

First record of *Idaea minuscularia* (RIBBE, 1912) in the Azorean archipelago (Lepidoptera, Geometridae, Sterrhinae)

Wolfgang WAGNER and Axel HAUSMANN

Wolfgang WAGNER, Baseler Straße 6, D-70619 Stuttgart, Germany; wolfgang@pyrgus.de, www.pyrgus.de

Dr. Axel HAUSMANN, Zoologische Staatssammlung München, D-81247 München, Germany; axel.hausmann@zsm.mwn.de

Abstract: Three larvae of the West Mediterranean *Idaea minuscularia* (RIBBE, 1912) are recorded on *Oxalis pes-caprae* L. (Oxalidaceae) just above the south coast of San Miguel Island (Azores, Portugal) in December 2013. This species and the whole genus *Idaea* TREITSCHKE, 1825 had hitherto been unknown from this archipelago. Species identity was verified by DNA barcoding which also revealed that the species has most probably been introduced only recently in this island.

Erstnachweis von *Idaea minuscularia* (RIBBE, 1912) auf den Azoren (Lepidoptera, Geometridae, Sterrhinae)

Zusammenfassung: Drei Raupen der westmediterranen *Idaea minuscularia* (RIBBE, 1912) wurden auf *Oxalis pes-caprae* L. (Oxalidaceae) gerade oberhalb der Südküste von San Miguel (Azoren, Portugal) im Dezember 2013 gefunden. Sowohl die Art als auch die gesamte Gattung *Idaea* TREITSCHKE, 1825 waren zuvor von diesem Archipel unbekannt. Die Artidentität wurde über DNA-Barcoding bestätigt; dabei zeigte sich, daß die Art wahrscheinlich erst kürzlich auf der Insel eingeführt wurde.

Introduction

Idaea TREITSCHKE, 1825 is a large Sterrhinae genus (approximately 680 known species) with diversity centres in the Mediterranean, Africa and the eremic regions of Western Asia. In Macaronesia, species numbers decrease considerably with increasing distance from continental Africa and Europe. While some 14 species are known from the Canaries close to Africa (Fuerteventura just 100 km distance), only the two endemic species *Idaea atlantica* (STAINTON, 1859) and *Idaea maderae* (BETHUNE-BAKER, 1891) are recorded from Madeira, in 500 km distance from Africa and 900 km from Portugal. The Azorean archipelago with some 1500 km distance from the Portuguese mainland has even been considered *Idaea*-free so far, both in old literature (WARREN 1905, REBEL 1940) and newer one (e.g. SOUSA 1991, VIEIRA 2002, BORGES et al. 2005, AGUIAR & KARSHOLT 2006). Thus the first author had been surprised at finding *Idaea* larvae in San Miguel Island in December 2013.

Material and methods

Three half-grown larvae were recorded by the first author in San Miguel Island, on the south coast between Água de Pau and Ribeira Chã (ca. 100 m above sea line, Miradouro do Pisão) on 17. XII. 2013. The larvae have been reared and the resulting moths (2 ♂♂, 1 ♀♀) sent to the second author, who determined them by standard genitalia dissection of 1 ♂ and by the DNA barcoding method targeting the 5'-barcode region of the mitochondrial COI gene, 658 bp, with standard procedures

and protocols (cf. HAUSMANN et al. 2013). All sequence records together with images, voucher deposition details, GPS coordinates, sequence and trace files are available on BOLD as a single citable dataset (dx. doi. org/ 10.5883/ DS-GEOEU1). The sequences are also available on GenBank (accession numbers see Fig. 9 and Appendix S2 in HAUSMANN et al. 2013).

Results

Determination

The genitalia of one dissected ♂ are most similar to those of *Idaea minuscularia* (RIBBE, 1912), with a patch of microspinules beside the cornutus in the phallus (aedeagus) as figured in HAUSMANN (2004). Genetic analysis by DNA barcoding revealed that the specimens show 100% congruence with SW-European material of *Idaea minuscularia*. The closely related *Idaea seriata* (SCHRANK, 1802) is divided into four haplotype-lineages of which one is almost barcode-sharing with *I. minuscularia* but with one constant difference in nucleotide position 138 (cf. HAUSMANN et al. 2013 and Fig. 9).

Habitat, bionomics

The species inhabited an anthropogenic habitat next to a parking lot of a viewpoint (Miradouro do Pisão) above the coast. The vegetation has been dominated by *Oxalis pes-caprae* L. (Oxalidaceae), *Parietaria* sp. (Urticaceae), *Pteridium aquilinum* (L.) KUHN (Dennstaedtiaceae) and grasses. All larvae have been found on *Oxalis*, together with a few larvae of the hawkmoth *Hippotion celerio* (LINNAEUS, 1758). In and around the same habitat occurred larvae of *Phlogophora meticulosa* (LINNAEUS, 1758), *Mythimna unipuncta* (HAWORTH, 1809), *Peridroma saucia* (HÜBNER, 1808), *Hypena lividalis* (HÜBNER, 1796), *Cyclophora azorensis* (PROUT, 1920) and *Ascotis fortunata* (BLACHIER, 1887). The last two geometrid species lived on a few shrubs of *Erica azorica* HOCHST. ex SEUB.

The *Idaea* larvae had been well concealed on the lower side of the leaves or in lower parts of the plants. They could be fed with *Oxalis*, but also accepted *Taraxacum* (Asteraceae) and *Lotus* (Fabaceae) in rearing. The resulting moths hatched in late January 2014 after a pupal stage of 2–3 weeks.

Discussion

Idaea minuscularia is a West Mediterranean species occurring in NW-Africa and in the Iberian Peninsula, including some Balearic Islands (HAUSMANN 2004) whilst



Figs. 1–8: *Idaea minuscularia* found on the Azores, San Miguel, Miradouro do Pisão, 17. xii. 2013 and reared back in Germany. **Fig. 1:** Half-grown larva. **Fig. 2:** Mature larva, lateral view. **Fig. 3:** Mature larva, dorsal view. **Fig. 4:** Male pupa, ventral view. **Fig. 5:** Male pupa, dorsal view. **Fig. 6:** Male, emerged 19. i. 2014. **Fig. 7:** Larval habitat: *Oxalis pes-caprae* dominated vegetation at Miradouro do Pisão. **Fig. 8:** Larval habitat (embankment on left side) at Miradouro do Pisão. — Figs. 1–8: W. WAGNER.

its closely related allopatric vicariant *I. seriata* shows a widespread distribution almost over the whole rest of Europe. *I. minuscularia* is often found near the coast in maquis shrubland and in villages on buildings and walls. In the Azores these coastal areas are mild throughout the year and thus the species probably has a continuous development with numerous generations per year, similar to its phenology in other parts of its range. The larval host plant appeared to be unknown so far. According to our results the larva is obviously polyphagous on low-growing herbs as it is the case with many of its congeners.

It can be stated that the species is very likely not indigenous to the Azores because of the 100% congruence of DNA barcodes with those of SW-European specimens and because of the hitherto lacking records despite a comparatively good entomological exploration of the Azores. Thus we suspect a quite recent accidental introduction by man (via ships, goods). It would be very interesting to pursue the species' possible establishment and further expansion in this archipelago.

When basing only on the genetic data (COI) as shown in Fig. 9, *Idaea minuscularia* seems to make *I. seriata* para-

phyletic. Since it is not the scope of this article to perform a taxonomic revision of the entire species-group of *Idaea seriata* this question awaits further study. We tentatively validate *I. minuscularia* at species rank basing on the differential features in ♂ and ♀ genitalia as outlined in HAUSMANN (2004).

Acknowledgements

We thank Stefano SCALERCIO (Cosenza), Marco INFUSINO (Messina), Penny HALE (Casares), Andreas WERNO (Saarbrücken), Andreas H. SEGERER (Munich) and Olfa EZZINE (Tunis) who collected some of the specimens for DNA Barcoding and helped in their processing. Some of the sequences shown in Fig. 9 were sequenced in the framework of the projects Barcoding Fauna Bavarica (BFB) and German Barcode of Life (GBOL; 01LI1101B) with financial support from the Bavarian and German Ministries of Research. The genetic analyses have received considerable support from Paul D. N. HEBERT and the Biodiversity Institute of Ontario (BIO) and the Canadian Centre for DNA Barcoding (CCDB University of Guelph). The data management and analysis system

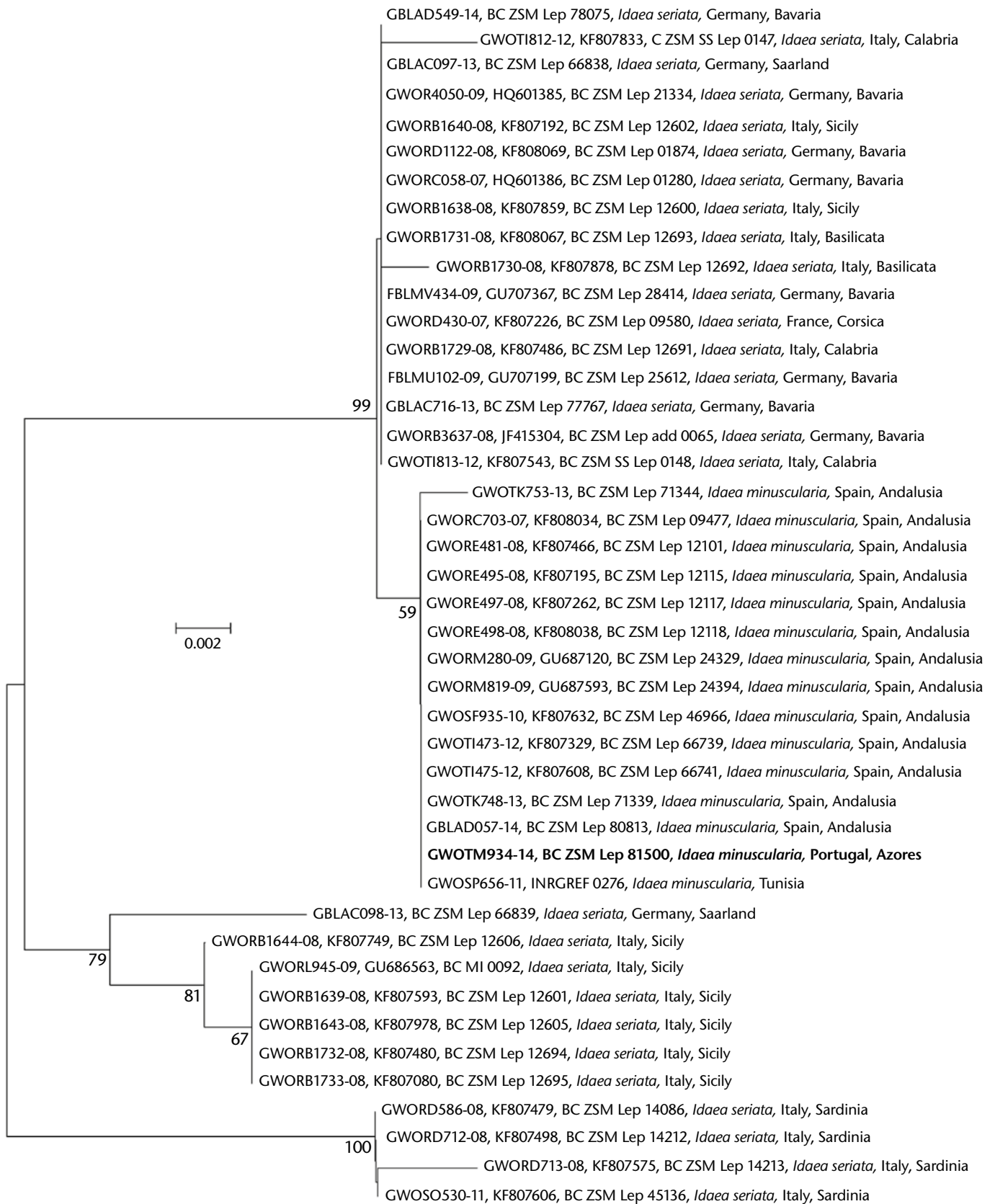


Fig. 9: Unrooted neighbour-joining tree based on 43 individuals with barcodes > 600 bp and belonging to the complex of *Idae seriata* and *Idae minuscularia*, calculated using the Kimura 2-parameter model with MEGA6 (BOLD alignment; complete deletion; cf. TAMURA et al. 2013). Bootstraps (500 replicates) only shown when >50. Specimen from the Azores in **bold letters**. — All sequence records, trace files and images are available and accessible on BOLD as a single citable dataset (dx.doi.org/10.5883/DS-GEOEU1).

BOLD was provided by Sujeevan RATNASINGHAM. The work was financially supported by Genome Canada (Ontario Genomics Institute) in the framework of the iBOL program, WG 1.9.

Literature

- AGUIAR, A. M. F., & KARSHOLT, O. ("2006" 2009): Systematic catalogue of the entomofauna of the Madeira Archipelago and Selvagens Islands, 1. Lepidoptera. – Funchal (Câmara Municipal), 140 pp.
- BORGES, P. A. V., CUNHA, R., GABRIEL, R., MARTINS, A. F., SILVA, L., & VIEIRA, V. (eds.) (2005): A list of the terrestrial fauna (Mollusca and Arthropoda) and flora (Bryophyta, Pteridophyta and Spermatophyta) from the Azores. – Horta, Angra do Heroísmo and Ponta Delgada (Direcção Regional do Ambiente and Universidade dos Açores), 318 pp.
- HAUSMANN, A. (2004): The geometrid moths of Europe, Vol. 2: Sterrhinae. – Stenstrup (Apollo Books), 600 pp.
- , GODFRAY, H. C. J., HUEMER, P., MUTANEN, M., ROUGERIE, R., VAN NIEUKERKEN, E. J., RATNASINGHAM, S., & HEBERT, P. D. N. (2013): Genetic patterns in European geometrid moths revealed by the Barcode Index Number (BIN) system. – PLoS ONE, San Francisco, 8 (12): e84518; doi: 10.1371/journal.pone.0084518.
- REBEL, H. (1940): Die Lepidopterenfauna des azorischen Archipels. Mit I. Anhang: Eine Lepidopterenausbeute von Madeira. – Societas Scientiarum Fennica, Communicationes Biologicae, Helsinki, 8 (1): 1–59.
- SOUSA, A. B. (1991): Novas citações de Lepidopteros para os Açores. – Boletim da Sociedade Portuguesa de Entomologia, Lisboa, 133: 1–20.
- TAMURA, K., STECHER, G., PETERSON, D., FILIPSKI, A., & KUMAR, S. (2013): MEGA6: Molecular Evolutionary Genetics Analysis Version 6.0. – Molecular Biology and Evolution, Oxford, 30: 2725–2729; dx.doi.org/10.1093/molbev/mst197.
- VIEIRA, V. (2002): New records and observations on macrolepidoptera (Insecta: Lepidoptera) from the Azores. – Arquipélago (Life and Marine Sciences), Ponta Delgada, 19A: 55–65.
- WARREN, W. (1905): Lepidoptera collected by W. R. OGILVIE-GRANT on the Azores and Madeira in 1903. – Novitates Zoologicae, Tring, 12: 439–447.

Received: 30. v. 2014