Eupithecia conquesta Tabell & Junnilainen, a new species from Cyprus (Lepidoptera, Geometridae, Larentiinae)

Jukka Tabell[1], Jari Junnilainen[2], Pasi Sihvonen[3]

1 *Laaksotie 28, 19600 Hartola, Finland; E-mail: jukka.tabell@phnet.fi*

2 *Mahlapolku 3, 01730 Vantaa, Finland; E-mail: junnilainen.jari@googlemail.com*

3 *Finnish Museum of Natural History, University of Helsinki, P.O. Box 17, FI-00014, Finland; E-mail: pasi.sihvonen@helsinki.fi*

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Abstract. A new *Eupithecia* species (Lepidoptera: Geometridae, Larentiinae), *E. conquesta* Tabell & Junnilainen is described from Cyprus. We illustrate the adults, the male and female genitalia of the new species, and those are compared against the closely related species *E. phoeniceata* (Rambur, 1834) and *E. oxycedrata* (Rambur, 1833). The genetic distance, based on DNA barcodes, of the new species are compared with those of all other Eupitheciini on the BOLD database. After our study, altogether 13 *Eupithecia* species are known from Cyprus.

Introduction

Eupithecia Curtis, 1825, classified in Geometridae: Larentiinae Duponchel, 1845, is the most species rich genus of the family Geometridae, including about 1400 species and 2100 named taxa (including subspecies and synonyms) worldwide, except Antarctica (Mironov 2003; Rajaei et al. 2022). *Eupithecia* are typically small, the wingspan is often between 12–30 mm, and the wings are generally different shades of brown, grey and black. Species identification based on the wing patterns is tricky. Therefore examination of the dissected genitalia and male 8th sternite, female genitalia, DNA barcodes, or information on life history and distribution are required for more reliable identification. The caterpillars tend to feed on flowers and seeds of their food plants rather than on leaves, which is an unusual feature among geometrids (Mironov 2014).

The fauna of *Eupithecia* in Cyprus, which is the most eastern Mediterranean island, is well explored and documented (Hausmann 1994, 1995; Mironov 2003; Fischer and Lewandowski 2006, 2010), and up to date 12 species are known. For this fauna, most species show Mediterranean distribution range. So far, no endemic *Eupithecia* taxa are known to occur in the islands of eastern Mediterranean, contrary to western Mediterranean with three narrowly endemic *Eupithecia* species (*E. lentiscata* Mabille, 1869 (Corsica, Sardinia, Southern Greece), *E. sardoa* Dietze, 1910 (Corsica, Sardinia, Mallorca), and *E. poecilata* Püngeler, 1888) (Corsica, Sardinia) (Mironov 2003).

In order to obtain reference material for our studies, the first author purchased a small batch of *Eupithecia* specimens from Attila Szabó (Hungary). Among them was a male specimen from

Cyprus, externally similar to a Cypriot specimen illustrated in Mironov (2003) as *E. phoeniceata* (Rambur, 1834). However, the dissection revealed obvious differences in the male genitalia structures, and the possibility of a new species was confirmed when dissecting a female specimen, derived from the collection of the second author. In addition, DNA barcoding results showed that the specimens from Cyprus are genetically different from other *Eupithecia* species. We consider this a valid species and describe it here as *E. conquesta* Tabell & Junnilainen, sp. nov.

Material and methods

Collection abbreviations

MZH Finnish Museum of Natural History, Helsinki, Finland;
JUJ research collection of Jari Junnilainen, Vantaa, Finland;
SZA research collection of Attila Szabó, Kiskunfélegyháza, Hungary;
TAB research collection of Jukka Tabell, Hartola, Finland;
det. determined by;
ex., **exx.** specimen, specimens;
leg. collected by;
GP genitalia preparation.

Photos of adult specimens were taken with a Canon EOS 7D, MP-E 65mm f/2.8 Macro and EF 100mm f/2.8 L IS USM Macro. Focus stacking was done with Cognisys StackShot and Helicon Focus 6.7.1, and final image editing with Adobe Photoshop CS5.1. The genitalia preparations were made following standard techniques (Robinson 1976), but the male genitalia, except the vesica, were not stained. The vesica was everted via the caecum that was cut open by placing the aedeagus inside a hypodermic syringe (Sihvonen 2001). The genitalia were photographed with a Leica DM1000 microscope and integrated Leica DF295 digital camera. Some genitalia preparations were photographed by montaging 2–6 images of different depth of focus into single images using image-stacking software as implemented in Photoshop CS6.0. Final plates were compiled with CorelDraw (2023 release).

The holotype specimen of the newly described species is deposited in the public collection of MZH, and the paratype specimens in the private research collections of JUJ, SZA and TAB. The holotype has been digitized and it has a unique QR identifier, following the open access policy of the museum. Tissues of four samples were sent to the Canadian Centre for DNA Barcoding (CCDB) to obtain molecular data of the 658 bp fragment of the mitochondrial COI gene (DNA barcode). The DNA barcodes of the species presented here were compared with those of all Eupitheciini available to us on the BOLD database (www.boldsystems.org). The barcodes used in this study are publicly available through the BOLD dataset DS-EUPCYP at dx.doi.org/10.5883/DS-EUPCYP.

Taxonomy

***Eupithecia conquesta* Tabell & Junnilainen, sp. nov.**

https://zoobank.org/EBC2549E-D841-4AE4-9984-B1EE6CD5EA75

Figs 1, 2, 5, 8, Table 1

Barcode Index Number. BOLD:AFC0556.

Type material. Holotype ♂ (GP 6222 J. Tabell, DNA sample 27549 Lepid Phyl) Cyprus, Paphos, 1.5 km N of Peyia [coordinates 34.90, 32.38], 10.xi.2021, about 400 m above sea-level], Leg.: Attila Szabó & Zsuzsi V.B. 350 m (coll. MZH), BOLD sample ID: MM27549, http://id.luomus.fi/GBT.24. Paratypes: 2 ♂, 2 ♀, same data as holotype; 1 ♂, 1 ♀ same collecting data, but 5.xi.2021; 7 ♂ (DNA sample 27544 Lepid Phyl; DNA sample 27548 Lepid Phyl), 6 ♀ Cyprus, Limassol, Salt lake Akrotiri 10 m, 34.601, 32.976, 30.x.2019, J. Junnilainen leg.; 5 ♂ (GP 2882 Sihvonen), 3 ♀ same collecting data, but 2.xi.2019; 3 ♂, 6 ♀ (GP 6236 J. Tabell, DNA sample 27545 Lepid Phyl) Cyprus, Limassol, Salt lake Akrotiri 10 m, 34.625, 32.948, 31.x.2019, J. Junnilainen leg. (colls. JUJ, TAB and SZA).

Diagnosis. *E. conquesta* belongs to the *E. interruptofasciata* species group, which comprises 14 species in Europe, two in northern Africa, four in Asia, and two in North America (Mironov 2003). Externally *E. conquesta* is similar to *E. oxycedrata* (Rambur, 1833) and *E. phoeniceata* (Figs 1–4). Compared to *E. oxycedrata*, the forewing is paler and more uniform, the wedge-shaped area between antemedial and medial lines is not or only slightly darker than rest of the wing, and it is apically wider, medial line is angled inwards near dorsum (forewing darker and vivid, wedge-shaped area darker and apically narrower, medial line angled outward in *E. oxycedrata*). In *E. phoeniceata* the antemedial and medial lines are more oblique, the wedge-shaped area is absent and the medial line is not angled near dorsum.

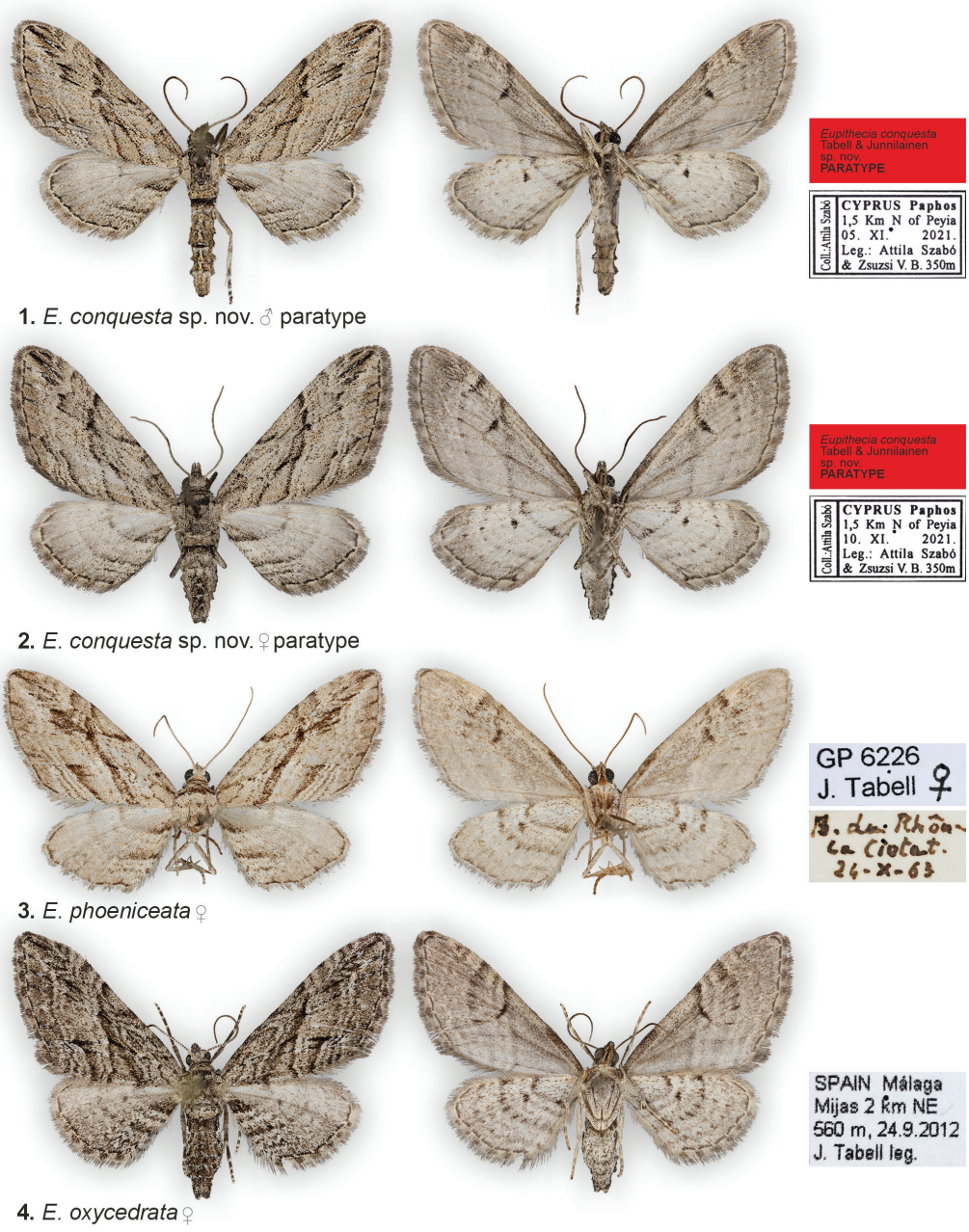
The male genitalia (Figs 5–7) are similar to those of *E. phoeniceata*, but the uncus is slightly longer, the gnathos is narrower, laterally parallel-sided (rounded in *E. phoeniceata*), the valva is broader and its lateral margin slightly concave (almost straight in *E. phoeniceata*), the juxta is wider, the vesica has three long cornuti and the basal diverticulum is tiny (juxta narrower, vesica has two long cornuti and basal diverticulum is large in *E. phoeniceata*). The female genitalia (Figs 8–10) are quite different from those of *E. phoeniceata*, and they are more similar to those of *E. oxycedrata*, but the colliculum is narrower than the bursa copulatrix, which is markedly longer than in *E. oxycedrata*, the robust spines are shorter, the anterior half of corpus bursae is less rounded and the base of corpus bursae is spineless (in *E. oxycedrata* the colliculum is as broad as bursa copulatrix, the bursa copulatrix shorter, robust spines longer, the anterior half of corpus bursae round, and base of corpus bursae with minute spines).

Wing patterns of adults and the female genitalia are the most similar in *E. conquesta* and *E. oxycedrata*, while the male genitalia and DNA barcodes are the most similar in *E. conquesta* and *E. phoeniceata*.

Molecular data. Four samples were sent for sequencing, resulting in 653 bp (n = 2) and 652 bp (n = 2) barcodes. The nearest neighbour is *E. phoeniceata*, with 4.07% minimum divergence (n = 5, public records). The barcodes of *E. conquesta* exhibit no intraspecific variation. The genetic distance to *E. oxycedrata* is 5.94%.

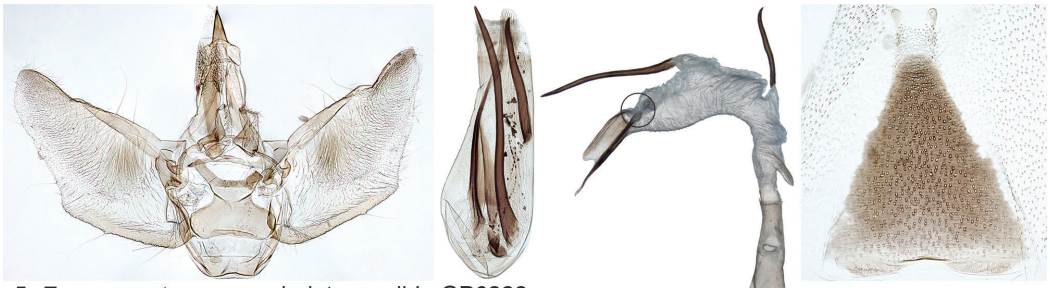
Table 1. Interspecific mean Kimura 2-parameter divergences (%) among members of the *Eupithecia interruptofasciata* species group, based on the analysis of the DNA barcode sequence of the COI gene. Maximum intraspecific distances are shown in grey cells. Number of examined specimens are given in parentheses.

	conq	**phoe**	**oxyc**	**pusi**	**sard**	**inte**	**niph**	**eric**
conquesta (4)	0	4.07	5.94	5.17	6.88	5.29	4.93	6.15
phoeniceata (5)		0.69	5.57	5.6	6.53	6.09	5.72	6.28
oxycedrata (5)			0.62	5.3	5.44	5.6	5.37	5.78
pusillata (59)				1.55	7.21	1.89	2.01	5.63
sardoa (1)					N/A	6.87	6.3	6.04
interruptofasciata (3)						0.93	0	5.98
niphadophilata (110)							1.37	5.8
ericeata (10)								0.97



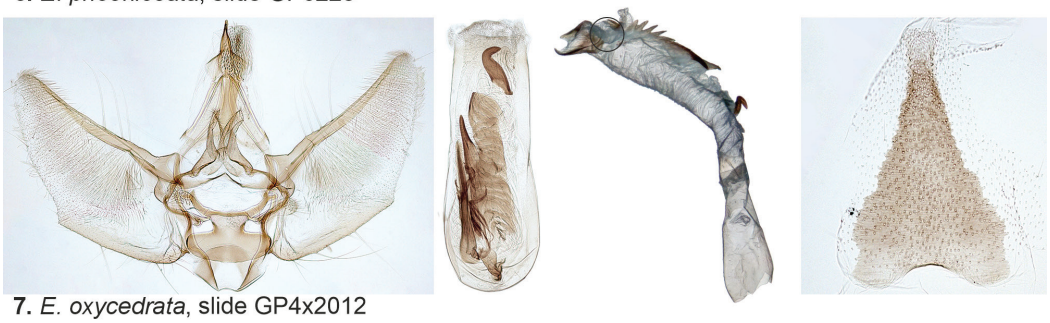
Figures 1–4. Adults and labels of *Eupithecia* spp. **1, 2.** *E. conquesta* sp. nov. **1.** ♂ paratype. **2**. ♀ paratype. **3.** *E. phoeniceata* (Rambur), France. **4.** *E. oxycedrata* (Rambur), Spain.

Description. Adult. Wingspan 16.5–20.0 mm. Labial palpus equal to diameter of eye, covered with brown and white scales. Frons and vertex pale brown, mixed off-white. Thorax mixed with pale brown and brown scales, with a transverse blackish brown frontal band. Antenna filiform,



5. *E. conquesta* sp. nov., holotype, slide GP6222

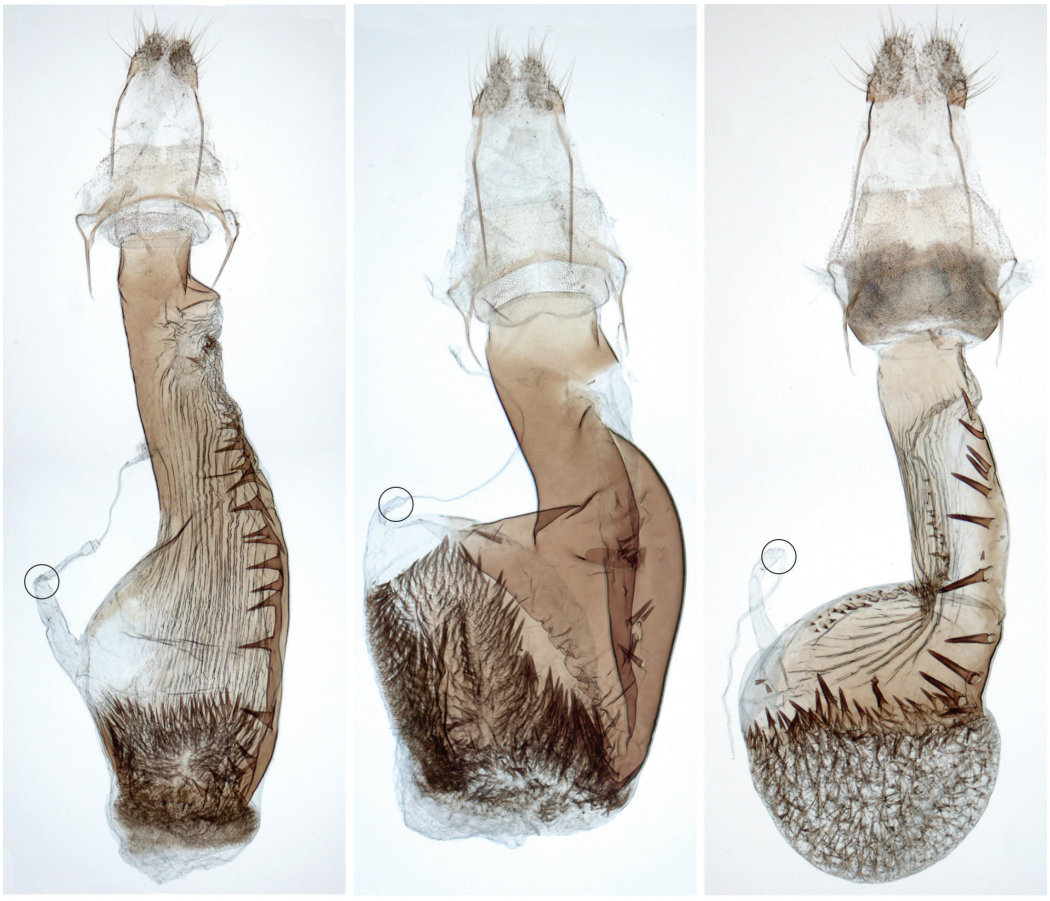
6. *E. phoeniceata*, slide GP6223



7. *E. oxycedrata*, slide GP4x2012

Figures 5–7. Male genitalia and sternite A8 of *Eupithecia* spp. **5.** *E. conquesta* sp. nov., holotype, GP 6222 J. Tabell. Vesica photographed from paratype slide Sihvonen 2882. **6.** *E. phoeniceata* (Rambur), France, Vidauban, 20.ix.2006, GP 6223 J. Tabell. Vesica photographed from slide Sihvonen 2880 (France: Var, Vidauban, 6.x.2005, coll. T. Ranki). **7.** *E. oxycedrata* (Rambur), Spain, Mijas, 24.ix.2012, GP 4x2012 J. Tabell. Vesica photographed from slide Sihvonen 2883 (Greece: Olympus, 750 m, 24.iv.2006, coll. JUJ). Circle indicates the point of origin of ductus ejaculatorius. Vesica of each species photographed from ventral view.

brown, basal third chequered brown and pale brown. Spur formula in male and female tibia 0–2–4 (hind leg with 2 + 2 spurs). Forewing elongate, costa slightly arched, terminal margin slightly curved; ground color pale brown, basal half sometimes slightly darker; medial lines oblique; basal line distinct, rectangularly angled onto costa, post-basal line indistinct, sharply angled onto costa, antemedial line oblique, sharply angled onto costa, angle touching discal spot and medial line, medial line less oblique, not angled but slightly curved, postmedial line curved, not angled, subterminal line medially angled, distinct only at lower part, terminal line continuous; basal area between base and basal line as well as medial area between antemedial and medial lines darker, terminal area with two dashes on R4 and R5, wavy line inconspicuous; discal spot small, rounded. Hindwing paler than forewing; medial and postmedial lines evenly curved, conspicuous from



8. *E. conquesta* sp. nov. paratype, slide GP6236

9. *E. phoeniceata* slide GP6226

10. *E. oxycedrata* slide GP6237

Figures 8–10. Female genitalia of *Eupithecia* spp. **8.** *E. conquesta* sp. nov., paratype, GP 6236 J. Tabell. **9.** *E. phoeniceata* (Rambur), France, La Ciotat, 24.x.1963, GP 6226 J. Tabell. **10.** *E. oxycedrata* (Rambur), Spain, Mijas, 24.ix.2012, GP 6237 J. Tabell. Circle indicates the point of origin of the ductus seminalis.

dorsum to costa, other medial lines visible on dorsal part, terminal line continuous; basal area dark brown dorsally; discal dot small, elongate or dot-like, paler than on the forewing. Fringe on all wings chequered pale brown and brown. Abdomen brown, mixed darker brown, medially pale brown, second segment dark brown, last segment pale brown. Tympanal organs large, almost meeting medially. Ansa bottle-shaped, with hammer-shaped apex. Underside of both wings rather uniform, terminal areas slightly darker, hindwing paler, forewing discal spot elongate, hindwing discal spot rounded.

Male genitalia. Uncus triangular, biapical. Gnathos transversely rectangular. Valva broad, costa sclerotized except apical 1/3, ventral margin ending in obtuse angle, sacculus lightly sclerotized. Papillae on the anterior arms of labides medium sized, apically covered with short setae. Saccus broad. Aedeagus shorter than length of valva. Vesica with three long cornuti and

with sclerotized, elongated plate near opening of ductus ejaculatorius, and small sclerotized lobe laterally near apex of aedeagus. Vesica large, opens at 90 degree laterally. Sternite A8 triangular, apex bifurcated, proximal margin concave, medially more sclerotized. Coremata with hair-like setae present on posterolateral corner on membrane between 8th sternite and genitalia capsule.

***Female genitalia*.** Papilla analis oval, densely covered with setae of different lengths. Anterior apophysis as long as tergite A8, posterior apophysis 1.7 × as long as anterior apophysis. Tergite A8 trapezoidal, anterior margin sclerotized, strongly concave. Antrum broad, membranous, cup-like. Colliculum strongly sclerotized, short, parallel-sided, narrower than bursa copulatrix. Bursa copulatrix tubular, long, sclerotized, with several longitudinal ridges and a long strongly sclerotized band armed with several robust spines, opposite to ductus seminalis; base of ductus seminalis expanded, apical part narrower; anterior part of corpus bursae densely covered with long spines; the most anterior part membranous, without spines.

Biology. Unknown. The collecting localities are salt lakeshores with *Juniperus* sp. and shrub vegetation. All specimens have been captured in autumn, from late September to mid-November. Caterpillars of closely related species feed on the needles of *Juniperus phoenicea* L., *Hesperocyparis macrocarpa* (Hartw.) Bartel and *Cupressus sempervirens* L. (*E. phoeniceata*) and *Juniperus oxycedrus* L. (*E. oxycedrata*) (Mironov 2003).

Derivation of name. *Lat*. conquestō = purchase, refers to the origin of the first studied specimen.

Distribution. Known only in two localities in Cyprus.

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References

Fischer H, Lewandowski S (2006) Die Geometriden-Fauna von Zypern - eine Überarbeitung aller bisher bekannten Arten. (2. Teil: Orthostixinae und Larentiinae) (Lepidoptera: Geometridae, Orthostixinae, Larentiinae). Atalanta 37(3/4): 329–344.

Fischer H, Lewandowski S (2010) Aktualisierte Checkliste der Geometridenarten von Zypern inklusive der wichtigsten Literaturangaben zu dieser Familie (Lepidoptera, Geometridae). Atalanta 41(1/2): 265–269.

Hausmann A (1994) Beitrag zur Geometridenfauna Zyperns. Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen 46(3/4): 81–98.

Hausmann A (1995) Neue Geometriden-Funde aus Zypern und Gesamtübersicht über die Fauna (Lepidoptera, Geometridae). Mitteilungen der Münchner Entomologischen Gesellschaft 85: 79–111.

Mironov VG (2003) Larentiinae II (Perizomini and Eupitheciini). In: Hausmann A (Ed.) The Geometrid Moths of Europe 4: 1–463. https://doi.org/10.1163/9789004308633_001

Mironov VG (2014) Geometrid moths of the genus *Eupithecia* Curtis, 1825 (Lepidoptera, Geometridae): Prerequisites and characteristic features of high species diversity. Entomological Review 94(1): 105–127. https://doi.org/10.1134/S0013873814010114

Rajaei H, Hausmann A, Scoble M, Wanke D, Plotkin D, Brehm G, Murillo-Ramos L, Sihvonen, P (2022) An online taxonomic facility of Geometridae (Lepidoptera), with an overview of global species richness and systematics. Integrative Systematics 5: 1–48. https://doi.org/10.18476/2022.577933

Robinson G (1976) The preparation of slides of Lepidoptera genitalia with special reference to the Microlepidoptera. Entomologist's Gazette 27: 127–132.

Sihvonen P (2001) Everted vesicae of the *Timandra griseata* group: methodology and differential features (Geometridae, Sterrhinae). Nota Lepidopterologica 24: 57–64. https://www.biodiversitylibrary.org/page/41370395#page/163/mode/1up