

Trophic links of *Parnassius (Kailasius) charltonius* GRAY, [1853] (Lepidoptera, Papilionidae) to the species of the genus *Corydalis* DC. (Papaveraceae) in the Alai and Turkestan Ranges

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Abstract: New data on hostplants specialization of *Parnassius (Kailasius) charltonius* GRAY, [1853] (Lepidoptera, Papilionidae) at the northern border of its distribution area in Alai and Turkestan Ranges are presented in this paper. The trophic links are revealed between the populations of the butterfly and 7 species of *Corydalis* DC. (Papaveraceae): *C. heterophylla* MIKHAILOVA, *C. pseudoadunca* M. POP., *C. paniculigera* REGEL et SCHMALH., *C. schelesnowiana* REGEL et SCHMALH., *C. pseudostricta* M. POP., *C. sochivkoi* MIKHAILOVA (all section *Strictae* (FEDDE) WENDELBO), and *C. onobrychis* FEDDE (section *Chrysocapnos* WENDELBO).

Keywords: *Parnassius*, *Kailasius*, *charltonius*, *romanovi*, *Corydalis*, section *Strictae*, section *Chrysocapnos*, trophic links.

Трофические связи парусника *Parnassius (Kailasius) charltonius* GRAY, [1853] (Lepidoptera, Papilionidae) с видами рода *Corydalis* DC. (Papaveraceae) в Алайском и Туркестанском хребтах

Abstract: В статье приводятся новые сведения о кормовой специализации *Parnassius (Kailasius) charltonius* GRAY, [1853] (Lepidoptera, Papilionidae) на северной границе его ареала в Алайском и Туркестанском хребтах. Выявлены трофические связи популяций парусника и 7 видов рода *Corydalis* DC. (Papaveraceae): *C. heterophylla* MIKHAILOVA, *C. pseudoadunca* M. POP., *C. paniculigera* REGEL et SCHMALH., *C. schelesnowiana* REGEL et SCHMALH., *C. pseudostricta* M. POP., *C. sochivkoi* MIKHAILOVA (все из секции *Strictae* (FEDDE) WENDELBO) и *C. onobrychis* FEDDE (секция *Chrysocapnos* WENDELBO).

Futterpflanzenbeziehungen von *Parnassius (Kailasius) charltonius* GRAY, [1853] (Lepidoptera, Papilionidae) zu den Arten der Gattung *Corydalis* DC. (Papaveraceae) in den Alai- und Turkestan-Gebirgen

Zusammenfassung: Neue Beobachtungen zur Raupenfutterpflanzenpezifität von *Parnassius (Kailasius) charltonius* GRAY, [1853] (Lepidoptera, Papilionidae) im Bereich der nördlichen Arealgrenze der Art in den Alai- und Turkestan-Bergketten werden vorgestellt. Trophische Beziehungen einzelner Falterpopulationen zu 7 Arten der Gattung *Corydalis* DC. (Papaveraceae) wurden nachgewiesen: *C. heterophylla* MIKHAILOVA, *C. pseudoadunca* M. POP., *C. paniculigera* REGEL et SCHMALH., *C. schelesnowiana* REGEL et SCHMALH., *C. pseudostricta* M. POP., *C. sochivkoi* MIKHAILOVA (alle Sektion *Strictae* (FEDDE) WENDELBO), sowie *C. onobrychis* FEDDE (Sektion *Chrysocapnos* WENDELBO).

Introduction

The Alai and Turkestan Ranges constitute the northern border of the distribution area of *Parnassius charltonius* GRAY, [1853]. The Alai Range is viewed as a bridge for the distribution of *P. charltonius* to the west and resul-

ting colonization of the eastern half of the Turkestan Range. Three subspecies have been described from the Alai Range: *P. ch. romanovi* GR.-GR., 1885, *P. ch. sochivkoi* CHURKIN, 2009, *P. ch. alraschid* CHURKIN & PLETNEV, 2012. From Turkestan Range *P. ch. platon* SOCHIVKO & KAABAK, 2011 is known (SOCHIVKO & KAABAK 2011, SOCHIVKO & MIKHAILOVA 2014).

P. charltonius is distributed over the mountainous regions of NW. India, N. Pakistan, NE. Afghanistan, Tajikistan and S. Kyrgyzstan (Text-Fig. 1). Recent research clarified the area borders in the north-eastern part of the entire distribution area, in the Inner Tian-Shan (CHURKIN 2009). Here the butterfly was found in the basins of Arpa and Alabuga Rivers on the foodplant *Corydalis pseudoadunca* M. POP.

G. GRUM-GRSHIMAILO was the first to mention this *Parnassius* butterfly inhabiting the territory of Middle Asia in his report on the expedition to Eastern Bukhara in 1884 (GRUM-GRSHIMAILO 1885). Two populations of the butterfly were discovered – the first in the Alai and the second in the neighboring Transalai Range –, both in the westernmost part of the Alai Valley. At the time of publication of his report G. GRUM-GRSHIMAILO was not yet aware of GRAY's description of *P. charltonius* and suggested to call this attractive butterfly “*Parnassius Romanovi* m.” to honor Grand Duke Nikolai Mikhailovitch ROMANOV, the patron and sponsor for the expedition. A couple of years later he recognized the priority of the then accepted name – *Parnassius charltonius* GRAY (GRUM-GRSHIMAILO 1890).

F. BRYK was the first to use the combination “*Kailasius charltonius* var. *romanovi* GR.-GR.” (BRYK 1913).

A. V.-A. KREUZBERG used again the epithet “*romanovi*” when he suggested to distinguish four big groups of populations within the distribution area of *P. charltonius*, the northernmost of which was called the “*romanovi* group” (KREUZBERG 1985). Some authors hold similar views (WEISS 1991, SAKAI et al. 2002, ROSE & WEISS 2011). A number of speculations about the distribution and morphological traits of the *romanovi* group were published recently (CHURKIN 2009, SOCHIVKO & KAABAK 2011, CHURKIN & PLETNEV 2012, 2014, CHURKIN & MICHEL 2014, SOCHIVKO & MIKHAILOVA 2014).

The variability of the butterflies within the *romanovi* group is reflected in the intraspecific systematics of *Parnassius charltonius*. In the opinion of some authors the

taxon *P. ch. romanovi* represents a distinct species *Parnassius romanovi* GRUM-GRSHIMAILO, 1885 (CHURKIN & MICHEL 2014). In the present paper we adhere to the traditional understanding of the infraspecific taxonomy of *Parnassius charltonius*.

Different species of the genus *Corydalis* DC. are the hostplants for *P. charltonius* caterpillars. In the Alai and Turkestan Ranges these are primarily species belonging to the section *Strictae* (FEDDE) WENDELBO. The section includes perennial xerophytic, mostly tall herbaceous plants (60–80 cm tall) able to grow throughout the entire summer period, forming sod mats up to 60 cm in diameter and colonizing diverse habitats: conglomerate bluffs, rocks, rubble-loamy slopes and gypsum outcrops along the rivers. *Corydalis heterophylla* MIKHAILOVA, *C. pseudo-adunca* M. POP. and *C. paniculigera* REGEL et SCHMALH. are found in Alai Range, while *C. schelesnowiana* REGEL

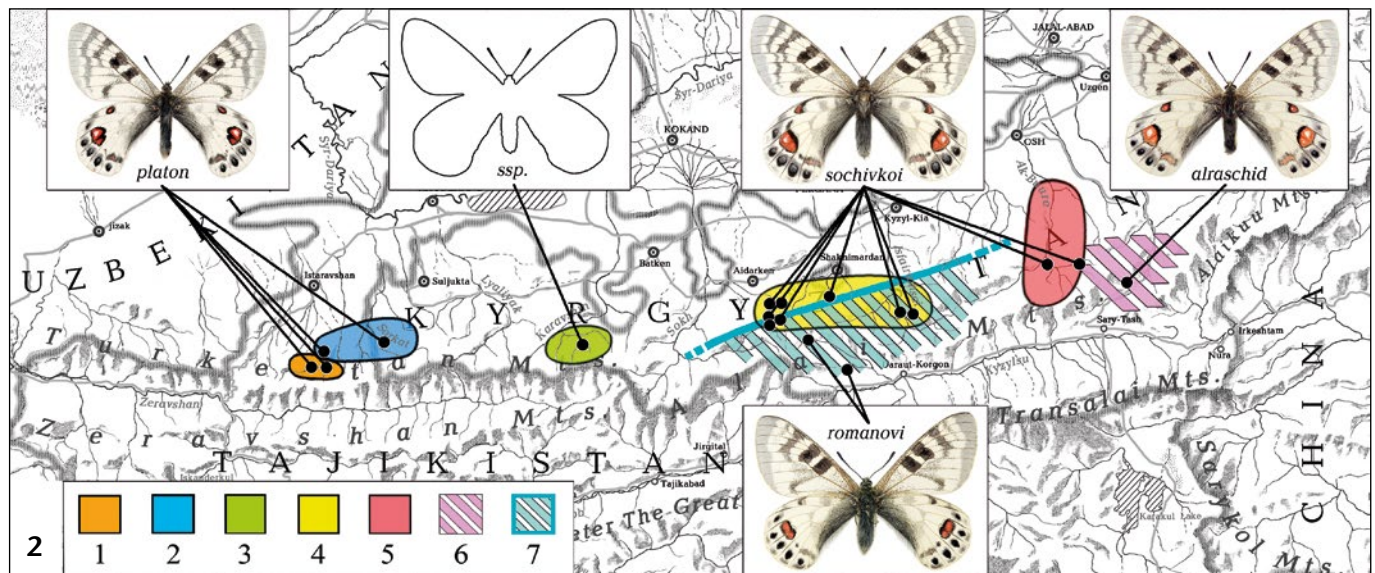
et SCHMALH., *C. pseudostricta* M. POP., *C. sochivkoi* MIKHAILOVA are found in Turkestan Range (MIKHAILOVA 1981, 1982, 2011).

C. gortschakovii SCHRENK and *C. onobrychis* FEDDE (section *Chrysocapnos* WENDELBO) are also hostplants for *P. charltonius*. The species of this section are perennial herbaceous plants 40–70 cm tall, forming sod mats and growing in rock splits, among stones, on loess slopes and wet alpine meadows. Both species occur in Alai Range, while in Turkestan Range only *C. onobrychis* grows (MIKHAILOVA & SOCHIVKO 2011).

According to R. KAMELIN's floristic zonation, the territory under exploration presents a junction of different floristic districts where the migration routes from different directions meet together (KAMELIN 1973). Perhaps this can explain the presence of eight *Corydalis* species in this area (Text-Fig. 2).



Text-Fig. 1: Distribution area of *Parnassius (Kailasius) charltonius* GRAY, [1853].



Text-Fig. 2: Trophic links of different populations of *Parnassius (Kailasius) charltonius* GRAY to the species of the genus *Corydalids* DC. in the Alai and Turkestan Ranges: 1: *C. pseudostricta* M. POP. 2: *C. schelesnowiana* REGEL et SCHMALH. 3: *C. sochivkoi* MIKHAILOVA. 4: *C. paniculigera* REGEL et SCHMALH. 5: *C. heterophylla* MIKHAILOVA. 6: *C. pseudoadunca* M. POP., partial distribution area. 7: *C. onobrychis* FEDDE, partial distribution area.

The previously collected plant material deposited in the Herbarium of Komarov Botanical Institute, St.-Petersburg (International Herbarium abbreviation: LE) and also those specimens collected recently by the authors are used to outline the hostplants distribution areas.

The present study investigates the feeding specialization of *P. charltonius* related to non-tuberous species of the genus *Corydalids* in Alai and Turkestan Ranges. The habitats with relevant trophic links are listed below. Different stages of insect live cycle were observed and documented (see examples in Plate 1), the hostplants were collected and identified, and also deposited in LE.

The habitats in the Alai Range

The population of *P. ch. sochivkoi*

Material studied: SW. Kyrgyzstan, Kadamzhai distr., 15–17 km N Khaidarken Town, Alai Range (northern slope), Allaiddin River, 2850–2900 m, 7.–10. VII. 2006 (larvae), imagines hatched in III.–IV. 2007, A. SOCHIVKO, L. KAABAK & V. LESIN leg.; same locality, 4.–11. VII. 2007, same collectors.

Note. It was reported that the butterfly had been found in the same district at the source of the Allaiddin River: “Gaumish Pass, East Kara-Su Range [*sic!* = Kuruk-Sai], 3500 m, 20.–27. VII. 1999” (SAKAI 2002).

Hostplants. *Corydalids onobrychis* FEDDE (Plate 1, Fig. 7): SW. Kyrgyzstan, Kadamzhai distr., 15–17 km N of Khaidarken Town, Alai Range (northern slope), Allaiddin River, shingle bed near the water, 2900 m, 5.–15. VII. 2006, A. SOCHIVKO leg., M. MIKHAILOVA det. – (LE).

C. paniculigera REGEL et SCHMALH.: SW. Kyrgyzstan, Kadamzhai distr., 15–17 km N Khaidarken Town, Alai Range (northern slope), Allaiddin River, conglomerate bluffs along the river canyon and rocks above them, 2800 m, 10. VII. 2006, A. SOCHIVKO leg., M. MIKHAILOVA

det.; same locality, 2800–2950 m, 1.–12. VII. 2007, A. SOCHIVKO leg., M. MIKHAILOVA det. – (LE).

The population of *P. ch. sochivkoi*

Material studied: SW. Kyrgyzstan, Kadamzhai distr., 25 km SW Shakhimardan Town, Alai Range (northern slope), Eki-Daban River, 3000 m, 23.–25. VII. 2009, A. SOCHIVKO leg.; 20 km E Khaidarken Town, Kaiyngdy River, 2500 m, 27.–28. VII. 2009, A. SOCHIVKO leg.

Hostplant. *Corydalids paniculigera* REGEL et SCHMALH. (Plate 1, fig. 4): SW. Kyrgyzstan, Kadamzhai distr., 30 km SW Shakhimardan Town, Alai Range (northern slope), Eki-Daban River, stony slopes under rocks, 3000 m, 24.–25. VII. 2009, A. SOCHIVKO leg., M. MIKHAILOVA det.; 20 km E Khaidarken Town, Kaiyngdy River, conglomerate bluffs along the river canyon, 2400–2500 m, 27.–28. VII. 2009, A. SOCHIVKO leg., M. MIKHAILOVA det. – (LE).

The population of *P. ch. sochivkoi*

Material studied: S. Kyrgyzstan, Osh distr., 50 km S Osh Town, Alai Range (northern slope), Ak-Buura River, 1800–2200 m, 24. VI. 2009, B. KHRAMOV leg.; 70–80 km S Osh Town, upper stream of Ak-Buura River, 2600–2700 m, 25. VI.–2. VII. 2009, S. CHURKIN, V. PLETNEV & B. KHRAMOV leg.; same locality, 2700–2800 m, 28.–29. VI. 2008, S. CHURKIN, V. PLETNEV & S. SALUK leg.; same locality, Turuk River (left trib. of Ak-Buura River), 2500 m, 28. VII. 2009, A. SOCHIVKO leg.

Note. The ovipositions of the butterfly were found by A. SOCHIVKO at 2000 m elevation on western facing abrupt rocks close to the hostplant. Imagines were observed higher, at 2500–2800 m.

Hostplant. *Corydalids heterophylla* MIKHAILOVA (Plate 1, fig. 5): S. Kyrgyzstan, Osh distr., 70 km S Osh Town, E.



Plate 1: Immature stages and hostplants of *Parnassius (Kailasius) charltonius sochivkoi* CHURKIN, 2009. — **Fig. 3:** Female laying eggs on conglomerate bluff near *Corydalis paniculigera*. — **Fig. 4:** *C. paniculigera* REGEL et SCHMALH. — **Fig. 5:** *C. heterophylla* MIKHAILOVA. — **Fig. 6:** Eggs from the previous year on rock near *C. heterophylla* plant. — **Fig. 7:** Larva feeding on *C. onobrychis* FEDDE. — **Fig. 8:** Pupa just before imago hatching. — All photos A. SOCHIVKO.

Alai Range (northern slope), Turuk River, abrupt cliffs along the river canyon and rubble-loamy slopes below them, 2000 m, 24.–26. vi. 2008, A. SOCHIVKO leg., M. MIKHAILOVA det.; same locality, among destroyed rocks, 2500 m, 28. vii. 2009, A. SOCHIVKO leg., M. MIKHAILOVA det. — (LE).

The population of *P. ch. alrashid*

Material studied: S. Kyrgyzstan, Osh area, Osh distr., E. Alai Range (northern slope), Gulcha River, 13.–23. vii. 2011, S. CHURKIN, V. PLETNEV & V. KOROSTELEV leg.

Hostplant. *C. pseudoadunca* M. POR.: S. Kyrgyzstan, Osh area, Osh distr., Alai Range (northern slope), Gulcha River, rubble-loamy slopes, vii. 2013, S. CHURKIN leg., M. MIKHAILOVA det. — (LE).

Besides the samples of cohabitation mentioned above, there are some data about the other populations of *P. charltonius* in Alai Range but without identified host-plants (listed below):

P. ch. romanovi: SW. Kyrgyzstan, W. Alai Range (southern slope), E-SE of Abramov glacier, the valleys of Kok-Su and Tekelik Rivers, 3000–3700 m (see Fig. 2).

Since G. GRUM-GRSHIMAILO had discovered this population in 1884, the subspecies was recently collected only once in 1974 by O. LEGEZIN. *P. ch. sochivkoi*: S. Kyrgyzstan, Shakhimardan Town area, over Yardan (Iordan) vill., Alai Range (northern slope), Dugoba River, 2500–3000 m. Discovered by V. MURZIN in 1984–1985 (MURZIN 1990). V. TSHIKOLOVETS describes its habitat as the following: cliffs, screes and rocky slopes with *Juniperus* growth (TSHIKOLOVETS 1997).

P. ch. sochivkoi: S. Kyrgyzstan, 30 km SW Shakhimardan Town, Alai Range (northern slope), upper stream of Isfairsamsai River, Langar vill. vicin., 2800–3300 m. Discovered by I. PLIUSHCH in 1996. Main observations were made by him in 1997 and 1999. I. PLIUSHCH (pers. comm.) characterizes the habitat as rocks and screes along one of the mountain gorges.

The habitats in the Turkestan Range

The population of *P. charltonius* ssp.

The ovipositions of the butterfly were found: SW. Kyrgyzstan, Batken prov., Leilek distr., Turkestan Range (northern slope), 15 km S Vorukh vill., Kindyk River (right trib. of Karavshin River), Kurkindyk stow, on stones near the hostplant, 2600 m, 2. VIII. 2009, A. SOCHIVKO leg. & det.

Hostplant. *Corydalis sochivkoi* MIKHAILOVA: SW. Kyrgyzstan, Batken prov., Leilek distr., Turkestan Range (northern slope), 15 km S Vorukh vill., Jiptyk River and Mynteke River confluence, conglomerate bluffs along the river and steep rubble-loamy slopes, 2600 m, 1. VIII. 2009, A. SOCHIVKO leg., M. MIKHAILOVA det.; same locality, Kindyk River (right trib. of Karavshin River), Kurkindyk stow, steep rubble-loamy slopes along the river, 2600 m, 2. VIII. 2009, A. SOCHIVKO leg., M. MIKHAILOVA det. — (LE).

The population of *P. ch. platon*

Material studied: SW. Kyrgyzstan, Batken prov., Leilek distr., Turkestan Range (northern slope), Sarkat River, 1500 m, 15. VII. 2009, A. SOCHIVKO leg.; same locality, 1500–1800 m, 12.–18. VII. 2009, A. SOCHIVKO, L. KAABAK and V. LESIN leg.; same locality, 20.–27. VII. 2010, L. KAABAK leg.

Hostplant. *Corydalis schelesnowiana* REGEL et SCHMALH.: SW. Kyrgyzstan, Batken prov., Leilek distr., Turkestan Range (northern slope), 20 km SW Isfana Town, Dinau vill. vicin., Sarkat River, conglomerate bluffs along the river canyon and steep rubble-loamy slopes, 1700 m, 6. VII. 2009, A. SOCHIVKO leg., M. MIKHAILOVA det. — (LE).

The group of populations of *P. ch. platon*

Material studied: NW. Tajikistan, Istaravshan distr., above Basmanda vill., Turkestan Range (northern slope), Yangiaryk River, 1900 m, 26.–27. VII. 2010, A. SOCHIVKO & V. LESIN leg.; same locality, Argly River, Ovchi vill. vicin., 2100–2200 m, 24.–26. VII. 2010, A. SOCHIVKO and V. LESIN leg.; same locality, Ughuk vill. vicin., Shagan River, 2200–2300 m, 28. VII. 2010, A. SOCHIVKO & V. LESIN leg.

Hostplants. *Corydalis schelesnowiana* REGEL et SCHMALH.: NW. Tajikistan, Istaravshan distr., Basmanda vill. area, Turkestan Range (northern slope), Yangiaryk River, 1800–1900 m, conglomerate bluffs along the river and steep rubble-loamy slopes, 27. VII. 2010, A. SOCHIVKO leg., M. MIKHAILOVA det. — (LE).

Corydalis pseudostricta M. Pop.: NW. Tajikistan, Istaravshan distr., Turkestan Range (northern slope), Ovchi vill. vicin., Argly River, 2100 m, rubble-loamy slopes, 26. VII. 2010, A. SOCHIVKO leg., M. MIKHAILOVA det.; same locality, Ughuk vill. vicin., Shagan River, 2000 m, rubble-loamy slopes, 28. VII. 2010, A. SOCHIVKO leg., M. MIKHAILOVA det. — (LE).

Conclusions

The distribution of *Parnassius charltonius* in the Alai and Turkestan Ranges is generally restricted to altitudes of 1800–3000 m. Here, in the most favorable conditions, the maximum density of butterflies and immature stages were observed. Rarely the butterflies life traces were found at lower altitudes: *P. ch. sochivkoi* at 1800 m, *P. ch. platon* at 1500 m. High summer temperatures impede the caterpillars' development at such altitudes.

Hostplants can be found at a broader range of altitudes than the butterflies, starting already: *Corydalis schelesnowiana* at 1200 m, *C. heterophylla* at 1000 m.

P. ch. sochivkoi inhabits almost the entire northern slope of Alai Range and uses at least 3 species of plants: *C. heterophylla*, *C. paniculigera* and *C. onobrychis*.

P. ch. alrashid is stated to link with *C. pseudoadunca* only (CHURKIN & PLETNEV 2012). However, the published data on distribution and food preferences of this subspecies remain scarce and need clarification.

Hostplant specialization of *P. ch. romanovi* in the Alai Range is not yet fully clear. The distribution area of this subspecies is congruent with *Corydalis gortschakovii* and *C. onobrychis* areals. In entomological publications *C. gortschakovii* is often mentioned as one of the hostplants for *P. charltonius* caterpillars on the territory of Middle Asia (ACKERY 1975, TSHIKOLOVETS 1997, TOROPOV & ZHDANKO 2006, WEISS 1991). Currently we do not possess any evidence for butterfly development on this species of *Corydalis* in Alai and Turkestan Ranges. Only A. V.-A. KREUZBERG (KREUZBERG 1984, 1987a, 1987b) linked the development of *P. charltonius* with *C. onobrychis*, that fits our new data.

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