

Distribution of the sand wasp *Bicyrtes variegatus* (Oliver, 1789) (Hymenoptera, Crabronidae) in the Galápagos Islands, with notes on its ecology

Andrea C. Román^{1,2}, Patricio Picón-Rentería^{2,3}, Charlotte E. Causton¹,
Lenyn Betancourt-Cargua¹, Catherine Frey³, Henri W. Herrera³

1 Charles Darwin Research Station, Charles Darwin Foundation, Santa Cruz, Galápagos, Ecuador

2 Universidad Nacional de Colombia, Instituto de Ciencias Naturales, Laboratorio de Sistemática y Biología Comparada de Insectos, Bogotá, Colombia **3** Entomology Museum, Facultad de Recursos Naturales. Escuela Superior Politécnica de Chimborazo. Panamericana sur Km 1½, Riobamba, Ecuador

Corresponding author: Andrea C. Román (andrea.carvajal@fcdarwin.org.ec)

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Abstract

Very little is known about the sand wasp, *Bicyrtes variegatus*, in the Galápagos archipelago. In this study, we compiled information from surveys, museum collections and the literature to better understand its distribution and ecology. We found records of *B. variegatus* on seven islands with the earliest known record from 1964, from San Cristóbal Island. Wasps have been collected in the littoral, arid, transition and humid vegetation zones and have been reported visiting endemic, native, cryptogenic, and introduced plants. Sun dances and a tight cluster of wasps, similar in form to what others have called “mating balls”, were observed in the hot season.

Keywords

Bembicinae, flower visitors, mating, sand wasp

Introduction

Despite the biological importance of the Galápagos archipelago, there are still groups of insects about which little is known (Causton et al. 2006). Recently, researchers have increased efforts to study the Hymenoptera of the Galápagos Islands, resulting in the discovery of new taxa as well as new locality records for species that were already registered (Fernández et al. 2018; Herrera et al. 2024). One of these is the sand wasp *Bicyrtes variegatus* (Oliver, 1789) (Crabronidae). Species of this genus are recognized by the scarlike middle ocellus, papal formula (6–4), and lateral projections of the propodeum (Bohart 1996). Of the 27 described species, 16 are found in South America, eight in North America, and the remaining species in Panama (Bohart and Menke 1976).

Species from this genus are solitary wasps, feeding mainly on Hemiptera of the families Alydidae, Coreidae, Cydnidae, Lygaeidae, Pentatomidae, Pyrrhocoridae, Reduviidae, Rhopalidae, and Scutelleridae, as well as Diptera (Eberhard 1974; Evans and O’Neill 2007). Evans and O’Neill (2007) identified three methods of provisioning nests (mass, delayed, and progressive), depending on the timing and duration of provisioning a cell, and found that the number of cells per nest ranges from one to five, with 3–24 prey in a cell. These authors also report nesting-site fidelity, in which wasps remain in the same place each year. Males display a variety of strategies for attracting mates including “sun dances”.

Bicyrtes variegatus is easily recognized by the yellow band across the anterior part of the scutellum (Bohart 1996) and has been reported from Texas to Argentina (Bohart and Menke 1976; Genise 1979; Amarante 2002; Buys and Trad 2021). Nesting aggregations have also been reported from Santa Cruz Island in the Galápagos (Larsson 1992). Throughout its range, this species is mainly found in coastal habitats, with observations of females digging nests on the beach (Evans 1976). *B. variegatus* is considered a mass provisioner, laying an egg on the prey that it places inside a cell in the ground nest and then closing the cell. This behavior has been associated with prey scarcity or poor weather conditions rather than with a particular habitat condition (Evans and O’Neill 2007). Once the larva matures, a cocoon is made and pupation is initiated. The cocoon was described by Buys and Trad (2021) as an ovoid and granulose structure with a length of 9–10 mm. *B. variegatus* is reported to build nests in the same area each year, with only the males seeking mates (Evans 1974; Evans and O’Neill 2007).

Very little is known about *B. variegatus* in the Galápagos Islands. In this study, we compiled information from surveys, museum collections, and literature to better understand the distribution and ecology of this species in the archipelago.

Methods

We reviewed specimens deposited in the Invertebrate Collection of the Charles Darwin Research Station (ICCDRS) up to August 2023 and specimens from the California Academy of Science (CAS) online database (Monarch 2023). John Heraty kindly

provided information on specimens at the University of California, Riverside (UCRC) and the Canadian Museum of Nature (CMNC), collected during the Peck expeditions (Peck, 2001). The ecological information on the labels or in the databases (e.g., interaction with plants) was also extracted. In addition, we conducted a search of the literature. Lastly, we checked material collected in the project “Study of invasive species and diversity of terrestrial invertebrates in the Galápagos Islands” within the framework of the ESPOCH agreement with the Charles Darwin Foundation”. In this, a structured method was used (Longino and Colwell 1997) to inventory Hymenoptera archipelago-wide in 2018, 2019, and 2021. Sampling was carried out in the littoral, dry, transition, and humid zones (Jackson 1993; Tye and Francisco-Ortega 2011) on the islands of Española, Fernandina, Floreana, Genovesa, Isabela (Alcedo, Darwin, and Sierra Negra volcanoes), Marchena, Pinta, San Cristóbal, Santa Cruz, and Santiago using three methods: i) Malaise traps (three traps per zone separated by a minimum of 50 m along the altitudinal transect and set out for eight days), ii) yellow trays (three trays per zone separated by a minimum of 5 m and placed around each Malaise trap for three days), and iii) sweep-net collections (four runs of 50 double passes and free capture in each zone).

Results and discussion

Distribution

The earliest record of *B. variegatus* that we found was from 1964 collected by R. L. Usinger on San Cristóbal Island and deposited at CAS. To date, *B. variegatus* has been reported from islands currently inhabited by humans (Floreana, Isabela, San Cristóbal and Santa Cruz), inhabited by humans in the past (Santiago; Lundh 2001), and from uninhabited islands (Española and Fernandina). In the material we examined we found records of *B. variegatus* from the littoral, arid, and transition vegetation zones (Tye and Francisco-Ortega 2011), but notably also from the more humid areas (e.g. Bellavista on Santa Cruz Island and Cerro Pajas on Floreana Island). The highest elevations it was recorded at was 400 m.a.s.l. NE of Cabo Hammond on Fernandina Island and 335 m.a.s.l. at Cerro Pajas on Floreana Island (Fig. 1). Collection localities include: Española: Gardner Bay; Fernandina: NE of Cabo Hammond; Floreana: Cerro Pajas, Finca Cruz, Mina de Granillo Negro, Playa Negra, Post Office Bay; Isabela: Bosque de los Niños and Puerto Villamil; San Cristóbal: Camino a las Negritas, Camino a Tijeras, El Chino, Puerto Baquerizo Moreno, Puerto Chino; Santa Cruz: Bellavista, Charles Darwin Research Station (CDRS), Mina Granillo Negro, Playa el Garrapatero, Tortuga Bay. In addition to these records, *B. variegatus*, incorrectly named *Bycertis*, is reported in the literature from Santiago (Traveset et al. 2013) at a site later identified as Puerto Egas (H.W.H.). No specimens were collected in the archipelago-wide surveys conducted by ESPOCH between 2018 and 2021, which included setting out traps in the littoral-arid zones, the preferred habitat of these wasps.

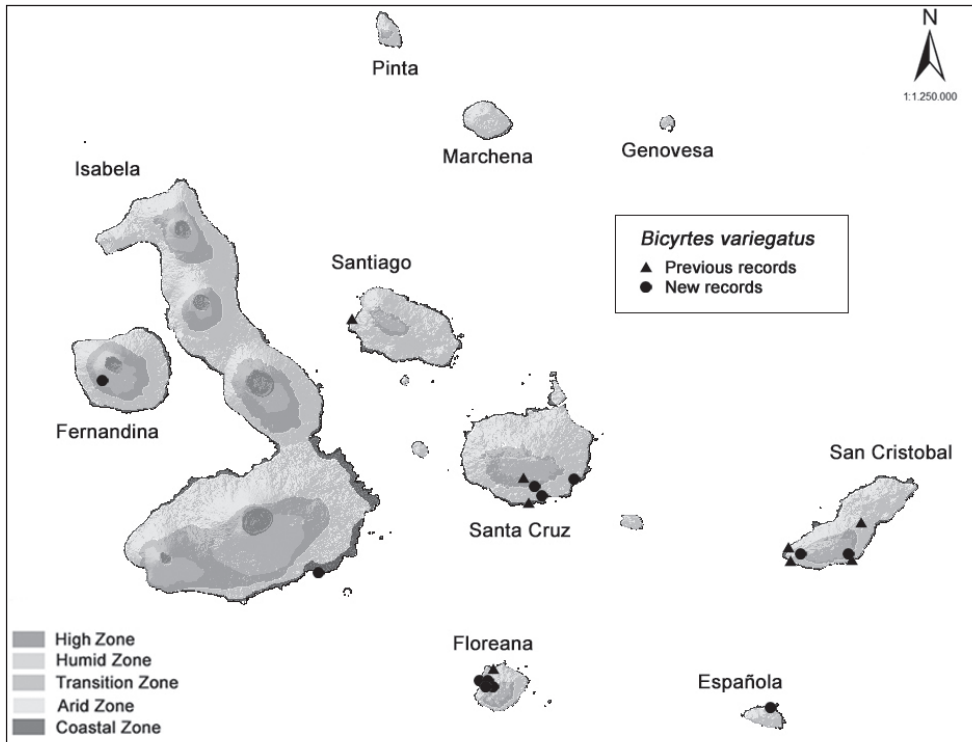


Figure 1. Distribution of *Bicyrtes variegatus* in the Galápagos archipelago.

How *B. variegatus* reached the archipelago is unknown. Little information is available in the literature about how *B. variegatus* can disperse over long distances, including how it has dispersed to new islands (e.g. Bohart and Menke 1976). It is possible that it arrived in the Galápagos in sand and soil imported for the construction of military posts during World War II (US 1947; Peck et al. 1998). These wasps are known to build their nests in sandy material (Evans and O'Neill 2007) and have been found in sand used in construction (Eberhard 1974). The cocoons of *B. variegatus* are made of soil particles bound together with silk, and the prepupae of some *Bicyrtes* species can remain dormant for extended periods (Martins et al. 1998; Buys and Trad 2021).

Interaction with plants and mating behavior

Bicyrtes are known to visit flowering plants in other parts of the world (Porter 1980; Freitas et al. 2001). Plants are visited to obtain carbohydrates, but are also used for hunting prey and resting (Martins et al. 1998; Evans and O'Neill 2007). In the Galápagos, multiple studies have documented Hymenoptera associated with plants (e.g. McMullen 1986, 1993; Linsley and Usinger 1966; Peck et al. 1998), but did not report *Bicyrtes* visiting flowers. However, *Bicyrtes* sp. was recorded in the literature

(Boada 2005; Traveset et al. 2013; Hervías-Parejo et al. 2018), or on labels, visiting the following plants: *Bidens pilosa* (cryptogenic), *Croton scouleri* (endemic), *Galactia striata* (native), *Heliotropium angiospermum* (native), *Lantana camara* (introduced), *Mollugo flavescens* (endemic), *Scalesia cordata* (endemic), *Scalesia gordilloi* (endemic), *Vachellia rorudiana* (native), *Vallesia glabra* (native), *Varronia leucophlyctis* (endemic), and *Waltheria ovata* (native).

Other than plant visits, little is known about the behavior of *B. variegatus* in Galápagos. In February 2022, we observed hundreds of *Bicyrtes* wasps flying near Garrapatero beach on Santa Cruz Island. The wasps were close to the sand and formed aggregations akin to mass swarms. These are aggregations of males in the sites where virgin females emerge (Evans and O'Neill 2007). Such “sun dances” have been documented as a mating strategy of sand wasps (Bembicinae) (O'Neill 2008). We also saw a tight cluster of wasps similar in form to what others have called “mating balls” (Evans and O'Neill 2007), although we did not observe mating (Fig. 2). This behavior was only observed in February during the hot rainy season. In the following months, only a few individuals were observed flying over the ground surface.



Figure 2. “Mating ball” of *Bicyrtes variegatus* on the sand. Credit for illustration: José Falcón Reibán.

Material examined

ECUADOR, Galápagos – **Española** • 3♂♂, 5♀♀; Gardner Bay; 1.35111°S, 89.662222°W; 0–20 m; 27 Apr. 1991; J. Heraty leg.; arid zone; swp; H91-006; UCRC: UCR-CENT00467383-00467390 – **Fernandina** • 1♂; 10 Km N[orth]e[ast] Cabo Hammond; 0.419166°S, 91.581111°W; 400 m; 9 May. 1991; J. Heraty leg.; transition [zone]; H91-027; UCRC: UCRCENT00467381 – **Floreana** • 1; Mina de Granillo Negro; 1.281212°S, 90.467887°W; 169 m; 8 May. 2019; A. Acurio, L. Betancourt leg.; ICCDRS 42756 • 1; 3Km E[ast] Playa Negra; 120 m; 21–28 Mar. 1989; S. Peck and B.J. Sinclair leg.; Malaise trap; (89–140); ICCDRS 48230 • 1; Post Office Bay; 30 Abr. 1983; Y. Lubin Leg.; ICCDRS 54389 • 1; Between beach & lagoon, E. end Post Office Bay; 1.235389°S, 90.451361°W; 14 Feb. 1967; Ira L. Wiggins leg.; CASENT 8556863 • 2 ♀♀; Cerro Pajas; 1.293611°S, 90.457222°W; 335 m; 27 Mar.-22 Apr. 1996; S. Peck leg.; Forest edge; Malaise; 96–54; CMNC: UCRCENT00467399, 00467400 • 2♀♀; Finca Cruz; 130 m, 16–22 Apr. 1996; S. Peck leg.; arid zone forest; Malaise; 96–107; CMNC: UCRCENT00467396, 00467397 • 6♀♀; Finca Cruz; 130 m; 27 Mar.-16 Apr 1996; S. Peck leg.; arid zone forest; Malaise; 96–58; CMNC: UCRCENT00467392-00467395 – **Isabela** • 1; P[uer]to Villamil; 7 Mar. 1989; B.J. Sinclair leg.; littoral; sweeping sand beach; ICCDRS 48225 • 1; Bosque de Niños; 20 Mar. 1995; P. Delgado leg.; Licking on *Scalesia cordata*; 11:51; ICCDRS 48223 – **San Cristóbal** • 1; Camino a las Negritas; 31 Mar. 2002; R. Boada leg.; *S. gordilloi* (leaves); ICCDRS 48221 • 1; Camino a las Negritas, 31 Mar. 2002; R. Boada leg.; *S. gordilloi* (flowers); ICCDRS 48228 • 1; [Puerto] Baquerizo; 10 m; 11–23 Feb. 1989; S. Peck leg.; Malaise trap; (89–47); ICCDRS 48224 • 1; El Chino, Z[one] Agrícola; 13 Apr. 2003; P. Lincango, A. Mieles leg.; Manual collection (Beach); ICCDRS 48226 • 1; P[uer]to Baquerizo [Moreno]; 12 Feb. 2007; M. Flores leg.; Manual collection (in the car); ICCDRS 48227 • 1; Puerto Chino; 26 Feb. 2011; M. Noguera leg.; Manual collection; on *Lantana camara*; #SC-544; ICCDRS 54393 • 1; Camino a Tijeras; 2 Mar. 2010; R. Castro, S. Chamorro leg.; Manual collection; on *Croton scouleri*; ICCDRS 54390 • 3; Progreso (trail to); 0.846271°S, 89.441822°W; 23 Feb. 1964; R.L. Usinger leg.; CASENT 8556860, 8556861, 8556862 – **Santa Cruz** • 1; C[harles] D[arwin] R[esearch] S[tation]; 5 Mar. 1996; C. Blanton leg.; ICCDRS 48222 • 1; Charles Darwin Research Station; 13 Feb. 2007; A. Muth leg.; Malaise; ICCDRS 48229 • 1; Bellavista; 0.6989167°S, 90.3207222°W; 199 m; 12 Feb. 2020; C.R. Gil Jaramillo leg.; Entomological net; ICCDRS 46547 • 1; Mina Granillo [Negro]; 8 May. 2011; S. Chamorro leg.; Manual collection; on *Bidens pilosa*; ICCDRS 54391 • 1; Tortuga Bay; 23 Feb. 2010; S. Chamorro leg.; Manual collection; on *Waltheria ovata*; ICCDRS 54392 • 2; Playa el Garrapatero; 16 Mar. 2022; A. Mieles Leg; Entomological net; ICCDRS 53891, 53892.

Author contributions

Conceptualization: ACR, PPR. Data curation and formal analysis: ACR, PPR, LBC. Supervision: HWH, CEC. Writing – original draft: ACR, PPR, CEC. Writing – review and editing: ACR, CEC, PPR, LBC, CF, HWH.

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