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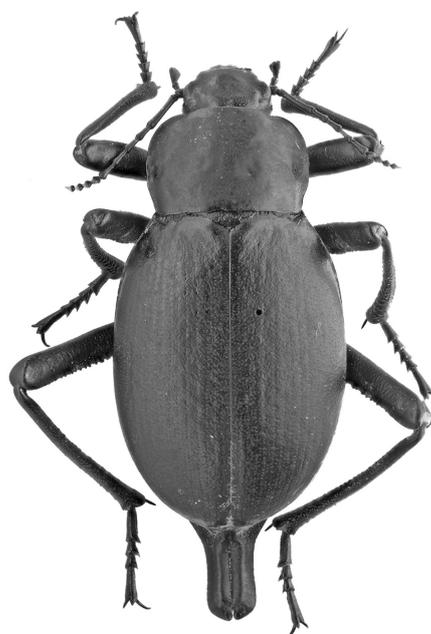


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**New data on the little known and rare Satyr species
Satyrus effendi Nekrutenko, 1989 (Lepidoptera: Satyridae)
from the Zangezur Ridge and its conservation measures**

**Новые сведения о малоизученном и редком виде сатирид
Satyrus effendi Nekrutenko, 1989 (Lepidoptera: Satyridae)
с Зангезурского хребта и меры по его охране**

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Key words: Lepidoptera, Satyridae, *Satyrus effendi*, ecology, environmental protection, Nakhchivan, fauna.

Ключевые слова: Lepidoptera, Satyridae, *Satyrus effendi*, экология, охрана окружающей среды, Нахичевань, фауна.

Abstract. New data on the distribution, ecology and population threats of the rare Satyr species *Satyrus effendi* Nekrutenko, 1989 (Lepidoptera, Satyridae) in the south of the Zangezur Ridge are presented. The variability of external morphological features is analyzed. The main factors influencing the dynamics of *S. effendi* populations in Nakhchivan Autonomous Republic (Azerbaijan) are described.

Резюме. Представлены новые сведения о распространении, экологии и угрозах популяциям редкого вида сатиров *Satyrus effendi* Nekrutenko, 1989 (Lepidoptera, Satyridae) на юге Зангезурского хребта. Анализируется изменчивость признаков внешней морфологии. Описаны основные факторы, влияющие на динамику популяций *S. effendi* в Нахичеванской Автономной Республике (Азербайджан).

Effendi's Satyr *Satyrus effendi* Nekrutenko, 1989 is one of the rarest and little known butterfly species from the Caucasus which belongs to the family Satyridae (Lepidoptera) [Nekrutenko, 1990]. This species is known for the few findings and it is a local endemic represented by several isolated populations in the highlands of the south of the Zangezur Ridge. The first known specimens of *S. effendi* in the museums and private collections date back to the second half of the 30s of the 20th century (“Нахичевань, Зангезурский хр., пос. Парагачай, 9000 ф., 9.08.1935” (in Cyrillic alphabet) [Nakhchivan, Zangezur Ridge, Paragachai village, 9000 f., 9.08.1935], “Нахичевань, Зангезурский хр., пос. Капуджих, 10500 ф., 17.08.1939” (in Cyrillic alphabet) [Nakhchivan, Zangezur Ridge, Kaputdzikh village, 10500 f., 17.08.1939]). Four males and two females were collected

later by A.V. Tsvetaev in 10.08.1970 near Pazmari village in Ordubad District of Nakhchivan at 3000 m a.s.l.. These specimens were included in the type series of the species, the holotype and paratypes are remaining in the fund collection of Zoological Museum of the Lomonosov Moscow State University (Russia) and in the private collection of V. Ganson [Nekrutenko, 1990]. Specimens of 1970 are also presented in the private collection of P.I. Beda (Lyubertsy, Moscow Region, Russian Federation). Besides, the specimens collected by Dr. V.K. Tuzov 30 July – 1 August 1986 near Nyus-Nyus village in Ordubad District of Nakhchivan were included in the type series. They were provided to the private collection of Dr. V.K. Tuzov and to the Zoological Museum of the National Academy of Sciences of Ukraine (according to Tschikolovets and Nekrutenko [2012], these types were not found there). Any other localities or collected samples of the species have not been known until recent time [Bogdanov, 2008], and the distribution of the species has been seemed to be restricted by the western slope of the southern part of the Zangezur Ridge inside the Nakhchivan territory. In 2011 the first data about finding of the species at the eastern slope of the Zangezur Ridge in Armenia were published. It was found in July and August near Kapuyt Lake in the Syunik Marz there, inside the territory mentioned by authors as “the prime butterfly area Lichk” [Aghababian, Khanamiryman, 2011]. Further articles of these authors (including the works of their co-authors) are based on this material [Khanamiryman et al., 2011; Khanamiryman, Kalashian, 2011].

Thus, four separate *S. effendi* populations have been known until now. Three populations are located in the Nakhchivan Autonomous Republic, Azerbaijan, near

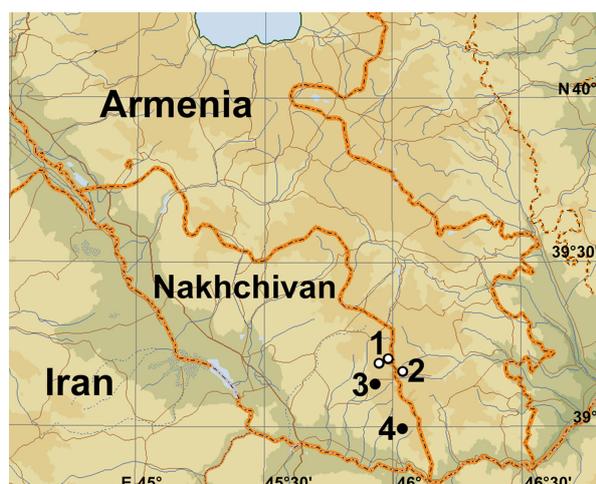


Fig. 1. The map of distribution of *Satyrus effendi*. The white circles indicate the confirmed modern observations of the species in 2010s.

Рис. 1. Карта распространения *Satyrus effendi*. Белыми кружками обозначены современные подтвержденные местонахождения вида в 2010-е годы.

Nyus-Nyus, Pazmari and highlands of Paragachai valley to the slopes of Kaputdzikh Mountain), and one inhabits the eastern Zangezur slope in Armenia near Kapuyt Lake (Fig. 1).

Notes on the distribution and biology of *S. effendi*.

In August 2016 we organized the expedition in Ordubad District of Nakhchivan Autonomous Republic for conducting the entomological and botanical investigations. During the field work the specification of the modern limits of distribution area and ecological characteristics of *S. effendi* were researched. The localities of previous species findings and the other mountainous places above 2200 m a.s.l. were additionally studied. The detailed investigation of Zangezur slopes near Nyus-Nyus village and adjacent southern and northern expositions above Ganza village, the tops of the mountains forming the western macroslope of the Zangezur Ridge didn't lead to any results. Also slopes and tops near Pazmari village, including the highest peaks above 3100 m a.s.l. to the north of this village that close the intermountain trough with the average heights of 2200 m a.s.l. were researched. In Pazmari vicinities different mountain expositions at 2200 – 3200 m a.s.l. were studied. In all this localities the species was not found in typical biotopes described in different sources as “well-warmed stony grassy slopes at 2000–3000 m” [Nekrutenko, 1989, 1990; Tschikolovets, Nekrutenko, 2012]. Besides, in Nyus-Nyus, Pazmari and Ganza vicinities the natural biotopes are strongly transformed by anthropogenic activity: about 90% of slopes square is used for intensive sheep and cattle grazing. The arable land, apiary, livestock temporary accommodations for the summer pastures are located in the ravines and intermountain troughs there. The pastures in the Pazmari vicinities are widespread up to 3100 m a.s.l., and livestock temporary accommodations are watered by local residents and covered by ruderal plants. The greatest species diversity of butterflies in this district is mentioned for the bottom of the gorge, among the springs, and with the height increasing

the diversity decreases. For instance, near Pazmari at 2600 m a.s.l. on the open stony pastures *Kretania alcedo* (Christoph, 1877), *Lycaena thetis* Klug, 1834, *Melanargia larissa* (Geyer, [1828]), *Pseudochazara daghestana savalanica* (Gross et Ebert, 1975), *P. thelephassa* (Geyer, [1827]), *Chazara persephone* (Hübner, [1805]), *Ch. briseis* (Linnaeus, 1764) are mentioned singularly. In this district at the height of 3000 m a.s.l. and higher some specimens of *Melanargia larissa*, *Chazara persephone* и *Plebejus argus* (Linnaeus, 1758) were observed.

The single small population of *Satyrus effendi* was found in 3–5 km east of Paragachai village of Ordubad District from 3000 to 3200 m a.s.l. Imagines inhabit the top of the slope spurs in this area, and also the highest adjacent sites of the northern exposition from this point to the west part of the Kaputdzikh Mountain directly at the Nakhchivan and Armenia boundary (Figs 2, 3). In this area the phytocenoses are obviously dispersed to vertical zones. Despite the great height of the *S. effendi*'s habitat in its biotope feather grass and bluegrass steppe communities are distributed; the dominant species are the endemic *Stipa araxansis* Grossh. (auct. *S. drobovii* (Tzvelev) Czerep.) and *Elytrigia aucherii* Boss. At the stony places around these communities the barbed plants are grown, such as *Acantholimon quinquelobum* Bunge and *A. karelinii* (Stschegl.) Bunge. The fewer plants are tragacanth as *Astragalus aureus* Willd., *A. flavirubens* Al. Fed., Fed. et Rzazade и *A. lagurus* Willd. On the top and the edge of the mountain bedrocks are exposed. On the rocky outcrops of the gray granite the petrophytes are dominated. By the floristic components they are little different from the steppe slope plant communities; the dominants are also *Acantholimon karelinii*, *Astragalus aureus*, *Stachys lavandulifolia* Vahl here, however on the cracks, rocks and scree *Sedum subulatum* (C.A. Mey.) Boiss., *Sempervivum transcaucasicum* Muirhead, *Vicia ciceroidea* Boiss. are common.

Thus, in the *S. effendi* biotope plant communities are formed by the mentioned above plants, herewith the indicator of species biotope is feather grass *Stipa araxansis* Grossh., that had not been found by us before in other places of Ordubad District during the expedition. The *S. effendi* females were mentioned only among the feather grass associations which is supposed to be a possible larval food plant (Fig. 3). Feather grass grows only at the tops of the spur slopes and saddle mountains here, therefore females kept to this sites and single females flew to the southern exposition of the slope.

Imagines feed on *Acantholimon* (Fig. 4) and *Scabiosa* flowers. Butterflies prefer sitting on the warm stones on the top of the ridge and the stones laying on the grassy meadows not lower than 3000 m a.s.l. at the northern expositions (Fig. 5). They are characterized by a fast low flight and maneuverable encircling of the rocky scree and outputs. The territorial behavior was not mentioned: in this place there were no *S. effendi* specimens among the hilltopping species. The females fly rarely and are confined to grassy associations with the predominance of feather grass.

In its locality from the Paragachai to Kaputdhikh Mountain the species was observed sympatric with the following butterfly species: *Melitaea interrupta* Kolenati,

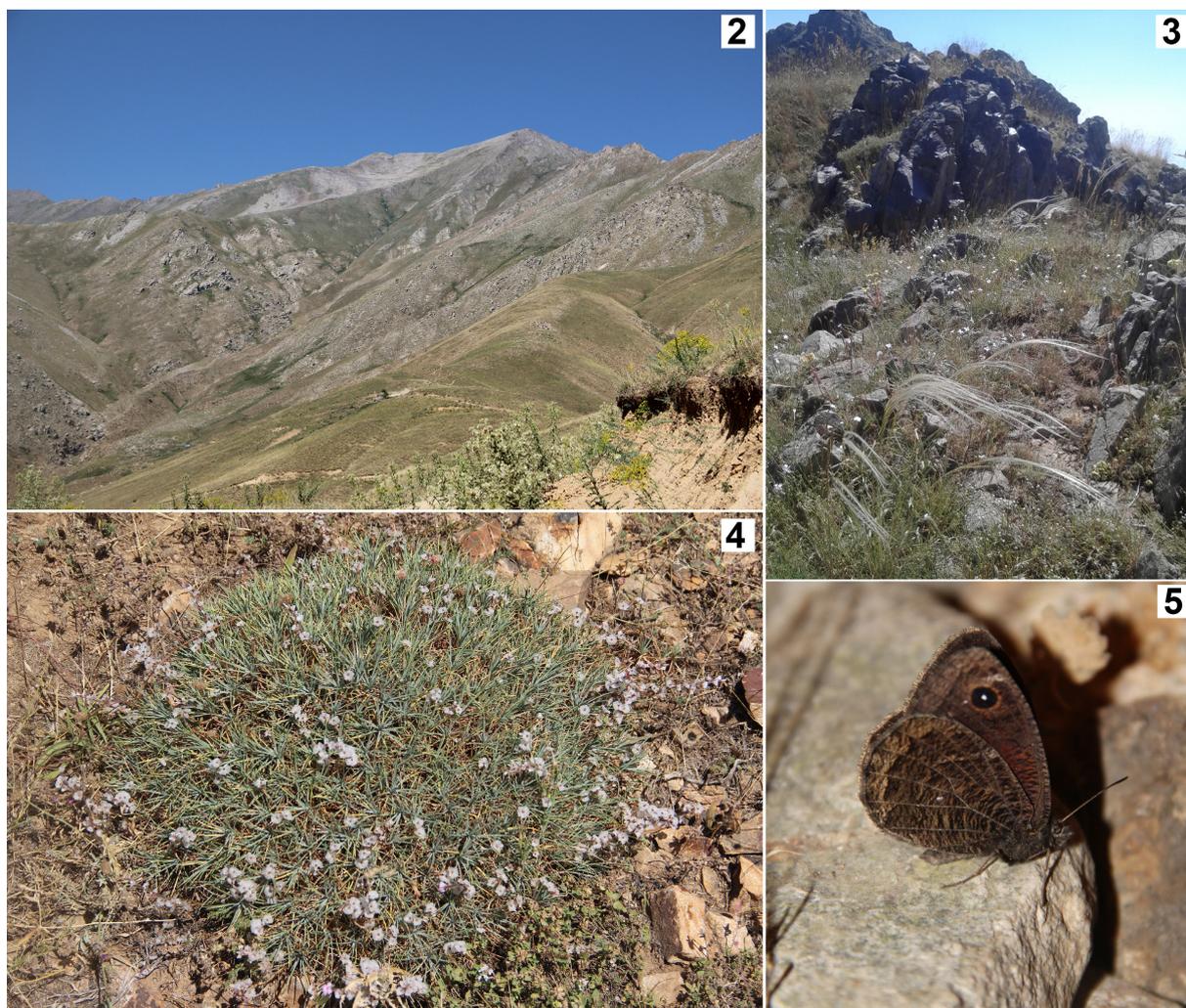
1846 (rare), *Chazara persephone* (frequent), *Pseudochazara thelephassa* (rare), *Polyommatus (Agrodiaetus) phyllis sheljuzhkoii* (Forster, 1960) (rare), *Hyponephele zuvandica* Samodurov et Korolev, 1996 (common), *Lasiommata megera* (Linnaeus, 1767) (frequent), *L. thetis* (common).

The recording of the species number was undertaken by the linear transects, and the density was researched by square method analysis. The recording area is about 2.5 km to 0.1 km (the width of the recording area was stated by the adjacent sites to the top, where the species were observed). In average, about 10 specimens were recorded during three hours of observations. The quantity of the species rises towards the top of the ridge, and the maximum of the specimens was recorded at 3200 m a.s.l. The number of observed specimens decreases towards the east (only two *Satyrus effendi* specimens were seen at the Kaputdzikh slope). Thus, our investigations confirmed the existence of one of formerly known populations of this species between Paragachai village and Kaputdzikh mountain at about

3000–3200 m a.s.l. From this place the first findings of the species are known in collections. The information about the distribution of the species from 1700 m a.s.l. [Nekrutenko, 1989] was not confirmed.

The imago variability analysis. The *S. effendi* species rank diagnosis was presented by Nekrutenko [1989] by the dichotomic identification key. The single apical spot on the forewing, the wide central brown-red patch on the fore wing underside, light veins on the hindwing underside and the absence of androconial patch were noted among the basic species features in the description. Afterwards these features used by different authors as main for the species identification [Nekrutenko, 1990; Tuzov et al., 1997].

According to Bogdanov [2008], the males have only one apical spot on the forewing. This feature is also included in the diagnosis and characterizes the type specimens [Nekrutenko, 1989, 1990]. The first description shows that one female has a small additional spot in the cell $Cu_1 - Cu_2$. However about 60% found by us specimens have

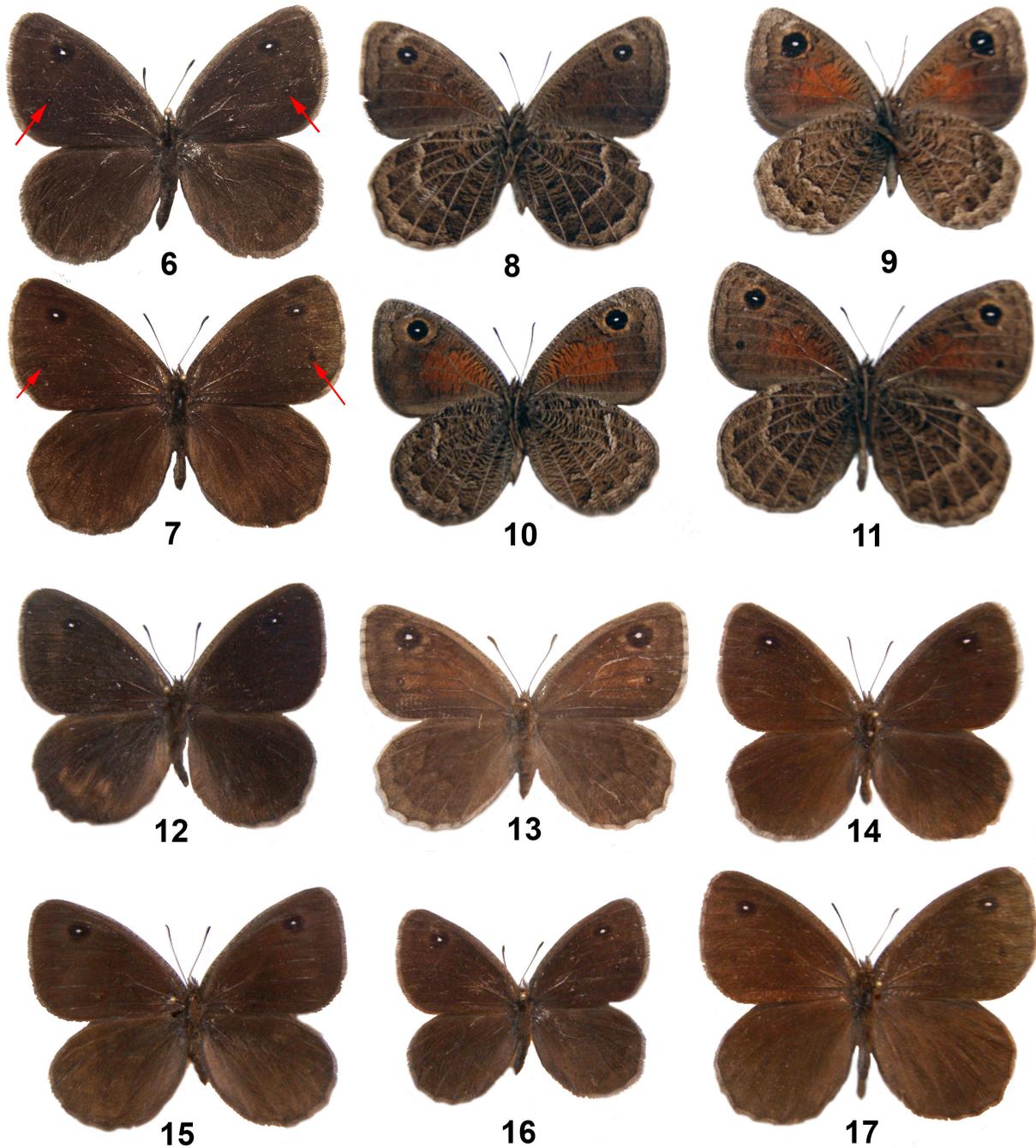


Figs 2–5. The biotopes and food plants of *Satyrus effendi*.

2 – the highlands of the southern part of the Zangezur Ridge; 3 – *Stipa araxensis* associations in the *S. effendi* biotope at 3050 m a.s.l.; 4 – *Acantholimon* is a preferred plant for the *S. effendi* imagines feeding; 5 – the *S. effendi* male sitting on the warm stones.

Рис. 2–5. Биотопы и кормовые растения *Satyrus effendi*.

2 – высокогорья южной части Зангезурского хребта; 3 – ассоциации *Stipa araxensis* в биотопе *S. effendi* на высоте 3050 м н.у.м.; 4 – *Acantholimon* – предпочитаемое растение для питания имаго *S. effendi*; 5 – самец *S. effendi*, сидящий на теплых камнях.



Figs 6–17. Variability of external characters of *Satyrus effendi*.

6–7 – the small additional spots in the cell $Cu_1 - Cu_2$ of males (arrows); 8–11 – the wings underside of 4 males, Azerbaijan, Nakhchivan Autonomous Republic, Paragachai – Kaputdzikh, 3000–3100 m a.s.l., 11.08.2016, D.V. Morgun leg. and coll.; 12–17 – the wings upperside of 5 males and 1 female (13), Azerbaijan, Nakhchivan Autonomous Republic, Paragachai – Kaputdzikh, 3000–3100 m a.s.l., 11.08.2016, D.V. Morgun leg. and coll.

Рис. 6–17. Изменчивость внешних признаков *Satyrus effendi*.

6–7 – мелкие дополнительные пятна в ячейке $Cu_1 - Cu_2$ у самцов (показаны стрелками); 8–11 – нижняя сторона крыльев четырех самцов, Азербайджан, Нахичеванская Автономная Республика, Парагачай – Капутджих, 3000–3100 м н.у.м., 11.08.2016, сборы и коллекция Д.В. Моргуна; 12–17 – верхняя сторона крыльев пяти самцов и одной самки (13), Азербайджан, Нахичеванская Автономная Республика, Парагачай – Капутджих, 3000–3100 м н.у.м., 11.08.2016, сборы и коллекция Д.В. Моргуна.

small black spots with white pupils in the cell $Cu_1 - Cu_2$ on the forewing (Figs 6, 7). This feature also expresses on the underside of the forewing of several specimens. The female also has the second spot on the upperside of the forewing. The variability of the brown-red patch on the underside of the forewing is high too (Figs 8–11). It varies by either

the square or expression grade: from the total absence to intensive patch covering the one third part of the wing square (Table 1).

The constant features including in the type series diagnosis are light veins on the hindwing underside and the absence of the androconial brand, but they are also

inherent for other species of the genus (*Satyrus amasinus* Staudinger, 1861 that is also distributed in Ordubad District at lower altitudes; the closest populations of *Satyrus iranicus* Schwingenschuss, 1939 are known from Talysh in Azerbaijan to the east and Van Province of Turkey to the west etc.). Thus, the most reliable features could be only differences of male genitalia: more rounded and compact tegumen shape of *S. effendi* male, configuration and proportions of valva and quantity and location of aedeagus teeth. Some morphological and ecological features are similar to the distributed to the west *Satyrus parthicus* Lederer, 1870, but *S. effendi* strongly differs by the absence of the male androconial brand, the dark monotonous fringe and the average bigger size (Figs 12–17).

The *S. effendi* population threats and conservation.

The primary factor in the decline of *S. effendi* can be an extreme fragmentation of their habitats following decades of habitat loss or unsuitable management. The remained grassy fields at high levels occur in small, isolated patches. As habitat loss is still continuing, fragmentation is a growing threat to this species. Habitat fragmentation occurs when habitat patches become smaller and further apart. Reducing habitat area can increase extinction risk through reductions in resource availability and a greater vulnerability to chance environmental variation. Habitat quality may also decline when habitat area decreases, because of increased “edge effects” from adjoining habitats. The threats are classified according to the International Union for Conservation of Nature approach here. The first is agriculture and particularly overgrazing.

The main reason of habitat fragmentation of *S. effendi* is the agricultural activity in the region despite the fact that it is included in the Ordubad National Park. The major driver of habitat loss and degradation is also the intensification of livestock grazing. The slopes situated behind the habitat of the species are strongly overgrazed as well as the potential habitats of *S. effendi* near Pazmari and Nyus-Nyus. Due to the overgrazing the main features of local species habitats are disturbance of plant cover in pastures, soil erosion, change of species composition of biocenoses that lead to the complex ecosystem degradation. The same threat was mentioned as one of the most important for eastern slopes of Zangezur Ridge in Meghri Region of Armenia [Khanamiryan, 2011].

It is difficult to estimate the population status and density dynamics due to the absence of the relevant data during last decades. But we suppose that the populations could always show low frequency and density. The future monitoring of the species populations is required, but it could be treated as endangered in the region now. However *S. effendi* is not included in the Red Data Book of Azerbaijan Republic [2013]. We also didn't mention any measures of nature conservation in this district of Ordubad National Park that can improve the population positive dynamics and avoid the risk of its habitat degradation. The signs marking the borders or objects of this reserved area were not found by us anywhere. The main conservation measure is the location of *S. effendi* populations in the closed area near the state Azerbaijan boundary that excludes the possibility of visiting this area.

Table 1. Variability of some diagnostic characters of *Satyrus effendi*. Males (n = 15).

Таблица 1. Изменчивость некоторых диагностических признаков *Satyrus effendi*. Самцы (n = 15).

Variable character Признак		Range (min) / Минимальное значение	Range (max) / Максимальное значение	SD / Стандартное отклонение	Mean / Среднее значение
Upperside Верхняя сторона крыльев	FW length from thorax to apex (mm) Длина переднего крыла от груди до вершины (мм)	24	32	5.65	28
	FW white pupils in black apical ocelli (number of specimens) Белые точки в черных апикальных глазках на переднем крыле (количество особей)	8	7	0.7	7.5
	FW black point in Cu ₁ – Cu ₂ (N) (number of specimens) Черная точка в ячейке Cu ₁ – Cu ₂ на переднем крыле (количество особей)	0	9	6.36	4.5
	FW white pupils in black ocelli in Cu ₁ – Cu ₂ (number of specimens) Белые точки в черных глазках в ячейке Cu ₁ – Cu ₂ на переднем крыле (количество особей)	0	6	4.24	3
Underside Нижняя сторона крыльев	FW brown-red discal area length (mm) Длина красно-коричневого дискального пятна на переднем крыле (мм)	0	12	8.48	6
	FW black point in Cu ₁ – Cu ₂ (number of specimens) Черная точка в ячейке Cu ₁ – Cu ₂ на переднем крыле (количество особей)	0	6	4.24	3
	FW whitish points in the submarginal area behind the apical spot (number) Беловатые точки в субмаргинальной области ниже апикального пятна на переднем крыле (количество)	0	2	1.41	1
	HW anal black spot (number of specimens) Черная точка в анальном углу на заднем крыле (количество особей)	0	3	2.12	1.5

Note. SD – standard deviation; FW – forewing; HW – hindwing.

Примечание. FW – переднее крыло; HW – заднее крыло.

The second factor influencing the species status is natural limitations of possible larval food plant. *Satyrus effendi* females were associated with *Stipa araxansis* on the top of the ridge, and this grain plant was not found anywhere at the lower elevations.

Other widespread and important factors determining the degradation of butterfly populations in some adjacent regions can't influence dramatically the status of *S. effendi* populations. Tourism and recreation is practically impossible in Nakhchivan Autonomous Republic nowadays and it is especially forbidden near its boundary. Ordubad National Park doesn't provide the facilities of environmental tourism. Infrastructure development is not expressed here as well as urbanization and spreading pollutions in this territory.

In Armenia this species is reserved in Zangezur Biosphere Complex in the area of Lichk Prime butterfly territory. This area (about 1979 ha) is located at the eastern slopes of the Zangezur Mountain Ridge. According to Aghababyan and Khanamiryan [2014], "population of *Satyrus effendi* is of special concern as it occupies around 0.5 ha, and this is a third known population of this endemic species around the world".

The major threats for butterflies of this area are related to overgrazing and in a less scale by the habitat change due to construction of the major gas pipeline. One of the major income sources for the two villages located at the area is livestock husbandry. Thus the area serves for grazing and haymaking. The livestock (mainly cattle, goats, and sheep) is grazing here from April till October. Due to the intensive grazing there is a danger of host-plants removal of key species, destruction of productive top-soil at the slopes by feet of livestock, and prevention of regeneration of trees in forest areas due to elimination of young growth.

Satyrus effendi is not included in the current edition of National Red Data Book of Armenia [2010], but it is recommended to be included there as a threatened species in the region [Khanamiryan, 2012].

In order to improve the conservation status of the local and rare endemic *S. effendi* and to reverse the negative trends, further actions are urgently needed. In particular:

- create and save *S. effendi* habitats as Prime Butterfly Area in the Ordubad National Park that could be integrated in the network of this territories in Western Palaearctic;
- establish a co-ordinated system of rare insects recording and monitoring to improve future priority assessments and assess the impact of conservation measures and future environmental change;
- develop national measures to conserve entire landscapes and reduce impact fragmentation and isolation;
- revise the national Red list of butterfly species and include *S. effendi* in it as threatened or near threatened species having monitored its actual population status in the region.

Anyhow, it would be necessary to conduct further ecological research of this endemic species to perform the adequate management of its habitat and lead the special conservation program.

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