

***Strumigenys perplexa* (Smith, 1876) (Formicidae, Myrmicinae) a new exotic ant to Europe with establishment in Guernsey, Channel Islands**

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Abstract

Ants are continually introduced into regions outside of their natural biogeographic ranges via global trade. The genus *Strumigenys* Smith 1860 (Formicidae: Myrmicinae) are minute predators with a growing history of global introductions, although tropical introductions into temperate zones are rarely able to establish outside of heated infrastructures. We report the first record of the Australasian *Strumigenys perplexa* (Smith 1876) to Europe and the British Isles from four sites on Guernsey, Channel Islands. This novel discovery is likely attributable to the species wide climatic and habitat tolerances, enabling the species to establish away from its natural range in Australasia and from heated-infrastructure. A key to the West Palaearctic *Strumigenys* species is provided alongside a preliminary and critical checklist of ant species recorded from the Channel Island archipelago, listing 32 species.

Keywords

Biological invasions, checklist, Dacetini, species introduction, taxonomic key

Introduction

Ants (Hymenoptera: Formicidae) are among the most successful group of biological invaders, particularly within insular systems (Moser et al. 2018). Their small size, relative inconspicuous nature, and social structure allow them to be frequently overlooked and transported via globally-facilitated human trade (McGlynn 1999). As a result, numerous ant species have been spread outside of their native ranges (McGlynn 1999). Compared to warmer zones, many introductions into temperate regions remain, however, limited to climate-controlled buildings (e.g. greenhouses) which provide shelter from unfavourable conditions (e.g. Donisthorpe 1915; Blatrix et al. 2018). Therefore, fewer successful introductions result in established viable outdoor populations (Dawson et al. 2017).

The ant genus *Strumigenys* (Formicidae: Myrmicinae) is increasingly emerging as a successful invader, with a recent review listing 24 species introduced outside their native range (Tang et al. 2019). *Strumigenys* is also the third most diverse ant genus, currently including 853 described species and is characterized by small size, cryptobiotic habits and specialized predatory behaviour (Bolton 2000; Bolton 2021). Most species forage and nest within the leaf litter, soil, and rotting wood, where many species are predators of small soft-bodied arthropods, such as Collembola (Masuko 1984). Many species within the genus have evolved a specialised kinetic trap-jaw mandibular mechanism with which to subdue prey (Gronenberg 1996; Booher et al. 2021). In some *Strumigenys* species groups the distinctive mandibular adaptations make the genus easily recognisable, particularly among the European ant fauna. Other distinctive morphological characters, such as spongiform tissue on the metasoma, dorso-ventrally flattened head and a diverse range of specialised pilosity as well as a reduction in antennomere count can be found in both short and long mandibular forms.

Strumigenys is mainly and widely distributed within the tropical and subtropical regions, with a peak of diversity observed in Borneo with 97 recorded species (Bolton 2000; Janicki et al. 2016). Temperate species are relatively common and diverse in temperate North America and Asia, but in contrast records of this genus in Europe are scant with just four native species reported: *S. argiola* Emery, 1869, *S. bauduieri* Emery, 1875, *S. tenuipilis* Emery, 1915 and *S. tenuissima* Brown, 1953 (Janicki et al. 2016; Seifert 2018). In addition, four introduced species have been recorded within Europe: *S. lewisi* Cameron, 1886 (but see discussion below), *S. membranifera* Emery, 1869, *S. rogeri* Emery, 1890 and *S. silvestrii* Emery, 1906. *Strumigenys rogeri* is only known from indoor and interception records, while *S. membranifera* and *S. silvestrii* are known to have established populations outdoors, but mainly limited to the more Mediterranean regions of Europe, characterized by warmer temperatures (Wetterer 2011; MacGown et al. 2012; Scupola 2019). Here we report a fifth introduced *Strumigenys* species from the Channel Islands, the Australian species *S. perplexa* Smith, 1876, which also represents the northernmost record for an outdoor population of the genus within Europe.

The Channel Islands are an archipelago of British Crown dependencies encompassing eight inhabited and several uninhabited islands located 15 to 50 kilometres off the northern French coast of Normandy within the English Channel (Fig. 1A, B). An

updated list of both native and introduced ant species and their distribution across the whole archipelago is included, alongside an updated dichotomous key to the Western Palearctic *Strumigenys* fauna.

Methods

Photographs taken by the second author (ADM) of individuals extracted via leaf litter sifting at Les Cotils Wood were initially posted onto the 'UK Bees, Wasps and Ants' Facebook group page on 25 Jan 2020, which were subsequently identified as *Strumigenys* by the first author (MTH). Sampling methods involved the collection of 5 litres of litter and soil and subsequent sieving using a 5 mm sieve onto a white tray. Morphological characters were examined using Bolton (2000) key to Australian *Strumigenys*. Determinations lead to unsatisfactory identifications in all other regional keys within Bolton (2000). Specimens were sent to Barry Bolton, for confirmation on MTH's determinations, as well as Mike Fox of the Bees, Wasps and Ants Recording Society (**BWARS**).

Microscopic examination and measurements were conducted using a Brunel BMDZ stereo-microscope, a Wild 5 with 2× objective and a Leica M205 C dissecting microscope by MTH, B. Bolton and BG respectively. Morphometric measurements were compared to Bolton's (2000) metric diagnoses of *S. perplexa* including: Total length (TL), Head length (HL), Head width (HW), Cephalic index (CI), Mandible length (ML), Mandible index (MI), Scape length (SL), Scape index (SI), Pronotal width (PW), Alitrunk (=mesosoma) length (AL = Weber's Length). All measurements are given in millimetres. Worker specimens measured include MTHENT1432, ANTWEB1013915, ANTWEB1013916, MTHENT1434 and two specimens in Barry Bolton collection (no codes). Queen specimens measured include ANTWEB1013917. Morphological characters were compared to AntWeb images of syntype specimens [CASENT0900905](#), [CASENT0909317](#) and [CASENT0909318](#) as well as specimen images of [CASENT0172367](#) and [CASENT0178872](#).

A number of specimens which had not been collected, but were only photographed in-situ were also included in our examination of specimens. The lack of congeneric species within the study area (Channel Islands) and the distinct morphological characters of the study species make in-situ photographs reliable records. In addition, and following the same approach, a predated springtail (Collembola) was identified using Hopkin (2007).

Photographs & distribution map

Specimen photographs (Figs 3, 4) were taken using a Leica DFC450 camera mounted on a Leica M205 C dissecting microscope and stacked in Leica Application Suite V. 4.5. In-situ photos were captured using a Canon EOS 5 DSR with Canon MP-E65 lens connected to an extension tube alongside a Canon MT-26 EX-RT twin flash system. Habitat shots were taken using an Olympus EM1-X with Olympus 12–40 mm

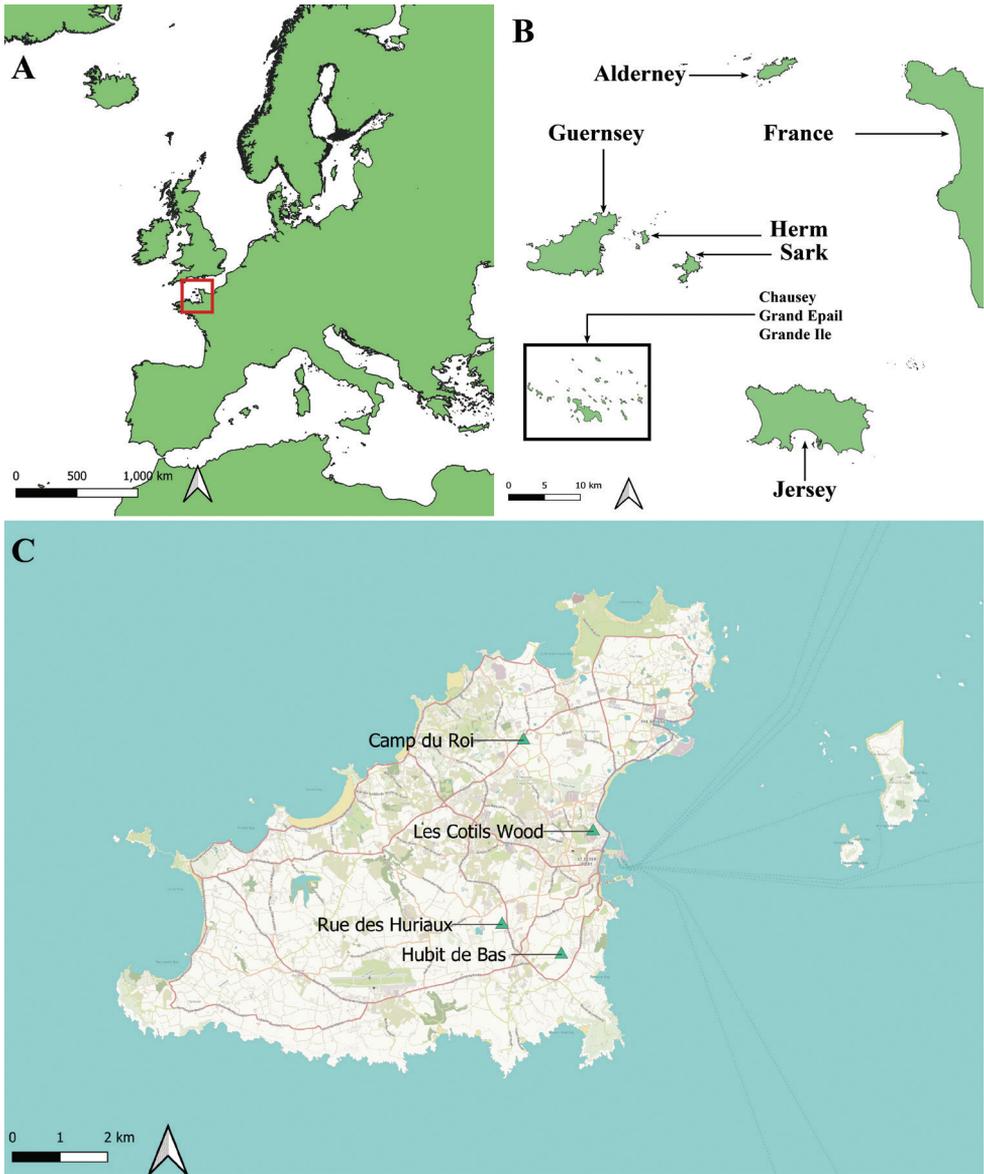


Figure 1. Study focus area in the Channel Islands **A** map of Western Europe with the location of the Channel Islands indicated by the red square **B** the Channel Islands. Chausey, Grand Epail and Grande Ile (magnified black square) are a small set of islands located south of Jersey **C** distribution of *S. perplexa* sites on the island of Guernsey, Channel Islands. Base map and data from OpenStreetMap and OpenStreet-Map Foundation.

PRO lens. Maps of Europe and the Channel Islands were generated in QGIS (v. Hannover 3.18.0) using OpenStreetMap Humanitarian Tiles and land polygons derived from OpenStreetMaps.



Figure 2. *Strumigenys perplexa* collection sites **A** let Cotils Wood in which specimens of *Strumigenys perplexa* were initially collected via litter sifting **B** the general habitat of Rus des Huriaux where specimens of *S. perplexa* were found through litter sifting. Photos by Andy Marquis.

Channel island checklist

Native ant species and introduced species recorded from the Channel Islands were obtained from the Global Ant Biodiversity Informatics (**GABI**) (Guénard et al. 2017) and the Bees, Wasps and Ants Recording Society (BWARS) database from across the archipelago. Records for both GABI and BWARS are validated by experts before incorporation into respective databases. Species distribution for each island is here presented, island names or particular locality information (e.g. city names, georeferenced) allowing the identification of the island for each record were used to develop the list of species found on each island. However, in a few cases, only the mention of Channel Islands without further geographic mentions was available. Species belonging to a species complex in which specimens have yet to be determined in light of modern taxonomic changes are included and discussed.

Results

The ants were determined to be *Strumigenys perplexa* (Smith, 1876), a member of the Austral *signeae*-complex within the *Strumigenys godeffroyi*-group. Determinations were confirmed by B. Bolton via morphological characters within Bolton (2000) key to Australian *Strumigenys*. In addition, morphometrics taken by B. Bolton, MTH and Benoit Guénard fell within the metric ranges given in Bolton (2000) for *S. perplexa*. Records are deposited with BWARS, Guernsey Biological Records Centre and the UK Non-Native Species Secretariat. Specimens are deposited in the personal

collections of MTH (MTHENT1434), B. Bolton and M. Fox (BWARS) as well as BMHN (MTHENT1432) and the Insect Biodiversity and Biogeography Laboratory (The University of Hong Kong, ANTWEB1013915, ANTWEB1013916, ANTWEB1013917).

Taxonomic treatment

Strumigenys perplexa (Smith 1876)

Figs 3–5

Orectognathus perplexa Smith, F., 1876: 491 (w. q.) New Zealand. Australasia

Synonyms: *Strumigenys antarctica* Emery, 1924: 321: *Strumigenys leae*: Brown, 1958: 38
See Bolton (2000) for full synonymy data.

Diagnosis. Worker diagnosis (adapted from Bolton (2000)): Mandibles long and subtly convex in dorsal view with apical fork and preapical tooth within the apical quarter. Apical fork of right mandible with intercalary tooth. Hairs on the leading edge of scape spatulate and curved apically; secondary hairs shorter, distinguishable from the former. Apicoscrobial hair simple, short and weakly curved. Cephalic dorsum with sharp reticulopunctate; 4–6 standing hairs on occipital margin. Eye with 7–10 ommatidia. Pronotal humeral hair simple, straight to weakly curved; pronotal dorsum and mesonotum each with 1–3 pairs stiff, erect, simple hairs. Alitrunk dorsum with fine and dense reticulation and punctation. Pronotum from reticulate-punctate to smooth; metapleuron is reticulate-punctate to entirely smooth, most common with smooth patches extending to the anterior portion of metapleuron and ventral sides portions of propodeum. Propodeum with pair of denticles formed of spongiform tissue. Petiole dorsum entirely reticulate-punctate; ventrally with curtain of spongiform tissue. Post-petiole dorsum smooth with sculpture consigned to the periphery; ventrally, laterally and encircling the disc with spongiform tissue. Gastral tergites with short, apically blunt hairs; often distributed evenly over sclerites. Basigastral costulae shorter than disc of postpetiole.

Queen: As worker but with usual queen modifications including larger eyes, mesosoma and metasoma, presence of three ocelli. Lamella of spongiform tissue on propodeal declivity is also discontinuous on the queen specimen but continuous on workers.

Measurements. Morphometrics were gathered by B. Bolton from two workers collected from Rue des Huriaux, by BG from two workers and a queen from Rue des Huriaux and by MTH from two workers collected from Les Cotils Wood and Rue Des Huriaux. Worker results were compared to Bolton (2000). See supplementary information (Suppl. material 1: Table S1) for more details. There are no measurements for a queen in Bolton (2000) or elsewhere, we have supplied the first here. Measurements are in millimetres (mm).

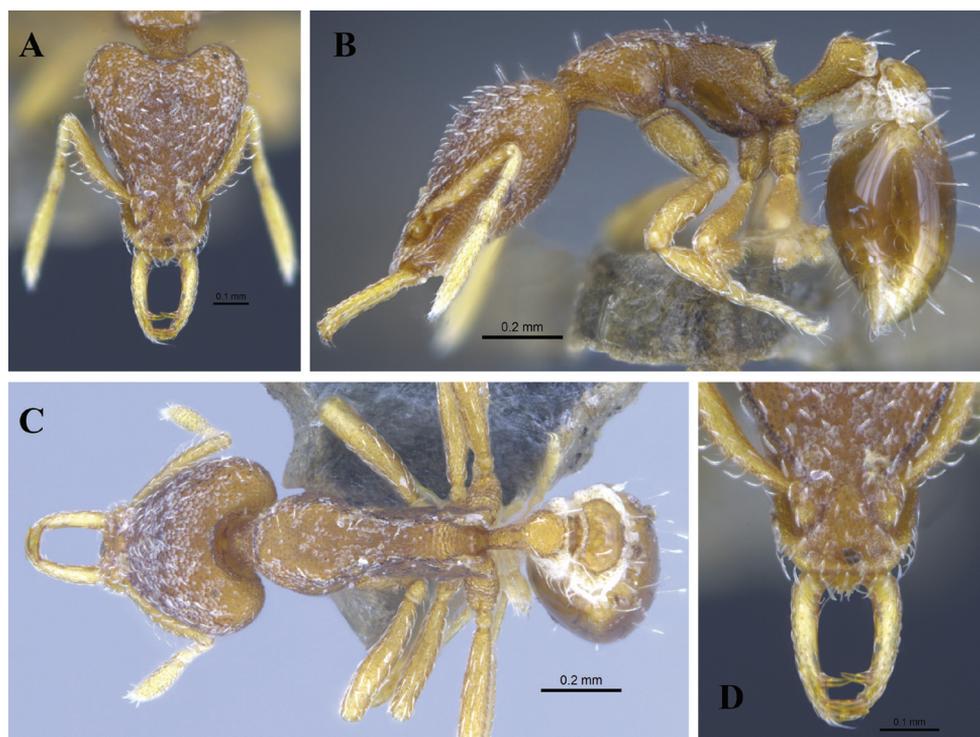


Figure 3. *Strumigenys perplexa* worker (ANTWEB1013915) **A** head view **B** profile view **C** dorsal view **D** mandibles view. Images by Benoit Guénard.

Worker morphometrics (n = 6): TL = 2.16–2.54, HL = 0.58–0.63, HW = 0.44–0.48, CI = 74–78, ML = 0.25–0.28, MI = 41–49, SL = 0.31–0.33, SI = 68–71, PW = 0.24–0.28, AL = 0.54–0.63.

Bolton (2000) worker (n = 35): TL = 2.0–2.6, HL = 0.53–0.65, HW = 0.42–0.49, CI = 69–79, ML = 0.21–0.30, MI = 34–48, SL = 0.29–0.36, SI = 68–78, PW = 0.25–0.30, AL = 0.53–0.68.

Queen morphometrics (n = 1): TL = 3.07, HL = 0.70, HW = 0.54, CI = 77, ML = 0.33, MI = 48, SL = 0.37, SI = 71, PW = 0.28, AL = 0.73

Material examined. Specimens examined: UK, 5 Workers, *Guernsey*, Rue des Huriaux, 49.444811, -2.563510, 03 May 2020, Det. M. Hamer 2020, Coll. A. D Marquis, Litter Sifting, M. Hamer Collection MTHENT1432, B. Bolton Collection, IBBL collection ANTWEB1013915, ANTWEB1013916, • UK, 1 Queen, *Guernsey*, Rue des Huriaux, 49.444811, -2.563510, 03 May 2020, Det. M. Hamer 2020, Coll. A. D Marquis, Litter Sifting, M. Hamer Collection, IBBL collection ANTWEB1013917, • UK, 1 Worker, *Guernsey*, Les Cotils Wood, 49.462479, -2.5371520, 25 Jan 2020, Det. M. Hamer 2020, Coll. A.D Marquis, Litter Sifting, M. Hamer Collection MTHENT1434

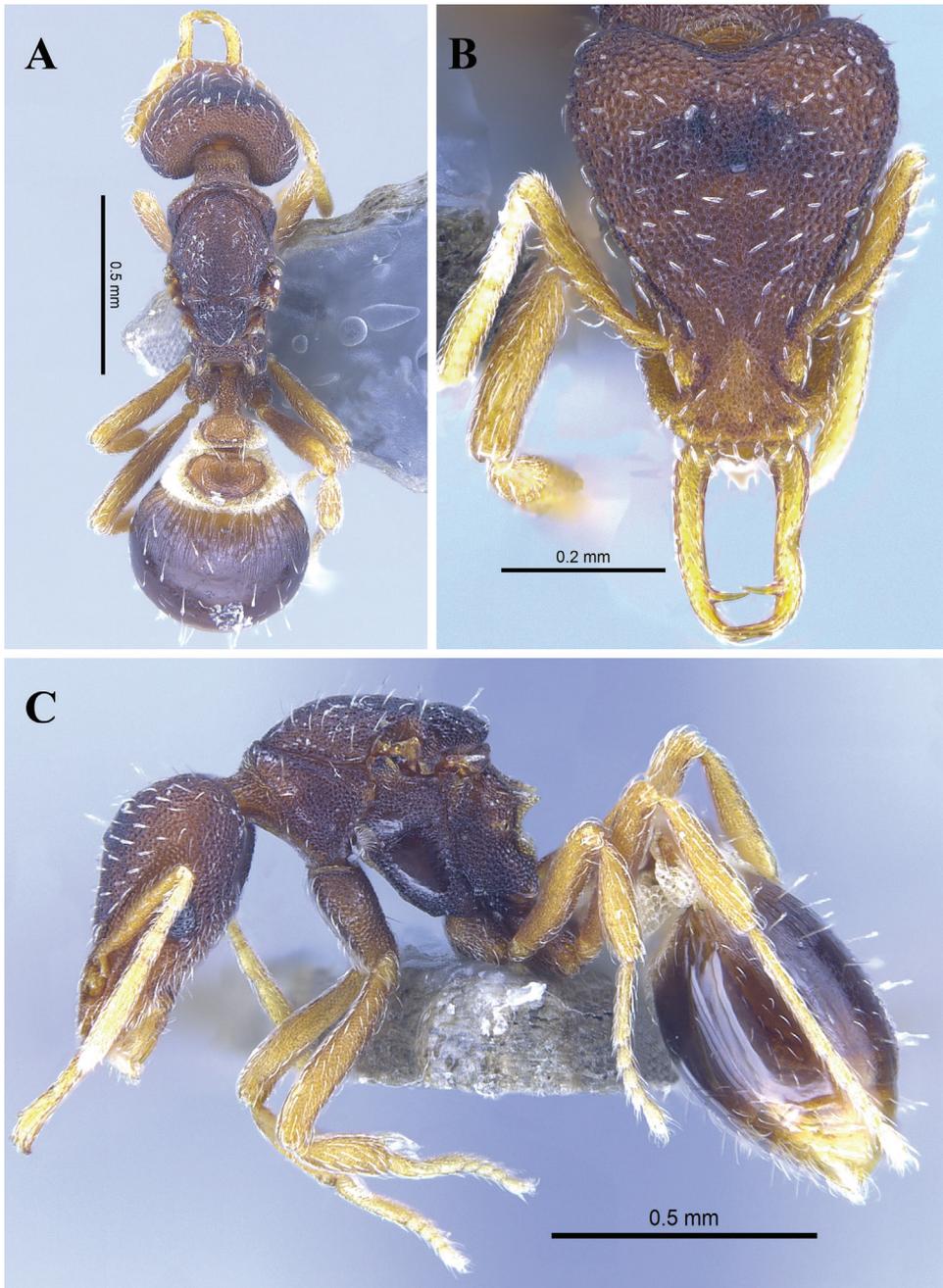


Figure 4. *Strumigenys perplexa* queen (ANTWEB1013917) **A** dorsal view **B** head view **C** profile view. Images by Benoit Guénard.

Determined to be *S. perplexa* from ADM photographs. UK, 19 Workers, *Guernsey*, Camp du Roi, 49.479724, -2.557311, 01 Nov 2020, Det. M. Hamer 2020, Coll. A. D Marquis, Litter Sifting, Fig. 5B • UK, 5 Workers, *Guernsey*, Les Hubit de



Figure 5. In-situ photo records in which specimens were not collected **A** *Strumigenys perplexa* worker carrying prey *Entomobrya intermedia* (Collembola: Entomobryidae) at Les Hubit de Bas **B** *S. perplexa* worker under wood from Camp du Roi. Photos by Andy Marquis.

Bas, 49.43915, -2.54637, 26 July 2020, Det. M. Hamer 2020, Coll. A.D Marquis, Under rotten log, Fig. 5A.

Distribution, ecology and behaviour. Specimens have been collected from four sites on the island of Guernsey, all outdoors. Collection sites are inland, ranging from deciduous forest (Les Cotils Wood, Fig. 2A) to semi-urban conurbations such as household gardens and on roadside verges (Rue des Huriaux Fig. 2B). It should be noted that Rue des Huriaux (Figs 1C, 2B) is an access track within 200 meters of a former garden centre. All specimens have been collected or photographed from within typical *Strumigenys* habitat i.e. soil, leaf litter, decomposing detritus or underneath logs. Workers were observed to be slow and deliberate in their movements and have been noted to prey upon *Entomobrya intermedia* Brooks, 1993 (Collembola: Entomobryidae) (Fig. 5A).

Key to West Palearctic *Strumigenys* species (workers)

[Adapted from Bolton, 2000: 285. with permission]

Note: there is also a single record of a *Strumigenys* species from Malta, identified as *S. lewisi* Cameron, by Schembri & Collingwood, 1995: 154, which is almost certainly a misidentification. Because Schembri & Collingwood gave no description or illustration of the Maltese species, and because no material from this collection is available for study, it is omitted here. Within Europe, a second mention of *S. lewisi* is found in Georgia, near the city of Batumi, (Arakelian and Dlussky 1991), however, following the examination of the drawings illustrating this species, we consider this record uncertain, as the preapical teeth seem rather short, the angle between the apical and preapical teeth more open, and the anterior margin of the clypeus strongly convex.

These specimens should be re-examined. *Strumigenys lewisi* is not the tramp species it was once thought to be, and its identity, entangled with several other species of the *S. godeffroyi* Mayr species group, was frequently misinterpreted and considerably confused (Bolton pers. comm.).

Taxonomic key of the native and introduced *Strumigenys* species known from Europe

- 1 Mandibles elongate and narrow, MI 34–58, linear or sublinear. At full closure elongate mandibles interlock only at their apices. Tooth at dorsal apex of mandible long and spiniform, strongly crossing over the tooth from the opposite mandible when closed. Inner margin of mandible with 1–4 teeth or denticles (Fig. 6 A–D)..... **2**
- Mandibles short and triangular, MI 15–20. At full closure mandibles engage throughout their visible length, without an open space between them. Tooth at apex of mandible small and inconspicuous, not spiniform, not strongly crossing over the tooth from the opposite mandible when closed. Inner margin of mandible with 12–14 teeth and denticles, some of which may be minute (Fig. 6E–H) **5**
- 2 Dorsum of mesosoma without standing hairs (Fig. 7A), these different from background pilosity i.e. not erect. Pronotal humeral hair absent. Cephalic dorsum with small orbicular setae. Mandibles each with 3–4 preapical denticles. When mandibles fully closed, the labral lobes are visible between them as a pair of elongate narrow triangles (Fig. 7B). (Austria, Azerbaijan, Bulgaria, Croatia, Czech Republic, France (southern mainland & Corsica), Georgia, Germany, Greece, Hungary, Israel, Italy (mainland, Sardinia & Sicily), Malta, Morocco, Russia (Caucasus), Serbia, Spain, Switzerland, Tunisia, Turkey)..... ***argiola***
- Dorsum of mesosoma with at least one pair of standing hairs (Fig. 7C, E). Pronotal humeral hair present (Fig. 7C) (can be abraded). Cephalic dorsum without orbicular setae. Mandibles each with 1–2 preapical teeth. When mandibles fully closed the labral lobes are not visible or at most appear between them as a pair of minute points basally (Fig. 7D, F) **3**
- 3 Ventrolateral margin of head interrupted by a deep, strongly incised preocular notch; in dorsal view anterior portion of eye is detached from side of head (Fig. 8A, B). With head in ventral view the preocular notch forms the apex of a transverse impression in the ventral surface of the head capsule that extends toward the midline, well behind the postbuccal impression. First gastral sternite without a basal spongiform pad. Apicoscrobial hair absent. Pronotal humeral hair flagellate (Fig. 7C). Mandibles each with 2 short preapical teeth, located close to the apicodorsal tooth, and the proximal preapical tooth longer than the distal (Fig. 6B) (Cosmopolitan tramp species)..... ***rogeri***
- Ventrolateral margin of head uninterrupted to anterior margin of eye; in dorsal view anterior portion of eye is not detached from side of head (Fig. 8C, D). With head in ventral view without a transverse impression in the ventral sur-

- face of the head capsule posterior to the postbuccal impression. First gastral sternite with a basal spongiform pad. Apicoscrobial hair present. Pronotal humeral hair straight and simple. Mandibles either with 1 spiniform preapical tooth, located close to the apicodorsal tooth, or also with a denticle close to the midlength which is much shorter than the spiniform preapical tooth (Fig. 6C, D)..... **4**
- 4 Leading edge of scape with all hairs curved toward the apex of the scape (Fig. 9B). Ventral surface of petiole with a conspicuous strip or curtain of spongiform material (Fig. 9A). Mandible with a single spiniform preapical tooth, located close to the apicodorsal tooth, without an additional denticle close to the midlength (Fig. 9B). Dorsum of mesosoma obviously with more than one pair of standing hairs, on pronotum and mesonotum. Mandibles relatively slightly shorter, MI 34–48. (Guernsey [British Channel Islands])...
..... ***perplexa***
- Leading edge of scape with 2 or more hairs curved toward the base of the scape (Fig. 9D). Ventral surface of petiole entirely lacks spongiform material (Fig. 9C). Mandible with a single spiniform preapical tooth, located close to the apicodorsal tooth, and also with an additional denticle close to the midlength (Fig. 9D). Dorsum of mesosoma with only a single pair of standing hairs, on the mesonotum. Mandibles relatively slightly longer, MI 50–57 (Madeira, southern Atlantic Islands. Portugal, Leiria district)..... ***silvestrii***
- 5 Pronotal humerus without a projecting hair; pronotum dorso-laterally with sharp raised margination (Fig. 10A). Dorsal mesosoma and first gastral tergite without standing hairs (Fig. 10A). Leading edge of scape with 1–2 hairs near the subbasal bend that are distinctly curved toward the scape base (Fig. 10B). Dorsal surface of mandible basally with a very distinct transverse sharp edge or rim that extends across its width, parallel to and in front of the anterior clypeal margin (Fig. 10B). CI 84–90, SI 51–57. (Cosmopolitan tramp species)..... ***membranifera***
- Pronotal humerus with a projecting simple hair; pronotum dorso-laterally without sharp raised margination (Fig. 10C). Dorsal mesosoma and first gastral tergite with standing hairs (Fig. 10C). Leading edge of scape with all hairs curved or inclined toward the scape apex (Fig. 10D). Dorsal surface of mandible basally without a transverse sharp edge or rim running across its width (Fig. 10D). CI 66–72, SI 69–76..... **6**
- 6 Dorsum of clypeus in full-face view densely clothed with conspicuous broadly spatulate to spoon-shaped hairs; in profile these hairs parallel with the surface from which they arise and closely applied (Fig. 11A). Medially curved ground-pilosity bordering the upper scrobe margins distinctly spatulate. (Algeria, Armenia, Bulgaria, Croatia, France (southern mainland & Corsica), Greece, Hungary, Italy (mainland, Sardinia & Sicily), Macedonia, Malta, Montenegro, Morocco, Romania, Russia, Serbia, Spain, Switzerland, Tunisia, Turkey)..... ***baudueri***
- Dorsum of clypeus in full-face view clothed with slender hairs that are very narrowly spatulate or simple and cylindrical; in profile these hairs markedly

- elevated and either arched or inclined anteriorly (Fig. 11B). Medially curved ground-pilosity bordering the upper scrobe margins fine and simple.....7
- 7 Hairs on clypeal dorsum narrowly spatulate; in profile the hairs distinctly anteriorly curved or anteriorly arched (Fig. 12A). (Bulgaria, France (mainland & Corsica), Greece, Italy, Spain, Turkey)*tenuipilis*
- Hairs on clypeal dorsum simple, fine and cylindrical throughout their length and tapered or truncated apically; in profile the hairs mostly straight, inclined anteriorly (Fig. 12B). (France (Corsica), Greece).....*tenuissima*

Channel Island checklist

A total of four ant subfamilies, 16 genera and 32 species (including species complexes), plus *Strumigenys perplexa*, are currently recorded from the Channel Islands (Table 1). Guernsey and Jersey hold the largest number of species, with 27 and 17 species respectively. *Temnothorax unifasciatus* (Latreille, 1798) is most widespread across the archipelago recorded from all islands except Grand Epail. In addition to *S. perplexa*,

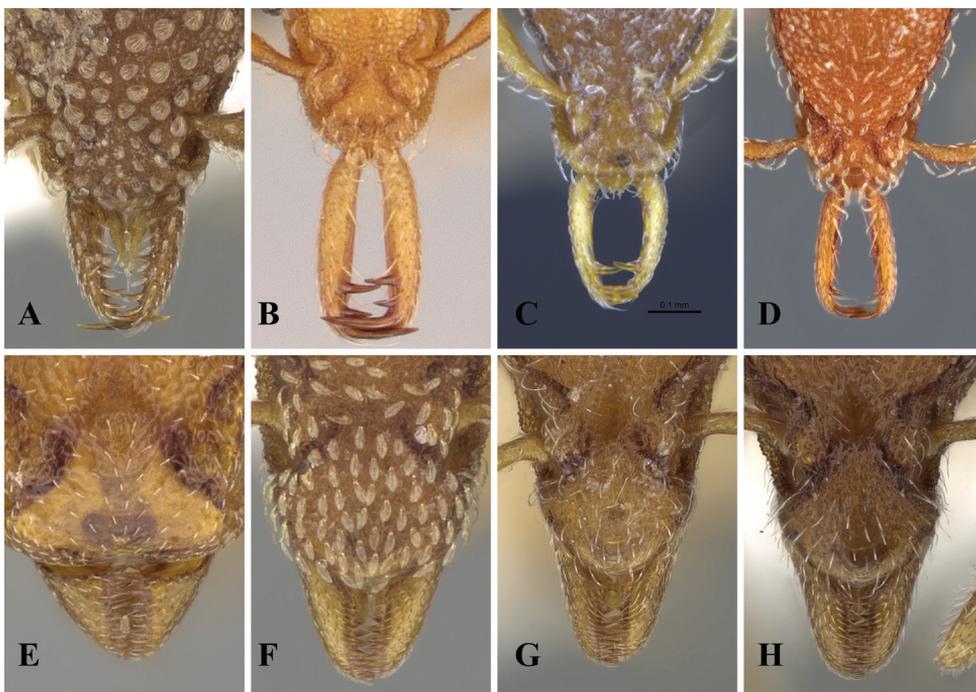


Figure 6. Mandible morphology of European *Strumigenys* species **A** *Strumigenys argiola* (CASENT0280693, Estella Ortega) **B** *S. rogeri* (CASENT0179508, Erin Prado) **C** *S. perplexa* (ANTWEB1013915, Benoit Guénard) **D** *S. silvestrii* (FMNHINS0000078527, Gracen Brilmyer) **E** *S. membranifera* (CASENT0023769, Michele Esposito) **F** *S. bauduerei* (CASENT0280694, Estella Ortega) **G** *S. tenuipilis* (CASENT0280695, Estella Ortega) **H** *S. tenuissima* (CASENT0280696, Estella Ortega). Pictures available from www.antweb.org.

Table 1. List of ant species recorded in the Channel Islands. ^E showing introduced species with established outdoor populations and ¹ introduced species not established outdoors. Species records indicated with a '?' require further identification work to resolve ambiguity.

Species names	Alderney	Chausey	Grand Epail	Grande Ile	Guernsey	Herm	Jersey	Sark	Channel Islands*
DOLICHODERINAE									
<i>Linepithema humile</i> ¹ (Mayr, 1868)					X				
<i>Tapinoma erraticum</i> (Latreille, 1798)					X				
<i>Tapinoma</i> sp. <i>erraticum</i> complex							?		
FORMICINAE									
<i>Formica cunicularia</i> Latreille, 1798	X	X			X	X	X	X	
<i>Formica fusca</i> Linnaeus, 1758	X	X			X	X	X	X	
<i>Formica pratensis</i> Retzius, 1783					X		X		
<i>Lasius alienus</i> (Foerster, 1850)	X	X			X	X	X	X	
<i>Lasius emarginatus</i> (Olivier, 1792)	X	X	X		X	X	X		
<i>Lasius flavus</i> (Fabricius, 1782)	X				X	X	X	X	
<i>Lasius fuliginosus</i> (Latreille, 1798)					X	X	X	X	
<i>Lasius mixtus</i> (Nylander, 1846)									X
<i>Lasius myops</i> Forel, 1894		X							
<i>Lasius niger</i> (Linnaeus, 1758)	X				X	X	X	X	
<i>Lasius psammophilus</i> Seifert, 1992					X	X	X		
<i>Lasius umbratus</i> (Nylander, 1846)					X				
<i>Plagiolepis pallescens</i> Forrel, 1889	X				X	X		X	
MYRMICINAE									
<i>Aphaenogaster subterranea</i> (Latreille, 1798)	X				X				
<i>Monomorium pharaonis</i> ¹ (Linnaeus, 1758)	X				X				
<i>Myrmecina graminicola</i> (Latreille, 1802)	X				X	X	X	X	
<i>Myrmica ruginodis</i> Nylander, 1846		X			X		X		
<i>Myrmica sabuleti</i> Meinert, 1861	X	X			X	X	X	X	
<i>Myrmica scabrinodis</i> Nylander, 1846	X	X			X	X	X	X	
<i>Solenopsis fugax</i> (Latreille, 1798)		X			X		X	X	
<i>Stenammina westwoodii</i> Westwood, 1839					X				
<i>Stenammina</i> sp. <i>westwoodii</i> complex							?	?	
<i>Stenammina debile</i> (Foerster, 1850)					X				
<i>Strumigenys perplexa</i> ^E (Smith, 1876)					X				
<i>Temnothorax albipennis</i> (Curtis, 1854)	X				X	X	X	X	
<i>Temnothorax unifasciatus</i> (Latreille, 1798)	X	X		X	X	X	X	X	
<i>Tetramorium atratulum</i> (Schenck, 1852)									
<i>Tetramorium caespitum</i> (Linnaeus, 1758)	X	X			X	X	X	X	X
<i>Tetramorium impurum</i> (Foerster, 1850)					X				
PONERINAE									
<i>Ponera</i> sp. <i>coarctata</i> complex					?	?	?		
<i>Hypoponera</i> sp. <i>punctatissima</i> ^E complex							?		
Total, not including complexes	15	11	1	1	27	15	17	14	

* No further mention.

two species and one species complex of exotic origin have been recorded, *Linepithema humile* (Mayr, 1868), *Monomorium pharaonis* (Linnaeus, 1758) and the *Hypoponera punctatissima* species complex. Four species complex groups are here recognized, including records for *Ponera coarctata*, *Hypoponera punctatissima*, *Tapinoma erraticum* and *Stenammina westwoodii* will require further taxonomic work on the basis of existing or new specimens collected.

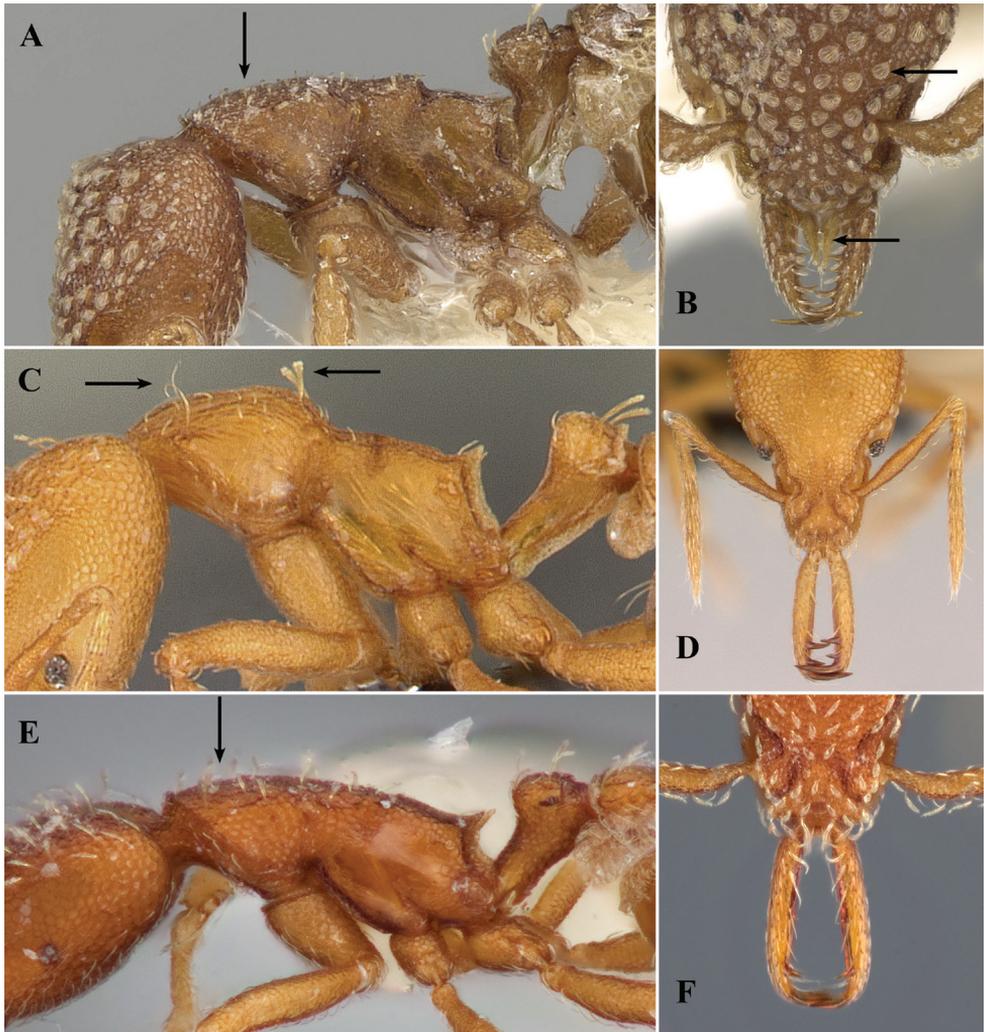


Figure 7. Distinguishing *Strumigenys argiola* from other long mandibular *Strumigenys* species **A** *S. argiola* with arrow showing the lack of standing hairs on mesosoma and pronotal humeral hair (CASENT0280693, Estella Ortega) **B** *S. argiola*, full face view with labral lobes and orbicular hairs indicated (CASENT0280693, Estella Ortega) **C** *S. rogeri* mesosoma profile, humeral hairs and standing mesoma hairs indicated (CASENT0179508, Erin Prado) **D** *S. rogeri* full face view showing lack of orbicular hairs and visible labral lobes (CASENT0179508, Erin Prado) **E** *S. silvestrii* mesosoma profile with standing hairs on mesosoma arrowed (FMNHINS0000078527, Gracen Brilmyer) **F** *S. silvestrii* in full face view with labral lobes not visible (FMNHINS0000078527, Gracen Brilmyer). Pictures available from www.antweb.org.

Discussion

The discovery of *S. perplexa* within the Channel Islands is remarkable not only because it represents the first record of this species in Europe but also the northernmost record of an outdoor population of any *Strumigenys* species for the continent. It also marks

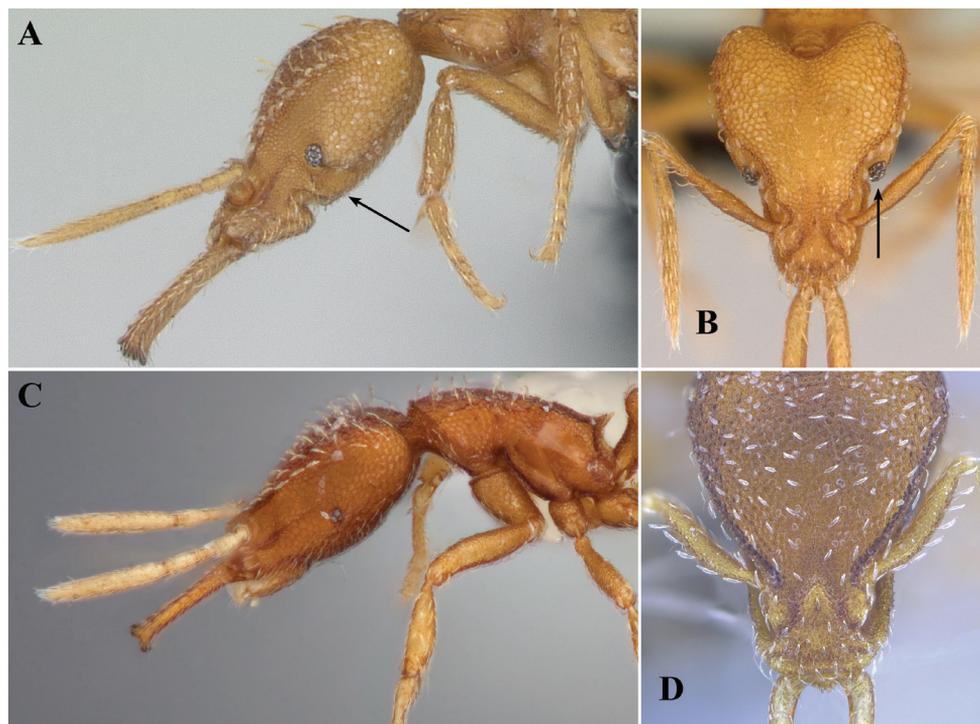


Figure 8. Separating *Strumigenys rogeri* from *S. silvestrii* and *S. perplexa* **A** *S. rogeri* head in profile indicating preocular notch (CASENT0135259, April Noble) **B** *S. rogeri* with anterior portion of eye detached from head (CASENT0179508, Erin Prado) **C** *S. silvestrii* displaying lack of preocular notch (FMNHINS0000078527, Gracen Brilmyer) **D** *S. perplexa*, lacking detached anterior portion of eye (ANTWEB1013916, Benoit Guénard). Pictures available from www.antweb.org.

the first finding of a member of this genus established outside of climate-controlled environments in the British Isles. The United Kingdom has continuously been the recipient of exotic ant species both historically and contemporarily (Donisthorpe 1927; Hamer and Cocks 2020). By 1925, 49 exotic species had been recorded, within the Royal Botanical Gardens, Kew, London, comprising a substantial 38 exotic ant records, which was undoubtedly driven by the trade and movement of horticultural material (Donisthorpe 1915; Donisthorpe 1927; Brangham 1938). Of the 49 records, *S. rogeri* represents the only previous member of *Strumigenys* recorded from the United Kingdom. *Strumigenys rogeri* is known to be a cosmopolitan species with a worldwide distribution facilitated by human commerce (Wetterer 2012a), and records in the United Kingdom originate from the “propagating pits” of both Kew Gardens, London (Donisthorpe 1915; Brangham 1938) and Edinburgh Botanical Gardens (Donisthorpe 1915). In recent years, a number of newly introduced ant species have been recorded in the UK including *Linepithema iniquum* (Mayr, 1870) and the highly invasive Argentine ant, *L. humile* (Fox and Wang 2016; Hamer and Cocks 2020). It is crucial for such findings to be appropriately recorded, particularly for those species of conservation or economical concerns (Notton and Norman 2017).

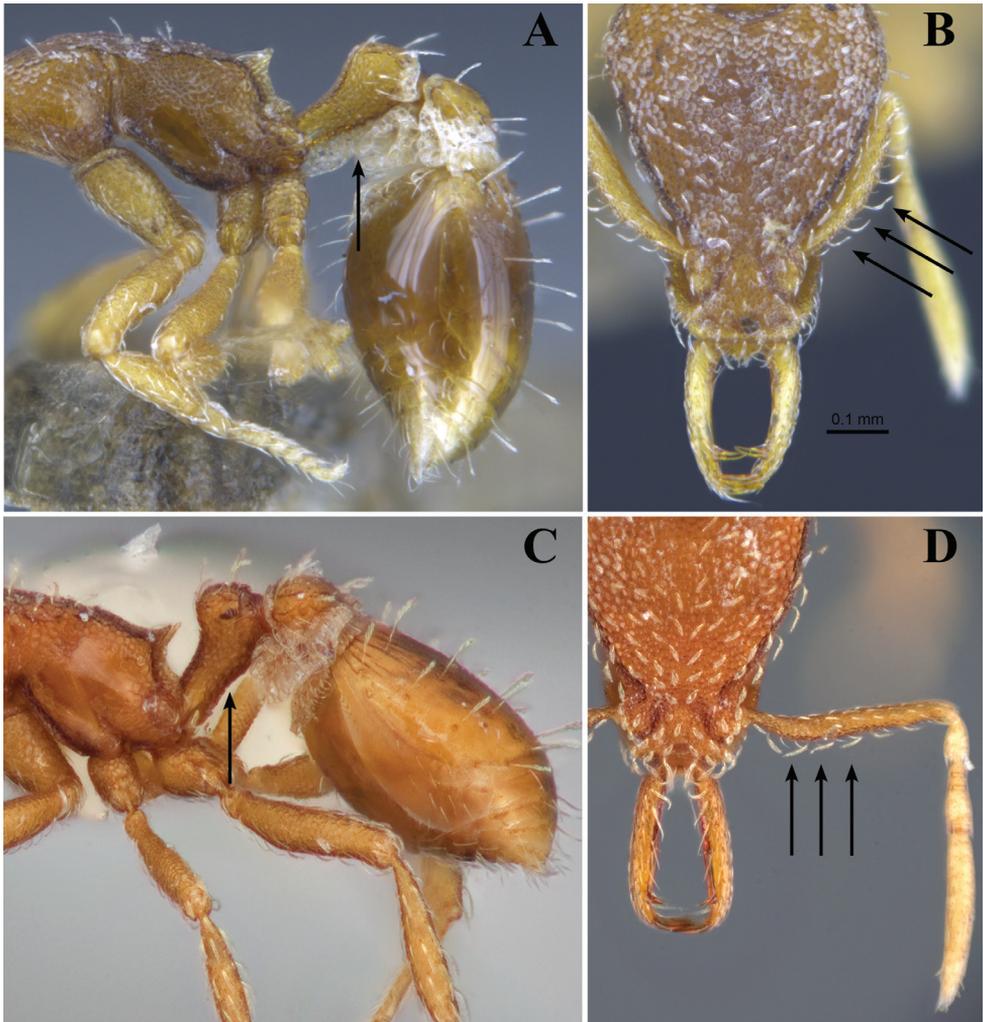


Figure 9. Separating *Strumigenys perplexa* and *S. silvestrii* **A** *Strumigenys perplexa* with ventral petiole spongiform strip indicated (ANTWEB1013915, Benoit Guénard) **B** *S. perplexa* showing all scape hairs curved toward apex (ANTWEB1013915, Benoit Guénard) **C** *S. silvestrii* indicating lack of ventral petiole spongiform tissue (FMNHINS0000078527, Gracen Brilmyer) **D** *S. silvestrii* with 2 or more hairs directed toward scape base (FMNHINS0000078527, Gracen Brilmyer). Pictures available from www.antweb.org.

Strumigenys perplexa was first described from New Zealand by Smith (1876) as *Orectognathus perplexus*. Specimens that were actually *S. perplexa* were subsequently collected and erroneously described as new species from elsewhere in Australasia resulting in the junior synonyms *S. leae* Forel (1913) and *S. antarctica* (Forel, 1892). Bolton (2000) synonymised *S. leae* and *S. antarctica* into *S. perplexa*. In Australia it seems *S. perplexa* is widely distributed (antmaps.org, Janicki et al. 2016) and tolerant of a broad range of habitats with nests located in dry, open woodland, to ‘moist fern gullies’



Figure 10. Separating *Strumigenys membranifera* from other short mandibular *Strumigenys* **A** *S. membranifera* in profile view with pronotal margination and lack of standing hairs on mesosoma and first tergite shown (CASENT0023769, Michele Esposito) **B** *S. membranifera* in full face view showing sharp transverse edge across width of mandible anterior to the clypeal margin, and hairs on subbasal bend that are directed toward scape base (CASENT0023769, Michele Esposito) **C** *S. baudueri* in profile with hairs on mesosoma and first gasteral tergite indicated (CASENT0280694, Estella Ortega) **D** *S. baudueri* full face face lacking hairs that direct toward scape base (CASENT0280694, Estella Ortega). Pictures available from www.antweb.org.

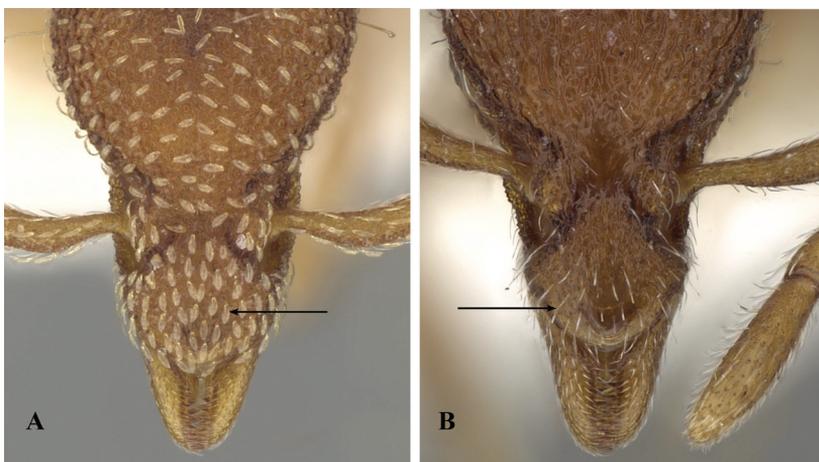


Figure 11. Separating *Strumigenys baudueri* from *S. tenuissima* and *S. tenuipilis* **A** *Strumigenys baudueri* in full face view with dense broadly spatulated hairs indicated (CASENT0280694, Estella Ortega) **B** *S. tenuissima* lacking dense spatulate hairs, hairs structurally different (CASENT0280696, Estella Ortega). Pictures available from www.antweb.org.

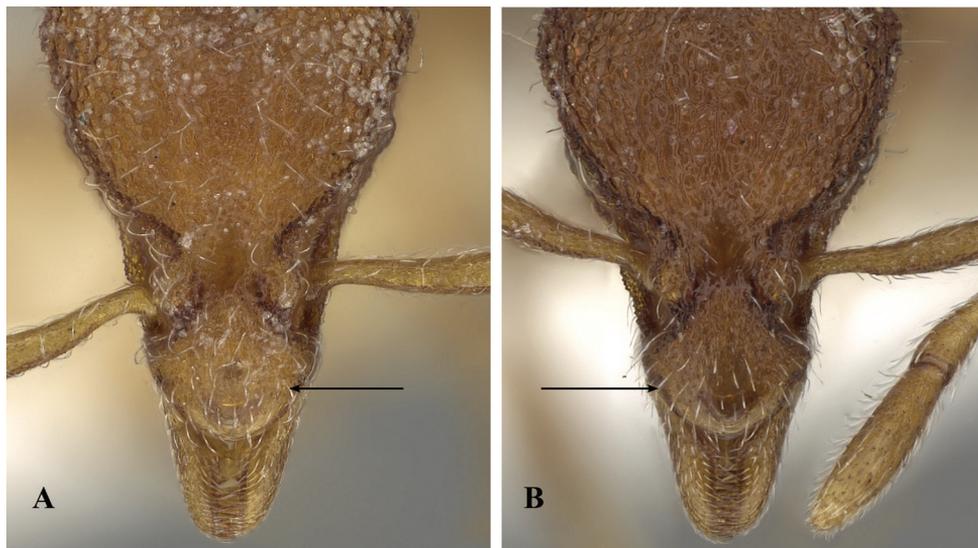


Figure 12. Distinguishing *Strumigenys tenuipilis* from *S. tenuissima* **A** *S. tenuipilis* in full face view with narrowly spatulate hairs indicated (CASENT0280695, Estella Ortega) **B** *S. tenuissima* in full face view with simple hairs shown (CASENT0280696, Estella Ortega). Pictures available from www.antweb.org.

(Brown 1957, 1958). Taylor (1968) however, notes that the temperate rainforests of Australia provide ‘optimum’ conditions for *S. perplexa*. On New Zealand, where it has been introduced, *S. perplexa* has been collected widely across the North Island (Brown 1958; Cumber 1959; Taylor 1987; Don 2007) and has been successful in native forests on the island (Taylor 1968). Populations on New Zealand as well as Lord Howe and Norfolk Islands are thought to be historical introductions from Australia (Wheeler 1927; Brown 1958). Considering the distance between the Channel Islands and Australia or New Zealand, these findings mark a substantial biogeographic ‘leap’ from the southern hemisphere, to the north west realm. Our results indicate that other temperate regions around the world should thus include *S. perplexa* into their list of potential successful exotic species able to establish populations outdoor, even at relatively high latitude and under cooler climate. Another Australian *Strumigenys* species, *S. emmae* (Emery, 1890), is also an emerging invader (Wetterer 2012b) but is currently restricted to tropical and sub-tropical climates.

Considering the tolerance of a wide range of climatic and habitat conditions in Australasia, it is of no surprise for *S. perplexa* to be able of establishing on Guernsey. Although Australia and Guernsey do not share overly similar climates, parts of New Zealand and Guernsey certainly do. Both landmasses have a maritime climate of mild winters and warm summers. In addition, numerous other organisms from New Zealand have established themselves in the United Kingdom, including the New Zealand flat worm (*Arthurdendyus triangulates* (Dendy 1896)) (Cannon et al. 1999), and several *Acanthoxyla* Uvarov, 1944 phasmid species (Brock et al. 2018), alongside various plants such as the neckless vine (*Muehlenbeckia complexa* Cunn (Polygonaceae)). Thus,

demonstrating the transferability of temperate climate tolerant species from Australasia to the Western Palearctic.

It is currently unclear whether the seemingly wide distribution of records from Guernsey (Fig. 1C) originates from a single source or from multiple. Speculative entry points include escapes from traded greenhouse plants, or the widespread use of the New Zealand broadleaf (*Griselinia littoralis* Cunn (Griselinaceae)) hedging. Brown (1958) notes that individuals were collected from Melbourne suburban garden and suggested this to be a likely introductory route to New Zealand. Winged reproductives have not been collected, and so it is unclear whether the population is reproducing, although it could be assumed from the wide distribution recorded here (Fig. 1C). It is likely that the introduction and spread of this species is relatively recent, with impromptu sampling by amateur entomologists and previous surveys of the island not finding the species (Donisthorpe 1947). However, the small size (2–3 mm) and deliberate, slow nature of the species could be a possible reason for the lack of previous records. Colonies are also small with between 40–200 workers and polygynous (Brown 1958). There is currently no evidence to suggest introduced *Strumigenys* fauna have detrimental effects on native fauna, however few studies have examined this topic (Deyrup and Deyrup 1999).

The population of *S. perplexa* should be monitored in order to fully ascertain their distribution and long-term survival on Guernsey. Considering the species' distinctive morphological characteristics relative to indigenous ant species and the lack of congeneric species, monitoring and recording can be completed with relative ease. However, close attention should be made to female reproductives for the workerless inquiline ant *Strumigneyx xenos* Brown, 1955 which parasitises *S. perplexa* colonies. Individuals have distinctively smaller mandibles and overall length, amongst other characters (Brown 1955). Introduced populations of *S. xenos* have been recorded in populations of *S. perplexa* in both New Zealand and Lord Howe Island (Brown 1955; Taylor 1968; Hoffmann et al. 2017). The species could potentially have followed *S. perplexa* in a similar fashion or will follow in the future if introductory routes remain open. Similar patterns of introduced social parasites tracking the newly established range of their host is not uncommon and has been recorded in *Tetramorium atratum* (Creighton, 1934) and *Vollenhovia nipponica* Kinomura & Yamauchi, 1992 which parasite *T. immigrans* Santschi, 1927 and *V. emeryi* Wheeler, 1906 respectively (Wetterer et al. 2015).

Channel Islands checklist

We recorded 32 species across the whole Channel Islands, providing a more comprehensive and updated checklist for the archipelago (Donisthorpe 1947). The ant fauna is typical of West Palearctic with a dominance in both Formicinae and Myrmicinae. Interestingly, several species which are abundant and frequently recorded in both northern France and southern Great Britain have yet to be recorded, namely *Myrmica rubra* (Linnaeus, 1758), *Leptothorax acervorum* (Fabricius, 1793), *Temnothorax nylanderii* (Foerster, 1850) and *Lasius playthorax* Seifert, 1991. Such species are

highly likely to be present and should be looked for in future surveys. Relative to the fauna of Great Britain, of which the islands are British Crown dependencies, the archipelago has several species that are unique, including; *Aphaenogaster subterranea* (Latreille, 1798), *Plagiolepis pallescens* Forel, 1889, *Tetramorium impurum* (Foerster, 1850) and the newly recorded *Strumigenys perplexa*. Moreover, the islands are home to rare species such as *Formica pratensis* Retzius, 1783, thought to be extinct in Great Britain, and *Temnothorax unifasciatus* which is absent from the mainland Great Britain except from an isolated record, likely imported, from West London.

Our checklist includes four complex species groups that are yet to be identified using current taxonomic concepts. Several complex are members of the Ponerinae sub-family including *Ponera coarcata* (Latreille, 1802), a complex split into *P. coarcata* and *P. testacea* Emery, 1895 by Csösz and Seifert (2003), recorded from Jersey, Herm and Guernsey, alongside a second complex group for *Hypoponera punctatissima*, recorded from Jersey. The *Hypoponera punctatissima* complex comprises two species, *Hypoponera punctatissima* (Roger, 1859) and *H. ergatandria* (Forel, 1893) (Seifert 2013, though see Bolton and Fisher 2011). Both are considered widespread tramp species with records of *H. punctatissima* known from outdoor xerothermic habitats (Seifert 2013). *Tapinoma erraticum* complex (Dolichoderinae) includes *T. erraticum* (Latreille, 1798) and *T. subboreale* Seifert, 2012, both of which are recorded from mainland Britain and France (Seifert 2012). *Tapinoma erraticum* has been confirmed from Guernsey and is potentially more widespread with the *Tapinoma erraticum* complex recorded from Jersey, while for now *T. subboreale* appears to have a more oriental distribution within Europe. The *Stenamamma westwoodii* complex (Myrmicinae) comprises two species, *S. debile* (Foerster, 1850) and *S. westwoodii* Westwood, 1839 (DuBois 1993), both recorded from Guernsey. Other records of the *S. westwoodii* complex from Jersey and Sark Islands should be confirmed. Future investigations and surveys, using contemporary taxonomic concepts identification tools and comprehensive collecting protocols will clarify these ambiguous records.

Conclusions

Overall, ant diversity known from the Channel Islands is relatively low, and more comprehensive surveys should determine if this relatively low richness is the result of incomplete sampling or of a biogeographic phenomenon resulting from the recent isolation of these islands following the Last Glacial Maximum period and the limited colonization process by native species. Our results also highlight the importance of anthropogenic introductions on these temperate islands, with four introduced species recorded thus far, including the new and notable outdoor presence of *S. perplexa* populations. This discovery represents not only the first record of *Strumigenys* away from heated infrastructure in Northern Europe, but also of surprising biogeographic novelty and major human-driven dispersal jump. Now that *S. perplexa* is seemingly well-established on Guernsey, additional survey work on the other Channel Islands, southern England or nearby European nations may provide further records of this species.

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Supplementary material I

Table S1. Morphological measurements descriptions based on Bolton (2000, p. 5).

Authors: Matthew T. Hamer, Andy D. Marquis, Benoit Guénard

Data type: measurements

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