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New data on distribution and molecular genetics of *Lignyoptera fumidaria* (Hübner, [1825]) (Lepidoptera: Geometridae)

S. A. Knyazev, A. U. Gabdullina & I. A. Makhov

Abstract

The rare and little known late-autumn species *Lignyoptera fumidaria* (Hübner, [1825]) is reported from Katon-Karagai National Park (Eastern Kazakhstan) for the first time. The present record is the second in Eastern Kazakhstan. The general species' distribution provided. Species' habitats in Katon-Karagai district of Eastern Kazakhstan are illustrated. Molecular data on the specimens from Kazakhstan studied for the first time.

KEY WORDS: Lepidoptera, Geometridae, *Lignyoptera fumidaria*, Biodiversity, Katon-Karagai, Kazakhstan.

**Nuevos datos sobre la distribución y genética molecular de *Lignyoptera fumidaria* (Hübner, [1825])
(Lepidoptera: Geometridae)**

Resumen

Se cita por primera vez la rara y poco conocida especie otoñal *Lignyoptera fumidaria* (Hübner, [1825]) del Parque Nacional Katon-Karagai (este de Kazajstán). El presente registro es el segundo en el este de Kazajstán. Se proporciona la distribución general. Se ilustran los hábitats de la especie en Katon-Karagai distrito del este de Kazajstán. Por primera vez, se estudian los datos moleculares sobre especímenes de Kazajstán.

PALABRAS CLAVE: Lepidoptera, Geometridae, *Lignyoptera fumidaria*, biodiversidad, Katon-Karagai, Kazajstán.

Introduction

The general data on the Lepidoptera of Katon-Karagai National Park not revised at this moment. Some information about moths, collected on the territory of the Park presented in the local reports and annals of the nature of the park. Also, late-autumn species complex was never studied here. At the middle of October 2020, a short series of *L. fumidaria* (Hübner, [1825]) was collected by the second author in two localities on the right coast of Bukhtarma river and these findings confirm the presence of this species in the Eastern Kazakhstan and expand its range by 180 km to the East. This species has previously been recorded in Kazakhstan by the single male near Serebryansk town also one male was reported from Russian Altai (VASILENKO, 2001). The main distribution of the species very local on the South of Europe and European part of Russia (SKOU & SIHVONEN, 2015; BELJAEV & MIRONOV, 2019).

Material and methods

Moths were collected by standard method using butterfly net at the daytime. The mounted specimens were photographed by the camera Canon EOS 5D Mark II with Canon 100 mm USM macro

lens. The photos of the genitalia were performed using a Nikon SMZ1500 stereoscopic microscope, Nikon D700 camera fitted with LV-TV adapter and Helicon software (Helicon Remote 3.8.1; Helicon Focus 6.7.1).

For molecular genetic analysis the legs were used. The lysis reaction proceeded overnight. DNA extraction was carried out using the QIAamp DNA Mini Kit (QIAGEN, Germany), according to the manufacturer's protocol. DNA elution was performed with 150- μ l elution buffer. Amplification of a 658-bp long COI fragment was performed using the primers HCO2198 (5'-TAAACTTCAGGGTGACCAAAAAATCA-3'; FOLMER *et al.*, 1994) and LCO1490, (5'-GGTCAACAAATCATAAAGATATTGG-3' FOLMER *et al.*, 1994). The PCR profile used for this marker was as follows: 95°C for 3 min, 95°C for 30 sec, 50°C for 45 sec, 72°C for 1 min, (step 2-4 cycled 34 times), 72°C for 10 min.

All specimens deposited in the collection of Zoological Institute RAS (ZISP, Saint Petersburg, Russia) and in private collection of Svyatoslav Knyazev (SKO, Omsk, Russia).

Lignyoptera fumidaria (Hübner, [1825]) (figs 2-6)

Geometra fumidaria Hübner, [1825] 1796. *Samml. Eur. Schmett., Geometrae*: pl. 101, figs 520, 521.

Type locality: Europe (syntype(s) lost).

Material examined: EAST KAZAKHSTAN, Katon-Karagai district, 4,5 km. N of Sogornoye vill., right bank of Bukhtarma river (Fig. 1), 2 ♂♂, 15-X-2020, 49°15'09.7"N 85°21'22.0"E, h= 690 m a.s.l., A. U. Gabdulina (SKO); 1 ♂, 21-X-2020 in the same locality, A. U. Gabdulina (SKO); 3 ♂♂, 22-X-2020, East Kazakhstan, Katon-Karagai district, 8 km NE of Katon-Karagai, right bank of Bukhtarma river, 49°12'35.4"N 85°42'56.1"E, h= 840 m a.s.l., A. U. Gabdulina (SKO).



Fig. 1.— Habitat of *Lignyoptera fumidaria* in Eastern Kazakhstan, Katon-Karagai district, 4,5 km. N of Sogornoye vill., right bank of Bukhtarma river, 15-X-2020 (photo by A. U. Gabdulina).

Additional material examined: HUNGARY, Budaörs, Huszonnégyökrös-hegy, 1 ♂, 16-XI-2006, O. Pekarsky & G. Petrányi (ZISP); Hungary, 1 ♂, coll. of Maksimov (ZISP); RUSSIA, Taganrog, 1 ♂, 16-X-1874, coll. Alphéraky. (ZISP); Sarepta, 1 ♂, coll. Erschov. (ZISP); Spask, 1 ♂, coll. Eversmann (ZISP); POLAND, Petrokovskaya Province [Poland, Łódź voivodeship], 1 ♂, Isaak. (ZISP); CRIMEA, Simferopol surroundings, Livenskiye Dubki, 3 ♂♂, 21-X-1906 (ZISP); HUNGARY [Ungarn], Svábhegy, 1 ♀, 12-XI-[1]924 (ZISP); Hungaria (ZISP); 1 ♂, Coll. Acad. Petrop. (ZISP); 1 ♂, coll. Bramson, ex mater. Mus. Acad. Petrop. (ZISP); HUNGARY [Hungarn], 1 ♂, coll. of Grand Duke Nikolai Mikhailovich (ZISP); Budaörs, Csilihegyek Uhrik, 1 ♂, 10-XI-[1]929 (ZISP); 1 ♂, Hungaria, coll. Erschov (ZISP).

Bionomics: Late-autumn species. In European part of its distribution the adults occur from late September to mid-December (SKOU & SIHVONEN, 2015). In East Kazakhstan imago occur from the beginning to the middle of October. The males fly in a daytime on rocky steppe shores and rocky slopes of Bukhtarma river with predominance of steppe grasses, *Rosa sp.*, *Spiraea sp.*, *Juniperus sp.* The air temperature on the days when the species was found was +9+16°C, wind speed near 4 m/s. Females are wingless and have not yet been found in East Kazakhstan.

Distribution: *Lignyoptera fumidaria* (Hübner, [1825]) distributed very locally in Europe (Austria, Hungary, Bulgaria), south of European part of Russia (from Crimea to South Ural), Altai Republic in Russia and Altai mountains in Eastern Kazakhstan.

Molecular data: Only two COI sequences of *L. fumidaria* from Hungary are available in the GenBank base. Both of these sequences are identical. Barcode sequences of the second species of the genus, *L. thaumastaria* Rebel, 1901, is not yet available. Analysis of barcodes revealed some intraspecific polymorphism in our specimens: (GenBank accessnumbers: MW737411; MW737412) three sites differ. It also was found a deep difference between European moths and specimens from Kazakhstan: the minimal genetic distance is 6% (see COI substitutions in Table 1). The degree of this divergence considerably exceeds the 'standard' 2.7-3.0% DNA barcoding threshold commonly used as a tentative indicator for species distinctness of the taxa compared (LAMBERT *et al.*, 2005; LUKHTANOV *et al.*, 2015). Nevertheless, no morphological differences were found (both in external morphology and genitalia structure - figs 2-8). Such divergence can be explained of the presence of mitochondrial haplotypes. Similar genetic patterns are known among Geometridae: in *Alcis repandata* (Linnaeus, 1758) (MÜLLER *et al.*, 2019), *Epirrita autumnata* (Borkhausen, 1794) (KVIE *et al.*, 2013), *Biston panterinaria* (Bremer & Grey, 1853) (CHENG *et al.*, 2016).

Table 1.– COI 5' substitutions in *L. fumidaria* collected in East Kazakhstan. Localities and ID (GenBank) of barcode are provided in parentheses.

Nucleotide site	1	11	31	34	50	59	61	70	81	130	145	202	217	229	250	274	276	281	282	283
<i>Lignyoptera fumidaria</i> - Hungary (Pest megye, Csiki-hegyek; Budapest: HM393738; HM910662)	A	C	C	T	C	T	A	T	A	A	T	C	G	G	T	T	C	T	T	C
<i>Lignyoptera fumidaria</i> - Kazakhstan, Katon-Karagai district, Sogornoye vill. Vicinity, Bukhtarma river	G	T	T	A	T	C	T	C	C	T	C	A	A	A	C	C	A	A	C	T
Nucleotide site	284	292	298	322	352	364	367	388	391	401	427	445	454	472	529	538	542	595	628	646
<i>Lignyoptera fumidaria</i> - Hungary (Pest megye, Csiki-hegyek; Budapest: HM393738; HM910662)	T	C	A	A	T	T	T	G	C	C	T	C	A	A	C	G	C	C	G	T
<i>Lignyoptera fumidaria</i> - Kazakhstan, Katon-Karagai district, Sogornoye vill. Vicinity, Bukhtarma river	C	T	T	G	C	C	C	A	T	T	C	T	G	G	T	A	T	T	A	C

Discussion

New records of *Lignyoptera fumidaria* in Katon-Karagai National Park expand the range of the species in Kazakhstan by 180 km to the East. Analyzing the general distribution of the species it can be assumed that it can also be found in the steppe regions of the South of Western Siberia and in the Kazakh uplands in vast territories between the Southern Urals and Altai mountains. The morphological identity and molecular data confirm the relationship of remote eastern population with European populations.

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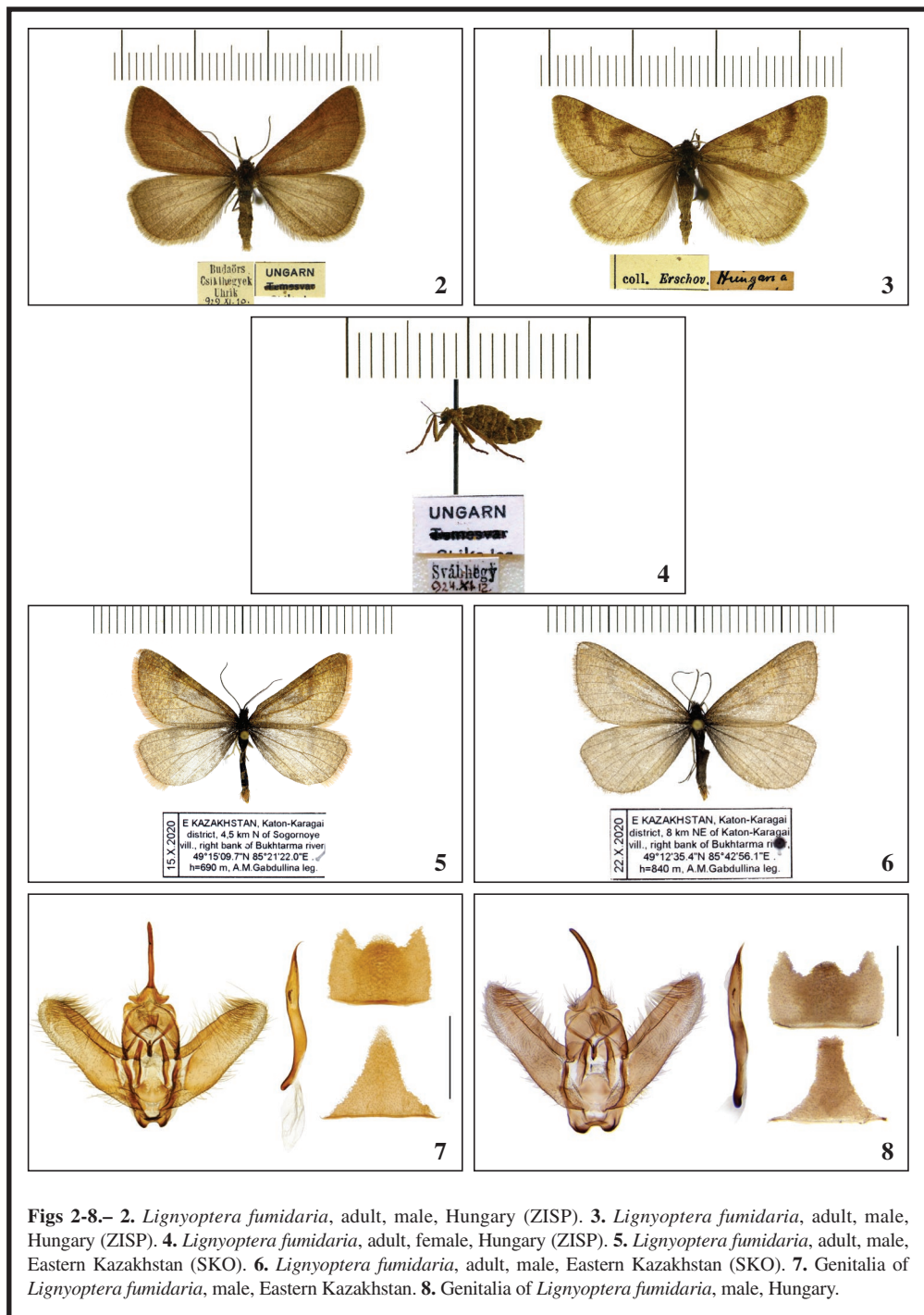
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Figs 2-8.— 2. *Lignyoptera fumidaria*, adult, male, Hungary (ZISP). 3. *Lignyoptera fumidaria*, adult, male, Hungary (ZISP). 4. *Lignyoptera fumidaria*, adult, female, Hungary (ZISP). 5. *Lignyoptera fumidaria*, adult, male, Eastern Kazakhstan (SKO). 6. *Lignyoptera fumidaria*, adult, male, Eastern Kazakhstan (SKO). 7. Genitalia of *Lignyoptera fumidaria*, male, Eastern Kazakhstan. 8. Genitalia of *Lignyoptera fumidaria*, male, Hungary.