

## Article

# The First Attempt to Assess the Taxonomic Diversity of the Nepticulidae of Armenia Resulted in the Discovery of New Species and Cryptic Taxa in the Caucasus \*\*

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**Abstract:** A taxonomic review of the Nepticulidae of Armenia is provided for the first time. Currently, the previously little-known fauna of the pygmy moths of Armenia consists of eight genera and 31 species, including seven new species described and illustrated in the current paper as follows: *Stigmella armi* Stonis, Dobrynina & Remeikis, sp. nov.; *Stigmella garnica* Stonis, Dobrynina & Remeikis, sp. nov.; *Stigmella inopinoides* Dobrynina, sp. nov.; *Stigmella magicis* Stonis & Dobrynina, sp. nov.; *Stigmella ararati* Stonis, Dobrynina & Remeikis, sp. nov.; *Trifurcula vardenisi* Stonis, Dobrynina & Remeikis, sp. nov.; and *Etainia caucasi* Remeikis, sp. nov. The most common Nepticulidae species in Armenia, *Stigmella muricatella* (Klimesch), still remains a taxonomic puzzle. However, the molecular sequences of the Armenian specimens and a specimen of *S. muricatella* from Greece were found to be similar, though clearly distinct from the widespread *S. rolandi* van Nieukerken due to numerous hypothetical mutational steps. Mitotype analysis revealed that the *Ectoedemia* specimens collected in Armenia do not belong to the expected widespread *E. spinosella* (Joannis) but are more similar to the less-known *E. mahalebella* (Klimesch). Moreover, some specimens from Armenia identified by us as *Simplimorpha promissa* (Staudinger) and *Ectoedemia (Zimmermannia) longicaudella* Klimesch may actually represent possible cryptic taxa, allopatric subspecies or species. However, from a practical point of view, the description of such difficult-to-diagnose taxa is inappropriate. Thus, we have refrained from describing such new taxa based solely on observed molecular differences.

**Keywords:** Caucasus; mitotype network; new species; taxonomy



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## 1. Introduction

The task of providing an inventory of biodiversity is a major focus of biological systematics or descriptive taxonomy, and it has the ultimate goal of documenting and realizing the extent of global biological diversity [1,2]. Describing species along with revealing their evolutionary history “is fundamental to understanding the biosphere and the origins of global biodiversity”. Descriptive taxonomy also “opens a treasure of nature-inspired solutions for creating a sustainable future” [3,4]. However, the task of detailing an inventory of biodiversity is colossal [4–9] and urgent, particularly in the face of current biological annihilation and the sixth major extinction event [10]. Although hundreds and hundreds of new species are discovered every year [11], the speed of their description is far from sufficient [12], and the majority of the Earth’s organisms, especially smaller ones, still await description [11].

Nepticulidae (commonly called pygmy moths) are a cosmopolitan plant-mining lepidopteran family. Currently, it consists of 1014 species worldwide [13,14], including the

seven new species provided from Armenia in the current paper. The family Nepticulidae includes the world's smallest lepidopterans with a forewing length of less than 1.8 mm or a wingspan of less than 4.0 mm [15]. The larvae of the vast majority of the Nepticulidae species are leaf miners. This family has been extensively characterized in papers or monographic reviews [16–20], with a special reference to Neotropical America recently [14,21].

Armenia is a landlocked country located in the Armenian Highlands in the Southern Caucasus Mountains in Western Asia between the latitudes 38° and 42° N and the meridians 43° and 47° E. The terrain is mostly mountainous, with fast-flowing rivers and a few forests. The land rises to 4090 m above sea level at Mount Aragats, while there is no point below 390 m above sea level. The average elevation of this country's area is the tenth highest in the world, and it has 85.9% of its terrain as a mountain area [22]. The climate in Armenia is markedly highland continental: the summers are hot, dry, and sunny, while winters are quite cold, with plenty of snow and temperatures ranging between −5 and −10 °C. Armenia contains two major terrestrial ecoregions: the Caucasian mixed forests and the Eastern Anatolian montane steppe [23].

Prior to this study, the taxonomic diversity of the Nepticulidae of Armenia was poorly known. One species, *Stigmella armeniana* Puplesis 1994, was described on the basis of a few specimens collected in Armenia by Povilas Ivinskis [19], while the primary description of another species, *Glaucolepis melanoptera* (van Nieukerken & Puplesis, 1991), also included one aberrant, non-type specimen from Armenia [19,24]. It should be mentioned that an earlier record of *Stigmella inopinata* Laštůvka & Laštůvka, 1990, based on specimens collected by Friedrich Kasy in Armenia [25], is considered a case of misidentification in our publication.

The Nepticulidae faunas of neighboring Georgia and Azerbaijan are essentially unknown, with the exception of a few proven species, including those provided in a monograph by Rimantas Puplesis [19]. However, an impressive catalog of the Lepidoptera of Iran, a country directly south of Armenia, has been published recently [26]. In this catalog, twenty-nine species of pygmy moths were confirmed for the fauna of Iran, and at least one named species was listed as possible but not yet proven [26].

The goal of the present study was to investigate the world's smallest lepidopterans of the family Nepticulidae in the Caucasus (Armenia) and, for the first time, to provide a taxonomic review of the Nepticulidae of Armenia, with the naming and describing of newly discovered species, as well as to discuss possible cryptic taxa in the southern Caucasus.

## 2. Materials and Methods

In 2022, during our targeted fieldwork in Armenia conducted within a framework of the Agreement of Scientific Cooperation between the Scientific Center of Zoology and Hydroecology of the National Academy of Sciences of Armenia and the State Research Institute Nature Research Centre and as part of an informal research project in cooperation with Dr. Mark Kalashian (a co-author of the current publication), we collected about 600 nepticulid specimens (only about 300 were pinned). All these collected specimens, except for the specimens belonging to *Glaucolepis melanoptera* (van Nieukerken & Puplesis), appeared to be new for the Armenian fauna. Based on the specimens collected in Armenia, we also discovered eight new species, seven of which are described in the current paper. In addition, the type series of the earlier discovered and described Armenian species, *Stigmella armeniana* Puplesis, was available for our study from the collection of the BRG (the type series will be transferred to the MfN, Berlin, after this study).

During our fieldwork in Armenia (Figure 1), we attracted moths using light from a Philips bulb ML 220–230 V, 160 W, suspended in front of a white screen and powered by the electric mains. Additionally, where electric mains were unavailable, we used old-fashioned fluorescent lanterns powered by D batteries of a dry cell (flashlight batteries) [14] and the currently advertised LepiLED lamp. The latter is lightweight, small, and operated with a 5–13 V voltage DC from powerbank batteries, purposely designed for the sampling of nocturnal insects [27].



**Figure 1.** Map of the region with the chosen locations for our fieldwork in Armenia: (a) Sevan, Tsovagyugh, 2000 m, 40°36′08″ N, 44°57′45″ E; (b) Antarut, 1780–1985 m, 40°22′36″ N, 44°16′03″ E; (c) Victory Park, Yerevan, 1142 m, 40°11′47″ N, 44°31′17″ E; (d) Jrvezh Forest Park, 1515 m, 40°11′07″ N, 44°37′11″ E; (e) Garni, 1312–1355 m, 40°07′18″ N, 44°45′17″ E; (f) Yeghegis, 1574 m, 39°52′10″ N, 45°22′12″ E; (g) Jermuk, 2000 m, 39°50′25″ N, 45°40′07″ E; (h) Noravank, 1468 m, 39°40′57″ N, 45°14′10″ E (Base map courtesy of Dr. Virginijus Gerulaitis, Vytautas Magnus University, Lithuania).

The methods and protocols for the specimen setting, species identification, and description were extensively outlined both earlier [20,28] and recently by Stonis et al. [14]. After the maceration of the abdomen in 10% KOH and subsequent cleaning, male genital capsules were removed from the abdomen and mounted with the ventral side uppermost [14]. The phallus was often removed and mounted alongside the genital armature. Abdominal pelts were not preserved during this study.

Permanent preparations on microscope slides were photographed and studied with a Leica DM2500 microscope and an attached Leica DFC420 digital camera. Adults were measured and studied using a Lomo stereoscopic microscope MBS-10 and photographed using a Leica S6D stereoscopic microscope with a Leica DFC290 digital camera attached.

**Collecting Sites.** Considering the mosaic of landscapes present at the majority of the collecting sites, there are various habitat types included in some localities characterized below. The habitats of the collecting localities were classified strictly following the EUNIS habitats' classification [29], adapted to Armenia by Fayvush & Aleksanyan [30], with codes provided in parentheses.

*Sevan*, Tsovagyugh, Gegharkunik Province, 2000 m, 40°36′08″ N, 44°57′45″ E (Figure 2a,b). The selected habitats near Lake Sevan, within the Sevan National Park, were in the area of a former lakebed following drainage, partly systematic and planted with tree and shrub vegetation, partly penetrated by vegetation from adjacent areas. At the collection site, the following types of habitats were present: highly artificial broadleaf deciduous forestry plantations (G1.C) with the dominance of poplars (*Populus* spp.) and willows (*Salix* spp.); mixed riparian floodplain and gallery woodlands (G1.2) tree stands, which were also comprised mainly of poplars and willows, as well as ash trees (*Fraxinus* spp.), willows (*Salix* spp.) and maples (*Acer* spp.); riverine scrub (F9.1) and the sea-buckthorn (*Hyppophae rhamnoides*) scrub in the Sevan basin (F3.19).



**Figure 2.** Collection sites in Armenia: (a,b) Sevan, Tsovagyugh, Gegharkunik Province, near Lake Sevan; habitats were formed on the former lakebed following its drainage, partly systematically planted with tree and shrub vegetation and partly penetrated by vegetation from adjacent areas. (c–f) Antarut, Aragatsotn Province, on the southern slope of Mt Aragats, mainly with *Quercus macranthera* forests in the canyons and traganth communities with a predominance of *Astragalus microcephalus* on mountain slopes.

Antarut, Aragatsotn Province, 1780–1985 m, 40°22′36″ N, 44°16′03″ E–40°21′50″ N, 44°16′25″ E (Figure 2c–f). This collecting site is located in central Armenia, on the southern slope of Mt Aragats, mainly in light oak forests (i.e., oak forests with *Quercus macranthera*, G1.A1D2); tree stands of ash trees (*Fraxinus excelsior*), maples (*Acer* spp.) and plum trees (*Prunus divaricata*) were also present. In the neighboring territory to the collection site, traganth communities with a predominance of *Astragalus microcephalus* (F7.4I211) were common.

Victory Park, Yerevan, 1142 m, 40°11'47'' N, 44°31'17'' E–40°11'41'' N, 44°31'25'' E (Figure 3a,b). Victory Park (or “Park Pobedy”) is situated somewhat north of Yerevan city center. It was created in the 1930s by planting various decorative trees and shrubs. According to the EUNIS classification, this habitat is classified as a large-scale ornamental garden area (I2.1). The tree stand was formed mainly by maples (*Acer* spp.), poplars (*Populus* spp.), plane trees (*Platanus orientalis*), elms (*Ulmus* spp.), ash trees (*Fraxinus excelsior*), and other trees.



**Figure 3.** Collection sites in Armenia: (a,b) Victory Park (or “Park Pobedy”), situated somewhat north of Yerevan city center, created in the 1930s by planting various mainly decorative trees and shrubs, including maples, poplars, plane trees, elms, ash trees and other trees; (c–f) Jrvezh Forest Park, in the western area of Yerevan city (belongs to Kotayk Province), created in the mid-1900s by the systematic planting of tree and shrub vegetation, both deciduous and coniferous; the park includes an old artificial pond.

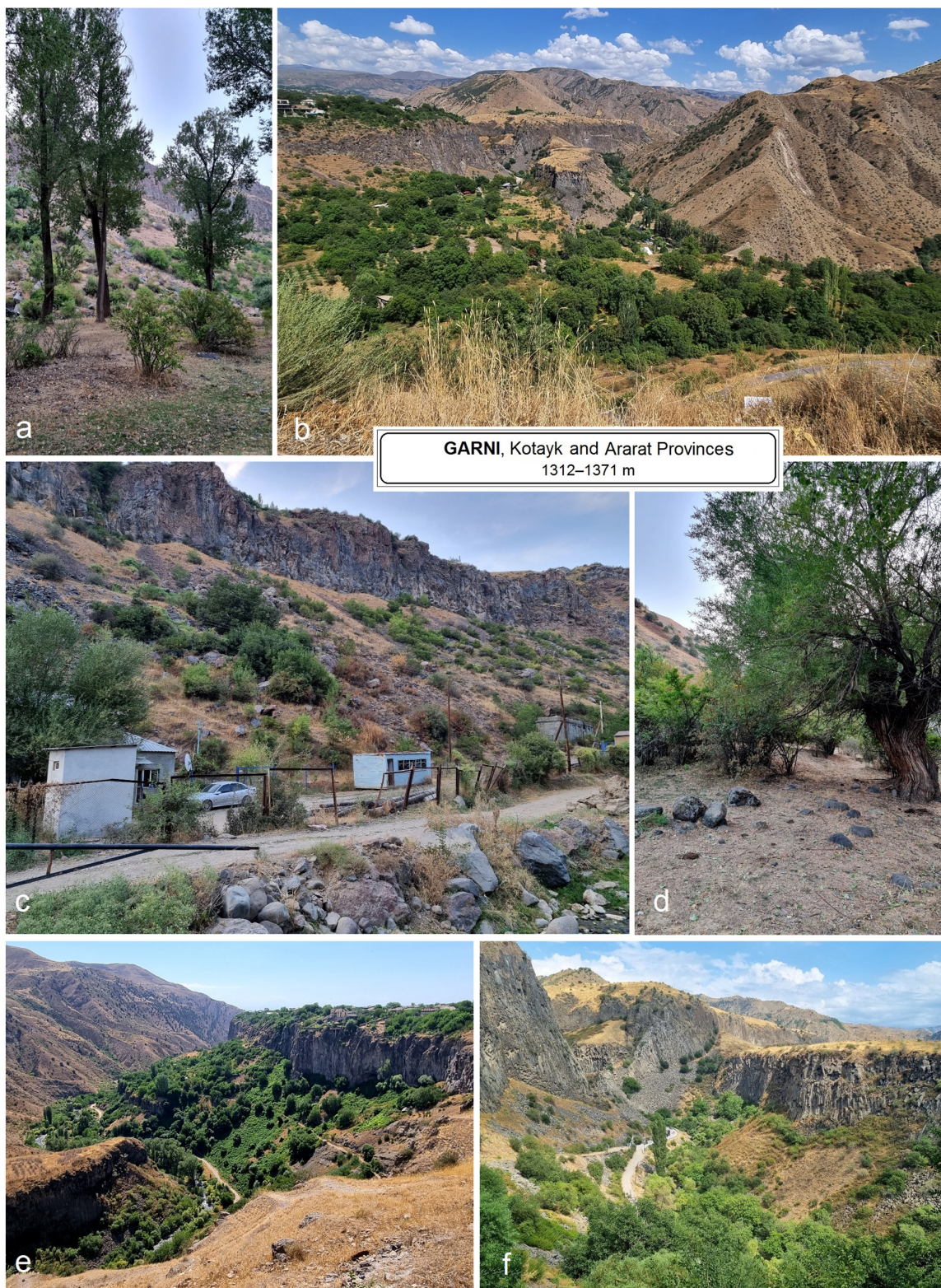
*Jrvezh Forest Park*, Yerevan, 1515 m, 40°11'07" N, 44°37'11" E (Figure 3c–f). This collection site is situated in central Armenia, in the western area of Yerevan city (Jrvezh Forest Park is in Kotayk Province, not Yerevan itself). It was created in the mid-1900s by the systematic planting of tree and shrub vegetation, both deciduous and coniferous. In this territory, a community classified as mixed forestry plantations (G4.F) is present; it includes ash trees (*Fraxinus excelsior*), maples (*Acer* spp.), and elms (*Ulmus* spp.), as well as pines (*Pinus* spp., mainly *P. kochiana* and *P. sylvestris* with small plots of *P. pallasiana*). In Jrvezh Forest Park, an old artificial pond was created; it belongs to the habitat type C1.3 (i.e., permanent eutrophic lakes, ponds, and pools).

*Garni*, Kotayk Province (1312–1355 m, 40°07'18" N, 44°45'17" E–40°06'41" N, 44°43'55" E) and Garni, Ararat Province (1371 m, 40°07'27" N, 44°45'40" E) (Figure 4a–f). Both habitats are located in central Armenia, on the sides of a gorge at the confluence of the Rivers Goght and Azat. Along the riversides, mixed riparian floodplain and gallery woodlands (G1.2) occur along old-growth willows (*Salix* spp.) and poplars (*Populus nigra*). On the slopes, almond open arid forests (F5.342) are common alongside steppe-like communities in some areas on sand substrates (E1.2H1), as well as bare inland basaltic and ultra-basic cliffs (H3.2H).

*Jermuk*, Vayots Dzor Province, 2000 m, 39°50'25.8" N, 45°40'07.6" E (Figure 5a–c). Jermuk town is situated in the southwestern part of Armenia, on the southern slopes of the Vardenis Range. The collection site is located in the town with remnants of oak forests comprising *Quercus macranthera* (G1.A1D2); in the tree stands, ash (*Fraxinus excelsior*), maples (*Acer* spp.) and plum trees (*Prunus divaricata*) are present along with artificially planted pines and many other trees and shrubs. The site is located above a gorge with bare inland basaltic and ultra-basic cliffs (H3.2H).

*Yeghegis*, Vayots Dzor Province, 1574 m, 39°52'10" N, 45°22'12" E (Figure 5d–f). The Yeghegis river gorge is situated in the southwestern part of Armenia, on the southern slopes of the Vardenis Range. Along the river, mixed riparian floodplain and gallery woodlands (G1.2) are present, comprising old-growth willows (*Salix* spp.) and a few poplar trees (*Populus nigra*). Temperate thickets and scrubs (F3.1) are also common on the slopes, with a predominance of hawthorns (*Crataegus* spp.), plums (*Prunus* spp.), nettle trees (*Celtis caucasica*) and wild roses (*Rosa* spp.), as well as bare inland basaltic and ultra-basic cliffs (H3.2H) on the top.

*Noravank*, Vayots Dzor Province, 1468 m, 39°40'57" N, 45°14'10" E (Figure 5g–i). Noravank (Gnishik River Canyon) is situated in the southwestern part of Armenia, on the northern slopes of the Vayots Dzor (formerly Daralagyaz) Range. Along the River Gnishik that flows through the gorge, thickets of *Salix* and *Tamarix* are present (F9.141 and F9.3142, respectively). There are also some plots of traditional vineyards (FB.41) abandoned in the mid-1900s. The slopes of the gorge are covered with vegetation classified into the following habitats: a) nettle tree open arid forests (F5.343) with a predominance of *Celtis* spp. and buckthorn open arid forests (F5.347) with a predominance of *Rhamnus pallasii* Fisch. & C.A. Mey. A significant part of the canyon is formed by rocks and scree with vegetation characteristic for such habitats, namely calcareous and the ultra-basic screen of the lower mountain belt of Armenia (H2.6H) and mountain limestone cliffs (H3.2E2).



**Figure 4.** Collection sites in Armenia: (a,d) Garni, Ararat Province; (b,c,e,f) Garni, Kotayk Province; both sites are located on the sides of a gorge at the confluence of the Rivers Goght and Azat; along the riversides, mixed riparian floodplain and gallery woodlands occur with old-growth willows and poplars; on the dry slopes, almond open arid forests are common, and steppe-like communities occur.



**Figure 5.** Collection sites in Armenia: (a–c) Jermuk, Vayots Dzor Province, on the southern slopes of the Vardenis Range, with remnants of oak forests comprising *Quercus macranthera* along with other artificially planted trees; (d–f) Yeghegis, Vayots Dzor Province, on the southern slopes of the Vardenis Range, with a predominance of hawthorns, plums, nettle trees (*Celtis caucasica*) and wild roses; (g–i) Noravank, Vayots Dzor Province, on the northern slopes of the Vayots Dzor Range, with thickets of *Salix* and *Tamarix* and a predominance of *Celtis*, *Rhamnus cathartica* and *Rh. pallasii*.

**Molecular analysis.** Genomic DNA was obtained from the 96% ethanol-preserved larval stages or adults using the GeneJet Genomic DNA Purification Kit (Thermo Fisher Scientific Baltics, Vilnius, Lithuania) protocol. The primers T3Lep-f (5'-attaacacctactaaagtcwacha atcataaratattgg-3'; modified Lep-f1 [31]) and T7Nancy-r (5'-aatagcactactataggdaraattaraatr taaacytcwg-3'; modified Nancy [32]) were used to amplify the partial sequences of the mitochondrial DNA cytochrome c oxidase subunit 1 (mtDNA CO1-5'). All PCR mixtures contained 12.5  $\mu$ L of a 2 $\times$  DreamTaq Green PCR Master Mix (Thermo Fisher Scientific Baltics, Vilnius, Lithuania), 2.5  $\mu$ L of 10 pmol/ $\mu$ L of each primer, 1–2  $\mu$ L of genomic DNA, and deionized water up to a total volume of 25  $\mu$ L. The PCR thermal regime was as follows: initial denaturation at 95  $^{\circ}$ C for 5 min; 45 cycles of denaturation at 94  $^{\circ}$ C for 40 s, annealing at 45  $^{\circ}$ C for 40 s, and extension at 72  $^{\circ}$ C for 1 min; the final extension was at 72  $^{\circ}$ C for 5 min. Each PCR product was electrophoresed on 1.5% agarose gel (Thermo Fisher Sci-



entific Baltics, Vilnius, Lithuania), stained with 10,000× GelRed (Biotium, Fremont, CA, USA) and visualized under UV light; GeneRuler Express DNA Ladder (Thermo Fisher Scientific Baltics, Vilnius, Lithuania) was used for the size measurement of the amplified DNA sequences. PCR products were subsequently purified using the Exonuclease I and FastAP Thermosensitive Alkaline Phosphatase (Thermo Fisher Scientific Baltics, Vilnius, Lithuania) protocol. Automated sequencing in both directions was performed in BaseClear B.V. (Leiden, The Netherlands) using the ABI 3730xl 96-capillary DNA analyzer (Applied Biosystems, Foster City, CA, USA). The obtained DNA sequences were manually aligned using BioEdit 7.2.5 software [33]. All data were deposited in the NCBI GenBank database (<https://www.ncbi.nlm.nih.gov/genbank/> accessed on 1 January 2024) under the accession numbers OR793219–OR793227, OR880346, and OR880347. Moreover, for further analysis, sequences were downloaded from the GenBank and the Barcode of Life Data System (BOLD) platform [34,35] (<https://www.boldsystems.org> accessed on 1 January 2024). The Neighbor-Joining (NJ) trees based on Kimura 2-parameter [36] or Tamura 3-parameter [37] models with a gamma distribution and 1000 or 10,000 bootstrap replications were constructed using the MEGA 7.0 software [38]. Mitotype diversity was obtained using the DnaSP 6 program [39]. ClustalX2 [40] was used for the Fasta format conversion to Nexus. The mitotype networks were generated using the Median Joining Network, Minimum Spanning Network [41], and the TCS Network [42] algorithms, which were implemented in the PopArt 1.7 program (<http://popart.otago.ac.nz> accessed on 10 January 2024).

**Abbreviations for institutions and specimen depository:** BRG–Biosystematic Research Group, currently based at the State Research Institute Nature Research Centre, Vilnius, Lithuania; MfN–Museum für Naturkunde, Berlin, formerly known as the Museum der Naturkunde für Humboldt Universität zu Berlin or Museum für Naturkunde/Leibniz-Institut für Evolutions und Biodiversitätsforschung, Berlin, Germany; RMNH–Naturalis Biodiversity Center, Zoological collections, Leiden, The Netherlands; VU–Vrije Universiteit, Amsterdam, The Netherlands.

### 3. Results

#### 3.1. A Review of the Currently Known Nepticulidae Taxa from Armenia

Based on the results of our collecting and previously known records, the current fauna of the Nepticulidae of Armenia consists of eight genera and 31 species of pygmy moths (Figure 6), including seven new species named and described in this current paper as follows: *Stigmella armi* Stonis, Dobrynina & Remeikis, sp. nov. (Figure 7g); *S. garnica* Stonis, Dobrynina & Remeikis, sp. nov. (Figure 7c); *S. inopinoides* Dobrynina, sp. nov. (Figure 7c); *S. magicis* Stonis & Dobrynina, sp. nov. (Figure 7a,b); *S. ararati* Stonis, Dobrynina & Remeikis, sp. nov. (Figure 7e,f); *Trifurcula vardenisi* Stonis, Dobrynina & Remeikis, sp. nov. (Figure 8a,b); and *Etainia caucasi* Remeikis, sp. nov. (Figure 8c–f).

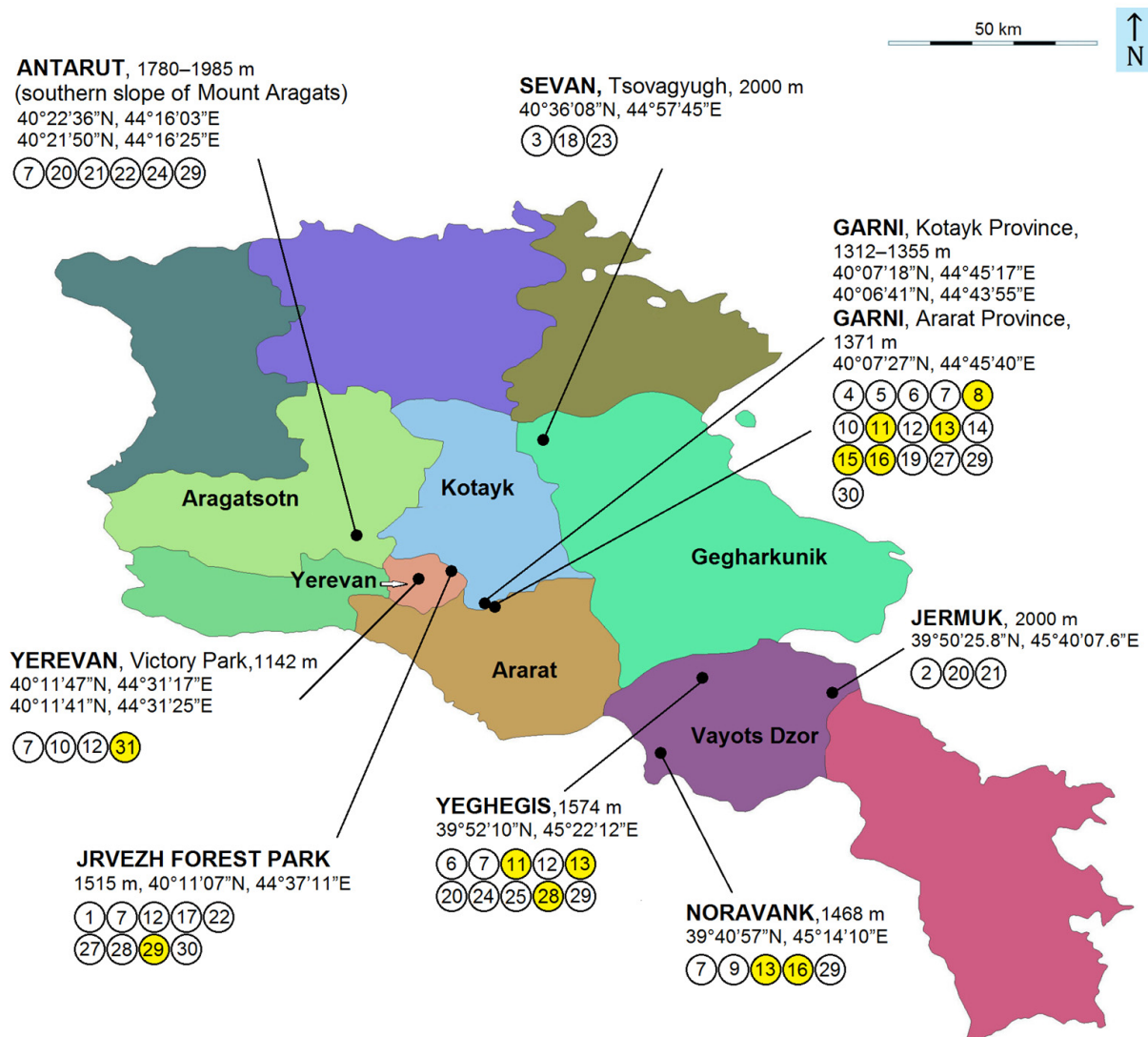
#### Genus *Simplimorpha* Scoble, 1983

##### 1. *Simplimorpha promissa* (Staudinger, 1870)

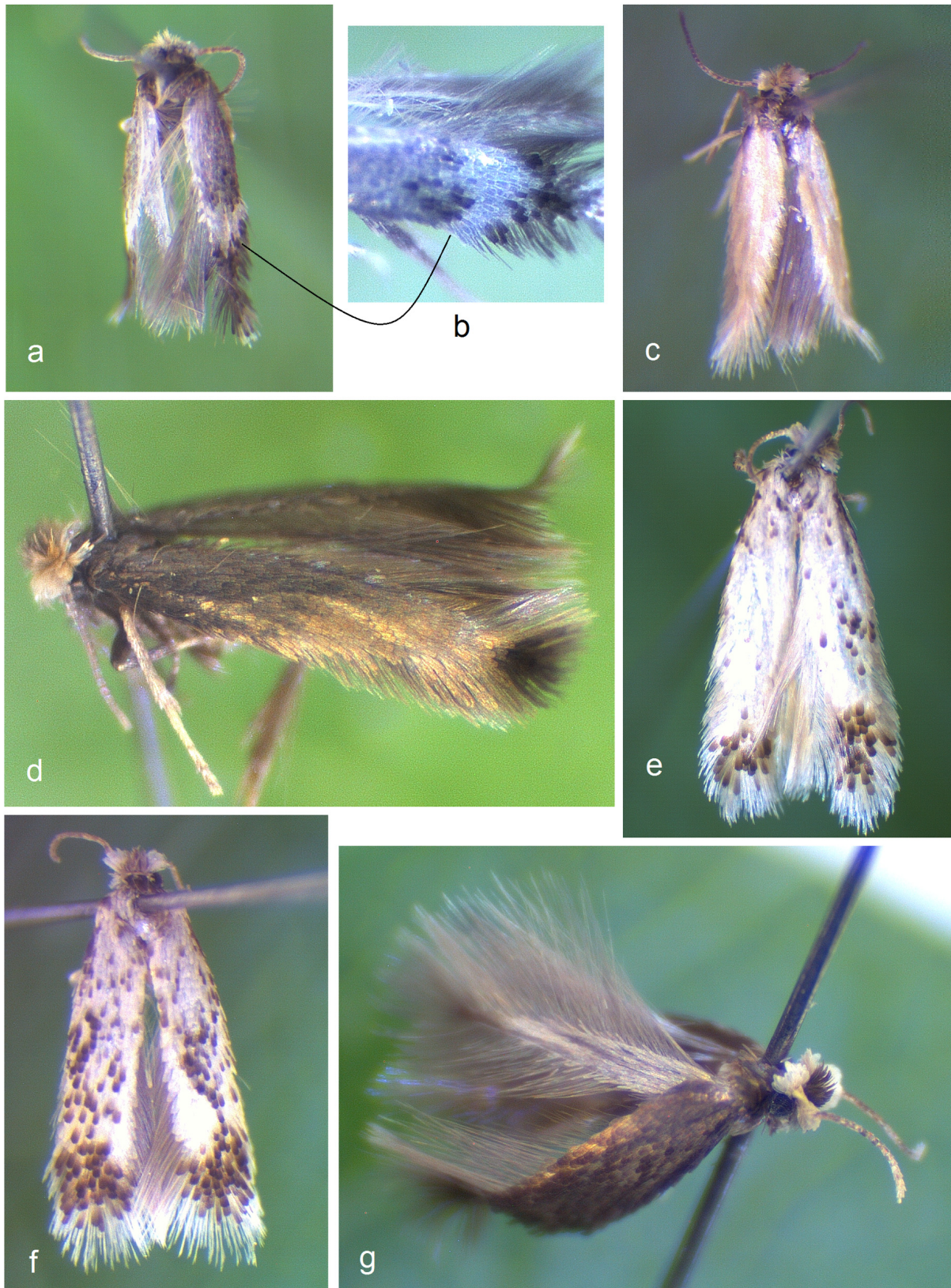
*Nepticula promissa* Staudinger, 1870 [43] (pp. 325, 326).

Host plants. *Cotinus coggygria* Scop. (Anacardiaceae); *S. promissa* also is known to feed on other species of the same plant family, but this has not yet been confirmed in Armenia: *Pistacia atlantica* Desf., *P. lentiscus* L., *P. terebinthus* L., *Rhus coriaria* L.

Distribution. *S. promissa* is known for its distribution in the Mediterranean region and central Europe, from Spain, France, and Italy to Austria, Slovakia, Ukraine, Romania, and Greece. The species also occurs in the Caucasus: Georgia (Abkhaz) [19] and Armenia (this new distribution record was provided in our recent publication [44]). The occurrence of *S. promissa* in Iran has not yet been confirmed [26].



**Figure 6.** Nepticulidae species detected in Armenia (the new species are shown in yellow): 1—*Simplimorpha promissa* (Staudinger); 2—*Stigmella confusella* (Wood & Walsingham); 3—*S. malella* (Stainton); 4—*S. klimeschi* Puplesis; 5—*S. armeniana* Puplesis; 6—*S. kopetdagica* Puplesis; 7—*S. muricatella* (Klimesch); 8—*S. arni* Stonis, Dobrynina & Remeikis, sp. nov.; 9—*S. nivenburgensis* (Preisecker); 10—*S. aceris* (Frey); 11—*S. garnica* Stonis, Dobrynina & Remeikis, sp. nov.; 12—*S. hybnerella* (Hübner); 13—*S. inopinoides* Dobrynina, sp. nov.; 14—*S. viscerella* (Stainton); 15—*S. magicis* Stonis & Dobrynina, sp. nov.; 16—*S. ararati* Stonis, Dobrynina & Remeikis, sp. nov.; 17—*S. carpinella* (Heinemann); 18—*S. lemniscella* (Zeller); 19—*S. kuznetzovi* Puplesis; 20—*S. dorsiguttella* (Johansson); 21—*S. roborella* (Johansson); 22—*S. basiguttella* (Heinemann); 23—*Bohemannia pulverosella* (Stainton); 24—*Ectoedemia longicaudella* Klimesch; 25—*E. mahalebella* (Klimesch); 26—*Fomoria septembrella* (Stainton); 27—*Trifurcula subnitidella* (Duponchel); 28—*T. vardenisi* Stonis, Dobrynina & Remeikis, sp. nov.; 29—*Glaucolepis melanoptera* (van Nieukerken & Puplesis); 30—*G. hamirella* (Chrétien); and 31—*Etainia caucasi* Remeikis, sp. nov.



**Figure 7.** Adults of new Nepticulidae species from Armenia; **(a,b)** *Stigmella magicis* Stonis & Dobrynina, sp. nov.; **(c)** *S. garnica* Stonis, Dobrynina & Remeikis, sp. nov.; **(d)** *S. inopinoides* Dobrynina, sp. nov.; **(e,f)** *S. ararati* Stonis, Dobrynina & Remeikis, sp. nov.; and **(g)** *S. armi* Stonis, Dobrynina & Remeikis, sp. nov.



**Figure 8.** Adults of new Nepticulidae species from Armenia; (a,b) *Trifurcula vardenisi* Stonis, Dobrynina & Remeikis, sp. nov.; (c,d) *Etainia caucasi* Remeikis, sp. nov.; (e) androconial patch of *E. caucasi* on the hindwing's upper side; (f) androconial patch of *E. caucasi* on the forewing's underside (the arrows point to the important diagnostic characters).

**Material examined.** The material examined was 1 ♂, Armenia, Yerevan, Jrvezh Forest Park, 1515 m, 40°11'07" N, 44°37'11" E, at light, 11 August 2022, leg. J.R. Stonis, genitalia slide no. RA1128 (MfN); 1 ♂, 1514 m, 40°11'06" N, 44°37'11" E, at light, 21 August 2022, leg. J.R. Stonis, genitalia slide no. RA1110 (MfN). Also, old (vacant) leaf mines on *Cotinus coggygria* and 9 ♀ adult specimens were collected at light in the Jrvezh Forest Park on 11–21 August 2023, the latter of which were entirely consumed during our DNA studies [44].

**Remarks.** See Section 3.2.3 for the genetic distinctness of *S. promissa* from Armenia.

## Genus *Stigmella* Schrank, 1802

### The *lapponica* group

#### 2. *Stigmella confusella* (Wood & Walsingham, 1894)

*Nepticula confusella* Wood & Walsingham, 1894 [45] (pp. 272, 273).

Host plants. *Betula nana* L., *B. pendula* Roth, *B. pubescens* Ehrh.; in Armenia, *B. litwinowii* Doluch.

Distribution. Widespread in Europe (except southern and southwestern regions), this species occurs from Ireland and France to northwestern Russia, Ukraine, and Bulgaria. Here, on the basis of documented leaf mines, we provide *S. confusella* for Armenia, the Caucasus (a new distribution record).

Material examined. Numerous old (vacant) leaf mines were examined on *Betula litwinowii*, Armenia, Vayots Dzor Province, Jermuk, 2106 m, 39°50'28" N, 45°40'14" E, 12 August 2022, leg. J.R. Stonis.

Remarks. For species illustrations, we recommend the following publications: [18] (419, 477, 551), [19] (figures 116–119).

### The former *rhamnella* group (see Section 3.2.2)

#### 3. *Stigmella malella* (Stainton, 1854)

*Nepticula malella* Stainton [46] (p. 304).

Host plants. *Malus domestica* Borkh., *M. sylvestris* Mill.

Distribution. This species is widespread in Europe, from Portugal and Ireland to Russia (the southern Ural) and Greece. Recently, this species was confirmed to occur in Iran [26]. Here, on the basis of documented leaf mines, *S. malella* is provided for Armenia, the Caucasus (a new distribution record). However, this needs to be viewed with caution because no adults have been reared to confirm the species.

Material examined. Armenia, Gegharkunik Province, N of Sevan, 1909 m, 40°37'21" N, 44°58'21" E, old (vacant) leaf mines were examined on *Malus* sp., 9 August 2022, leg. J.R. Stonis.

Remarks. For species illustrations, we recommend the following publications: [18] (423, 482, 556), [19] (figures 225–227).

#### 4. *Stigmella klimeschi* Puplesis, 1988 [47] (pp. 274, 275).

Host plants. *Rhamnus* spp.

Distribution. Previously, this species was known only in Central Asia (Kazakhstan and Tajikistan) [19]. Here, on the basis of collected adult specimens, we provide *S. klimeschi* for Armenia, the Caucasus (a new distribution record).

Material examined. The material examined was 1 ♂, Armenia, Kotayk Province, Garni, 1312 m, 40°06'41" N, 44°43'55" E, at light, 14 August 2022, leg. J.R. Stonis, genitalia slide no. DV059 (MfN); 1 ♂, Garni, 1355 m, 40°07'18" N, 44°45'17" E, at light, 16 August 2022, leg. J.R. Stonis, genitalia slide no. DV051 (MfN).

Remarks. For species illustrations, we recommend the following publications: [19] (figures 241–245), [47].

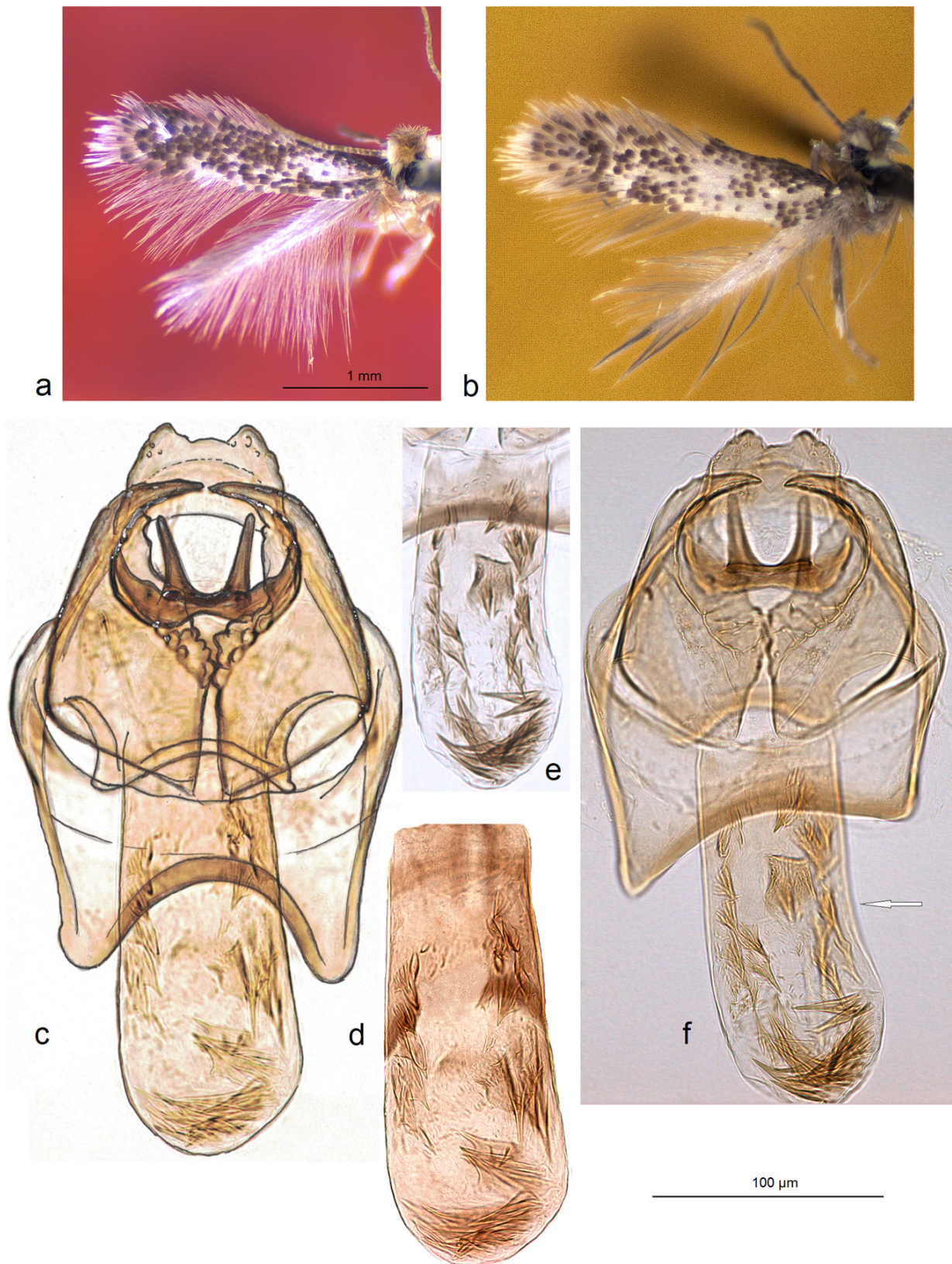
#### 5. *Stigmella armeniana* Puplesis, 1994 [19] (p. 90).

Host plant. *Rhamnus erythroxylodes* subsp. *sintenisii* (Rech.f.) Mabb.

Distribution. This species is known to occur only in Armenia (Ararat Province, E of Garni, Chosrov Reserve) [19].

Material examined. The material examined was 3 ♂ (holotype and paratypes), Armenia, Ararat Province, E of Garni, 30 September 1986, larvae on *Rhamnus*, ex. l. 22 February 1987, leg. P. Ivinskis, genitalia slide nos AN375 (holotype), AN376 (paratype) (MfN).

Remarks. Here, we provide the first photographic documentation of *S. armeniana*, a previously little-known species named after Armenia (Figure 9a–f).



**Figure 9.** The first photographic documentation of *Stigmella armeniana* Puplesis, a previously little-known species named after Armenia [19]: (a) adult, holotype; (b) same, paratype; (c,d) male genitalia, holotype, slide no. AN375; (e,f) the same paratype, slide no. AN376 (MfN) (the arrow points to the most important character).

## 6. *Stigmella kopetdagica* Puplesis, 1994 [19] (p. 92).

Host plant. *Rhamnus coriacea* (Regel) Kom.

Distribution. Previously, this species was known only from western Turkmenistan, Central Asia [19]. Here, on the basis of collected adult specimens, we provide *S. kopetdagica* for Armenia, the Caucasus (a new distribution record).

Material examined. The materials examined was 1 ♂, 1 ♀, Armenia, Kotayk Province, Garni, 1355 m, 40°07'18" N, 44°45'17" E, at light, 23 July 2022, leg. V. Dobrynina, genitalia slide no. DV009♂(MfN); 1 ♂, Garni, 1312 m, 40°06'41" N, 44°43'55" E, at light, 14 August 2022, leg. J.R. Stonis, genitalia slide no. DV056 (MfN); 1 ♂, Garni, 1355 m, 40°07'18" N, 44°45'17" E, at light, 16 August 2022, leg. J.R. Stonis, genitalia slide no. DV044 (MfN); 1 ♂, Ararat Province, E of Garni, 1371 m, 40°07'27" N, 44°45'40" E, at light, 30 August 2022, leg. J.R. Stonis, genitalia slide no. DV073 (MfN); 1 ♀, Vayots Dzor Province, 1 km E Yeghegis, 1574 m, 39°52'10" N, 45°22'12" E, at light, 26 July 2022, J.R. Stonis (MfN).

Remarks. For species illustrations, we recommend the following publication: [19] (figures 246–248).

The former *sanguisorbae* group (see Section 3.2.2)

## 7. *Stigmella muricatella* (Klimesch, 1978)

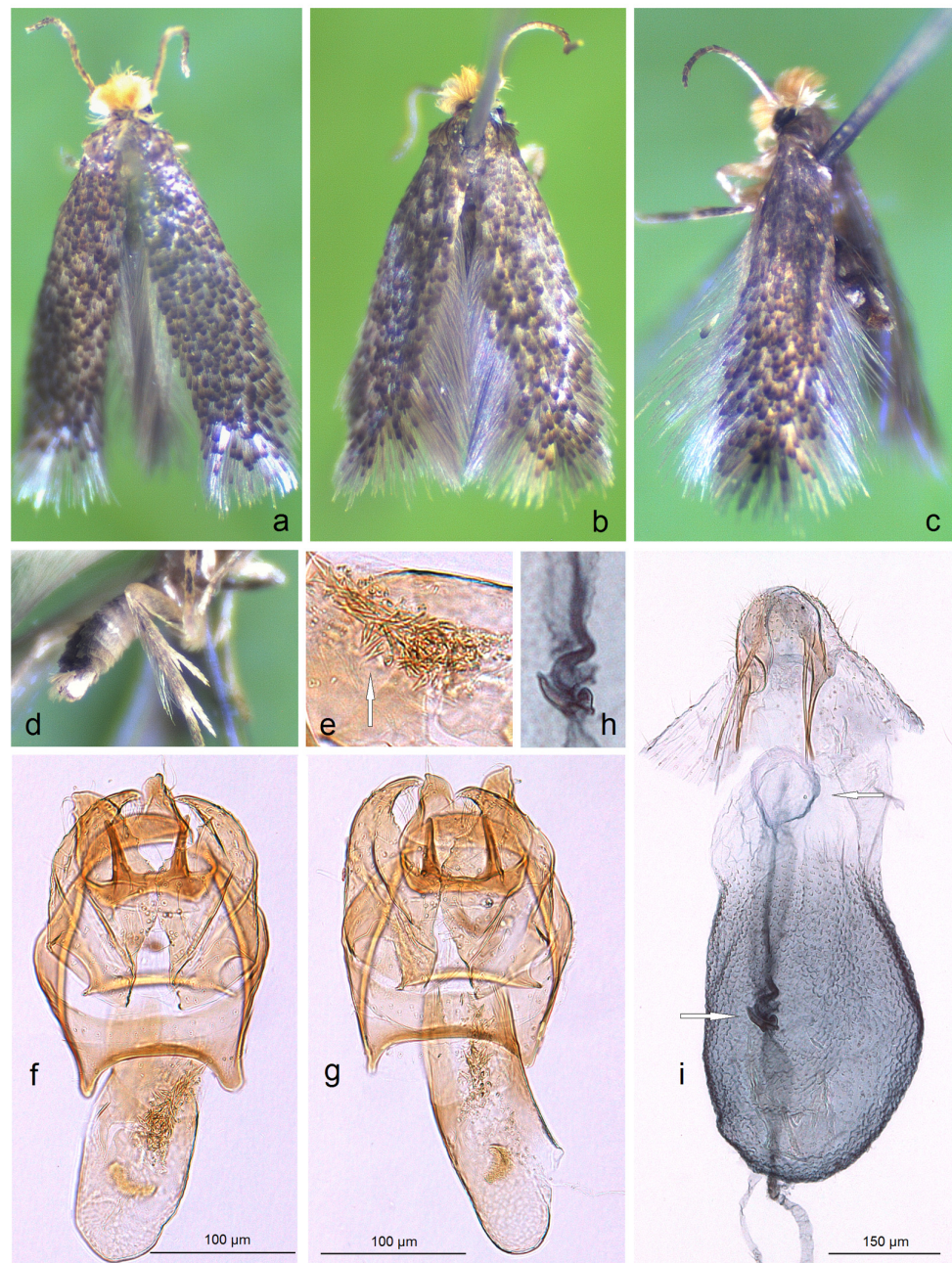
*Nepticula muricatella* Klimesch [48] (pp. 266, 267).

Host plants. *Rosa* spp., incl. *R. fedtschenkoana* Regel., *Sanguisorba minor* Scop., *S. muricata* (Spach) Gremli, *Sarcopoterium spinosum* (L.) Spach.

Distribution. The species distribution was known in Greece, Turkey (Anatolia), and Tajikistan [19]. However, the adults from Tajikistan differed from the European specimens in the cream background color of the forewing. Here, on the basis of collected adult specimens, we provide *S. muricatella* for the Caucasus (Armenia) (a new distribution record).

Material examined. The material examined was 4 ♂, 2 ♀, Armenia, Yerevan, Victory Park, 1142 m, 40°11'41" N, 44°31'25" E, at light, 29 July–19 August 2022, leg. J.R. Stonis, genitalia slide nos DV125♂, DV127♂, DV128♂(MfN); 9 ♂, Yerevan, Irvezh Forest Park, 1515 m, 40°11'07" N, 44°37'11" E, at light, 11 August–24 August 2022, leg. J.R. Stonis, genitalia slide nos DV112, DV114, DV119 (MfN); 55 ♂, 6 ♀, Kotayk Province, Garni, 1355 m, 40°07'18" N, 44°45'17" E, at light, 23 July–28 August 2022, leg. V. Dobrynina and J.R. Stonis, genitalia slide nos DV002♂\*, DV006♂, DV008♂, DV010♂\*, DV012♂, DV013♂, DV016♂, DV018♂, DV026♂, DV031♂, DV036♂, DV038♂, DV057♂, DV058♂, DV060♂, DV062♂, DV063♂, DV064♂, DV066♂, DV067♂, DV070♂, DV071♂, DV081♂, DV084♂, DV086♂, DV089♂, DV090♂, DV091♂, DV093♂, DV097♂, DV100♂, DV101♂, DV102♂, VD109♂, RA1134♀(MfN); 7 ♂, Ararat Province, E of Garni, 1371 m, 40°07'27" N, 44°45'40" E, at light, 30 August 2022, leg. J.R. Stonis, genitalia slide nos DV074♂, DV075♂, DV077♂, DV080♂, DV088♂, DV095♂(MfN); 1 ♂, Aragatsotn Province, 2 km N of Antarut, 1780 m, at light, 40°21'50" N, 44°16'25" E, 2 August 2022, J.R. Stonis; 2 ♂, 4 km N Antarut, 1985 m, 40°22'36" N, 44°16'03" E, 12 August 2022, leg. J.R. Stonis, genitalia slide no. RA1121♂(MfN); 7 ♂, 1 ♀, Vayots Dzor Province, 1 km E Yeghegis, 1574 m, 39°52'10" N, 45°22'12" E, at light, 26 July–15 August 2022, leg. J.R. Stonis and V. Dobrynina, genitalia slide nos DV022♂, DV027♂, DV035♂, RA1108♂, RA1135♀(MfN); 6 ♂, Noravank, 1468 m, 39°40'57" N, 45°14'10" E, at light, 17 August 2022, leg. J.R. Stonis, genitalia slide nos RA1103♂, RA1107♂(MfN) (\* only genitalia preserved, without a pinned specimen).

Remarks. Here, we provide the first photographic documentation of *S. muricatella*, a previously little-known species described by Josef Klimesch [48] but very common in Armenia (Figure 10a–i).



**Figure 10.** The first photographic documentation of *Stigmella muricatella* (Klimesch), previously a little-known Nepticulidae species found to be abundant among the samples of all other hitherto discovered species in Armenia: (a–d) adults; (e,f) male genitalia, slide no. DV060; (g) the same, slide no. DV101 (h,i) female genitalia, slide no. RA1135 (MfN) (the arrows point to the diagnostic characters).

We barcoded three specimens from Armenia; the sequences are available in GenBank under accession IDs: OR793225, OR793226, and OR793227.

#### The *paliurella* group

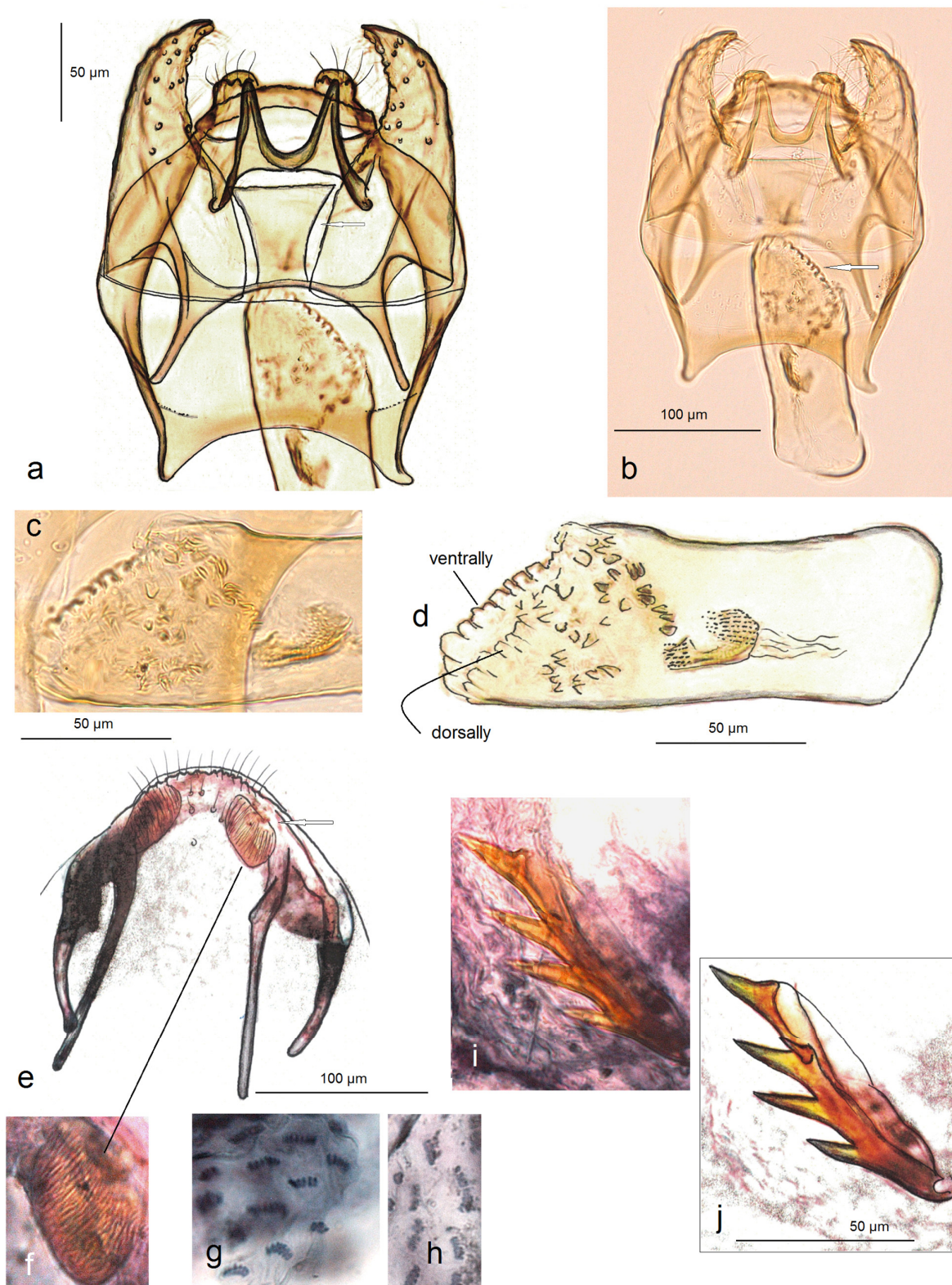
#### 8. *Stigmella armi* Stonis, Dobrynina & Remeikis, sp. nov.

<https://zoobank.org/NomenclaturalActs/2225ef11-7c42-463b-bd25-360e74b04dab>

(accessed on 12 December 2023)

(Figures 7g and 11a–j)





**Figure 11.** Genitalia of *Stigmella armi* Stonis, Dobrynina & Remeikis, sp. Nov.: (a–d) holotype, details of male genitalia, slide no. DV122 (MfN); (e–j) paratype, details of female genitalia slide no. DV041 (MfN): I apophyses; (f) ovipositor pad; (g,h) pectinations; and (i,j) vaginal sclerite (the arrow points to the diagnostic character).

**Diagnosis.** *Stigmella armi* sp. nov. belongs to the *paliurella* species group. Externally, this new species can be differentiated from other Palearctic members of the group, including

the dark-winged Central Asian *S. turbatrix* Puplesis, by the smoothly scaled, dark brown forewing. In the male genitalia, *S. armi* is characterized by a unique combination of a large gnathos, trapezoid juxta, well-separated lobes of uncus, and an apically distinctly serrated phallus. In the female genitalia, this new species is also distinctive because of the presence of unique, transversely striated ovipositor pads; furthermore, no other species in this group possesses a vaginal sclerite with long pointed spines.

**Description.** *Male.* Forewing length 1.9 mm; wingspan 2.3 mm ( $n = 1$ ). Similar to the female but damaged (see Remarks). *Male genitalia.* The genitalia capsule is about 330  $\mu\text{m}$  long and 190  $\mu\text{m}$  wide. The tegumen is band-shaped. The uncus has two well-separated lobes. The gnathos is large, with two well-separated, basally wide caudal processes and short, lobe-like anterior processes. The valva is curved and pointed apically. Juxta is relatively large, trapezoid. The vinculum is relatively wide and long, with short curved lateral lobes. The phallus is 170  $\mu\text{m}$  long, 50  $\mu\text{m}$  wide, distinctly oblique, and serrated apically; the vesica has only some small, indistinctive cornuti.

*Female.* The forewing length is 2.0 mm; the wingspan is 2.6 mm ( $n = 1$ ). *Head.* Palpi cream; frontal brown-black tuft; collar and scape large, cream; antenna is 1/4 shorter the length of forewing with about 19 segments; grey-brown flagellum the on upper side, cream on the underside. *Thorax.* The tegula, thorax, and forewing are densely covered with dark brown scales with some golden gloss and weak purple iridescence (the latter is more distinct basally and apically); the fringe is brownish grey; the fringe line is absent; the underside of the forewing is brown without spots. The hindwing and its fringe are brownish-grey and, at a certain angle of view, greyish cream. Legs are cream, with brown-grey scales on the upper side. *Female genitalia.* The ovipositor is short and widely rounded with unique, transversally striated ovipositor pads. Anterior apophyses are distinctly shorter than posterior apophyses. The vaginal sclerite is 85  $\mu\text{m}$  long, strongly chitinized with four 23  $\mu\text{m}$  long, pointed spines and one shorter spine. The corpus bursae with distinctive comb-like pectinations. The ductus spermathecae is unknown (see Remarks).

**Bionomics.** Adults fly in late July and August. Otherwise, the biology is unknown.

**Distribution.** This species is known to occur in Garni, at the border of two provinces in Armenia (Ararat and Kotayk), at an elevation of 1300–1400 m.

**Etymology.** The new species is named after the country where *S. armi* sp. nov. was discovered. “Arm” is an international abbreviation for Armenia and is commonly used in that country.

**Remarks.** The male holotype is preserved in a plastic capsule with a broken and missing head. The scaling and color of the thorax, tegulae, and forewing are almost identical to the female paratype. Therefore, the external description of the new species is based on the well-preserved female paratype. Female genitalia were damaged during the preparation of the genitalia mount (slide no. DV041), but the major morphological structures, including the unique ovipositor pads, apophyses, unique vaginal sclerite, and pectinations of bursa, were well-preserved and visible.

**Type material.** Holotype, ♂, Armenia, Ararat Province, E of Garni, 1371 m, 40°07'27" N, 44°45'40" E, at light, 30 August 2022, leg. J.R. Stonis, genitalia slide no. DV122♂(MfN). Paratype: 1 ♀, Armenia, Kotayk Province, Garni, 1312 m, 40°06'41" N, 44°43'55" E, at light, 25 July 2022, leg. V. Dobrynina, genitalia slide DV041♀(MfN).

The *betulicola* group

9. *Stigmella nivenburgensis* (Priessecker, 1942)

*Nepticula nivenburgensis* Priessecker [49] (pp. 209–211).

*Stigmella thibaulti* Varenne & Nel, 2019 [50] (p. 85), syn. by [51] (p. 303).

Host plants. *Salix* spp. and *Populus nigra* L.

Distribution. This species is widespread in Europe (predominantly southern and central), from Spain and Italy to Russia (central and southern European regions) and Greece. It is also known from the western part of Central Asia (Turkmenistan) [19] and

East Asia (Japan, China, and Korea) [52]. Here, on the basis of a collected adult specimen, we provide *S. nivenburgensis* for Armenia, the Caucasus (a new distribution record).

Material examined. The material examined was 1 ♂, Armenia, Vayots Dzor Province, Noravank, 1468 m, 39°40'57" N, 45°14'10" E, at light, 17 August 2022, J.R. Stonis, genitalia slide no. RA1104 (MfN).

Remarks. For species illustrations, we recommend the following publications: [18] (470, 667, 556), [19].

#### The *ultima* group

##### 10. *Stigmella aceris* (Frey, 1857)

*Nepticula aceris* Frey, 1857 [53] (pp. 386, 387).

Host plants. *Acer campestre* L., *A. ginnala* Maxim., *A. platanoides* L., *A. tataricum* L.

Distribution. This species is widespread in Europe, from Spain and Italy to Norway, Russia (Central European regions), Bulgaria, and Greece. It is also known in the Caucasus (Georgia) [19] and Iran [26]. Here, on the basis of collected adult specimens, we provide *S. aceris* for Armenia (a new distribution record).

Material examined. Armenia, 1 ♂, Yerevan, Victory Park, 1141 m, 40°11'41" N, 44°31'12" E, at light, 1 August 2022, leg. J.R. Stonis, genitalia slide no. DV126 (MfN); 1 ♂, same locality, 19 August 2022, leg. J.R. Stonis, genitalia slide no. RA1109♂ (MfN); 1 ♀, Ararat Province, E of Garni, 1371 m, 40°07'27" N, 44°45'40" E, at light, 22 August 2022, leg. J.R. Stonis (MfN).

Remarks. For species illustrations, we recommend the following publications: [18] (422, 482, 556), [19] (figures 220–222).

#### The *irregularis* group

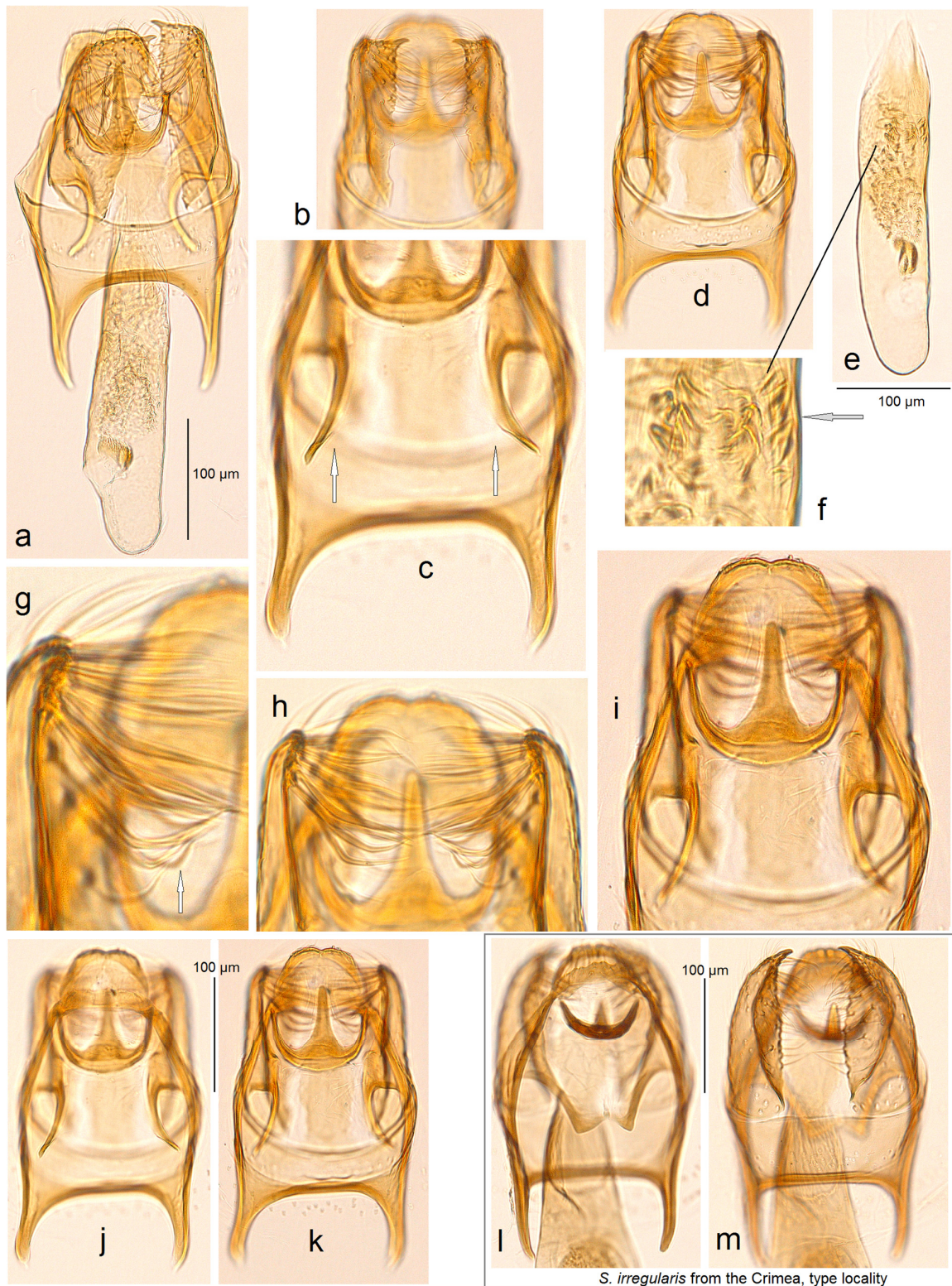
##### 11. *Stigmella garnica* Stonis, Dobrynina & Remeikis, sp. nov.

<https://zoobank.org/NomenclaturalActs/3A72E0EF-1C5C-47E2-9677-953E86F4E1A2> (accessed on 12 December 2023)

(Figures 7c and 12a–k)

**Diagnosis.** *Stigmella garnica* sp. nov. belongs to the *irregularis* species group, formerly comprising only a single named species, the southeast European *S. irregularis* Puplesis, 1994. Externally, this new species can be differentiated from the resembling *S. irregularis* by its paler, golden cream forewing. In the male genitalia, the shape of the transtilla and the presence of very long chetae of the valva, and the presence of larger, triangular cornuti distinguish *S. garnica* sp. nov. from *S. irregularis* (Figure 12l,m).

**Description.** *Male.* The forewing length is 1.6–1.7 mm; the wingspan is 3.7–3.9 mm ( $n = 2$ ). *Head.* Palpi cream; frontal tuft yellowish cream but blackish brown centrally; collar and scape glossy whitish cream to golden cream; antenna is slightly shorter than the length of the forewing, with 24 segments; flagellum pale grey to grey, golden glossy. *Thorax.* Tegula glossy golden cream, with blackish-brown to brown scales distally; thorax glossy golden cream; forewing glossy golden cream, with some blackish-brown and brown scales on the costal margin basally; fringe glossy cream; fringe line absent; forewing underside is brown to pale brown, without spots, or androconia. The hindwing and its fringe are brown to pale brown without androconia. The legs are glossy cream, but the forelegs have blackish-brown scales on the upper side. *Male genitalia.* The genitalia capsule is 285–325 µm long and 160–195 µm wide. Tegumen is band-shaped. The uncus is large, widely rounded or truncated without clearly differentiated (individualized) lobes. Gnathos has a large caudal process and slender, rounded lateral arms. Valva is relatively wide with a slender, pointed apex and very long chetae. Juxta is absent, but there is a slightly thickened membrane between the valvae ventrally. Transtilla is long, well-separated sublateral processes but without a distinctive transverse bar. The vinculum is short but with very long and slender lateral lobes. The phallus is 115 µm long and 55–60 µm wide; the vesica has numerous tiny, indistinctive cornuti aggregated into an irregular band and some larger, triangular cornuti at the right edge of the band caudally.



**Figure 12.** Male genitalia of *Stigmella garnica* Stonis, Dobrynina & Remeikis, sp. nov. and European *S. irregularis* Puplesis: (a) *S. garnica* sp. nov., paratype, slide no. DV055 (MfN); (b–k) same, holotype, genitalia slide no. RA1106 (MfN); and (l,m) *S. irregularis* Puplesis, a resembling species collected in the Crimea is a locality type with genitalia slide no. RA1129 (MfN) (the arrows point to the most important diagnostic characters).

*Female.* Females are similar to the male (but excluded from the type series). *Female genitalia.* Their ovipositor is short and rounded. Anterior apophyses are shorter than posterior apophyses. The accessory sac is short, wide, and folded. Ductus spermathecae is short, with 1.5 coils and a relatively large vesicle. Corpus bursae is relatively short but wide, covered with comb-like pectinations and with a signum-like band of prominent spine-like pectinations basally.

**Bionomics.** Adults fly in August. Otherwise, the species biology is unknown.

**Distribution.** This species is known in two localities in Armenia: Yeghegis (Vayots Dzor Province) and Garni (at the border of Ararat and Kotayk provinces), at an elevation of 1300–1400 m.

**Etymology.** The new species is named after Garni, a locality where *S. garnica* sp. nov. was discovered for the first time.

**Type material.** Holotype, ♂, Armenia, Vayots Dzor Province, 1 km E Yeghegis, 1574 m, 39°52′10″ N, 45°22′12″ E, at light, 15 August 2022, leg. J.R. Stonis, genitalia slide no. RA1106♂(MfN). Paratype: 1 ♂, Armenia, Kotayk Province, Garni, 1312 m, 40°06′41″ N, 44°43′55″ E, at light, 14 August 2022, leg. J.R. Stonis, genitalia slide no. DV055♂(MfN); 1 ♀, excluded from the type series, Armenia, Ararat Province, E of Garni, 1371 m, 40°07′27″ N, 44°45′40″ E, at light, 22 August 2022, leg. J.R. Stonis, genitalia slide no. RA1140♀(MfN).

#### The *hybnerella* group

##### 12. *Stigmella hybnerella* (Hübner, 1796)

*Tinea hybnerella* Hübner, 1796 [54] (pl. 34; figure 236).

Host plants. *Crataegus* spp., incl. *C. laevigata* (Poir.) DC., *C. monogyna* Jacq., *C. ambigua* C. A. Mey. ex A. K. Becker; also known to feed on *Amelanchier* spp., *Cotoneaster* spp. and *Sorbus aria* (L.) Crantz, *S. torminalis* (L.) Crantz. [18].

Distribution. This species is widespread in Europe and known from the western regions of Asia: the Caucasus (Azerbaijan) and the western part of Central Asia (Turkmenistan: Kopet Dag) [19]. Recently, this species has been proven to occur in Iran [26]. Here, on the basis of collected adult specimens, we provide *S. hybnerella* for Armenia (a new distribution record).

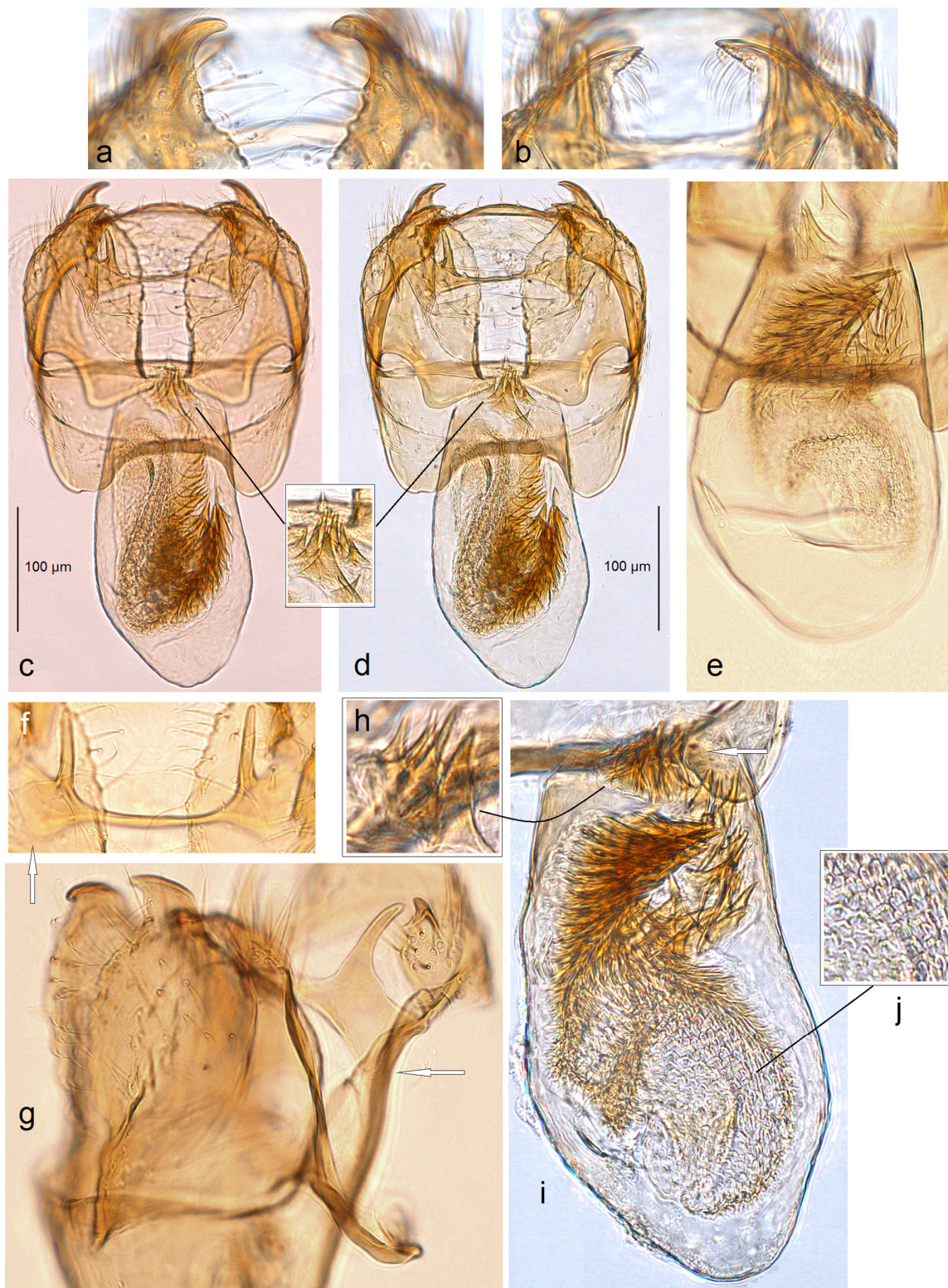
Material examined. The material examined was 2 ♂, 1 ♀, Armenia, Yerevan, Victory Park 1141 m, 40°11′47″ N, 44°31′17″ E, at light, 19 August 2022, leg. J.R. Stonis (MfN); 3 ♂, Yerevan, Jrvezh Forest Park, 1514 m, 40°11′06″ N, 44°37′11″ E, at light, 21 August 2022, leg. J.R. Stonis, genitalia slide no. RA1111 (MfN); 1 ♂, Kotayk Province, Garni, 1312 m, 40°06′41″ N, 44°43′55″ E, at light, 14 August 2022, leg. J.R. Stonis, genitalia slide no. DV054; 2 ♂, Garni, 1355 m, 40°07′18″ N, 44°45′17″ E, at light, 16 August 2022, leg. J.R. Stonis, genitalia slide nos DV043, DV053 (MfN); 2 ♂, Ararat Province, E of Garni, 1371 m, 40°07′27″ N, 44°45′40″ E, at light, 28 August 2022, leg. J.R. Stonis, genitalia slide nos DV092, DV095 (MfN); 1 ♂, same locality, 22 August 2022, leg. J.R. Stonis (MfN); 2 ♂, 2 ♀, Vayots Dzor Province, 1 km E Yeghegis, 1574 m, 39°52′10″ N, 45°22′12″ E, at light, 26.vii–15 August 2022, J.R. Stonis, genitalia slide nos DV019♂, DV020♂(MfN).

Remarks. For the species illustrations, we recommend the following publications: [18] (431, 492, 567), [19] (figures 338–340).

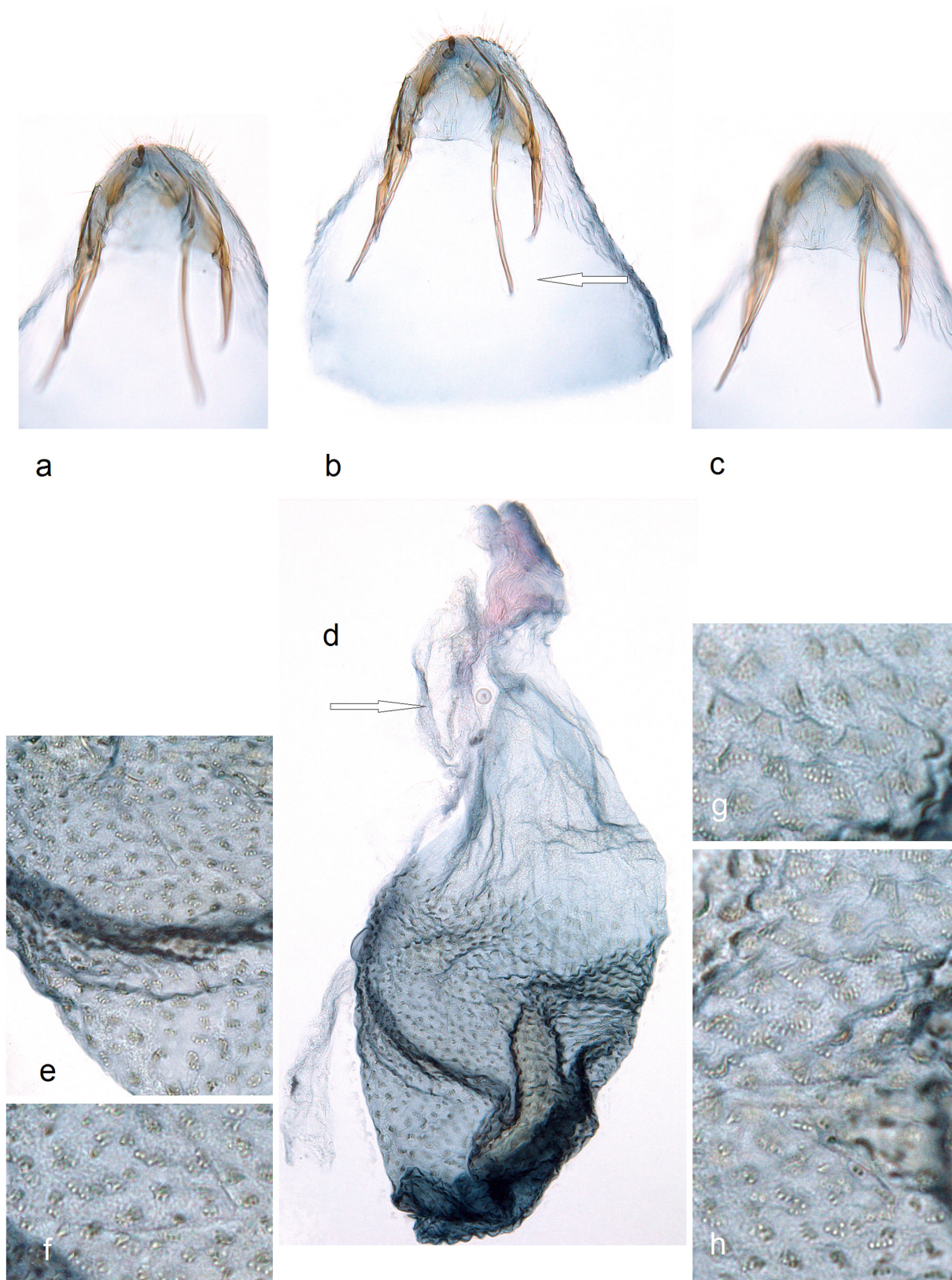
##### 13. *Stigmella inopinoides* Dobrynina, sp. nov.

<https://zoobank.org/NomenclaturalActs/AFC3B5F3-796C-4F77-8A09-1FF0D062346D> (accessed on 12 December 2023)

(Figures 7d, 13a–j and 14a–h)



**Figure 13.** Male genitalia of *Stigmella inopinoides* Dobrynina, sp. nov.: (a,b) paratype, apical processes of valva, slide no. DV017 (MfN); (c,d) holotype, slide no. DV005 (MfN); (e) paratype, phallus, genitalia slide DV098 (MfN); (f) paratype, gnathos, slide DV037 (MfN); (g) paratype, lateral view of capsule, slide DV037 (MfN); (h–j) and paratype, details of phallus, slide DV017 (MfN) (the arrows point to diagnostic characters).



**Figure 14.** Female genitalia of *Stigmella inopinoides* Dobrynina, sp. nov., genitalia slide no. RA1132, excluded from the type series: (a–c) apophyses; (d) corpus bursae; and (e–h) pectinations on bursa (MfN) (the arrows point to the most important diagnostic characters).

**Diagnosis.** *Stigmella inopinoides* sp. nov. belongs to the *hybnerella* species group and closely resembles *S. inopinata* A. Laštůvka & Z. Laštůvka (1990) [26]. Externally, the new species resembles *S. inopinata* but tends to be paler, grey, and strongly golden glossy. The male genitalia of *S. inopinoides* sp. nov. differ from those of *S. inopinata* in the distinct apical cluster of cornuti in the phallus, as well as the wider, trapezoid anterior excavation of the vinculum and significantly stronger developed apical processes of the valva. In the female genitalia, the new species is characterized by the absence of distal folds of the accessory sac (these folds are distinctive in *S. inopinata*) and significantly longer posterior apophyses (in *S. inopinata*, posterior and anterior apophyses are almost equal in length).

**Description.** *Male.* The forewing length is 1.9–2.3 mm; the wingspan is 4.3–5.0 mm ( $n = 23$ ). *Head.* Palpi and frons grey; frontal tuft orange, medially and usually brown-grey; the collar is comprised white, almost piliform scales; the scape is glossy white; the antenna is slightly shorter than half the length of the forewing, with 29 segments; flagellum brownish grey with a slight golden gloss on the upper side and underside. *Thorax.* The tegula, thorax, and forewing are smoothly scaled and grey with a strong golden gloss; the fringe is grey with some golden gloss; the fringe line is absent; the forewing underside is dark grey with a slight purple iridescence, without spots or androconia. The hindwing and its fringe are grey to pale grey without androconia. The legs are glossy grey. *Male genitalia.* The genitalia capsule is 245–250  $\mu\text{m}$  long and 200–225  $\mu\text{m}$  wide. The tegumen is band-shaped. The uncus is wide, laterally, with small, slender lobes (in a permanent genitalia slide, they are often bent ventrally). Gnathos is U-shaped, with a well-separated caudal process and slender transverse bar. The valva is wide with an inwardly slightly curved and pointed apical process and an inwardly slightly curved and the pointed process of the valval inner lobe. The juxta is absent. The transtilla has large, widely rounded, lobe-like sublateral corners but no sublateral processes. The vinculum is short, with short but wide lateral lobes; the anterior excavation is trapezoid. The phallus is 235–265  $\mu\text{m}$  long and 115–125  $\mu\text{m}$  wide; the vesica with a large (usually curved) band of tiny and spine-like cornuti; apart from the band, there is always a distinctive apical cluster of spine-like cornuti.

*Female.* The forewing length is 2.1 mm; the wingspan is 4.8 mm ( $n = 1$ ). Externally, they are similar to males (but excluded from the type series). *Female genitalia.* The ovipositor is short and rounded. Anterior apophyses are short; posterior apophyses are significantly longer. The accessory sac is short and only slightly folded, without distal folds. Ductus spermathecae has 2.5 coils and a relatively slender vesicle. Corpus bursae is wide and covered with distinctive comb-like pectinations in basal 2/3.

**Bionomics.** Adults fly in July and August. Otherwise, the species biology is unknown.

**Distribution.** This species is known from the following three localities in Armenia: Garni (Kotayk province), Yeghegis, and Noravank (Vayots Dzor Province), at an elevation of 1300–1550 m. Here, it was assumed that the earlier record of *S. inopinata* from Armenia [26], based on a few specimens collected by Friedrich Kasy, actually belonged to the new species, *S. inopinoides* sp. nov. However, these specimens collected in Armenia by Friedrich Kasy were unavailable for our study. It should also be mentioned that the Armenian specimens collected by Kasy were excluded from the type series by the authors during the description of the European *S. inopinata* [26].

**Etymology.** The new species is named after the European *S. inopinata* A. Laštůvka & Z. Laštůvka, a resembling species.

**Type material.** Holotype,  $\sigma$ , Armenia, Kotayk Province, Garni, 40°07'18" N, 44°45'17" E, 1355 m, 23 July 2022, at light, leg. V. Dobrynina, genitalia slide no. DV005 (MfN); Paratypes (21  $\sigma$ ): 1  $\sigma$ , the same label as holotype, genitalia slide no. DV003 (MfN); 18  $\sigma$ , Kotayk Province, Garni, 40°07'18" N, 44°45'17" E and 40°07'27" N, 44°45'40" E, 1355–1371 m, 23 July–30 August 2022, at light, leg. J.R. Stonis, genitalia slide nos DV017, DV034 $\sigma$ , DV042 $\sigma$ , DV046 $\sigma^*$ , DV048 $\sigma$ , DV049 $\sigma$ , DV050 $\sigma$ , DV061 $\sigma$ , DV083 $\sigma$ , DV085 $\sigma$ , DV098 $\sigma$ , DV103 $\sigma^*$ , DV104 $\sigma$ , DV105 $\sigma$ , DV106 $\sigma$ , DV107 $\sigma$ , DV110 $\sigma$  (MfN); 2  $\sigma$ , Vayots Dzor Province, 1 km E Yeghegis, 39°52'10" N, 45°22'12" E, 1574 m, 26 July 2022, at light, leg. J.R. Stonis, genitalia slide nos DV028, DV037 (MfN); 1  $\sigma$ , Vayots Dzor Province, Noravank, 17 August 2022, 39°40'57" N,



45°14'10" E, 1468 m, at light, leg. J.R. Stonis, genitalia slide no. RA1125 (MfN) (\* only genitalia preserved, without a pinned specimen).

**Excluded from the type series.** The following was excluded: 1 ♀, Kotayk Province, Garni, 1312 m, 40°06'41" N, 44°43'55" E, at light, 25 July 2022, leg. J.R. Stonis, genitalia slide no. RA1132♀(NRG).

**Remarks.** Our molecular studies clearly show the uniqueness of this new species (DNA sequences yet unpublished).

The *ulmivora* group

14. *Stigmella viscerella* (Stainton, 1853)

*Nepticula viscerella* Stainton, 1853 [55] (p. 3958).

Host plants. *Ulmus* spp.

Distribution. Europe (except northern regions) from Portugal, Great Britain to Russia (central and southern European regions), Bulgaria, and Greece. Here, on the basis of documented leaf mines and a collected adult specimen, we provide *S. viscerella* for Armenia, the Caucasus (a new distribution record).

Material examined. The material examined was 1 ♂, Armenia, Kotayk Province, Garni, 1312 m, 40°06'41" N, 44°43'55" E, at light, 14 August 2022, leg. J.R. Stonis, genitalia slide no. DV068 (MfN).

Remarks. For species illustrations, we recommend the following publications: [18] (425, 486, 560), [19] (figures 157–160).

15. *Stigmella magicis* Stonis & Dobrynina, sp. nov.

<https://zoobank.org/NomenclaturalActs/CC58B6B5-3365-4383-94AF-B46424A01E4F>

(accessed on 12 December 2023)

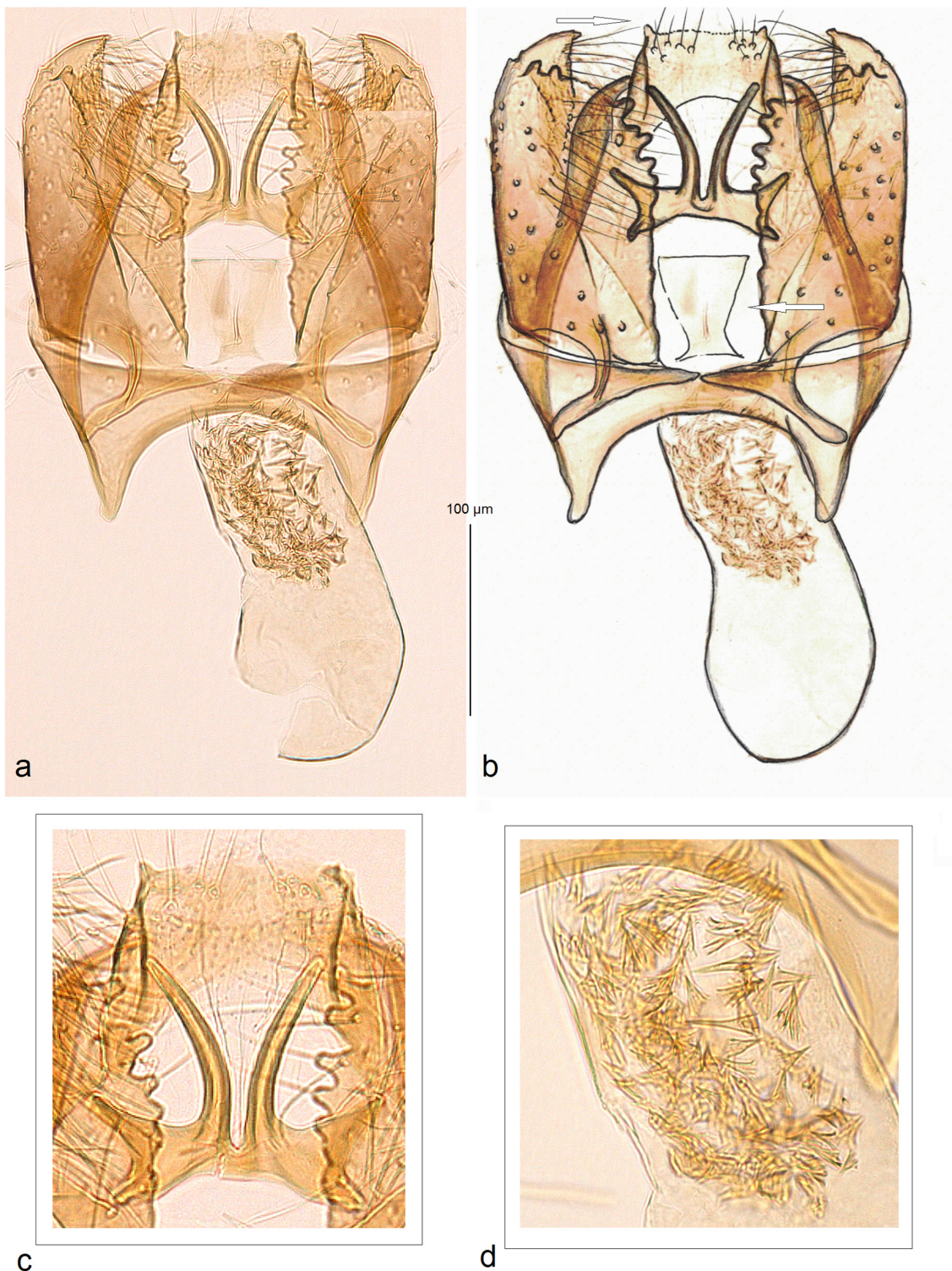
(Figure 7a,b and Figure 15a–d)

**Diagnosis.** Due to some similarities in the male genitalia, including the presence of plate-like juxta, *Stigmella magicis* sp. nov. was tentatively placed into the *ulmivora* species group. Externally, the new species can be confused with some other species, including unrelated ones, which also possess a silvery shiny fascia on the forewing. In the male genitalia, *S. magicis* sp. nov. is characterized by the unique combination of a rectangular uncus with tiny lateral processes, outwardly curved caudal processes and wide lateral arms of the gnathos, and a band of small spine-like cornuti in the phallus.

**Description.** *Male.* The forewing length is 1.7 mm; the wingspan is 3.8 mm ( $n = 1$ ). *Head.* Palpi cream; the frontal tuft is yellowish cream; the collar and scape are glossy cream; the antenna is distinctly shorter than half the length of the forewing with 22 segments; the flagellum is glossy, pale brown. *Thorax.* The tegula, thorax, and basal part of the forewing are grey and golden glossy; the forewing has a wide, silvery-shiny postmedian fascia; the fringe is pale grey-brown to pale grey on tornus; the fringe line is absent; the forewing underside pale grey-brown without spots or androconia. The hindwing and its fringe are pale grey without androconia. The legs are brownish cream. *Male genitalia.* The genitalia capsule is 270 µm long. The tegumen is band-shaped. The uncus is wide and rectangular, with tiny lateral processes. The gnathos has two long and slender, outwardly curved caudal processes and wide lateral arms. The valva is wide, with a short but wide and distally pointed apical process. The juxta is lobe-like, trapezoid, and widens caudally. The transtilla has relatively long and slender sublateral processes; the transverse bar of the transtilla is interrupted in the middle. The vinculum is very short, with medium short, triangular, anteriorly pointed lateral lobes; the anterior excavation is oval-shaped. The phallus is 200 µm long, 70 µm wide medially, and 90 µm wide basally, and the vesica has a short but wide band of various spine-like cornuti.

**Bionomics.** Adults fly in August. Otherwise, their biology is unknown.

**Distribution.** This species is known to occur in a single locality in Armenia: Garni (Kotayk Province), at an elevation of 1350 m.



**Figure 15.** Male genitalia of *Stigmella magicis* Stonis & Dobrynina, sp. nov., holotype, genitalia slide DV069: (a,b) general view; (c) uncus and gnathos; (d) cornuti (MfN) (the arrow points to the juxta, an important diagnostic character).

**Etymology.** The species name is derived from the Latin *magicus* (magic), in reference to the spectacular male genitalia with curved gnathos.

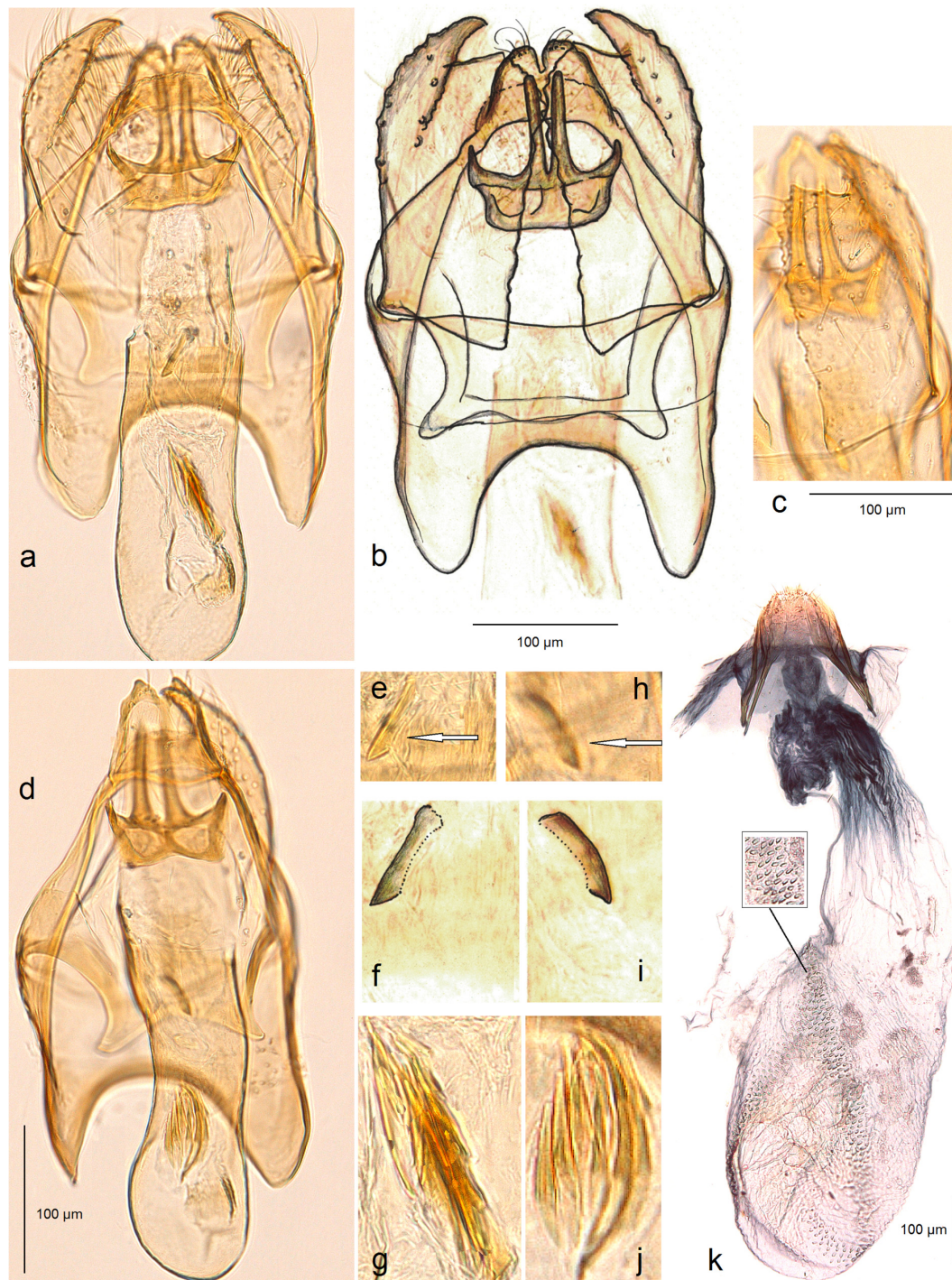
**Type material.** Holotype, 1 ♂, Armenia, Kotayk Province, Garni, 1355 m, 40°07'18" N, 44°45'17" E, at light, 16 August 2022, leg. J.R. Stonis, genitalia slide no. DV069 (MfN).

The *salicis* group16. *Stigmella ararati* Stonis, Dobrynina & Remeikis, sp. nov.

<https://zoobank.org/NomenclaturalActs/D8045370-C321-4903-84AD-FE229BC80491>

(accessed on 12 December 2023)

(Figure 7a,f and Figure 16a–k)



**Figure 16.** Genitalia of *Stigmella ararati* Stonis, Dobrynina & Remeikis, sp. nov.: (a,b) general view, holotype, male genitalia, slide no. DV078 (MfN); (c) valva, paratype, male genitalia slide no. DV076 (MfN); (d) general view of male genitalia with left valva missing, slide no. DV076 (MfN); (e–g) apical cornutus and cluster of cornuti, holotype; (h–j) the same, paratype, slide no. DV076 (MfN); and (k) female genitalia, slide no. RA1124 (MfN) (the arrows point to the diagnostic characters).

**Diagnosis.** *Stigmella ararati* sp. nov. belongs to the *salicis* species group. Externally, the new species is characterized by the glossy cream forewing rather irregularly and sparsely speckled with large blackish brown scales. The male genitalia of *S. ararati* sp. nov. differ from those of other members of the group, including the Central Asian *S. johanssoni* Puplesis & Diškus, in having a distinct, large apical cornutus, compact cluster of spine-like cornuti in the phallus and rectangular inner lobe of valva. The female genitalia can be confused with those of some other species of the *salicis* group.

**Description.** *Male.* The forewing length is 2.1–2.4 mm; the wingspan is 4.6–5.3 mm ( $n = 3$ ). *Head.* Palpi cream; the frontal tuft comprises cream piliform scales on the frons and contrasting brownish grey piliform scales on the vertex; the collar is cream, comprised of lamellar scales; the scape is cream; antenna is distinctly shorter than half the length of the forewing with 24–25 segments; flagellum is glossy pale brown. *Thorax.* The tegula is glossy cream, speckled with dark brown scales; the thorax is glossy cream, where brown scales are absent or indistinctive; the forewing is glossy cream, rather irregularly and sparsely speckled with large blackish brown scales, except for an indistinct cream tornal spot abundant on the apex and basally along the costal margin; the fringe is cream to silvery cream; the fringe line is absent; the forewing underside is densely irrorated with small cream or ochre cream scales without spots or androconia. The hindwing and its fringe are ochreous cream, without androconia. The legs are ochreous cream to cream, sometimes covered with pale grey scales on the upper side. *Male genitalia.* The genitalia capsule is 340–360  $\mu\text{m}$  long and 230  $\mu\text{m}$  wide. The tegumen is band-shaped. The uncus is slender and long, with two triangular lateral lobes. The gnathos has two long, closely set caudal processes and a large central plate. The valva has a large, pointed apical process and a wide, distally angular inner lobe. The juxta is indistinctive and membranous. The transtilla has weakly individualized triangular sublateral processes. The vinculum has large, triangular lateral lobes. The phallus is 290–310  $\mu\text{m}$  long; vesica has a distinct, large apical cornutus and a compact basal cluster of spine-like cornuti.

*Female.* The forewing length is 2.2 mm; the wingspan is 4.7 mm ( $n = 1$ ). Externally, they are similar to the male. *Female genitalia.* The ovipositor is short and rounded. Anterior and posterior apophyses are short and almost equal in length. The accessory sac is small and heavily folded. Ductus spermathecae is very slender, probably without coils (or broken in slide no. RA1124). Corpus bursae is large and oval-shaped, with a band-like signa.

**Bionomics.** Adults fly in August. Otherwise, the species biology is unknown.

**Distribution.** This species is known from two localities in Armenia: Garni (Ararat Province) and Noravank (Vayots Dzor Province) at an elevation of 1370–1470 m.

**Etymology.** The new species is named after Mount Ararat, an iconic mountain of Armenia, viewed in present-day Turkey from the type locality in Garni, Ararat Province.

**Type material.** Holotype, 1  $\sigma$ , Armenia, Ararat Province, E of Garni, 1371 m, 40°07'27" N, 44°45'40" E, at light, 22 August 2022, leg. J.R. Stonis, genitalia slide no. DV078 $\sigma$ (MfN). Paratypes: 2  $\sigma$ , same label data as holotype, genitalia slide no DV076 $\sigma$ (MfN). Excluded from the type series: 1  $\text{♀}$ , Vayots Dzor Province, Noravank, 1468 m, 39°40'57" N, 45°14'10" E, at light, 17 August 2022, J.R. Stonis, genitalia slide no. RA1124 $\text{♀}$ (MfN).

#### The *floslactella* group

##### 17. *Stigmella carpinella* (Heinemann, 1862)

*Nepticula carpinella* Heinemann, 1862 [56] (p. 251).

Host plants. *Carpinus betulus* L., *C. orientalis* Mill.

Distribution. This species is widespread in Europe, from Great Britain, France, and Italy to Sweden, Russia (South European regions), and Greece. Recently, this species has been proven to occur in Iran [26]. Here, on the basis of collected adult specimens, we provide *S. carpinella* from the Caucasus, Armenia (a new distribution record).

Material examined. The material examined was 1  $\sigma$ , Armenia, Yerevan, Jrvezh Forest Park, 1514 m, 40°11'06" N, 44°37'11" E, at light, 13 August 2022, J.R. Stonis (MfN); 1  $\sigma$ ,

Jrvezh Forest Park, 1514 m, 40°11'06'' N, 44°37'11'' E, at light, 21 August 2022, J.R. Stonis, genitalia slide no. RA1112 (MfN).

Remarks. For species illustrations, we recommend the following publications: [18] (432, 494, 569), [19] (figures 344–346).

The *lemniscella* group (= former *marginicolella* group)

18. *Stigmella lemniscella* (Zeller, 1839)

*Lyonetia lemniscella* Zeller, 1839 [57] (p. 215).

Host plants. *Ulmus* spp.; *U. pumila* (= *U. microphylla*) in Armenia.

Distribution. This species is widespread in Europe, from Spain, Italy, and Ireland to Finland, Russia (central and southern European regions), Slovenia, and Bulgaria. Here, on the basis of documented leaf mines, we provide *S. lemniscella* from the Caucasus, Armenia (a new distribution record).

Material examined. Armenia, Gegharkunik Province, S of Tsovaguygh (north-eastern bank of Lake Sevan), 1909 m, 40°37'21'' N, 44°58'21'' E, numerous documented fresh but vacant leaf mines, 9 August 2022, leg. J.R. Stonis (BRG).

Remarks. For species illustrations, we recommend the following publications: [18] (437, 500, 575), [19] (figures 402–404).

The *hemargyrella* group

19. *Stigmella kuznetzovi* Puplesis, 1994 [19] (pp. 152, 153).

Host plant. *Acer turcomanicum* Pojark.

Distribution. Previously, the species was known only from the western part of Central Asia (Turkmenistan: Kopet Dag) [19]. Here, on the basis of collected and studied adult specimens, we provide *S. kuznetzovi* for the Caucasus, Armenia (a new distribution record).

Material examined. The material examined was 2 ♂, Armenia, Kotayk Province, Garni, 1355 m, 40°07'18'' N, 44°45'17'' E, at light, 16 August 2022, leg. J.R. Stonis, genitalia slide nos DV045, DV052 (MfN); 1 ♂, Ararat Province, E of Garni, 1371 m, 40°07'27'' N, 44°45'40'' E, at light, 28 August 2022, leg. J.R. Stonis, genitalia slide no. DV096 (MfN).

Remarks. For species illustrations, we recommend the following publication: [19] (figures 457–460).

The *ruficapitella* group

20. *Stigmella dorsiguttella* (Johansson, 1971)

*Nepticula dorsiguttella* Johansson, 1971 [58] (p. 251).

Host plants. *Quercus* spp.; *Q. macranthera* Fisch & C.A. Mey ex Hohen in Armenia.

Distribution. This species is distributed in Europe from Portugal, Spain and Italy to Sweden, Ukraine (Crimea), Greece, and Turkey. Here, on the basis of collected and studied adult specimens, we provide *S. dorsiguttella* for the Caucasus, Armenia (a new distribution record).

Material examined. The material examined was 5 ♂, 1 ♀, Armenia, Aragatsotn Province, 2 km N of Antarat, 1780 m, 40°21'50'' N, 44°16'25'' E, at light, 2 August 2022, leg. J.R. Stonis, genitalia slide no. RA1122♂ (MfN); 1 ♀, Vayots Dzor Province, 1 km E Yeghegis, 1574 m, 39°52'10'' N, 45°22'12'' E, at light, 15 August 2022, leg. J.R. Stonis, genitalia slide RA1133 (MfN). Also, leaf mines recorded: Armenia, Vayots Dzor Province, Jermuk, 2106 m, 39°50'28'' N, 45°40'14'' E, 12 August 2022, leg. J.R. Stonis (BRG).

Remarks. For species illustrations, we recommend the following publication: [18] (446, 513, 586).

21. *Stigmella roborella* (Johansson, 1971)

*Nepticula roborella* Johansson, 1971 [58] (p. 258).

Host plants. *Quercus* spp.; *Q. macranthera* Fisch & C.A. Mey ex Hohen in Armenia.

Distribution. This species is widespread in Europe from Spain, Italy, Great Britain to Norway, Finland, Russia (western and central European regions), Greece, and Turkey. *S. roborella* also occurs in the Caucasus: Georgia and Armenia (the latter is a new distribution record).

Material examined. The material examined was 3 ♂, 1 ♀, Armenia, Yerevan, Jrvezh Forest Park, 1514 m, 40°11'06" N, 44°37'11" E, at light, 13–23 August 2022, leg. J.R. Stonis, genitalia slide nos DV115♂, RA1114♂ (MfN); 1 ♂, 6 ♀, Aragatsotn Province, 2 km N of Antarut, 1780 m, at light, 40°21'50" N, 44°16'25" E, 2 August 2022, leg. J.R. Stonis (MfN); 1 ♂, Aragatsotn Province, 4 km N of Antarut, 1985 m, 40°22'36" N, 44°16'03" E, 12 August 2022, leg. J.R. Stonis (MfN). Also, leaf mines recorded: Vayots Dzor Province, Jermuk, 2106 m, 39°50'28" N, 45°40'14" E, 12 August 2022, leg. J.R. Stonis (BRG).

Remarks. For species illustrations, we recommend the following publications: [18] (448, 515, 588), [19] (figures 477–479).

## 22. *Stigmella basiguttella* (Heinemann, 1862)

*Nepticula basiguttella* Heinemann, 1862 [56] (pp. 258, 259).

Host plants. *Castanea sativa* Mill. and *Quercus* spp.; *Q. macranthera* Fisch & C.A. Mey ex Hohen in Armenia.

Distribution. This species is widespread in Europe from Portugal, Spain, and Italy to Great Britain, Norway, Finland, Russia (central and southern European regions), Bulgaria, and Greece. *S. basiguttella* also occurs in the Caucasus from western Georgia to southeastern Azerbaijan [19] and in Iran [26]. Here, on the basis of a collected adult specimen, we provide *S. basiguttella* for Armenia (a new distribution record).

Material examined. 1 ♂, ARMENIA, Aragatsotn Province, 2 km N of Antarut, 1780 m, at light, 40°21'50" N, 44°16'25" E, 2 August 2022, leg. J.R. Stonis (MfN).

Remarks. For species illustrations, we recommend the following publications: [18] (445, 511, 584), [19] (figures 480–482).

## Genus *Bohemannia* Stainton, 1859

The *pulverosella* group

### 23. *Bohemannia pulverosella* (Stainton, 1849)

*Trifurcula pulverosella* Stainton, 1849 [59] (p. 30).

*Bohemannia piotra* Puplesis, 1984 [60] (pp. 149–164).

Host plants. *Malus domestica* Borkh., *M. sylvestris* Mill., *M. mandshurica* (Maxim.) Kom.

Distribution. This species is distributed in Europe from Ireland and Great Britain to Finland, Russia (up to the Ural region), Austria, Hungary, Romania, Croatia, Slovenia and Bulgaria. *B. pulverosella* also was recorded to occur in continental East Asia (Russia: Primorskiy Krai) [60]. Here, on the basis of examined leaf mines, we provide *B. pulverosella* for Armenia (a new distribution record).

Material examined. Armenia, Gegharkunik Province, N of Sevan, 1909 m, 40°37'21" N, 44°58'21" E, fresh but vacant leaf mines, 9 August 2022, leg. J.R. Stonis.

Remarks. For species illustrations, we recommend the following publication: [18] (453, 526, 594).

## Genus *Ectoedemia* Busck, 1907

Subgenus *Zimmermannia* Hering, 1940

### 24. *Ectoedemia (Zimmermannia) longicaudella* Klimesch, 1953 [61] (pp. 193, 194).

Host plants. *Quercus petraea* (Matt.) Liebl., *Q. robur* L., *Q. macranthera* Fisch & C.A. Mey ex Hohen, a native host plant in Armenia, also *Castanea sativa* Mill. [18,62].

Distribution. This species is distributed predominantly in Europe from Portugal, Spain, and Italy to Belgium, Sweden, Finland, Russia (central European regions), and Greece. The species was also recorded from northeastern Turkey [62] and mentioned from the western Caucasus (Georgia). Here, on the basis of collected adults, we provide *E. (Z.) longicaudella* for Armenia (a new distribution record).

Material examined. The material examined was 1 ♂, SPAIN, Noguera Teruel, 1600 m, 9–10 August 1989, leg. C. Gielis, genitalia slide no. RA1143 (MfN); 14 ♂, UKRAINE, Crimea, 20 km W Feodosia, Kara-Dag, 2–16 July 1987, leg. R. Puplesis, genitalia slide no.

RA1146 (MfN); 1 ♂, UKRAINE, Crimea, 20 km SW Feodosiya, Karadag Reserve, 26 July 2011, at light, leg. J.R. Stonis, A. Navickaitė, G. Varačinskas, genitalia slide no. RA1145 (BRG); 1 ♂, same label (MfN); 1 ♂, ARMENIA, Vayots Dzor Province, 1 km E Yeghegis, 1574 m, 39°52'10" N, 45°22'12" E, at light, 15 August 2022, leg. J.R. Stonis, genitalia slide no. RA1105 (MfN); 1 ♂, 3 ♀, Aragatsotn Province, 2 km N of Antarat, 1780 m, at light, 40°21'50" N, 44°16'25" E, 2 August 2022, leg. J.R. Stonis, genitalia slide no. RA1144♀(MfN); 9 ♂, 2 ♀, 4 km N Antarat, 1985 m, 40°22'36" N, 44°16'03" E, 12 August 2022, leg. J.R. Stonis, RA1119♂, RA1120♂, RA1123♂(MfN); 1♂, same label, genitalia slide no. RA1147♂(BRG).

Remarks. See Section 3.2.3 for the genetic distinctness of *E. (Z.) longicaudella* from Armenia.

Subgenus *Ectoedemia* Busck, 1907

The *rubivora* complex

25. *Ectoedemia mahalebella* (Klimesch, 1936)

*Nepticula mahalebella* Klimesch, 1936 [63] (pp. 207, 208).

Host plants. *Amygdalus nana* L., *Cerasus avium* (L.) Moench, *C. fruticosa* Pall., *C. mahaleb* (L.) Mill. and *Prunus* spp.

Distribution. This species is widespread in Europe, from France and Italy to Slovakia, Ukraine (Crimea), Bulgaria, and Greece. Here, on the basis of collected adults, we provide *E. mahalebella* from the Caucasus, Armenia (a new distribution record).

Material examined. The material examined was 2 ♂, 2 ♀, Armenia, Kotayk Province, Garni, 1312–1355 m, 40°07'18" N, 44°45'17" E–40°06'41" N, 44°43'55" E, at light, 14–23 July 2022, leg. J.R. Stonis, genitalia slide nos DV014♂, DV030♂, RA1136♀(MfN); 1 ♂, Garni, 1312 m, 40°06'41" N, 44°43'55" E, at light, 25 July 2022, leg. V. Dobrynina, genitalia slide no. DV023 (MfN); 2 ♂, Ararat Province, E of Garni, 1371 m, 40°07'27" N, 44°45'40" E, at light, 22 August 2022, leg. J.R. Stonis, genitalia slide nos DV079, DV108 (MfN); 1 ♀, Vayots Dzor Province, 1 km E Yeghegis, 1574 m, 39°52'10" N, 45°22'12" E, at light, 26 July 2022, leg. J.R. Stonis (MfN).

**Genus *Fomoria*** Beirne, 1945

The *weaveri* group

26. *Fomoria septembrella* (Stainton, 1849)

*Nepticula septembrella* Stainton, 1849 [59] (p. 29).

Host plants. *Hypericum* spp.

Distribution. This species is widespread in Europe, from Portugal, Spain, and Ireland to Norway, Finland, Russia (western and central European regions), Croatia, and Greece. *F. septembrella* also is known in the Caucasus (Azerbaijan and Georgia) [19], Iran [26], and the western part of Central Asia (Turkmenistan: Kope Dag) [19]. Here, on the basis of the collected adult, we provide *F. septembrella* for Armenia (a new distribution record).

Material examined. The material examined was 1 ♂, Armenia, Yerevan, Jrvezh Forest Park, 1514 m, 40°11'06" N, 44°37'11" E, at light, 13 August 2022, leg. J.R. Stonis, genitalia slide RA1130 (MfN).

Remarks. For species illustrations, we recommend the following publications: [18] (460, 533, 601), [19] (figures 670–672).

**Genus *Trifurcula*** Zeller, 1848

The *subnitidella* group

27. *Trifurcula subnitidella* (Duponchel, 1843)

*Elachista subnitidella* Duponchel, 1843 [64] (p. 326, pl. 77, figure 8).

Host plants. *Lotus corniculatus* L., *L. pedunculatus* Cav.

Distribution. This species is distributed in Europe from Portugal, Spain, and Italy to Ireland, Sweden, Finland, Russia (up to the Ural region), Bulgaria, and Greece. The species

was also recorded in North Africa (Tunisia). Here, on the basis of collected adults, we provide *T. subnitidella* from the Caucasus, Armenia (a new distribution record).

**Material examined.** The material examined was 2 ♂, Armenia, Yerevan, Jrvezh Forest Park, 1514 m, 40°11'06" N, 44°37'11" E, at light, 11–13 August 2022, leg. J.R. Stonis, genitalia slide no. DV111 (MfN); 1 ♂, Jrvezh Forest Park, 1515 m, 40°11'07" N, 44°37'11" E, at light, 23 August 2022, leg. J.R. Stonis, genitalia slide no. DV121 (MfN).

**Remarks.** For species illustrations, we recommend the following publications: [18] (453, 525, 594) and [19] (figures 742–744).

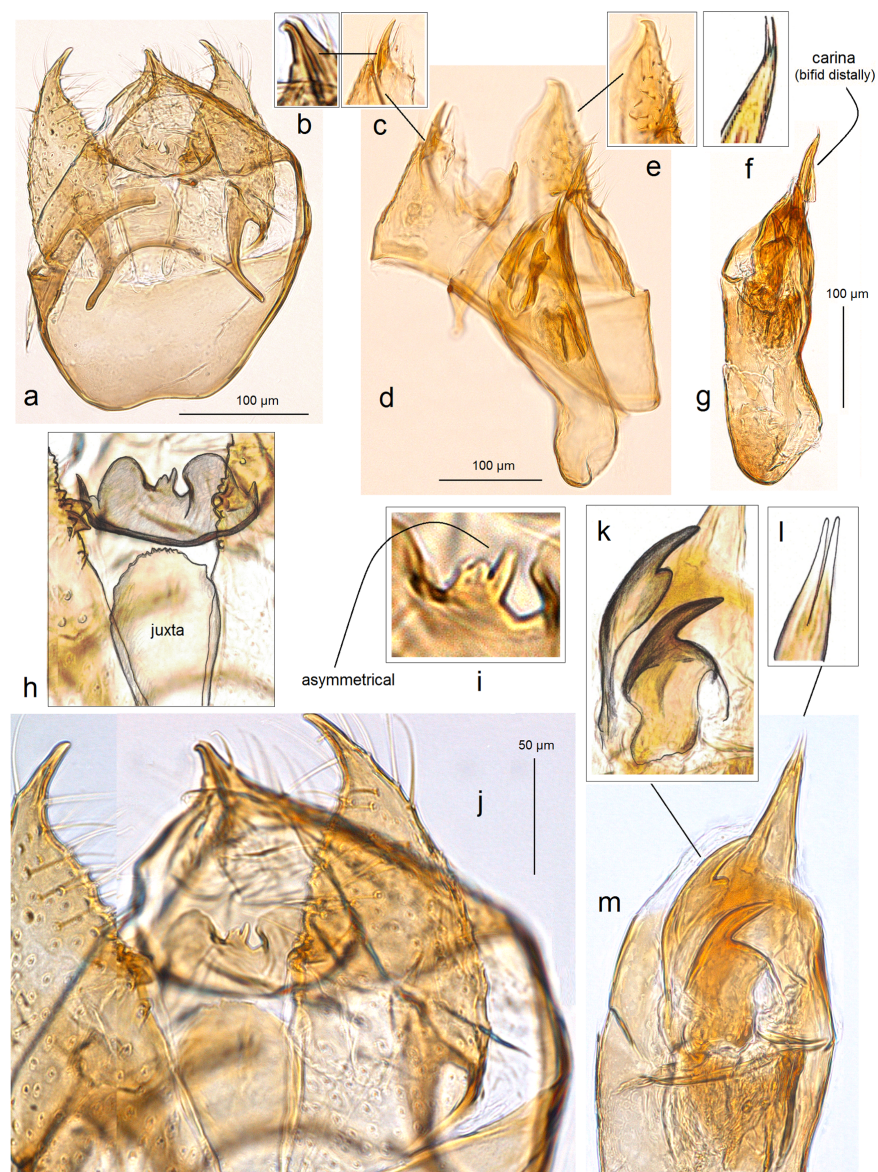
#### The *cryptella* group

#### 28. *Trifurcula vardenisi* Stonis, Dobrynina & Remeikis, sp. nov.

<https://zoobank.org/NomenclaturalActs/B5B2DC80-167C-4BD2-BE7E-33B4FE7A5608>

(accessed on 12 December 2023)

(Figure 8a,b and Figure 17a–m)



**Figure 17.** Male genitalia of *Trifurcula vardenisi* Stonis, Dobrynina & Remeikis, sp. nov.: (a,b) holotype, ventral view of the capsule with phallus removed, slide no. DV021 (MfN); (c–e) paratype, lateral view of the capsule with phallus removed, slide no. DV118 (MfN); (f,g) phallus, holotype; and (h–m) details of the capsule and phallus of holotype.



**Diagnosis.** *Trifurcula vardenisi* sp. nov. belongs to the *cryptella* species group. Externally, the new species can be confused with some other Nepticulidae species possessing an irrorated forewing. The male genitalia of *T. vardenisi* sp. nov. differ from those of all other members of this group by the unique, asymmetrical gnathos and the specific pair of large apical cornuti of the phallus.

**Description.** *Male.* The forewing length is 2.6 mm; the wingspan is 5.7 mm ( $n = 2$ ). *Head.* The palpi is cream; the frontal tuft is pale orange to orangish ochre; the collar is distinctive, comprised orangish cream piliform scales; the scape is cream, distally speckled with dark grey scales; the antenna is only slightly longer than half the length of forewing with 31–33 segments; the flagellum is grey on the upper side and underside. *Thorax.* The tegula, thorax, and forewing is densely irrorated with dark grey-brown or dark grey scales; sometimes, the forewing has a few milky white scales in the apical part; the fringe is greyish white to pale grey; the fringe line is indistinctive or absent; the forewing underside is dark grey-brown, without spots or androconia. The hindwing and its fringe are grey without androconia. The legs are grey and brownish cream distally. *Male genitalia.* The genitalia capsule is 330–340  $\mu\text{m}$  long and 260  $\mu\text{m}$  wide. The tegumen is not extended into a pseuduncus but is short. The uncus is deeply split longitudinally. The gnathos is asymmetrical, with lateral lobes and a short asymmetrical process medially. The valva is wide, tapering distally, with a slender apical process. The juxta is lobe-like, widened caudally, with serrated caudal margin. The transtilla has slender and relatively long sublateral processes and a slender transverse bar. The vinculum is large, widely rounded, or truncated distally, without lateral lobes. The phallus is 330  $\mu\text{m}$  long, 75–102  $\mu\text{m}$  wide medially, and 95–100  $\mu\text{m}$  wide basally, with long, pointed carina and a pair of large, curved apical cornuti, each possessing a very wide, rounded base.

*Female.* Unknown.

**Bionomics.** Adults fly in July and August. Otherwise, this species biology is unknown.

**Distribution.** This species was discovered in two localities of Armenia: Yeghegis (Vayots Dzor Province) and Jrvezh Forest Park (Yerevan), at an elevation of 1515–1570 m.

**Etymology.** *Trifurcula vardenisi* sp. nov. is named after the Vardenis Range (the type locality of this new species, Yeghegis, is situated on the southern slope of this mountain range).

**Type material.** Holotype, 1  $\sigma$ , Armenia, Vayots Dzor Province, 1 km E Yeghegis, 1574 m, 39°52'10" N, 45°22'12" E, at light, 26 July 2022, leg. J.R. Stonis, genitalia slide no. DV021 (MfN). Paratype: 1  $\sigma$ , Yerevan, Jrvezh Forest Park, 1515 m, 40°11'07" N, 44°37'11" E, at light, 11 August 2022, leg. J.R. Stonis, genitalia slide no. DV118 (MfN).

### Genus *Glaucolepis* Braun, 1917

The *raikhonae* group

#### 29. *Glaucolepis melanoptera* (van Nieukerken & Puplesis, 1991)

*Trifurcula (Glaucolepis) melanoptera* van Nieukerken & Puplesis, 1991 [25] (pp. 205–208).

Host plant. Unknown, probably *Prunus* spp. [25].

Distribution. This species is found in Spain, France, Italy (incl. Sardinia, Sicilia), Ukraine (Crimea), Slovakia, Czech Rep., Austria, Hungary, Croatia, Greece, Armenia, and Turkmenistan [25].

Material examined. The material examined was 5  $\sigma$ , Armenia, Yerevan, Jrvezh Forest Park, 1515 m, 40°11'07" N, 44°37'11" E, at light, 11–23 August 2022, leg. J.R. Stonis, genitalia slide nos DV113, DV116, DV117 (no pinned specimen, only genitalia), DV120, RA1113 (MfN); 6  $\sigma$ , 4  $\text{♀}$ , Kotayk Province, Garni, 1355 m, 40°07'18" N, 44°45'17" E, at light, 23 July–16 August 2022, leg. V. Dobrynina and J.R. Stonis, genitalia slide nos DV004 $\sigma$ , DV011 $\sigma$ , DV015 $\sigma$ , DV025, DV047 $\sigma$ , RA1138 $\text{♀}$ (MfN); 2  $\sigma$ , 1  $\text{♀}$ , Vayots Dzor Province, 1 km E Yeghegis, 1574 m, 39°52'10" N, 45°22'12" E, at light, 26.vii–15 August 2022, leg. V. Dobrynina and J.R. Stonis, genitalia slide no. DV029 $\sigma$ (MfN); 2  $\sigma$ , 1  $\text{♀}$ , Ararat Province, E of Garni, 1371 m, 40°07'27" N, 44°45'40" E, at light, 22–30 August 2022, leg. J.R. Stonis, genitalia slide nos DV087 $\sigma$ , DV094 $\sigma$ (MfN); 3  $\sigma$ , 1  $\text{♀}$ , Noravank, 1468 m, 39°40'57" N, 45°14'10" E, at light,

17 August 2022, leg. J.R. Stonis, genitalia slide no RA1102♂, RA1141♀(MfN); 2 ♂, Aragatsotn Province, 2 km N of Antarat, 1780 m, at light, 40°21'50" N, 44°16'25" E, 2 August 2022, leg. J.R. Stonis (MfN).

Remarks. For species illustrations, we recommend the following publications: [19] (figures 730–734) and [25].

### 30. *Glaucolepis hamirella* (Chrétien, 1915)

*Nepticula hamirella* Chrétien, 1915 [65] (pp. 364, 365).

Host plants. *Calamintha* spp., *Clinopodium calamintha* (L.) Stace and *Micromeria* spp.

Distribution. This species was originally described from Algeria [65] (see Remarks). Here, on the basis of the collected adults, we provide *G. hamirella* for the Caucasus, Armenia (a new distribution record).

Material examined. The material examined was 2 ♂, Armenia, Kotayk Province, Garni, 1312 m, 40°06'41" N, 44°43'55" E, at light, 24 July 2022, leg. V. Dobrynina & J.R. Stonis, genitalia slide nos DV032, DV033 (MfN); 1 ♂, Ararat Province, E of Garni, 1371 m, 40°07'27" N, 44°45'40" E, at light, 22 August 2022, leg. J.R. Stonis, genitalia slide no. DV082 (MfN).

Remarks. Recently, the taxonomic status of *Glaucolepis saturejae* (Parenti), a former synonym of *G. hamirella*, was restored [52]. However, our Armenian specimens ideally match the North African *G. hamirella*, not the restored European *G. saturejae*.

### Genus *Etainia* Beirne, 1945

The *sericopeza* group

### 31. *Etainia caucasi* Remeikis, sp. nov.

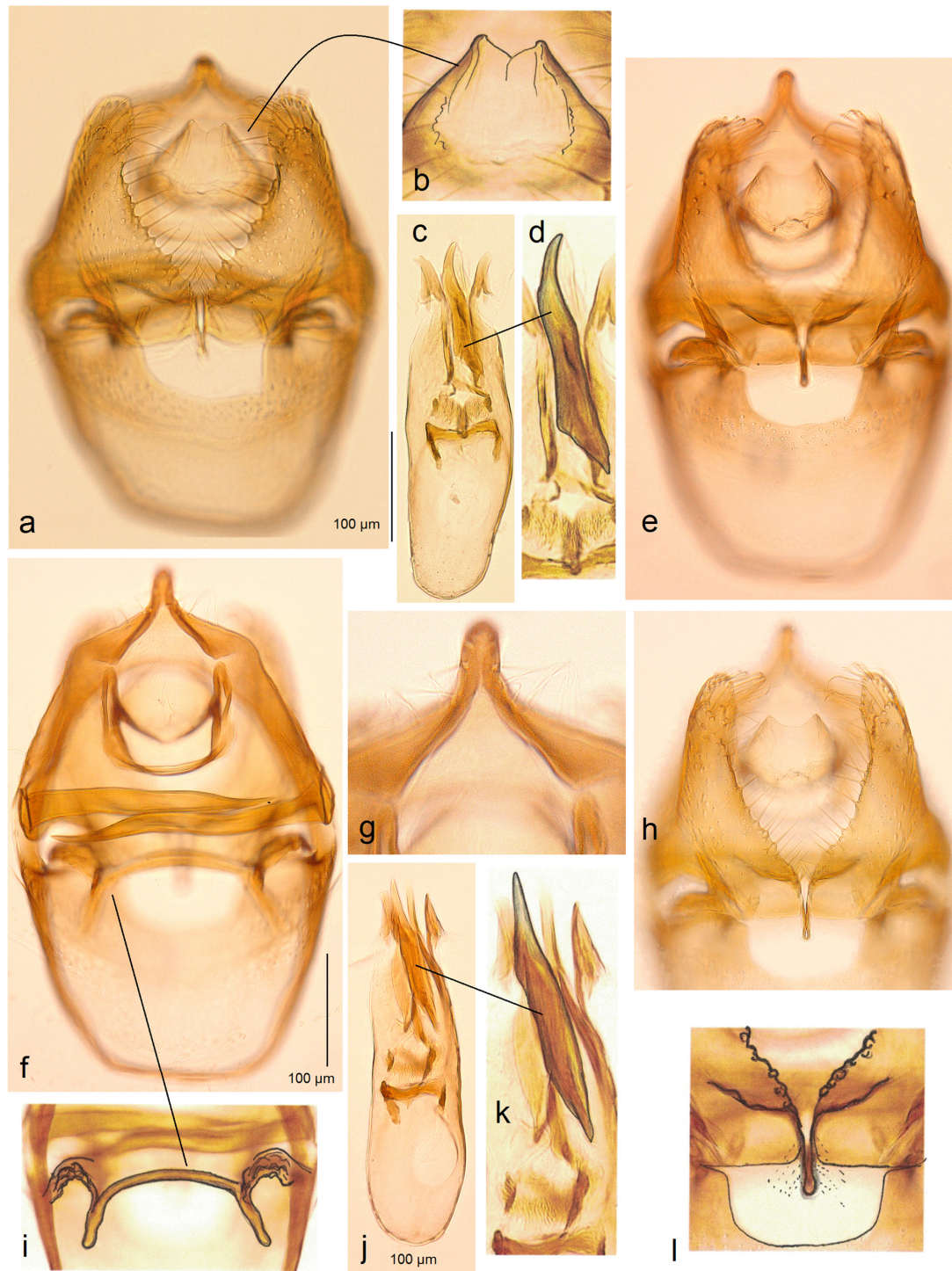
<https://zoobank.org/NomenclaturalActs/F4B3ECA8-0206-4087-A3BE-8453966ADC18> (accessed on 12 December 2023)

(Figure 8c–f, Figures 18a–l and 19a–i)

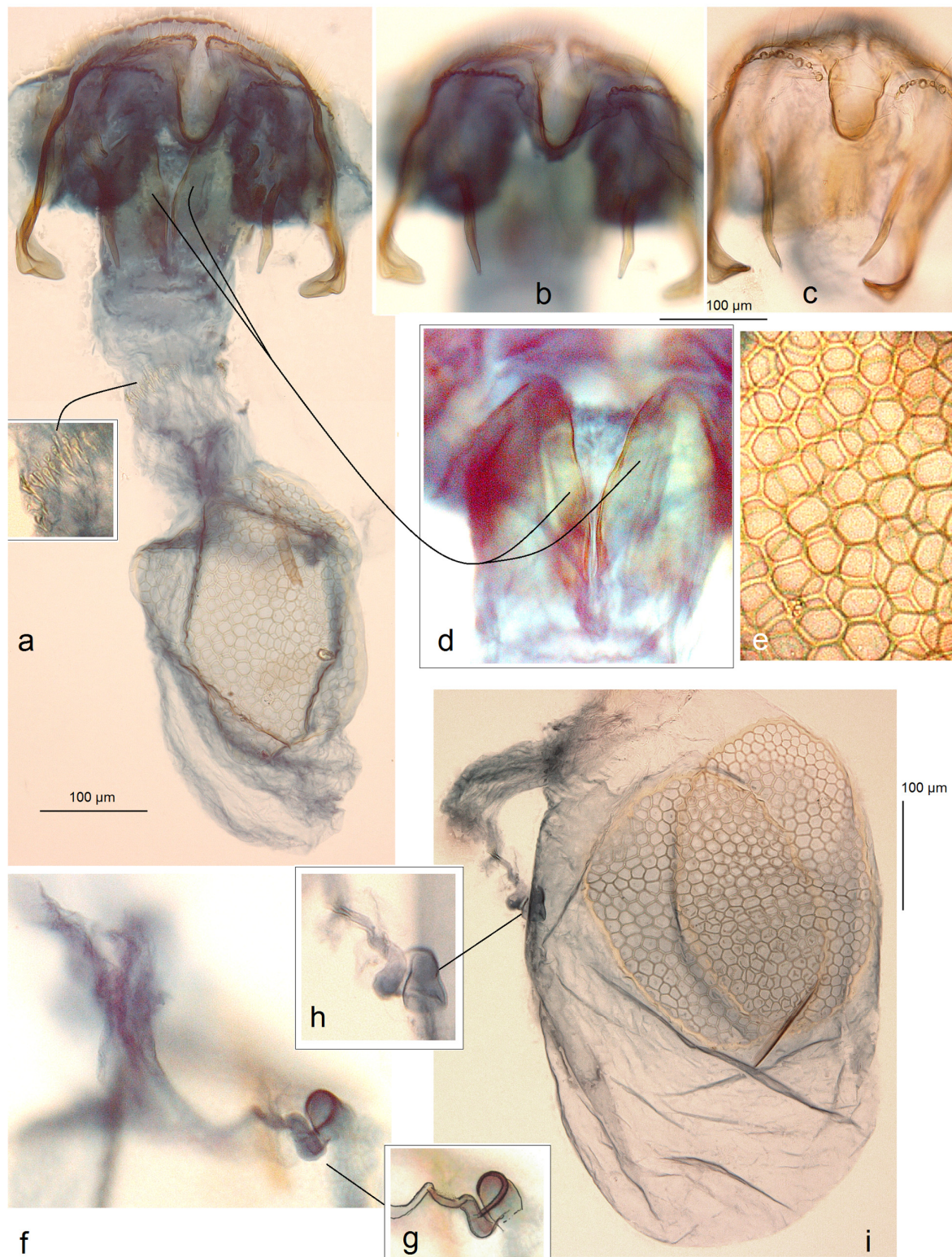
**Diagnosis.** *Etainia caucasi* sp. nov. belongs to the *sericopeza* species group and closely resembles the European *E. louisella* (Sircom, 1849). However, this new species differs from *E. louisella* in the caudally truncated or bilobed gnathos possessing a distinctive basal elaboration, as well as in the strongly chitinized, clearly visible basal connection of the valvae ventrally, the longer apical cornutus (or carina) of the phallus, the deep, rectangular posterior excavation of the vinculum in the male genitalia, and the distally strongly bent anterior apophyses, the shape of vaginal sclerites, and details of ovipositor morphology in the female genitalia. Externally, males of *E. caucasi* sp. nov. are characterized by a large black androconial patch of the forewing underside, with a few pale-brown scales in the middle surrounded by cream scales and a spot of black androconia on the hindwing's upper side.

**Description.** *Male.* The forewing length is 2.5–2.9 mm; the wingspan is 5.6–6.6 mm ( $n = 2$ ). *Head.* The palpi are cream; the frontal tuft is orangish ochre, with some blackish brown piliform scales; the collar is indistinctive, comprised pale ochre-brown or pale ochre piliform scales; the scape is cream to yellow cream; antenna is slightly longer than half the length of forewing with 46 segments; the flagellum is ochre-brown to pale ochre with some dark grey scales. *Thorax.* The tegula is fuscous, distally yellowish cream; the thorax is densely covered with blackish-grey scales; the forewing is blackish grey-brown, with a distinctive yellowish cream basal spot, wide median fascia, and two postmedian spots on the costal margin and tornus; the fringe is blackish grey and apically pale grey to almost white; the fringe line is absent; the forewing underside is grey or grey-brown, with a large black androconial patch with a few pale brown scales in the middle surrounded by cream scales. The hindwing is grey, with a spot of black androconia basally; the fringe is grey. The legs are brownish cream on the upper side with some brown scales or entirely covered with blackish-grey scales. *Male genitalia.* The genitalia capsule is 490 µm long and 315–340 µm wide. The uncus is fused with the pseuduncus, which is slender and medium long. Gnathos has a wide, distally truncated, or bifid (or variously split) caudal plate and distinctly elaborated base. The valva is wide, gradually narrowing towards the apex, apically rounded, without apical process; the basal connection between the valvae

is strongly chitinized and distinctive; valval basal apodemes are very large. The juxta is absent. Transtilla has relatively long sublateral processes and a long, slender transverse bar. The vinculum is large, anteriorly rounded, or truncated, without lateral lobes, posteriorly (caudally) with a distinctive rectangular excavation. The phallus is 140–160  $\mu\text{m}$  long, distinctive, with well-chitinized lateral carinae and very long, well-developed median carina (or cornutus).



**Figure 18.** Male genitalia of *Etainia caucasi* Remeikis, sp. nov.: (a,b) paratype, slide no. RA1115, capsule with phallus removed; (c,d) same, phallus; and (e–l) holotype, slide no. RA1116, details of capsule and phallus (MfN).



**Figure 19.** Female genitalia of *Etainia caucasi* Remeikis, sp. nov., paratypes (MfN): (a) slide no. RA1117, general view; (b) the same, ovipositor and apophyses; (c), the same, slide no. RA1118; (d) slide no. RA1117, lobe-like sclerites; (e) the same, details of signum; (f,g) the same, ductus spermathecae; and (h,i) slide no. RA1118, corpus bursae and ductus spermathecae.

*Female.* The forewing length is 3.2–3.3 mm; the wingspan is 6.9–7.2 mm ( $n = 3$ ). Externally, they are similar to males but without androconial spots. *Female genitalia.* 785 µm long. The ovipositor is very short and widely rounded. Posterior apophyses are slightly

longer than anterior apophyses and curved inwardly. The accessory sac is indistinctive or absent. Ductus spermathecae is short but wide, with 1.5 coils and a relatively large vesicle. Corpus bursae is relatively small and oval-shaped with two large signa reticulata, which are almost equal in size (300 and 265  $\mu\text{m}$  long) and occupy most of the 534  $\mu\text{m}$  long bulbous part of the corpus bursae.

**Bionomics.** Adults fly in July and August. Otherwise, this species biology is unknown.

**Distribution.** In Armenia, this species is known from a single locality: Yerevan (Victory Park), at an elevation of 1150 m. Here, we also assume that former records of *Etainia louisella* from Georgia (Lagodekhi Reserve) and the Crimea (Karadag Reserve, Krasnolesye and Mys Martyan) [19] actually belong not to *E. louisella* but *E. caucasi* sp. nov; our previous study showed that the males of these specimens possess a truncated or split gnathos; however, the collection series of these peculiar specimens were not re-examined during the current study.

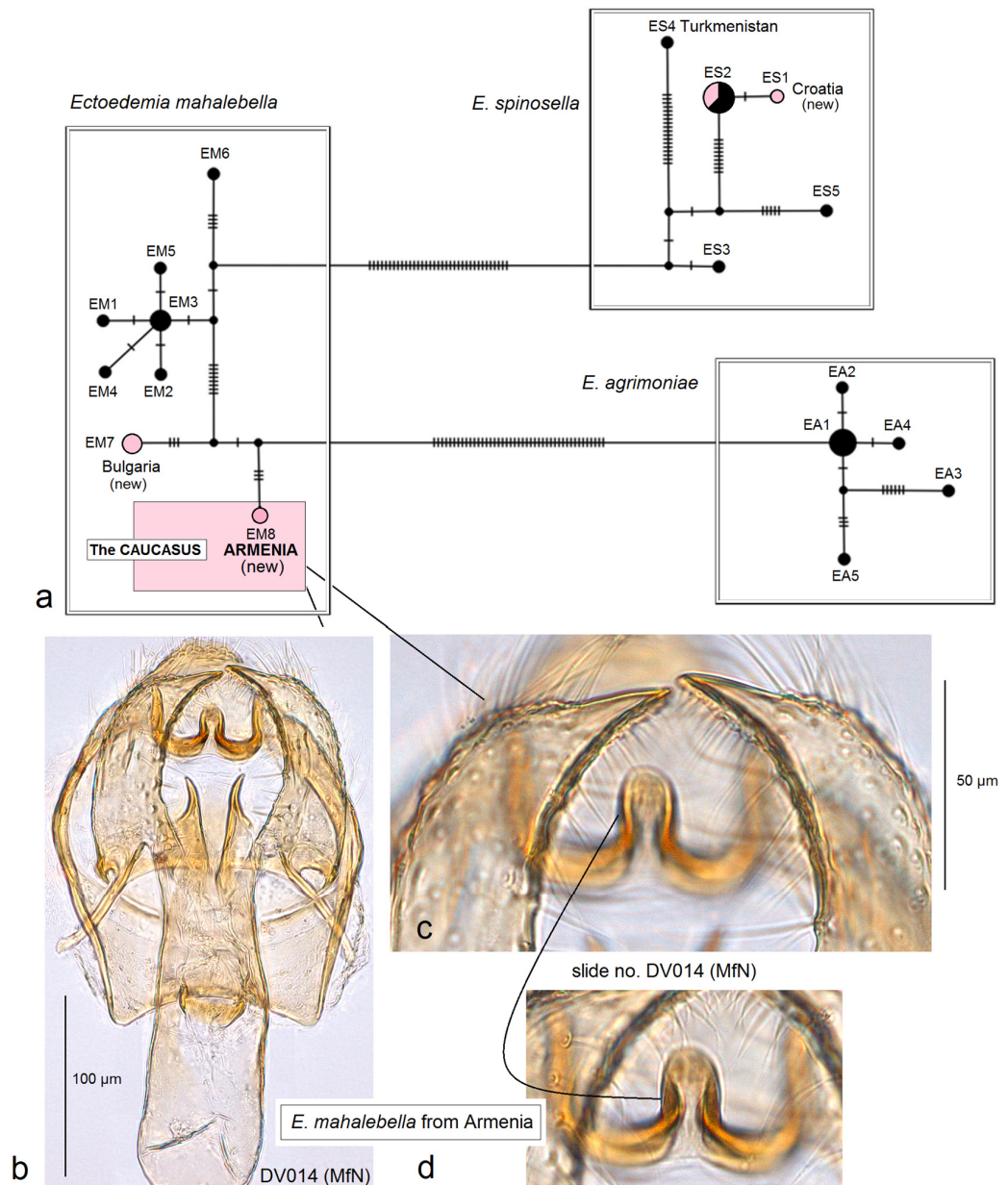
**Etymology.** The new species is named after the Caucasus, which is the region where the new species occurs.

**Type material.** Holotype, ♂, ARMENIA, Yerevan, Victory Park, 1141 m, 40°11'41" N, 44°31'12" E, at light, 1 August 2022, leg. J.R. Stonis, genitalia slide no. RA1116♂(MfN). Paratypes: 1 ♀, same label data as holotype, genitalia slide no. RA1117♀(MfN); 1 ♂, Victory Park, 1142 m, 40°11'41" N, 44°31'25" E, at light, 29 July 2022, leg. J.R. Stonis, genitalia slide no. RA1115♂(MfN); 1 ♀, Victory Park 1141 m, 40°11'47" N, 44°31'17" E, at light, 19 August 2022, leg. J.R. Stonis (MfN).

### 3.2. Molecular Data vs. Morphology

#### 3.2.1. *Ectoedemia mahalebella* (Klimesch) vs. *E. spinosella* (Joannis)

Although these two *Ectoedemia* species can be relatively easily differentiated by the either contorted or sinuous initial gallery of the leaf mine and by the size of the signa in the corpus bursae of the females, they can still be confused if the identification is based solely on the morphology of the male genitalia with adults having rubbed scaling. Considering intraspecific and geographic variability, the male genitalia of these species are indistinguishable. As a result, at the beginning of our research, all collected and subsequently dissected *Ectoedemia* males with whitish forewing fascia were provisionally identified as *E. spinosella* (Joannis, 1908). This seemed quite logical as *E. spinosella* is not only widespread in Europe but is also found abundantly in an area near the Caucasus, specifically on the other side of the Caspian Sea in the Kopet Dag mountains in western Turkmenistan, as well as in Tajikistan [66]. However, a comparison of our new molecular sequences from specimens collected in Armenia with new sequences obtained from specimens of *E. mahalebella* (Klimesch) collected in Bulgaria and *E. spinosella* from Croatia and the sequences of both species downloaded from the BOLD database (Figure 20a), clearly confirmed that instead of the expected *E. spinosella*, *E. mahalebella* (Figure 20b–d) was detected in Armenia. Moreover, during our mitotype analysis, we found that the sequences of *E. spinosella* from western Turkmenistan were not identical to the sequences of *E. spinosella* from Europe but differed in many hypothetical mutational steps (see Figure 20a). It should be mentioned that *E. spinosella* occurring in western Turkmenistan was initially described as a separate species, *E. albiformae* Puplesis & Diškus, 2003 [20], but later synonymized with the European *E. spinosella* [67]. This synonymization has already been recently confirmed without considering molecular data [66]. According to our mitotype network, if *E. spinosella* from Turkmenistan is not so “typical” *E. spinosella*, then it is certainly not *E. mahalebella*, which is now discovered abundantly in the adjacent Caucasus (Armenia).



**Figure 20.** *Ectoedemia mahalebella* (Klimesch): (a) the mitotype network of 658 bp long mtDNA COI-5' sequences constructed by the Minimum Spanning Network algorithm. It includes six newly analysed (pink color) and twenty-four sequences of *E. agrimoniae* downloaded from BOLD (black color) (EA1 (LEFIE688-10, LEFIE689-10, LEFIF352-10, LEFIJ1492-12, NEPT153-10 all Finland), EA2 (NEPT022-10 Belgium), EA3 (NEPT077-10 Italy), EA4 (NEPTA051-13 Greece), EA5 (NEPTA052-13 Romania)), *E. mahalebella* (EM1 (NEPT046-10 France), EM2 (NEPT047-10 France), EM3 (NEPT076-10, NEPT219-10 both Italy; NEPT128-10 France), EM4 (NEPT191-10 Croatia), EM5 (NEPTA1048-15 Switzerland), EM6 (NEPTA146-13 Greece), EM7 (OR793222, OR793223 both Bulgaria, new), EM8 (OR793224 Armenia, new)), and *E. spinosella* (ES1 (OR793219 Croatia, new), ES2 (OR793220, OR793221 both Croatia, new; NEPT016-10 Netherlands; NEPT070-10, NEPT071-10 both Italy; NEPT111-10 France), ES3 (NEPT140-10 Greece), ES4 (NEPTA1460-15 Turkmenistan), and ES5 (LEASW1368-20 Greece)). The size of each circle is proportional to the mitotype frequency. The unnamed small circles represent mitotypes not sampled in the study but which were predicted to be. Dashes on the lines connecting mitotypes indicate hypothesized mutational steps; (b–d) male genitalia of *E. mahalebella* from Armenia.

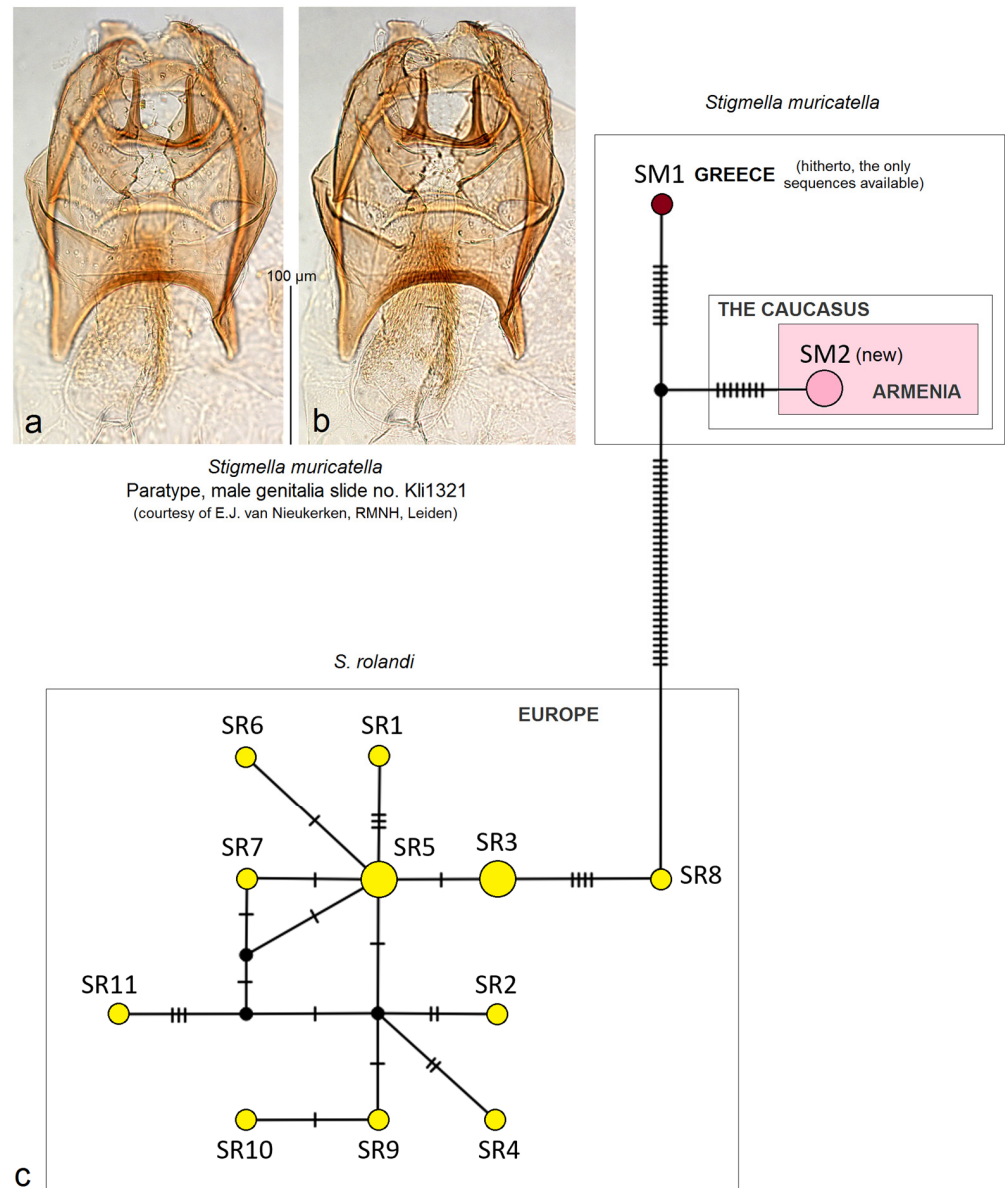
### 3.2.2. A Study Case of *Stigmella muricatella* (Klimesch)

During our research, *S. muricatella* (Klimesch) was found to be incomparably abundant among the samples of all other discovered species in Armenia. The adults of this species were attracted to light traps numerously wherever these light traps were set. However, the most abundant of the Nepticulidae species of Armenia is still a taxonomic puzzle. Knowing that a resembling species, *S. rolandi* van Nieuwerkerken, is widespread in southern Europe and common in geographically nearby Crimea while also possibly occurring in the Tyan Shan Mts [19], it was expected that our Armenian samples represent *S. rolandi*, a morphologically similar species. We barcoded two specimens from Armenia (Figure 21c) to compare their sequences with those of *S. rolandi* and *S. muricatella*. Hitherto, the only useful barcoded specimen of *S. muricatella* available for comparison was a female from Greece [68]. The molecular sequences of our Armenian specimens and the female from Greece were not identical, but relatively close, and clearly distinct due to their numerous hypothetical mutational steps from *S. rolandi*. In a photo of the *S. muricatella* male genitalia mount of the paratype, which was kindly sent by Erik J. van Nieuwerkerken (Figure 21a,b), it can be seen that the cornuti are very numerous and rather equal sized. In comparison, all our Armenian specimens (nearly 60 genitalia slides) possess less and clearly differentiated cornuti: some are very tiny, but others are significantly (or slightly) larger and triangular. Meanwhile, the shapes of the uncus, gnathos, transtilla, and vinculum seem to be variable among our Armenian specimens. Nevertheless, the cornuti of the samples from Armenia are always of the same pattern: they are differentiated sized. We also newly checked specimens of the so-called *S. muricatella* from Tajikistan (BRG/MfN) (documented by Puplesis in 1994 [19]) and found that they possess even less cornuti and a more golden creamy forewing speckled with dark brown scales (the Armenian specimens are rather metallic grey with black scales). Therefore, it can be concluded that *S. muricatella* is probably a widespread and variable species. Despite the discovered presence of numerous, but not differentiated cornuti in the paratype of *S. muricatella*, we still treated our Armenian specimens (along with the barcoded female from Greece) as *S. muricatella*. Otherwise, along with the species "A", i.e., the "real" *S. muricatella* by Klimesch, it is necessary to name a separate species "B" from Armenia (including the barcoded specimen from Greece), and one more species "C" on the basis of the specimens from Tajikistan. In this case, *S. muricatella* and its new "satellites" from Asia can be seen as a bunch of young, closely similar, and hardly differentiated species, like in the known case of the *S. oxyacanthella* group. From a practical point of view, this is undesirable because of the difficult diagnostics of the species. Therefore, although *S. muricatella* still remains a puzzle, for now, we followed the first scenario.

### 3.2.3. Designation of the *Stigmella rolandi* Species Group

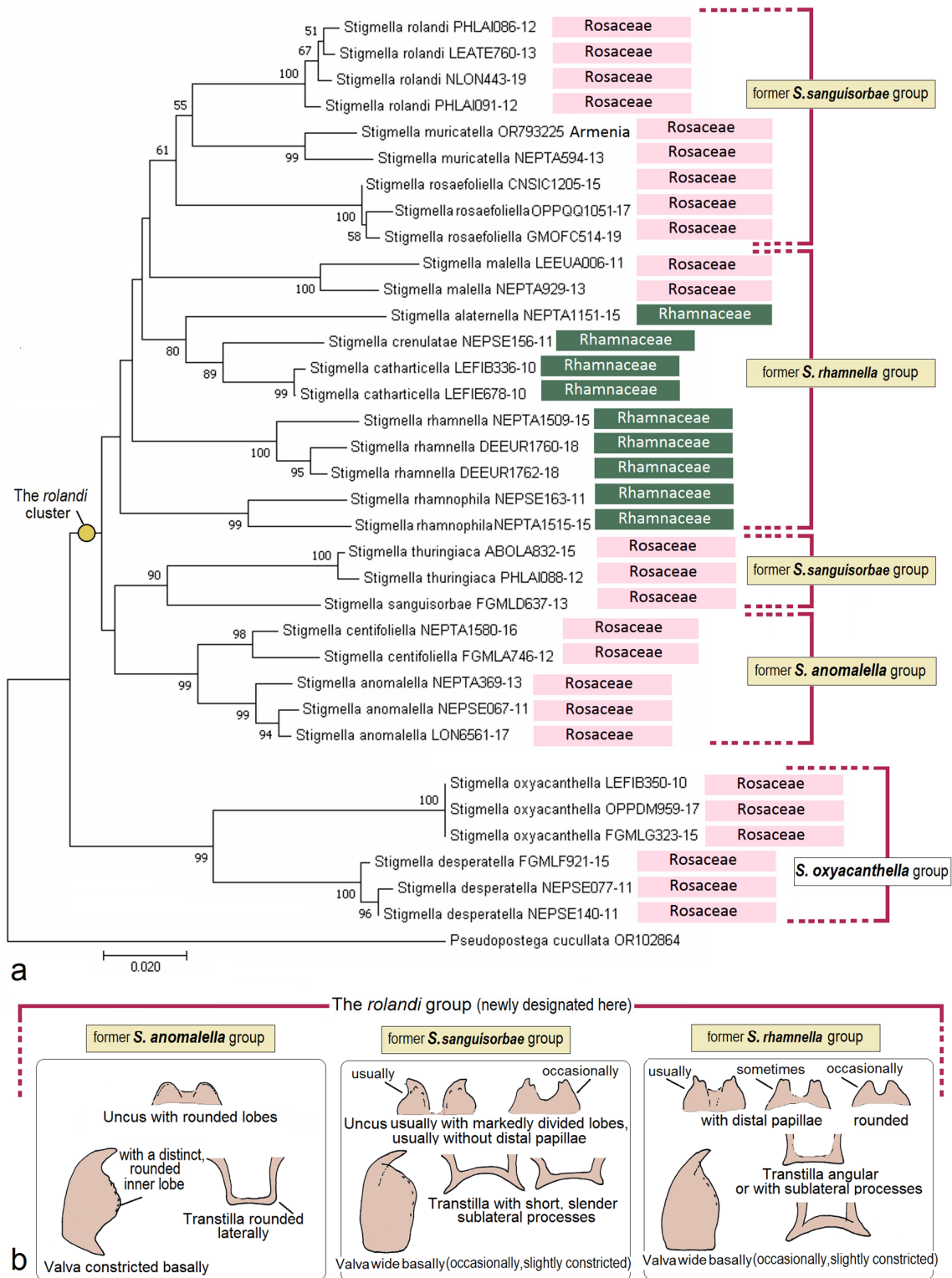
The examined *Stigmella muricatella* belonged to the former *S. sanguisorbae* species group, an informal group, not a taxonomic unit. In our constructed NJ tree (Figure 22a), the newly obtained molecular sequences of *S. muricatella* stood "nicely" among the species of the former *S. sanguisorbae* group as a distinctly separate but sister clade with *S. rolandi*. However, in this analysis, we also found that despite a very similar morphology, some other species of the former *S. sanguisorbae* group, *S. thuringiaca* (Petty) and *S. sanguisorbae* (Wocke), always took a separate position from the remaining species of the former *S. sanguisorbae* species group; in all our trees, these species appeared to be a sister clade with the former *S. anomalella* group. Such a similarity of the analysed molecular sequences between some species of the former *sanguisorbae* and *anomalella* groups are confirmed by the similarity of morphological and biological characters. Therefore, it is clear that these three species groups (including the former *S. rhamnella* group) belong to a common cluster of groups (Figure 22b). Both genital structures of the male and especially differences in the morphology of the female genitalia in the species of this cluster are so minimal, and sometimes overlapping, that it is possible to combine either all three groups into one group, the *S. anomalella* group (*sensu lato*), or to merge at least two groups, using the most similar *S. sanguisorbae* group to the *S. rhamnella* group, but to leave the *S. anomalella* group (designated

by R. Johansson in 1971 [58]) as a separate but close informal unit. Here, we decided to merge all three groups into one group and, avoiding terminological confusion, named it the *S. rolandi* group (designated by J.R. Stonis and A. Diškus).



**Figure 21.** *Stigmella muricatella* (Klimesch): (a,b) first photographic documentation of male genitalia, slide no. Kli1321, paratype (courtesy of Erik J. van Nieukerken, RMNH); (c) the mitotype network of 658 bp long mtDNA CO1-5' sequences constructed using the TCS Network algorithm. It includes three newly analysed (pink color) and sixteen (other colors) sequences of *S. muricatella* downloaded from BOLD (SM1 (NEPTA594-13 Greece), SM2 (OR793225, OR793226, OR793227 all Armenia, new)) and *S. rolandi* (SR1 (DEEUR1012-16 Austria), SR2 (DEEUR1024-16 Austria), SR3 (LEATE760-13, LEATH369-14, NEPTA694-13 all Italy), SR4 (LON7167-18 Croatia), SR5 (LON7168-18, NLON450-19 both Croatia; NEPTA692-13 Greece), SR6 (NEPTA1269-15 Croatia), SR7 (NEPTA693-13 Greece), SR8 (NLON443-19 Croatia), SR9 (NLON444-19 Croatia), SR10 (PHLAI086-12 Romania), SR11 (PHLAI091-12 Hungary)) species. For other explanatory notes, see Figure 20.

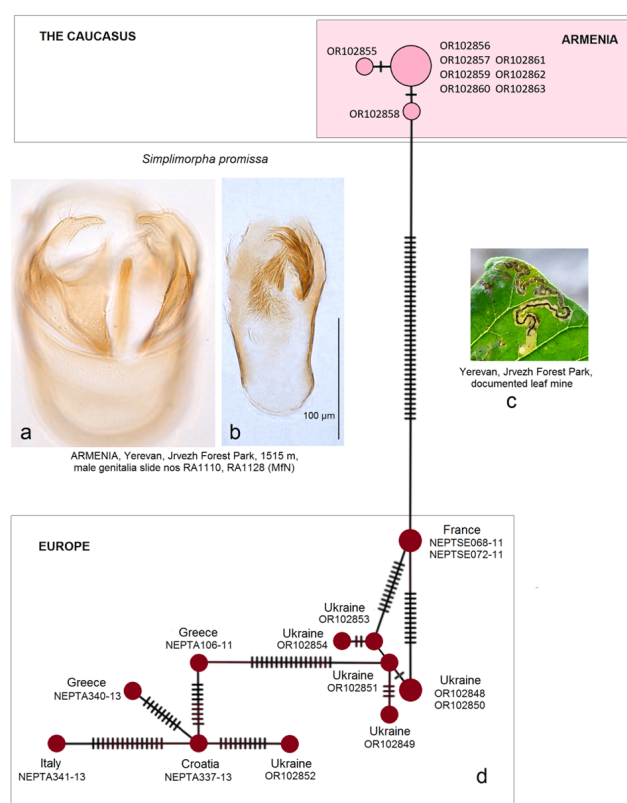




**Figure 22.** *Stigmella muricatella* (Klimesch) and the newly designated *S. rolandi* group: (a) the NJ tree based on 658 bp long mtDNA CO1-5' sequences. The analysis involved one new mitotype from Armenia and thirty-three mitotypes downloaded from the BOLD database. The divergence was calculated using the Tamura 3-parameter model and a gamma distribution; (b) pictorial diagnosis of the former species groups of the *S. rolandi* cluster based on the male genitalia characters.

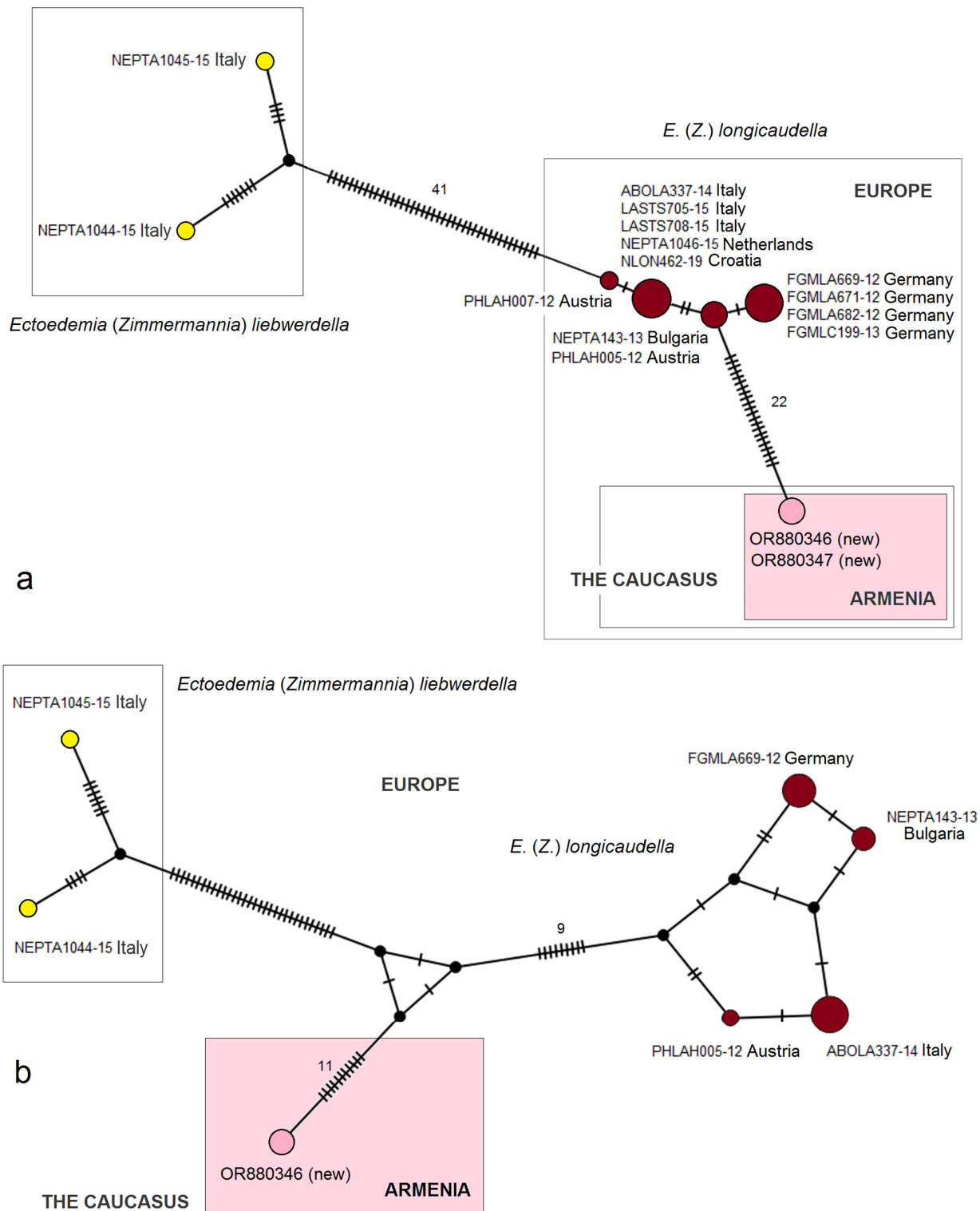
### 3.2.4. Cryptic Taxa

During our research in Armenia on the naturally growing host plant *Cotinus coggygria* [69,70], the leaf-mining *Simplimorpha promissa* (Staudinger) (Figure 23a–c) was discovered for the first time, and a sample of nine specimens from Jrvezh Forest Park, Yerevan (1515 m) was sequenced. All obtained molecular sequences were characterized by high conservatism among themselves, but they were extraordinarily distant (by approximately 38 hypothetical mutation steps) from those of the studied European specimens [44] (Figure 23d). An examination of the morphology and biology of the specimens collected in Armenia showed no clear diagnostic characters useful for the morphological differentiation of the Armenian sample from the genetically distant European specimens; both the male genitalia and the leaf mines, as well as host plant and seasonality of mining, appeared closely similar. Therefore, having only mitotype differences but the absence of diagnostic morphological and biological characters, we refrained from describing a new possible cryptic taxon (a new subspecies or species) [44].

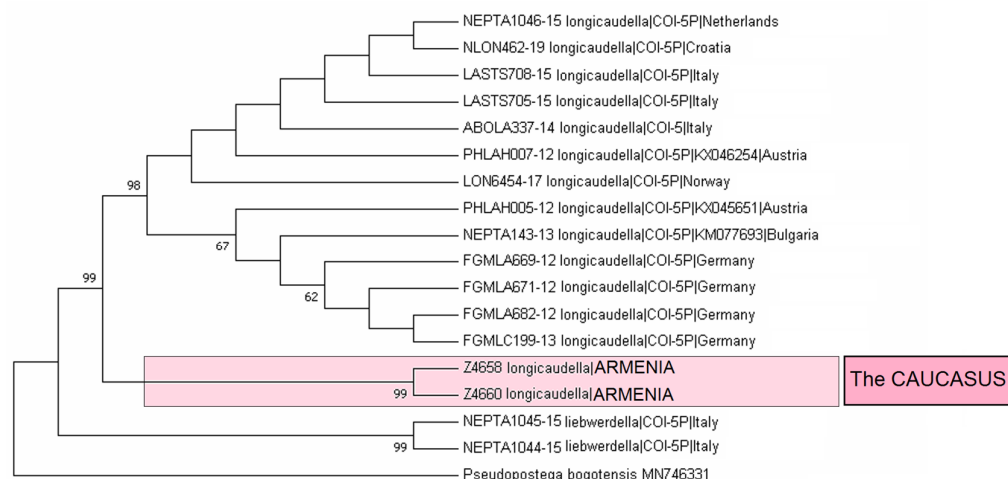


**Figure 23.** *Simplimorpha promissa* (Staudinger): (a,b) male genitalia, Armenia, genitalia slide nos RA1110, RA1128 (MfN); (c) leaf mine; (d) the mitotype network of the 653 bp long mtDNA COI-5' sequences, constructed using the Minimum Spanning Network algorithm (after [44]). It includes sixteen newly analyzed sequences and six sequences downloaded from BOLD. For other explanatory notes, see Figure 20.

While studying *Ectoedemia* (*Zimmermannia*) *longicaudella* Klimesch collected in An-tarut, Aragatsotn Province, we also found a significant difference between the molecular sequences of the Armenian and European specimens: the Armenian sequences differed from *E. (Z.) longicaudella* sequences from Bulgaria, Croatia, Italy, Austria, Germany, and the Netherlands by at least 22 hypothetical mutational steps (Figure 24a), and the studied Armenian sample differed even more from another closely related species, *E. (Z.) liebwerdella* Zimmermann, a type species of the subgenus *Zimmermannia* Hering (Figure 24a,b). In our NJ tree (Figure 25), the sequences from the Armenian specimens appeared to be clearly separate, but a sister clade to *E. (Z.) longicaudella*.



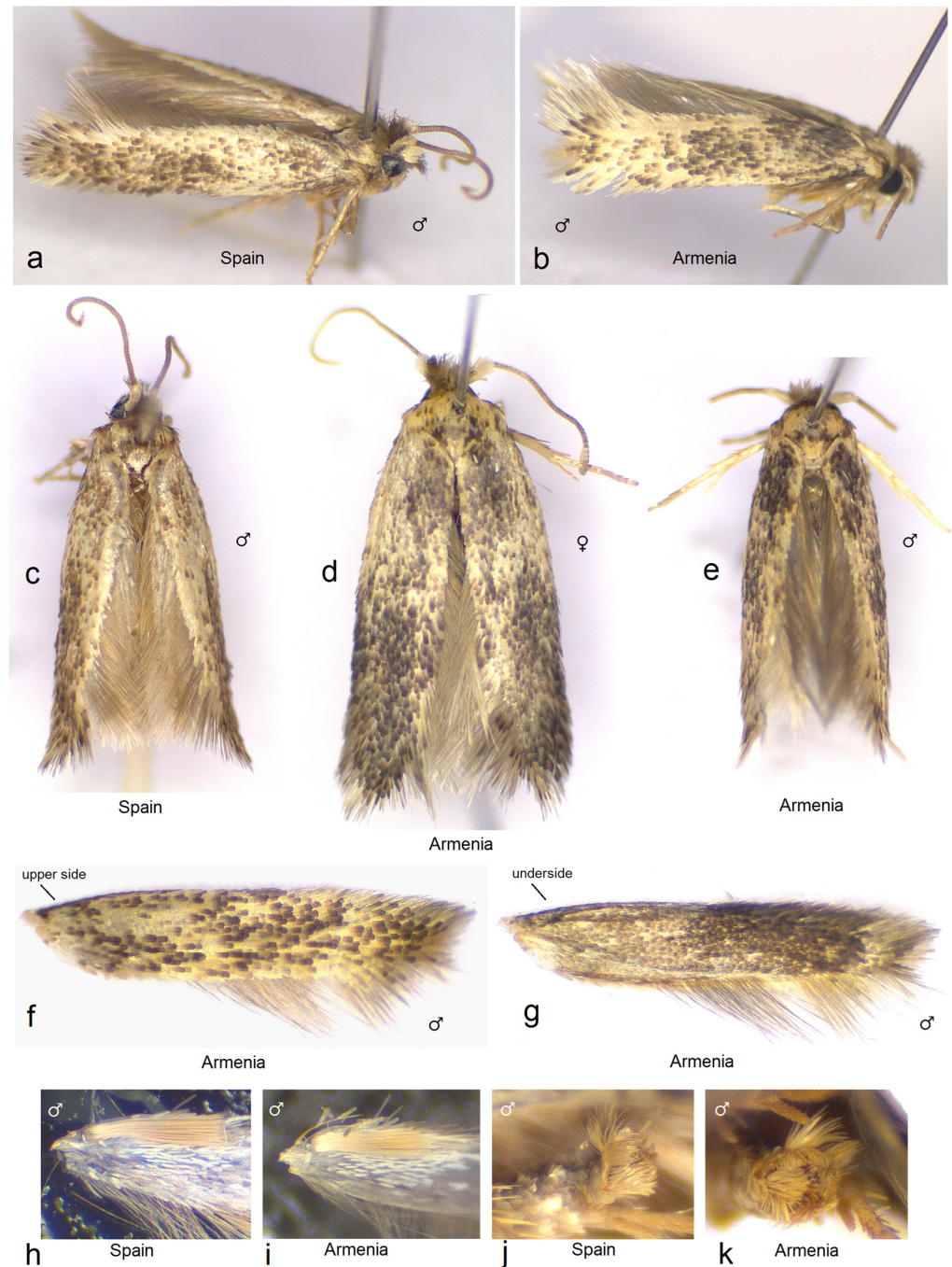
**Figure 24.** The mitotype networks of the 658 bp long mtDNA COI-5' of *Ectoedemia (Zimmermannia) longicaudella* Klimesch: (a) constructed using the Median Joining Network algorithm. It includes new sequences from Armenia and sequences downloaded from BOLD; (b) constructed using the Integer NJ Net algorithm. The unnamed small circles represent mitotypes not sampled in the study but which were predicted to be. Dashes on the lines connecting mitotypes indicate hypothesized mutational steps.



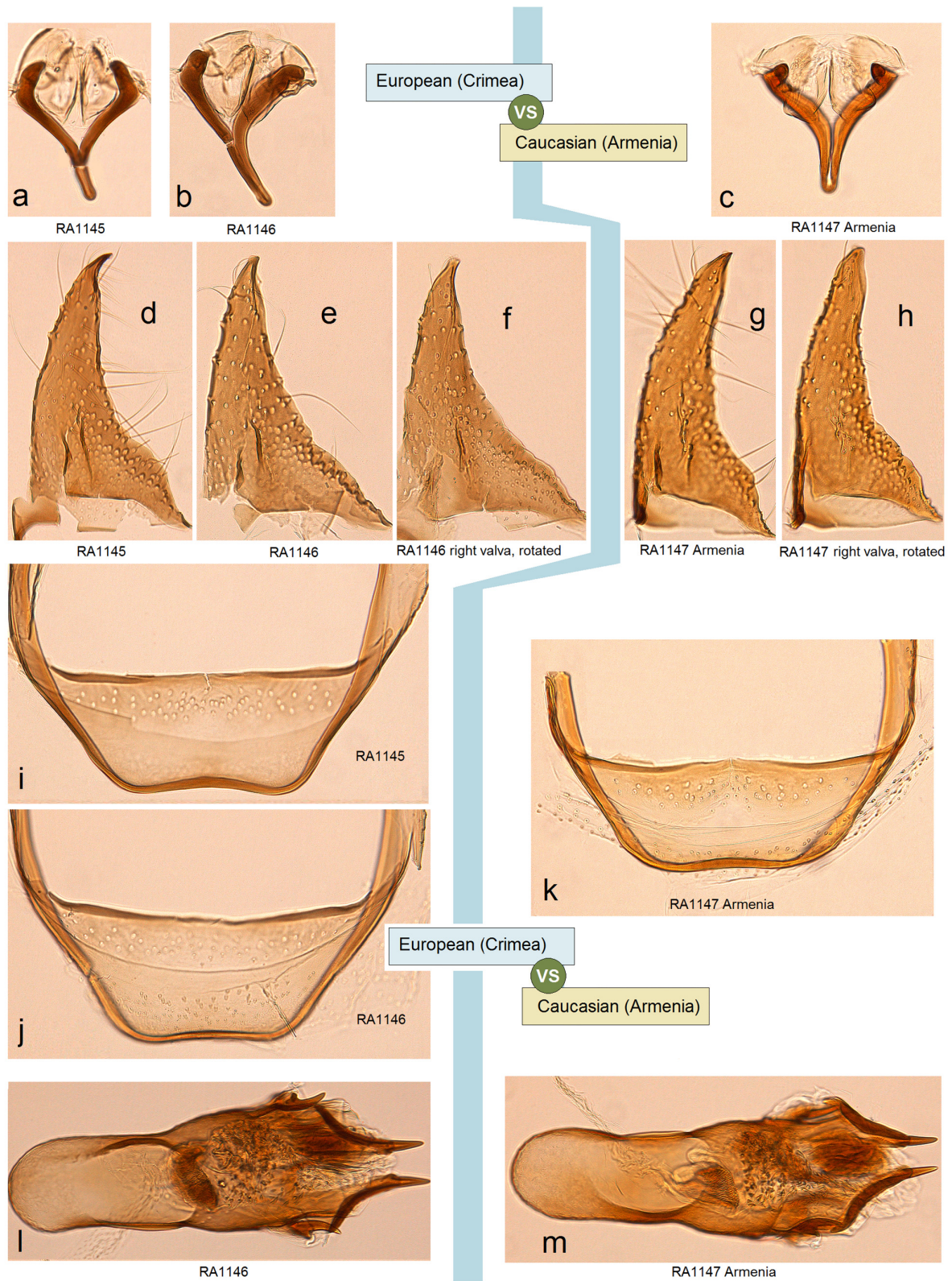
**Figure 25.** The Neighbor-Joining tree of the 658 bp long mtDNA COI-5' *Ectoedemia (Zimmermannia) longicaudella* Klimesch sequences. The analysis involved fifteen nucleotide sequences of *E. (Z.) longicaudella*: two newly analyzed from Armenia and thirteen downloaded from the BOLD database. The Kimura-2 parameter model was used to calculate divergence. The percentage of replicate trees in which the associated taxa clustered together in the bootstrap test (1000 replicates) are presented next to the branches (only bootstrap values above 50 are shown). Two sequences of the species *E. (Z.) liebwerdella* as the morphologically closest species to *E. (Z.) longicaudella* were used in the analysis. *Pseudopostega bogotensis* (Opostegidae) was used as an outgroup.

Since the biology of *E. (Z.) longicaudella* is still poorly known, and our specimens from Armenia were collected even without biological data (caught using light traps), it was not possible to determine any differences in the larval morphology, life cycle, or bark-mine morphology. It did, however, present the task of looking for morphological differences between Armenian and European adult specimens (Figure 26a–k). We found that features of the scaling, including the thorax and forewing pattern, as well as androconial formations of the hindwing and the anal tufts of the abdomen, did not differ. Therefore, we assumed that two separate taxa could not be differentiated on the basis of their external morphology. In the study of the male genitalia, each sclerite was dissected separately, documented, measured, and compared (Figure 27a–m). However, only in the shape of gnathos were differences detected; in the specimens from Armenia, this sclerite possesses lateral arms curved in a slightly different way. Although this examination did not provide the desired results, we also checked some dry genital mounts. These mounts, both of the studied European specimens and our specimens from Armenia, were made at the same time and using the same technique and fixation substitutes. The examination of such dry slides showed some significant differences; in the dry preparations (both in the studied sample of the European *E. (Z.) longicaudella* and in photographs and drawings of the genitalia provided by other researchers), the gnathos was turned ventrally, while the gnathos did not turn in the dried preparations of the Armenian sample, but remained directed caudally, while the highly elaborate lateral arms of the gnathos were clearly visible (Figure 28e). Moreover, in the dried preparations of the studied Armenian sample, the vinculum appeared to be significantly longer, and inner bulges were visible on the inner side of the valvae (Figure 28d,f). It is interesting that genitalia slide no. 1834 (VU) [71] from a region adjacent to Armenia (Turkey, Anatolia: Kizilchamam) documented by Erik J. van Nieukerken was also identical to our Armenian mounts (see [71] (figure 91). All these features were not observed in mounts of the European specimens (Figure 28a,c). Apparently, although the dissection of separate sclerites did not show obvious differences, the differences may be in the attachment mechanism, elasticity, or other cryptic elements of these sclerites. The female genitalia of the Armenian sample seem to be distinctive enough, as they are characterized by a highly elaborate vaginal sclerite, strongly chitinized ductus spermathecae, and longer and slender anterior apophyses (Figure 29a–d). We assume

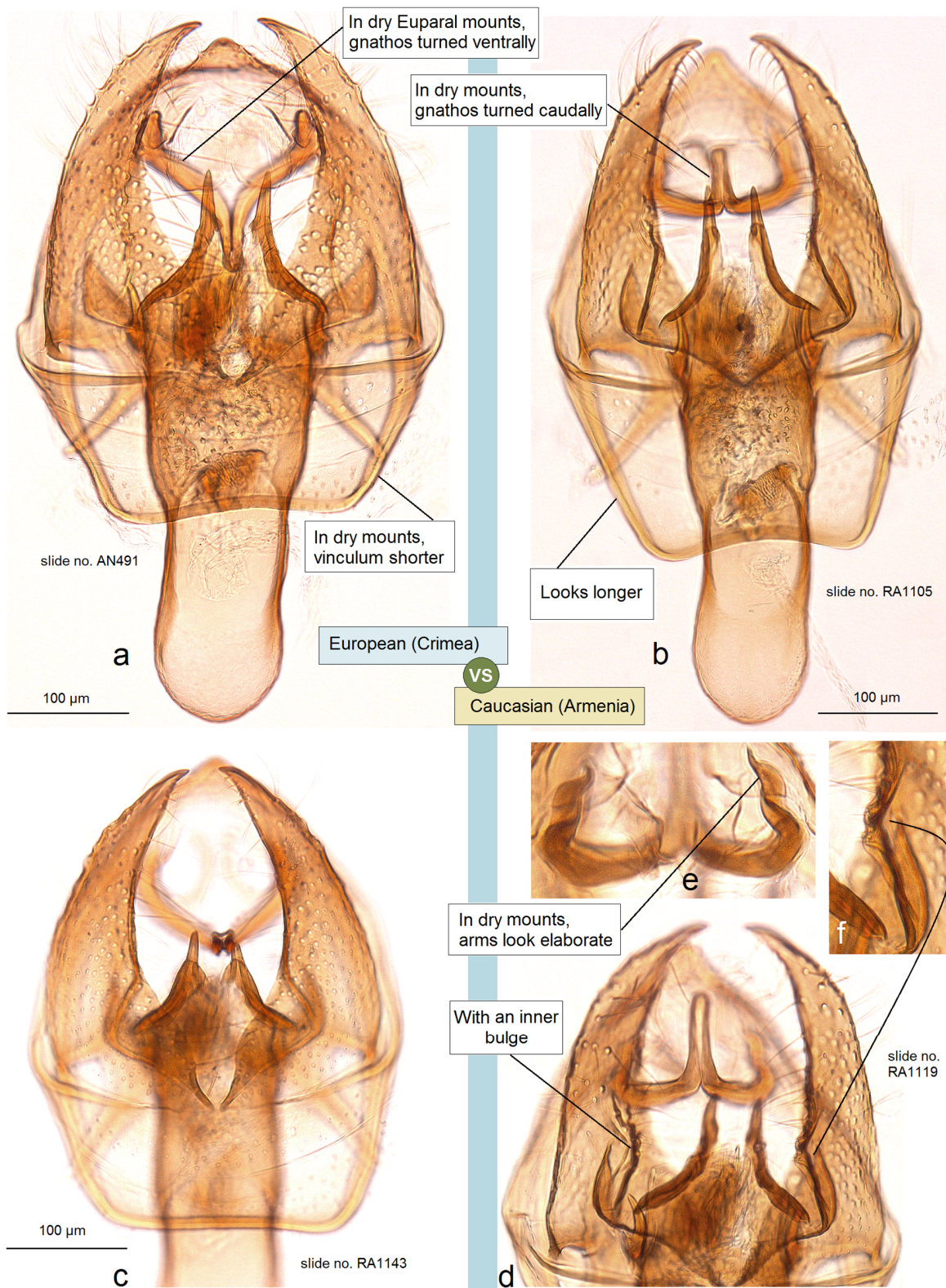
that the specimens from Armenia, together with the specimen documented by Erik J. van Nieukerken from adjacent Kizilchamam, Turkey, represent a new but cryptic taxon (a new subspecies or species). However, from a practical point of view, the description of one more difficult-to-diagnose taxon among the already rather difficult-to-diagnose species of the subgenus *Zimmermannia* is inappropriate. Thus, we have been refrained from describing a new taxon.



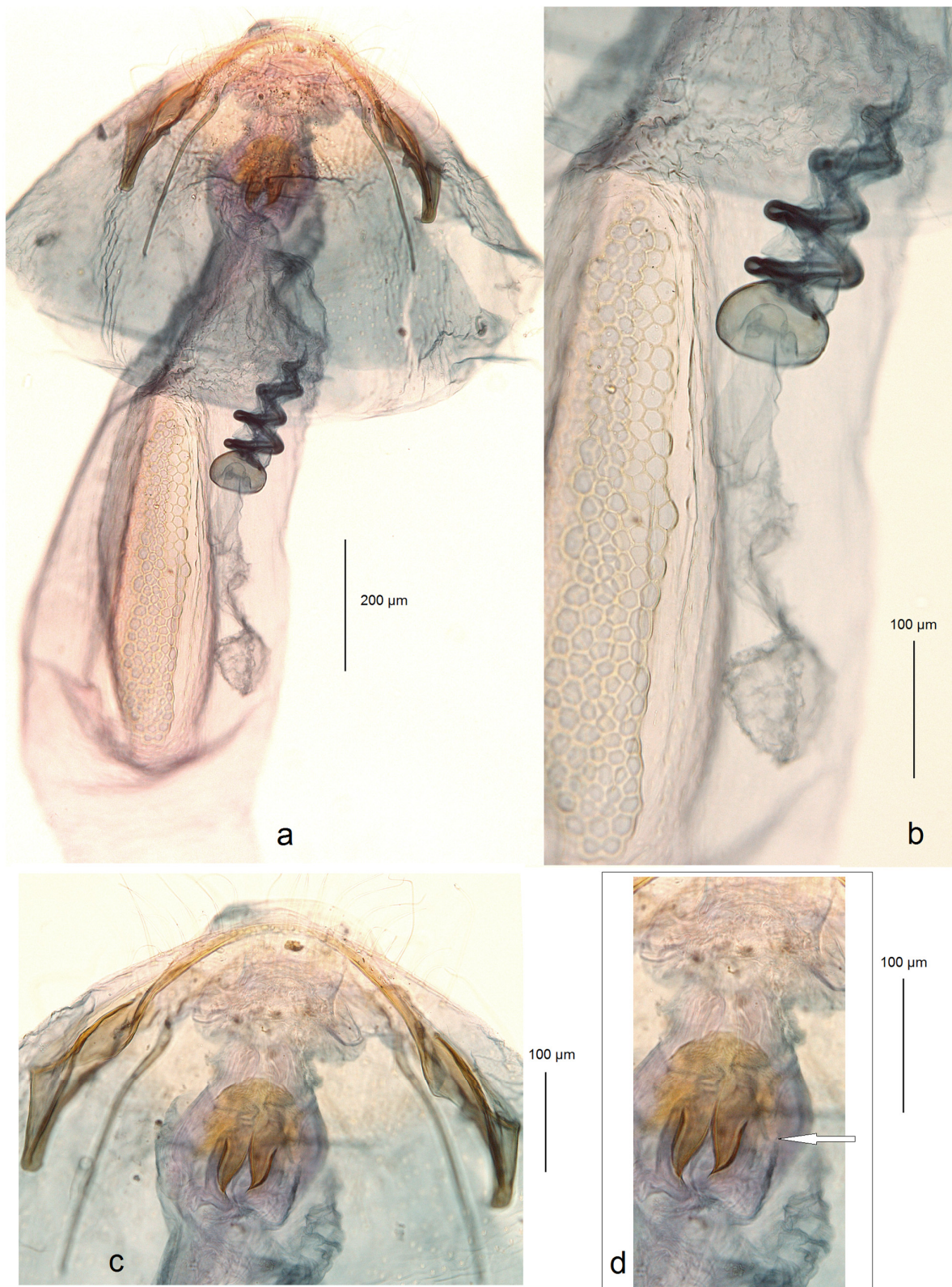
**Figure 26.** Adults of *Ectoedemia (Zimmermannia) longicaudella* Klimesch: (a,b) lateral view; (c–e) dorsal view; (f) forewing upper side; (g) forewing underside; (h,i) hair-pencil and special scales of the male hindwing; and (j,k) anal tufts.



**Figure 27.** Dissected sclerites of the male genitalia of *Ectoedemia (Zimmermannia) longicaudella* Klimesch: (a–c) gnathos; (d–h) valva; (i–k) vinculum; and (l,m) phallus.



**Figure 28.** General view of male genitalia of *Ectoedemia* (*Zimmermannia*) *longicaudella* Klimesch in dry mounts: (a) genitalia slide no. AN491, the Crimea; (b) genitalia slide no. RA1105, Armenia; (c) genitalia slide no. RA1143, the Crimea; and (d–f) genitalia slide no. RA1119, Armenia.



**Figure 29.** Female genitalia of *Ectoedemia (Zimmermannia) longicaudella* Klimesch, slide no. RA1144, Armenia: (a) general view; (b) ductus spermathecae; (c) apophyses and vaginal sclerite; and (d) enlarged vaginal sclerite (MfN).



#### 4. Discussion

In total, the research revealed thirty-one Nepticulidae species in Armenia belonging to eight genera. Only the following two species were known to exist in Armenia previously: *Stigmella armeniana* Puplesis [19] and *Glaucolepis melanoptera* (van Nieuwerkerken & Puplesis) [24]. One additional species previously listed for the Armenian fauna (*Stigmella inopinata* Laštůvka, A. & Laštůvka, Z.) [25,72] was not confirmed and was treated by us as a misidentified record.

Although the currently revealed fauna is characterised by high endemism, a large number of discovered species (9) were hitherto known to be of European distribution (including Euro-Caucasian or Euro-Anatolian species): *Stigmella confusella* (Wood & Walsingham), *S. viscerella* (Stainton), *S. lemniscella* (Zeller), *S. dorsiguttella* (Johansson), *S. roborella* (Johansson); *Ectoedemia* (*Zimmermannia*) *longicaudella* Klimesch, *E. mahalebella* (Klimesch), *Trifurcula subnitidella* (Duponchel), and *Simplimorpha promissa* (Staudinger); the latter was first mentioned as a species of the Armenian fauna already in our previous publication [44]. Ten other species identified in the Armenian fauna were previously known to be of Euro-Asian distribution, including at least six species recently confirmed in Iran [26], so their discovery in Armenia is not unexpected: *Stigmella muricatella* (Klimesch), *S. malella* (Stainton), *S. nivenburgensis* (Priessecker), *S. aceris* (Frey), *S. carpinella* (Heinemann), *S. hybnerella* (Hübner), *S. basiguttella* (Heinemann), *Fomoria septembrella* (Stainton), *Glaucolepis melanoptera* (van Nieuwerkerken & Puplesis) and *Bohemannia pulverosella* (Stainton), the latter being widespread in Europe and also known from Far Eastern Russia.

The smallest group of species discovered during our study were those previously known only from neighboring Central Asia: *Stigmella klimeschi* Puplesis, *S. kopetdagica* Puplesis and *S. kuznetzovi* Puplesis. It should be noted that *S. kopetdagica* Puplesis, and *S. kuznetzovi* are known to occur in Asia only in the westernmost part of the region, specifically in the Kopet Dag mountain range (western Turkmenistan), whose biota has clear biogeographical connections with the European biota [19].

Thus, among species of the Armenian fauna that have been clarified at the moment, about 38% of taxa are shared with the fauna of Asia (22% specifically with the fauna of Central Asia), and about 60% with the European fauna (note that these include some species that are associated with both European and Asian faunas).

Rather unexpected was that so many species new to science were discovered during this research: *Stigmella armi* Stonis, Dobrynina & Remeikis, sp. nov.; *S. garnica* Stonis, Dobrynina & Remeikis, sp. nov.; *S. inopinoides* Dobrynina, sp. nov.; *S. magicis* Stonis & Dobrynina, sp. nov.; *S. ararati* Stonis, Dobrynina & Remeikis, sp. nov.; *Trifurcula vardenisi* Stonis, Dobrynina & Remeikis, sp. nov.; *Etainia caucasi* Remeikis, sp. nov. (moreover, one new *Stigmella* species was identified but left unnamed and undescribed in the current publication). Thus, the new species account for 25% of the currently known Armenian species (i.e., every fourth species collected in Armenia was new to science). Until other differing data are obtained, all of these species, together with the earlier described *S. armeniana* Puplesis [19], can be provisionally treated as endemics of the Caucasus (or Armenia) (i.e., 28%, or almost a third of the currently known fauna of Armenia). In addition, some of the species named in this publication are possibly cryptic and are not yet described but endemic taxa. Moreover, at least two species of *Stigmella* and *Acalyptis* collected during our research in Armenia were clearly new to science, but they were left undescribed and excluded from this review due to insufficient collection material (we only had female singletons).

Although we only rely on the previous experience of work, we assume that the currently identified species in Armenia may account for only about 40–45% of the species actually occurring in this country, i.e., in total, about 70–80 species of Nepticulidae can be discovered in the future in Armenia. Among those still undiscovered species, we expect a significant portion of species similar to European species but cryptic. We believe that further research is necessary in this fascinating and biogeographically very important region.

**Author Contributions:** Conceptualization, J.R.S.; research permits, M.Y.K., J.R.S. and V.D.; field collecting and observations, J.R.S., V.D. and M.Y.K.; rearing adults from cocoons, A.D. and J.R.S.; specimen setting and labeling, V.D.; specimen dissections and genitalia slides, V.D., A.R. and A.D.; species identifications, V.D., J.R.S., A.R. and A.D.; measurements, A.R. and J.R.S.; host-plant identifications and habitat characterization, M.Y.K.; molecular analysis, S.O., A.R. and V.D.; methodology, S.O., A.R. and J.R.S.; visualization—adult photography, J.R.S.; genitalia photography, A.R. and J.R.S.; drawings, J.R.S.; SEM photography, J.R.S., V.D. and A.R.; molecular cladograms, S.O., A.R. and J.R.S.; preparation of illustration collages and plates, J.R.S.; sorting and consideration of species groups, A.D. and J.R.S.; writing—original draft, J.R.S., S.O., A.R. and M.Y.K.; reference list, A.D.; writing—review and editing, J.R.S., S.O. and A.R. All authors have read and agreed to the published version of the manuscript.

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