Ischnura hastata – a new species for Graciosa Island, Azores, Portugal (Odonata: Coenagrionidae)

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Abstract. A small population of *Ischnura hastata* (Say, 1839) was observed on 20-vii- and 21-vii-2016 at the freshwater pond 'Charco da Caldeira' in the Caldeira of Graciosa island, Portugal. It constitutes both the first record in this island and the presence in all major islands of the Azores archipelago.

Further key words. Dragonfly, damselfly, Zygoptera, Anisoptera, parthenogenesis, eutrophication, dispersal

Introduction

The Azores is a volcanic archipelago situated in the North Atlantic Ocean (38°30'N, 28°0'W), composed of nine islands. They belong to the Macaronesia biogeographical region, the archipelagos of which share similar evergreen forest (Borges et al. 2010; Rego et al. 2015). Graciosa (39°2'38"N, 27°59'1"W) is the second smallest (61 km²), and the lowest island of the archipelago with the maximum altitude of 402 m a.s.l.. Because of its outermost position within the central group of islands, the odonate fauna of Graciosa is less explored than that of the other islands of the Azores (Vieira & Cordero-Rivera 2013).

Four Odonate species have been considered resident in the Azores islands (cf. Weihrauch 2011; Vieira & Cordero-Rivera 2013, 2015a, 2015b), namely: *Ischnura hastata* (Say, 1839), *I. pumilio* (Charpentier, 1825), *Anax imperator* Leach, 1815, and *Sympetrum fonscolombii* (Selys, 1840). Further a migrant species, *Pantala flavescens* (Fabricius, 1798), was recently recorded for São Miguel Island (Vieira & Cordero Rivera 2015a). *Ischnura hastata* is native to the Americas (Belle & van Tol 1990; Westfall & May 2006) and its populations found in the Azores archipelago represent the only known example of parthenogenesis in the order Odonata (Cordero-Rivera et al. 2005; Lorenzo-Carballa et al. 2009).

All four species were known from all islands except Graciosa, from which only *A. imperator* and *S. fonscolombii* had been reliably recorded (Cordero- Rivera et al. 2005; Vieira & Cordero-Rivera 2013, 2015b). Very few records of odonates have been published for this island.

Given that *I. hastata* is of great interest in every Azorean island due to its unique parthenogenetic reproduction (Cordero-Rivera et al. 2005; Lorenzo-Carballa et al. 2009; Vieira & Cordero-Rivera 2015b), the first author made a visit to Graciosa on 20 and 21 July 2016, in order to locate and survey local populations.

Material and methods

The Zygoptera surveys were conducted on 20- and 21-vii-2016 at the same 14 localities explored during the previous visits to Graciosa island (cf. Vieira & Cordero-Rivera 2013). Field observations were carried out along the shoreline of the pond 'Charco da Caldeira' (Fig. 1) within two main selected sites with the GPS coordinates (latitude, -longitude, in zone 26S, geodesic system WGS84): 39.028496, -27.974331 and 39.027998, -27.974116. This pond is a topographic depression of elliptical form (1.6 × 0.8 km) and 270 m depth that accumulates mainly rainwater. It is formed by the collapse of the central part of a polygenetic volcano of the Caldeira, which occupies the southeastern part of the island. It was surrounded mainly by plantations of *Cryptomeria japonica*, *Acacia melanoxylon* and some plants of native laurel forest (e.g., *Morela faia*). The pond lacks fish and has a low density of introduced frogs (*Pelophylax perezi*). Fringing vegetation is well preserved because it is free of cattle. At the time of sampling, aquatic vegetation included *Potamogeton polygonifolius*, *Juncus effuses* and *Paspalum* sp. Data were obtained either by photographing living individuals in the field or by netting them, using a hand-held aerial net and sweeping vegetation immediately adjoining the pond. Damselfly individuals were identified in the hand and released afterwards.

Fig. 1. General view of the pond 'Charco da Caldeira' where *Ischnura hastata* was recorded. Graciosa Island, Azores, Portugal (21-vii-2016). Photo: VV

Results

During intensive searches in water bodies of Graciosa *I. hastata* was only found at the pond 'Charco da Caldeira'. In total, 15 adult females were observed: 10 ♀ on afternoon 20-vii-2016, and 5 ♀ on 21-vii-2016. Other Odonata species found at this pond on the same dates were *Anax imperator* (2♂ 3♀) and *Sympetrum fonscolombii* (3♂ 5♀).

Discussion

Lorenzo-Carballa et al. (2009) showed that in the Azores *Ischnura hastata* is the dominant odonate species in ponds and pools with good water quality (oligotrophic) and abundant vegetation, particularly *Potamogeton* species. A study on the islands of São Miguel and Pico showed that it was abundant in all oligotrophic ponds analysed. In ponds of medium quality (mesotrophic) the species is sporadically present. It was absent from all eutrophic ponds impacted by cattle grazing and from ponds subject to water extraction by humans.

In contrast to recognised habitat preferences of sexual populations on the American continent (cf. Lorenzo-Carballa et al. 2009, 2012) the parthenogenetic Azorean populations of *I. hastata* appear to be highly sensitive to eutrophication. Thus, in the Azores, the species can be considered as bioindicator of high water quality (Lorenzo-Carballa et al. 2009; Vieira & Cordero-Rivera 2015b).

Ischnura hastata is able to recolonise previously eutrophic ponds when they recover and again offer a suitable breeding habitat (*i.e.* richness in *Potamogeton*, *Paspalum* and other macrophytes). For example, this species reappeared in 2014 at Lagoa do Capitão (Pico island), where it was absent between 2003 and 2012, and at Lagoa das Furnas (São Miguel Island) was only observed from mid-April to October 2015 and 2016, respectively, after a government program to improve water quality in these ponds (own unpublished data).

Our study show that *I. hastata* also occurs in Graciosa, demonstrating the tremendous ability of the species to disperse and to colonise islands e.g., in the Caribbean and the Galapagos (cf. Dunkle 1990; Vieira & Cordero-Rivera 2015b). All populations found in the Azores, including Graciosa, have only females, and to date, no males have been registered in the Azorean archipelago. It is considered the only known example of natural parthenogenesis in the order Odonata, which gives this archipelago a great relevance from an evolutionary and conservational point of view (Cordero-Rivera et al. 2005; Lorenzo-Carballa et al. 2009; Vieira & Cordero-Rivera 2015b).

Terrestrial organisms native to these islands have arrived by a number of mechanisms: transport by wind, ocean currents, other animals or by human activity, either through purposeful or accidental introduction (Vieira & Cordero-Rivera 2015a). We are unable to identify which of these mechanisms resulted in the presence of *I. hastata* in Graciosa. However, we suggest two scenarios for the coloniza-

tion of *I. hastata* in this island: (i) the species came naturally, due its great dispersal capacity (e.g., from the neighbouring islands of Terceira, São Jorge and Pico); or (ii) the species was introduced associated with animals or plants whose importation has occurred repeatedly throughout history of the island.

Very few records of odonates have been published for this island, and no damselflies were previously found, probably due to a lack of sampling (Cordero-Rivera et al. 2005), a lack of permanent water bodies needed for *I. hastata* larval development (for discussion see Lamelas-López et al. 2016), or poor water quality on the island. In fact, the demand for water has occurred throughout the history of Graciosa. For example, in 1844, the drought was extreme, to the point where hundreds of barrels of water were imported from the nearby island of Terceira and it was also planned the use of water resources of other islands of the central group (Bruno 2016; J. Cunha pers. comm.).

Lamelas-López et al. (2016) recorded odonate larvae throughout the year in Terceira ponds, but they were more abundant from mid-April to late August. The same authors suggested that the survival of larvae is influenced by the fluctuating nature of the ponds (permanent *vs* temporary ponds) together with the abiotic conditions (mainly temperature and photoperiod), which can vary seasonally or spatially. We have also observed that the small ponds and temporary water masses of Graciosa fluctuate greatly in size and depth, according to the amount of rainfall. They experience periods of drying, which occur mostly during the summer months, which can affect Odonata survival, in particular that of *I. hastata*. Further on, Azevedo et al. (2005) observed that all the ponds were strongly eutrophic and, moreover, several ponds known through historical records do not longer persist.

In conclusion, our observations of *I. hastata* constitute the first documented record of this species in Graciosa. With the exception only of *I. pumilio,* still to be recorded from Graciosa, all four resident species known from the Azores are found in all islands.

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