REDISCOVERED AFTER 102 YEARS: *STRUMIGENYS ROGERI* (FORMICIDAE; MYRMICINAE) IS REDISCOVERED IN BRITAIN FROM THE EDEN PROJECT, EAST CORNWALL (VC 2)

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ABSTRACT

Ants are well known for their ability to survive transportation via human commerce and to establish populations in regions outside of their native ranges. In temperate regions, such as Britain, non-native ant species are often restricted to heated infrastructure such as homes and glasshouses. The ant genus *Strumigenys* comprises over 800 species around the globe, with several species having established populations outside their native ranges. In the British Isles, only two *Strumigenys* species are known, *S. perplexa* (Smith) and *S. rogeri* Emery. Here we provide the first record of *S. rogeri* in mainland Britain for 102 years from the Eden Project, Cornwall. Details on species identification, microhabitats and natural history are provided, as well as high resolution images.

INTRODUCTION

Artificially heated buildings, particularly those used for growing and displaying plants, often support populations of unintentionally introduced non-native arthropod species. Introductions occur via the trading and turnover of tropical plants, soil, and leaf litter where such insects reside. In Britain, introductions have occurred for over a century (Godfrey, 1907; Donisthorpe, 1908; Donisthorpe, 1915; Mann, 2006; Gregory, 2014; Salisbury *et al.*, 2019; Gregory & Lugg, 2020; Telfer, 2020). Among insects, ants are notorious for their capacity to survive transportation via human trade and commerce (McGlynn, 1999), with over 500 species recorded outside of their native ranges to date (Wong, Economo & Guénard, 2023).

In temperate regions such as Britain, exotic ants (i.e. non-native ant species) are frequently restricted to heated infrastructure and often incapable of establishing wild populations (Boer & Vierbergen, 2008; Blatrix *et al.*, 2018; Schar *et al.*, 2018). This is particularly the case for species originating from the tropical latitudes (Wong, Economo & Guénard, 2023). Although large arboreal and epigeic ants are readily detected (Donisthorpe, 1915), exotic ants are often small, cryptic species, occurring in leaf-litter and soil and therefore regularly escape plant quarantine protocols (Wong, Economo & Guénard, 2023).

The hyper-diverse ant genus *Strumigenys* comprises over 800 species around the globe (Bolton, 2023). Workers are diminutive, move slowly and are difficult to distinguish from surrounding leaf litter in which they live, even by trained eyes (Wetterer, 2012). Many, but not all, *Strumigenys* species are specialised predators with an ultra-fast trap-jaw to ensnare their prey (Booher *et al.*, 2021). Species richness peaks in the tropics but remains relatively poor in Europe in comparison, with only nine known species (Hamer, Marquis & Guénard, 2021; Noordijk *et al.*, 2021). Several species in the genus have successfully

established themselves in regions outside of their native ranges (Tang *et al*., 2019). In Europe, five of the nine species of *Strumigenys* are non-native, with *S. perplexa* (Channel Islands) and *S. emmae* (Emery) (The Netherlands) being the most recent additions (Hamer, Marquis & Guénard 2021; Noordijk, Bloem & Heijerman, 2021). Most non-native populations of *Strumigenys* are known only from greenhouses, whilst those recorded in the wild (*S. silvestrii* Emery and *S. membranifera* Emery) are recorded in the Mediterranean region where climatic conditions are likely more favourable. *Strumigenys rogeri* is the only *Strumigenys* species thus far known from mainland Britain, having been recorded over a century ago from within several public greenhouses (Godfrey, 1907; Donisthorpe, 1908).

Here we describe the rediscovery of *S. rogeri* in mainland Britain, from the tropical biome at the Eden Project, Bodelva, East Cornwall (SX0454/SX0455, VC 2), on the basis of several collection sessions and almost a dozen specimens. These represent the first records of the species in East Cornwall (the species' most southerly record in Britain), as well as the first record in Britain for over a century.

Materials and Methods

Site Information and Collection Methods

The Rainforest Biome (formerly the Humid Tropics Biome) at the Eden Project mimics rainforest conditions by maintaining humidity around a mean of 90% and temperature at a mean of 24 °C (range 18 to 35 °C). Inside the biome, numerous exotic plants are grown and exhibited for the public. Over time, leaf litter and plant debris have accumulated in areas. Ant specimens were collected by sifting this litter into observation trays as well as by general hand-searching within the litter itself.

Morphometrics

Metric diagnosis (Bolton, 1983) was used to help validate our identification of *Strumigenys rogeri* specimens. Linear morphometric measurement values included total length (TL), head length (HL), head width (HW), mandible length (ML), antennal scape length (SL), pronotal width (PW) and alitrunk length (AL, frequently referred to as Weber's length in modern ant studies). All measurements were in millimetres (mm). Indices included; cephalic index ($CI = HW/HL \times 100$), mandible index ($MI = ML/HL \times 100$), and scape index ($SL/HW \times 100$).

Results

A total of 13 *Strumigenys rogeri* workers (Fig. 1a–c) were collected between the years 2009 and 2011 within the Eden Project, Cornwall. Workers were collected in soil and leaf litter within the Humid Tropics Biome which houses various tropical plants. Specimens were identified by using Bolton's key within Hamer *et al*., (2021), displaying all diagnosable morphological characters for the species, and fitting well to the morphometric ranges of Bolton (1983). Specimen codes are given for specimens examined morphometrically by the first author.

Specimens examined

- Two workers, UK, Cornwall (VC 2), Eden Project, Humid Tropics Biome, SX0454/SX0455 (Lat; 50.3626, long; −4.7451), 17.iv.2009, coll. Mark G. Telfer, hand-searching in bamboo litter (ANTWEB1010985-86)

- Two workers, same collection site as previous, 17.iv.2010, coll. Clive R. Turner, hand-searching
- Six workers, same collection site as previous, 29.v.2010, coll. Clive R. Turner, hand-searching by sieving surface leaf litter and bark chippings into observation trays (ANTWEB1010980-81, 83–84)
- Two workers, same collection site as previous, 19.ii.2011, coll. Clive R. Turner, handsearching by sieving surface leaf litter and bark chippings into observation trays
- One worker, same collection site as previous, 04.iii.2011, coll. Clive R. Turner, sieved leaf litter and bark chippings (ANTWEB1010982).

Measurements (mm) and indices

Bolton (1983) – TL 2.3–2.8; HL 0.58–0.74; HW 0.42–0.52; ML 0.31–0.40;SL 0.36–0.46; PW 0.27–0.32; AL 0.58–0.68; CI 69–75; MI 51–58; SI 82–89 (40 measured).

This study – TL 2.28–2.48; HL 0.56–0.61; HW 0.42–0.45; ML 0.33–0.36, SL 0.35–0.38; PW 0.24–0.30; AL 0.55–0.62; CI 71.4–75.9; MI 55.66–61.08; SI 83.02–87.24 (7 measured).

Discussion

Only two *Strumigenys* species are known from the British Isles, *S. perplexa* and *S. rogeri* (Hamer, Marquis & Guénard, 2021). *Strumigenys perplexa* is established in the wild and relatively common on Guernsey (Andy Marquis, pers. comm.), whereas *S. rogeri* has only been recorded indoors and, until this discovery, appeared not to have become established. The most recent known record of *S. rogeri* was by Donisthorpe (1908) in 1907 from underneath flowering-pots in the 'propagating pits' at the Royal Botanic Gardens, Kew. A few years earlier, *S. rogeri* had been recorded by Godfrey and Stewart [as *Strumigenys incisa* Godfrey, 1907], also from propagating pits, at the Royal Botanic Garden, Edinburgh, in 1904 and 1905 respectively (Godfrey, 1907; Donisthorpe, 1915). There do not appear to have been any further British records of *S. rogeri* in the 102-year period between 1907 and 2009.

Strumigenys rogeri is a member of the *rogeri*-group, a species group most diverse in the Afrotropical and Malagasy regions (Bolton, 2000). Within the *rogeri*-group, *S. rogeri* is a member of the *rogeri*-complex, consisting of two additional species, *S. bernardi* Brown, and *S. vazerka* Bolton. *Strumigenys rogeri* is separable from both species by the following: its straight, linear mandibles; the presence of a longer, dentiform, distal preapical tooth on the mandible; and its generally larger body size and head width (*S. rogeri* HW 0.42–0.52 > HW 0.36–0.41 *S. bernardi* and *S. vazerka*). Concerning the *Strumigenys* recorded in Britain, *S. rogeri* can be differentiated from *S. perplexa* by the following: a clear interruption on the ventral head margin where a preocular notch is present (Fig. 1a–b), absent in *S. perplexa*; mandibles with two short preapical teeth, whereas *S. perplexa* only has one; the anterior portion of the eyes are detached from the head in *S. rogeri* (Fig. 1a), whereas they are not in *S. perplexa*. Further differentiating characters can be found in the key to Western Palaearctic *Strumigenys* by Bolton in Hamer *et al.* (2021), though readers should be aware of the recent presence of *S. emmae* in The Netherlands (Noordijk *et al.*, 2021) and Poland (Michlewicz, 2022), a species not factored into the key.

Considered to be native to the Afrotropics, *S. rogeri* is now near cosmopolitan, recorded from numerous countries across the world (Wetterer, 2012). Both

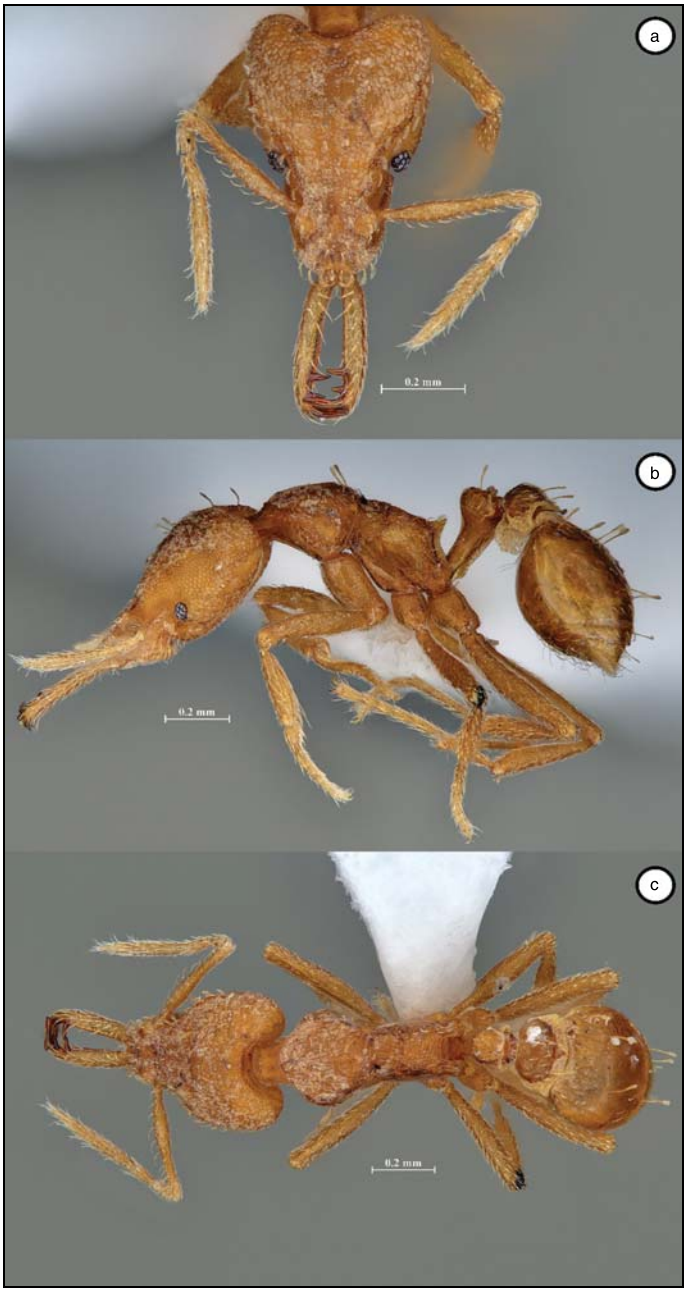

Fig. 1. *Strumigenys rogeri* worker specimen (ANTWEB1010983). a) full face view, b) lateral view, c) dorsal view.

S. bernardi and *S. vazerka* are thus far only known from the Afrotropics. In Europe, *S. rogeri* has been recorded from Germany, Denmark, and Norway (Eichler, 1952; Gjershaug *et al.*, 2016; Shar *et al.*, 2018). In the tropics and sub-tropics, *S. rogeri* seems to be capable of surviving and establishing populations outdoors where, according to Clouse (1999) and Deyrup *et al.*, (2000), it is a very successful coloniser, and may be responsible for displacing the native *S. louisianae* Roger, 1863 in Florida (Wetterer, 2012). However, this information is somewhat anecdotal because survey methodologies were not standardised across time intervals (1960 to 2000), plus other ecological changes in Florida may confound and influence the perceived decline of *S. louisianae* (Deyrup, Davis & Cover, 2000). However, *S. rogeri* is certainly capable of penetrating and invading mature rainforests, unlike typical exotic species which are more associated with synanthropic habitats (Longino, 2008; Wetterer, 2012). Similarly to other tramp species (*S. emmae* and *S. membranifera* Emery), *S. rogeri* displays thelytokous reproduction (whereby females are produced from unfertilized eggs, a trait thought to aid successful establishment in non-native ranges), is polygynous and preys upon the same arthropod species, but is associated with wetter more pristine environments in its non-native range in Florida than *S. emmae* and *S. membranifera* (Deyrup, Davis & Cover, 2000; Wetterer, 2012; Lee *et al.*, 2018; Wang *et al.*, 2023). In the temperate region however, specimens of *S. rogeri* have yet to be collected in the wild, undoubtedly due to its climatic requirements. We therefore doubt populations of this species will ever be capable of establishing wild populations in Britain. Considering the minute size, cryptic lifestyle and specialised feeding behaviour, we suggest that this species should not be considered as a pest. In fact, the presence of this species could be considered an integral part of the tropical biome's food web.

The true origin of the *S. rogeri* population at the Eden Project remains a mystery. Individuals could have been introduced to the site from imported plant material from outside the country. However, taking into consideration the minute size of the species and its cryptic nature, the species could also have been introduced to the site via trading of plants between greenhouses and tropical plant propagators within Britain; going entirely unnoticed and escaping plant quarantine protocols. As far as the authors are aware, no systematic surveys using leaf litter sifting, sorting and extraction techniques (the most reliable way to collect *Strumigenys* (Bolton, 2000)) have taken place in any of the numerous tropical greenhouses and biomes in Britain. If such surveys were to be carried out, we predict that further discoveries of *S. rogeri* would be made, along with other tramp *Strumigenys* species and undoubtedly other exotic ant species.

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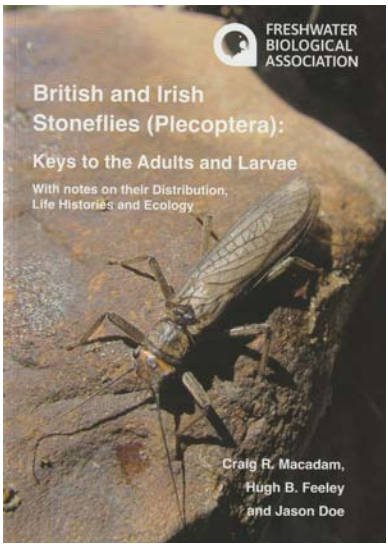
BOOK REVIEW

British and Irish Stoneflies (Plecoptera): Keys to the adults and larvae. With notes on their distribution, life histories and ecology by Craig Macadam, Hugh B. Feeley and Jason Doe. 2022. Freshwater Biological Association Scientific Publication No. 73. 215 pp. £45.00. ISBN 978-0-9000386-85-5.



This FBA publication is by far the most comprehensive book ever written about British stoneflies. Plecoptera, or pleated wing flies, are a small ancient order of aquatic insects, the British total amounting to a mere 35 species compared to a total of 570 species found across Europe. Despite our depauperate fauna, our stoneflies display an unrivalled degree of endemism with two species and two subspecies recognised as endemic to the British Isles. It is surprising therefore that records and articles about stoneflies rarely feature in our journal, with just two species reported in over 20 years. This publication should rectify the position.

The volume begins with a checklist of British and Irish stoneflies and an historical account, with photographs, of entomologists who have made significant contributions to our knowledge of the order. There follow sections on Life cycle, Life histories and Temperature (water temperature is critical for postembryonic development), Larval development, Adult emergence, Plecoptera behaviour and interspecific competition, Mating, Feeding, and Distribution and Conservation status. Females, for example, deposit an egg mass in one go, either dropping it from the air, by skimming the water surface with their body causing the egg mass to fragment, or by running across the water resulting in the egg mass breaking up and eggs falling separately onto the substrate below. The section on Collecting Plecoptera is unusual as larvae provide the most important site/habitat data and are far more studied than adults, particularly when monitoring water quality. Larvae are best sampled in most wadeable habitats using a standard kick-net, whereas in deeper water, techniques such as grab-sampling or extension nets are required. Adults are