amazonica (Poepp.) J. C. Sowerby	BRAZIL: Amazonas GUYANA: Upper Takutu-Upper Essequibo (Karanambu Ranch)	Prance and Arias 1975; Seymour and Matthews 2006	–
Cyclocephala williami Ratcliffe, 1992a	*Psidium sp.*	COSTA RICA	Ratcliffe 1992a; Ratcliffe 2003	–
Dyscinetus nr. *plicatus* (Burmeister, 1847)	*Annona* sp. ex aff. *Annona densicoma* Mart.	BRAZIL (lower Rio Purús)	Gottsberger 1989	The scarab was attracted to floral odors but was not collected in inflorescences (Gottsberger 1989).
Erioscelis columbica Endrödi, 1966	*Dieffenbachia nitidipetiolata* Croat & Grayum	COSTA RICA: Herédia (La Selva Biological Station) PANAMA	Young 1986; Young 1988a; Young 1988b; Young 1990; Beath 1999; Ratcliffe 2003	The plant was reported as *D. longispatha* (Croat 2004).
	Dieffenbachia sp.	COSTA RICA: Herédia (La Selva Biological Station)	Label data of M. Grayum	A single voucher examined from INBC
	Philodendron anisotomum Schott	COSTA RICA: Herédia (La Selva Biological Station)	Croat 1997, citing pers. comm. from H. Young	–
	Philodendron aurantiifolium Schott	COSTA RICA: Herédia (La Selva Biological Station)	Label data of M. Grayum; Grayum 1996	A single voucher examined from INBC. Grayum (1996) reported this beetle as *E. proba* Sharp, which does not occur in Costa Rica (Ratcliffe 2003)
	Philodendron brevispathum Schott	COSTA RICA: Herédia (La Selva Biological Station)	Grayum 1996; Croat 1997	Beetle was reported as *E. proba* Sharp (Grayum 1996; Croat 1997), which does not occur in Costa Rica (Ratcliffe 2003)
	Philodendron grandipes K. Krause	COSTA RICA: Limón	Croat 1997	–
	Philodendron guttiferum Kunth	COSTA RICA: Herédia (La Selva Biological Station)	Morón 1997, citing pers. comm. from A. Solís	–
	Philodendron jodavisianum G. S. Bunting	COSTA RICA: Herédia (La Selva Biological Station)	Croat 1997, citing pers. comm. from H. Young	–
	Philodendron radiatum Schott	COSTA RICA: Herédia (La Selva Biological Station)	Croat 1997, citing pers. comm. from H. Young	–
	Philodendron rothschuhianum (Engl.) Croat & Grayum	COSTA RICA: Herédia (La Selva Biological Station)	Croat 1997, citing pers. comm. from H. Young	–
	Philodendron tripartitum (Jacq.) Schott	COSTA RICA: Herédia (La Selva Biological Station)	Croat 1997, citing pers. comm. from H. Young	–
	Syngonium schottianum Wendl. ex Schott	COSTA RICA: Herédia (La Selva Biological Station)	Morón 1997, citing pers. comm. from A. Solís; Beath 1998; Label data of M. Grayum	Three vouchers examined from INBC

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Erioscelis emarginata (Mannerheim, 1829)	Araceae	BRAZIL: Pará	Martínez 1968	–
	NO DATA	BRAZIL	Mannerheim 1829	–
	Philodendron bipinnatifidum Schott ex Endl.	BRAZIL: São Paulo (around Botucatu) PARAGUAY (Villa Encarnacion)	Schrottky 1910; Gottsberger 1986; Gottsberger and Amaral 1984; Gottsberger and Silberbauer-Gottsberger 1991	–
	Xanthosoma striatipes (Kunth & C. D. Bouché) Madison	PARAGUAY (Villa Encarnacion)	Schrottky 1908; Schrottky 1910	This association was questioned by Gottsberger and Amaral (1984).
Erioscelis proba Sharp, 1877	*Dieffenbachia seguine* (Jacq.) Schott	FRENCH GUIANA (Nouragues Field Station)	Label data of M. Gibernau	28 vouchers examined from UNSM
	Montrichardia arborescens (L.) Schott	FRENCH GUIANA: Kourou, Sinnamary	Gibernau *et al.* 2003	–
	Philodendron squamiferum Poepp.	FRENCH GUIANA	Ponchel 2006	–
Mimeoma acuta (Arrow, 1902)	*Astrocaryum alatum* Loomis	COSTA RICA: Herédia (La Selva Biological Station)	Bullock 1981	–
	Bactris coloradonis L. H. Bailey	COSTA RICA: Herédia (La Selva Biological Station)	Beach 1984; Ratcliffe 2003, citing pers. comm. with J. Beach and H. Young	–
	Bactris hondurensis Standl.	COSTA RICA: Herédia (La Selva Biological Station)	Bullock 1981; Ratcliffe 2003, citing pers. comm. with J. Beach and H. Young	–
	Bactris longiseta H. Wendl. ex Burret	COSTA RICA: Herédia (La Selva Biological Station)	Bullock 1981	–
Mimeoma englemani Ratcliffe, 1977	*Bactris* spp.	PANAMA	Ratcliffe 2003	Ratcliffe (2003) did not state these associations occur in Panama, although *M. englemani* is currently known only from Panama.
Mimeoma maculata (Burmeister, 1847)	*Astrocaryum paramaca* Mart.	FRENCH GUIANA	Ponchel 2006; Ponchel 2010	The plant was reported as *Astrocaryum paramaka* [*sic*].
Mimeoma signatoides (Höhne, 1923)	*Socratea* sp.	VENEZUELA (Henri Pittier National Park)	Label data of A. Serez and N. Ramirez	A single voucher examined from USNM
Peltonotus malayensis Arrow, 1910	*Epipremnum falcifolium* Engl.	BRUNEI	Jameson and Wada 2004	–
Peltonotus nasutus Arrow, 1910	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	THAILAND: Changwat (Thung Yai Wildlife Sanctuary)	Grimm 2009	–
Ruteloryctes morio (Fabricius, 1798)	*Nymphaea lotus* L.	BENIN CÔTE d'IVOIRE: Zanzan (Comoé National Park) SENEGAL: Kaolack, Tambacounda	Ervik and Knudsen 2003; Hirthe and Porembski 2003; Krell *et al.* 2003	–
	Nymphaea sp.	West Indies (erroneous label data)	Fabricius 1798	–
Cyclocephalini	*Echinopsis ancistrophora* Speg. subsp. *ancistrophora*	ARGENTINA	Schlumpberger and Raguso 2008	Reported as a destructive, nocturnal scarab. Based on photographs, the the beetles are probably cyclocephalines (in litt. with B. Schlumpberger, April 2011).
	Rhodospatha sp.	COSTA RICA: Herédia (La Selva Biological Station)	Schatz 1990	–

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Appendix 1. Continued.

Dynastinae	*Bactris gasipaes* Kunth	PERU: Huánuco	Listabarth 1996	–
	Bactris maraja Mart.	PERU: Huánuco	Listabarth 1996	This scarab was reported as a most rare visitor (Listabarth 1996).
	Bactris bifida Mart.	PERU: Huánuco	Listabarth 1996	This scarab was reported as a most rare visitor (Listabarth 1996).
	Bognera recondita (Madison) Mayo & Nicolson	BRAZIL: Amazonas (Lago Cauxi near Atalaia)	Gonçalves and Maia 2006; Bogner 2008, citing upublished data of E. G. Gonçalves	The authors did not explicity state the locality of the association data, although extensive observations of *B. recondita* were made only in Amazonas, Brazil
	Homalomena sp.	MALAYA	Grayum 1990, citing pers. comm. From G. E. Schatz	This is likely a misidentification. *Peltonotus* was not in the Cyclocephalini prior to 2006 (Smith 2006). These beetles could be *Parastasia* spp. (Scarabaeidae: Rutelinae), species of which are known visitors of *Homalomena* spp. on Borneo (Malaysia) (Momose *et al.* 1998; Chen *et al.* 2011).
	Monstera oreophila Madison	PANAMA: Chiriquí	Grayum 1990	–
Scarabaeidae	*Ammandra decasperma* O. F. Cook	COLOMBIA: Valle del Cauca (Buenaventura)	Cook 1927	–
	Annona montana Macfad.	COSTA RICA: Herédia (La Selva Biological Station)	Bawa *et al.* 1985b	–
	Asimina sp.	NO DATA	Gottsberger 1988	–
	Attalea speciosa Mart.	BRAZIL: Maranhão (Lago Verde); Pará (Serra Norte, Canoal)	Anderson *et al.* 1988	–
	Chlorospatha spp.	NO DATA	Madison 1981	–
	Evodianthus funifer (Poit.) Lindm. subsp. *funifer*	PERU (Lower Río Llullapichus, Panguana Field Station)	Gottsberger 1991	–
	Homalomena hammelii Croat and Grayum	NO DATA	Grayum 1984	–
	Philodendron bipinnatifidum Schott ex Endl.	BRAZIL: Minas Gerais (Lagoa Santa)	Warming 1883	–
	Philodendron davidsonii Croat	NO DATA	Grayum 1984	–
	Philodendron grandipes K. Krause	NO DATA	Grayum 1984	–
	Philodendron ligulatum Schott	NO DATA	Grayum 1984	–
	Philodendron venosum (Willd. Ex Schult. & Schult.f.) Croat	NO DATA	Grayum 1984	–
	Philodendron radiatum Schott	NO DATA	Grayum 1984	–
	Philodendron rothschuhianum (Engl.) Croat & Grayum	NO DATA	Grayum 1984	–
	Porcelia sp.	NO DATA	Gottsberger 1988	–
	Syngonium schottianum H. Wendl. ex Schott	NO DATA	Grayum 1984	–
	Xanthosoma robustum Schott	NO DATA	Grayum 1984	–

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Appendix 1. Continued.

Coleoptera	*Philodendron acuminatissimum* Engl.	NO DATA	Madison 1979	–
	Philodendron cruentospathum Madison	NO DATA	Madison 1979, citing pers. comm. from C. H. Dodson	Inflorenscences of this plant species rotate to capture water after anthesis which is a strategy to drive beetles out of the spathe (Madison 1979).
	Philodendron senatocarpium Madison	NO DATA	Madison 1979	Inflorescences of this plant species are often filled with water which is a strategy to drive beetles out the spathe (Madison 1979).
	Philodendron venosum (Willd. ex Schult. & Schult.f.) Croat	NO DATA	Madison 1979	Inflorescences of this plant species are often filled with water which is a strategy to drive beetles out the spathe. Scarabs have been reported from *P. venosum* (Grayum1984).
	Rhodospatha forgetii N. E. Br.	NO DATA	Grayum 1986, citing pers. comm. from G. Schatz	The beetles could be cyclocephalines based on the observations of Schatz (1990).
	Xanthosoma sagittifolium (L.) Schott	NO DATA	Madison 1979	The plant species displays a "drowning" strategy similar to *Philodendron* (Madison 1979).
Evidence of beetle feeding	*Nymphaea oxypetala* Planch.	VENEZUELA	Wiersema 1987	–

Appendix 2. Cyclocephaline synonyms reported in the floral association literature.

Valid Name	Synonym (Reported Name)	Reference
Cyclocephala amazona (Linnaeus, 1767)	*Cyclocephala signata* (Fabricius, 1781)	Mora-Urpí and Solís 1980; Mora-Urpí 1982; Gottsberger 1986
Cyclocephala brevis Höhne, 1847	*Cyclocephala pubescens* Burmeister, 1847	Valerio 1984; Valerio 1988
Cyclocephala epistomalis Bates, 1888	*Cyclocephala mollis* Endrödi, 1963	Prance 1980
Cyclocephala mafaffa Burmeister, 1847	*Cyclocephala maffafa* [*sic*] *grandis* Burmeister, 1847	Ponchel 2006
Cyclocephala melanocephala (Fabricius, 1775)	*Cyclocephala dimidiata* Burmeister, 1847 *Dichromia dimidiata* (Burmeister, 1847)	Cockerell 1897; Moore 1937; Saylor 1945; Linsley 1960

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Appendix 3. Plant synonyms reported in floral association literature and on voucher specimen label data.

Valid Name	Synonym (Reported Name)	Reference
Annona warmingiana Mello-Silva & Pirani	*Annona pygmaea* (Warm.) Warm.	Gottsberger 1986; Gottsberger 1989
Astrocaryum aculeatissimum (Schott) Burret	*Astrocaryum aryi* Mart.	Luederwalt 1926
Attalea speciosa Mart.	*Orbignya phalerata* Mart.	Anderson *et al.* 1988
Attalea spectabilis Mart.	*Orbignya spectabilis* (Mart.) Burret	Küchmeister *et al.* 1993
Bactris coloradonis L. H. Bailey	*Bactris porschiana* Burret	Beach 1984; Ratcliffe 2003
Bactris hirta var. *pectinata* (Mart.) Govaerts	*Bactris hirta* var. *spruceana* (Trail) A.J.Hend.	Henderson *et al.* 2000
Bactris hondurensis Standl.	*Bactris wendlandiana* Burret	Bullock 1981; Ratcliffe 1992a
Bactris maraja Mart.	*Bactris monticola* Barb. Rodr.	Listabarth 1996
Brugmansia sp.	*Datura arborea* (no author)	Ohaus 1910; Gottsberger 1986
Cryosophila williamsii P. H. Allen	*Cryosophila albida* Bartlett	Henderson 1984; Silberbauer-Gottsberger 1990
Datura innoxia Mill.	*Datura meteloides* DC. ex Dunal	Cockerell 1897
Lecythis lurida (Miers) S. A. Mori	*Holopyxidium jaranum* Huber ex Ducke	Prance 1976
Mandevilla longiflora (Desf.) Pichon	*Macrosiphonia longiflora* (Desf.) Mül. Arg.	Gottsberger 1986
Magnolia ovata (A. St.-Hil.) Spreng.	*Talauma ovata* A. St.-Hil, 1824	Gibbs *et al.* 1977; Gottsberger 1986; Gottsberger 1989
Oenocarpus sp.	*Jessenia* sp.	Label data of Balslev and Henderson. Three specimens deposited in UNSM
Nymphaea glandulifera Rodschied	*Nymphaea blanda* var. *fenzliana* (Lehm.) Casp.	Cramer *et al.* 1975
Philodendron bipinnatifidum Schott ex Endl.	*Philodendron selloum* C. Koch	Gottsberger 1986; Gottsberger and Amaral 1984; Gottsberger and Silberbauer-Gottsberger 1991
Philodendron venosum (Willd. ex Schult. & Schult.f.) Croat	*Philodendron karstenianum* Schott	Grayum 1984
Phytelephas aequatorialis Spruce	*Palandra aequatorialis* (Spruce) O. F. Cook	Balslev and Henderson 1987
Tabernaemontana sp.	*Peschiera* sp.	Gottsberger 1986
Victoria amazonica (Poepp.) J. C. Sowerby	*Victoria regia* Lindl.	von Bayern 1897; Knuth *et al.* 1904; Gessner 1962; Martínez 1968
Xanthosoma mexicanum Liebm.	*Xanthosoma pilosum* K. Koch & Augustin	Beath 1998
Xanthosoma sagittifolium (L.) Schott	*Xanthosoma violaceum* Schott	Morón 1997
Xanthosoma striatipes (Kunth & C. D. Bouché) Madison	*Caladium striatipes* (Kunth & C. D. Bouché) Schott	Schrottky 1910; Gottsberger 1986; Gottsberger 1989
Xanthosoma wendlandii (Schott) Standl.	*Xanthosoma hoffmanni* [*sic*] (Schott) Schott	Morón 1997

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Appendix 4. Unavailable and unresolved plant names from the floral association literature and voucher specimen label data.

Valid Name	Reported Name	Reference or Label Data
Alocasia macrorrhizos (L.) G. Don (pers. comm. with T. B. Croat, May 2011)	*Xanthosoma macrorrhizas*	Valerio 1984; Label data of unaccredited collector
Dieffenbachia tonduzii Croat & Grayum (pers. comm. with T. B. Croat and M. Grayum, May 2011)	*Dieffenbachia longivaginata* Croat & Grayum *ined.**	Label data of M. Grayum. Beetle voucher specimens deposited at INBC
Philodendron ligulatum Schott (pers. comm. with T. B. Croat and M. Grayum, May 2011)	*Philodendron atlanticum* Croat & Grayum	Grayum 1984; Label data of H. Young
Philodendron ptarianum Stey. or *Philodendron rugosum* Bogner & G.S.Bunting	*Philodendron ptarianum* Stey. var. *rugosum* Bunt.	Ramírez 1989; Ramirez 1992
Unresolved	*Cereus pernambucensis* Lem.	Rosa *et al.* 1995; Rosa *et al.* 1999; Lechance *et al.* 2001
Unresolved	*Kielmeyera variabilis* Mart. & Zucc.	Gottsberger 1986
Unresolved	*Malmea manausensis* Maas & Miralha	Gottsberger *et al.* 1998

**ined*: a name only that appears in an unpublished manuscript and is thus invalid.

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