

## Short Communication: Biology and distribution of *Parnassius apollo* (Linnaeus, 1758) a rare species in Mordovia Republic, Russia

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**Abstract.** Ruchin AB, Grishutkin GF. 2018. Short Communication: Biology and distribution of *Parnassius apollo* (Linnaeus, 1758) a rare species in Mordovia Republic, Russia. *Biodiversitas* 19: 431-436. There are three isolated populations of *Parnassius apollo* in Mordovia. The population, found in Mordovia Nature Reserve, is in a sad state and requires urgent protection measures. The second largest population lives in Bolshie Berezniki district. Butterflies from this population are locally found on glades, cuttings, floodplain meadows. It has fragmented (mosaic) structure of records and a low number of adults. The largest population inhabits Smolny National Park. Irruption typically occurs in this population every few years. The most significant negative impact on the population of Apollo in Mordovia is caused by overgrowing of habitats by small-leaved forests, fragmentation of landscapes, isolation of populations. Data on the number of butterflies and the species composition of fodder plants for the imago of Apollo are given.

**Keywords:** Abundance, butterflies, ecology, Mordovia Republic, *Parnassius apollo*, rare species

### INTRODUCTION

The Apollo butterfly *Parnassius apollo* (Linnaeus, 1758) is one of the largest swallowtail butterflies. This species is considered the most vulnerable of Lepidoptera in the northern Palearctic (Gorbach et al. 2015; Todisco et al. 2010; van Swaay et al. 2012). It occurs in most of the large mountainous areas in Europe: Spain, south of France, Switzerland, Austria, south of Germany as far as the Mosel, Italy, the Balkans and Greece, south of Norway, Sweden and Finland at 1000-2400 m above sea level, sometimes at lower altitudes. Its range extends to the Tian-Shan, Siberia, and Mongolia; and from the Northern Urals to Transcaucasia, Turkey and the Middle East. The global distribution area of the species covers territories both within and outside Europe (van Swaay et al. 2017). In Lithuania, Latvia, Belarus, Romania, as well as in Smolensk, Voronezh (butterfly was registered in 1971 for the last time), Moscow, Yaroslavl and some other regions of Russia, it is now known only from old findings (Nakoneczny et al. 2007, Red Data Book of Russian Federation 2001). The Apollo butterfly is a critically endangered and therefore nationally and internationally protected species.

The purpose of our research was to study the distribution of Apollo, its populations, abundance and distribution of the specimens in largest population in Republic of Mordovia, and a brief analysis of the butterflies number in adjacent regions.

### MATERIALS AND METHODS

#### Study site

The Republic of Mordovia is located in the center of the East European Plain between 42°11' and 46°45' east longitude and 53°38' and 55°11' north latitude in the southwestern periphery of the Volga basin in the interfluvium of rivers Moksha and Sura. The territory includes forest and forest-steppe zones of Central Russia. The eastern part of Mordovia occupies the northwest of the Volga Upland and the western part of the Oka-Don lowland. In this regard, a variety of habitats is observed in the area of study. Broad-leaved forests cover the central and eastern parts. Forest-steppe landscapes predominate in the east and southeast (Yamashkin 1998).

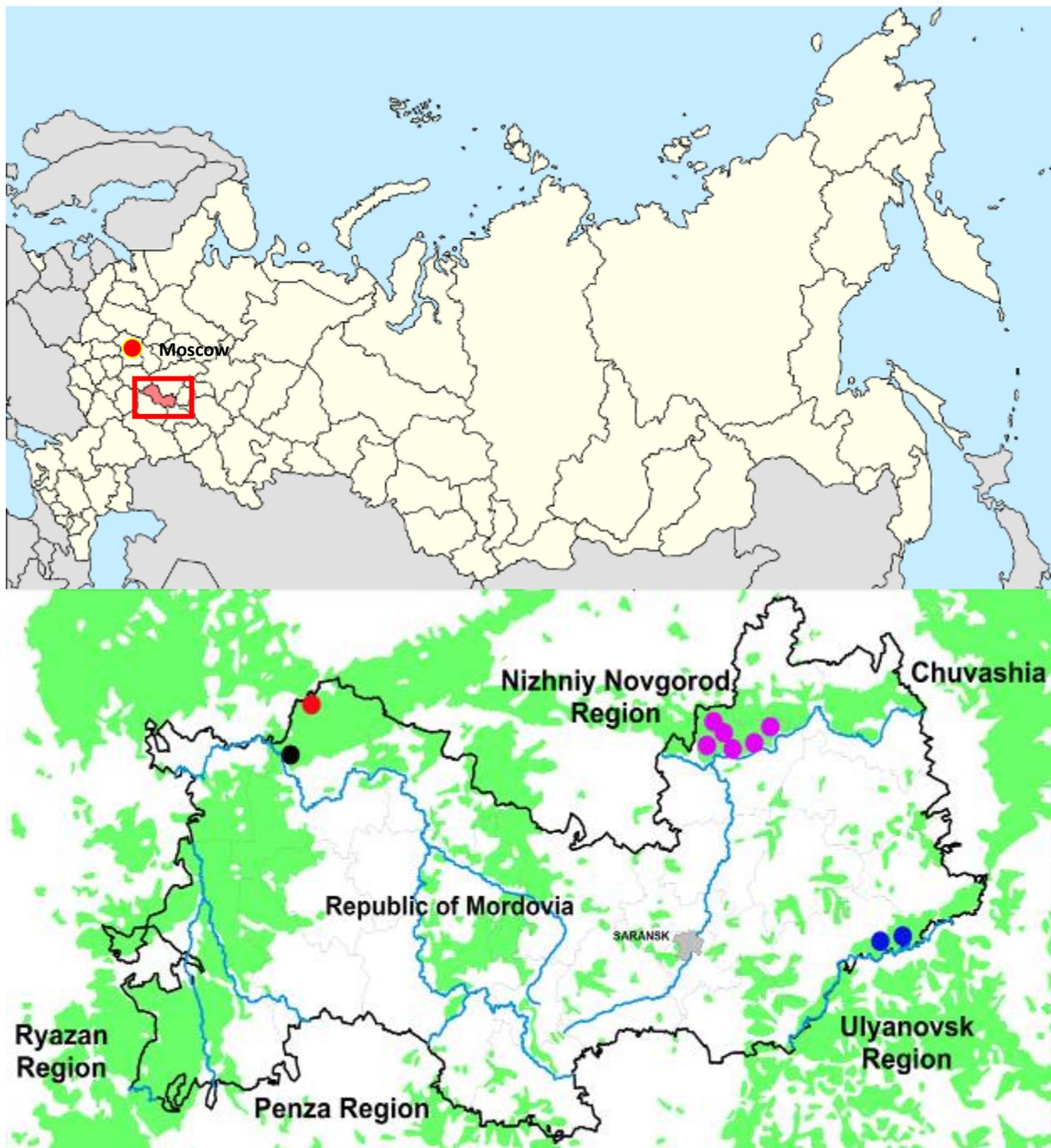
#### Materials

Material, observed in the wild, is presented here. Catches were not performed. Numbers were evaluated visually on certain routes, while simultaneously monitoring the feeding of imago butterflies.

Republic of Mordovia: 1 imago, Temnikov district, Mordovia Nature Reserve, Inor cordon, 4.vii.1984, O. Volkov leg.; 1 larva, Temnikov district, Mordovia Nature Reserve, cordon Srednaya Melnitsa, 4.vi.2016, A. Nikolaeva leg.; 1 imago, Temnikov district, Mordovia Nature Reserve, cordon Srednaya Melnitsa, 23.vi.2016, D. Parshin leg.; 74 imago, Bolshie Berezniki district, 9 km S from Simkino Village, 28.iv.1995, 10.vii.1996, 12.vii.2001, 14.vii.2002, 03.vii.2009, 28.vi.2009, A. Ruchin leg.; 2

imago, Ichalki district, Smolny National Park, Lvovskoe forestry, Obrezki Village, 22.vii.2007, 05.vii.2008, A. Ruchin leg.; 5 imago, Ichalki district, Smolny National Park, Lvovskoe forestry, Obrezki Village, 3.vii.2017, G. Semishin leg.; 5 imago, Ichalki district, Smolny National Park, Lvovskoe forestry, zone 63, zone 70, 2.vii.2007, A. Lapshin leg.; 29 imago, Ichalki district, Smolny National Park, Barakhmanovskoe forestry, zone 101, 20.vii.2006, zone 112, 10.vii.2002, 20.vii.2006, zone 98, 25.vii.2017, zone 99, 27.vii.2017, A. Ruchin leg.; 12 imago, Ichalki

district, Smolny National Park, Kemlyanskoe forestry, zones 42, 61, 65, 76, 86, 77, 93, 106, 6.vii.2001, 2.vii.2004, 4.vii.2004, G. Grishutkin leg.; 7 imago, Ichalki district, Smolny National Park, Barakhmanovskoe forestry, zone 113, 20.vii.2006, A. Ruchin leg.; more than 400 imago, Ichalki district, Smolny National Park, Barakhmanovskoe forestry, zones 74-77, 86-113, 2.vii.2004, 4.vii.2004, 25.vii.2005, 17.vii.2006, 26.vi.2009, G. Grishutkin leg.; 1 imago, Ichalki district, Sosnovka Village, 03.vii.2008, A. Ruchin leg.



**Figure 1.** Map of the finds of the Apollo in Mordovia. A black point shows the extinct population. Red, blue and purple points show the presently existing populations (respectively, in Temnikov district, Bolshie Berezniki district and Ichalki district)

## RESULTS AND DISCUSSION

### Results

There are only four populations of Apollo (Figure 1) reliably known in Mordovia in the last 50 years, one of which is now extinct.

In Mordovia Nature Reserve this species was first discovered by S.M. Nesmerciuk in 1937, and by O.G. Volkov, later in 1984 (Ruchin and Egorov 2017). After that, Apollo was not observed here for a long time. Only in 2016, it was found on the edge of broad-leaved forest near the Srednaya Melnitsa cordon. One of the reasons for the Apollo rarity in the reserve is the narrow food specialization of caterpillars. Small groups of caterpillar forage plants are located in a small area along the edge of the forest and along the road near the Srednaya Melnitsa cordon. The previously known (in 1984) population on Inor cordon in the Mordovia Nature Reserve is now extinct (Ruchin and Egorov 2017).

The species is frequently registered in the territory of the Smolny National Park. Flight is usually observed in July, in some years on 30% of the park territory. It is most

intensive in the southern part of Smolny National Park (sometimes up to 70-100 butterflies per 1 km). In much smaller numbers, it is noted in the other parts of the park. For example, in the central part of the park, there are usually no more than 10-17 specimens a year (Ruchin and Kurmaeva 2010). The species was quite abundant up until 2004, in some areas of the park there were observed from 12 to 100 butterflies per 1 km. Then the number began to decline. Now it is stable at a relatively low level. Annually (2006-2017) there were registered 6-10 butterflies per 1 km of routes. Yet, no number reduction tendencies have been traced.

Flight in the most habitats in Mordovia takes place from the middle of June to the first decade of August (more often in July only) (Figure 2). It occurs in dry pine forests on sandy or sandy-stony soils, in dry mixed forests, in pine forests. Butterflies are observed at the forest fringes, cuttings, glades, along the forest roads, under electric lines, on light feelings. Usually *Sedum maximum* (L.) Holub, grows in such areas, which is the basic forage plant for caterpillars.



**Figure 2.** The imago and caterpillar of Apollo and the habitat of the species: A. Imago (Ichalki district, Smolny National Park, Barakhmanovskoe forestry, zones 100, 26.vi.2009, photo by G. Grishutkin); B. Larva (Temnikov district, Mordovia State Nature Reserve, cordon Srednaya Melnitsa, 4.vi.2016, photo by A. Nikolaeva); C. Biotope (Ichalki district, Smolny National Park, Barakhmanovskoe forestry, zones 100, 26.vi.2009, photo by G. Grishutkin); D. Biotope (Ichalki district, Smolny National Park, Barakhmanovskoe forestry, zones 98, 25.vii.2017, photo by A. Ruchin).

Unlike the rather narrow spectrum of plants that imago of Apollo visit in Europe (Baz 2002), according to our observations in Mordovia fodder plants for adults are: *Eryngium planum* (L.), *Echinops sphaerocephalus* (L.), *Campanula glomerata* (L.), *Centaurea jacea* (L.), *Sedum maximum* (L.), *Melampyrum nemorosum* (L.), *Trifolium montanum* (L.), *Gypsophila paniculata* (L.), *Butomus umbellatus* (L.), *Achillea millefolium* (L.), *Knautia arvensis* (L.), *Leucanthemum vulgare* (Lam.)

### Discussion

In neighboring regions, Apollo occurs also locally. Local populations from several areas are known in the Ulyanovsk region. All these areas are highly forested. In the southern steppe regions, the species was noted only in the middle of the 20th century, and now these populations died out (Red Data Book of Ulyanovsk Region, 2015). Apollo was very common in Penza region at the beginning of the 20th century. However, by the end of the twentieth century, its numbers had sharply declined and many populations died out. Currently, this species occurs in the eastern and southern areas of the region, where, apparently, it is possible to identify 4-5 local populations. They inhabit sandy hills and ridges of the Sura River valley and sandy terraces above the floodplain of the River Hoper (Red Data Book of Penza Region, 2005). In Ryazan region, there are only four known habitats; all of them suffer steady decline in numbers (Red Data Book of Ryazan Region, 2011). In Oka Nature Reserve, Apollo was common in the 1970s, and even then its numbers declined sharply. Since 1998, it has been recorded in the reserve only three times (Nikolaeva, Nikolaev, 2017). There are a few presently known populations in the central part of Nizhny Novgorod region. Until the mid-1970s, the species also inhabited the southern part of the region (the Red Data Book of the Nizhny Novgorod Region, 2014). The number of Apollo in Nizhny Novgorod region is declining and, currently, it is on the verge of extinction (critically endangered) (Korb, 2015). In Chuvashia, Apollo is found only in two populations in the north and south of the region, isolated from each other by the Volga River and cultivated plots. Within 50 years of observations, only twice its number sharply increased. Now the population is at a consistently low level (Red Data Book of Chuvash Region, 2010).

Nakonieczny et al. (2007) cited many factors that affect populations of Apollo within its range. Of all these factors, we will pay attention to a few that can have a particularly strong impact on Apollo populations. Weather anomalies, especially cold and rainy days in summer, may have affected the development of larvae (Zukowski 1959; Descimon et al. 2005; Gorbach et al. 2015). This was the exact weather in the spring and summer of 2017, when the warm spring in April was replaced by cold and torrential rains in May and June. However, as our observations showed, this weather did not significantly affect the number of adult butterflies in the Smolny National Park, so it did not differ from the 2016 population. Thus, the anomalous weather contrary to the literature (Zukowski 1959; Descimon et al. 2005) did not have an obvious effect on the number of Apollo. In our opinion, in the main

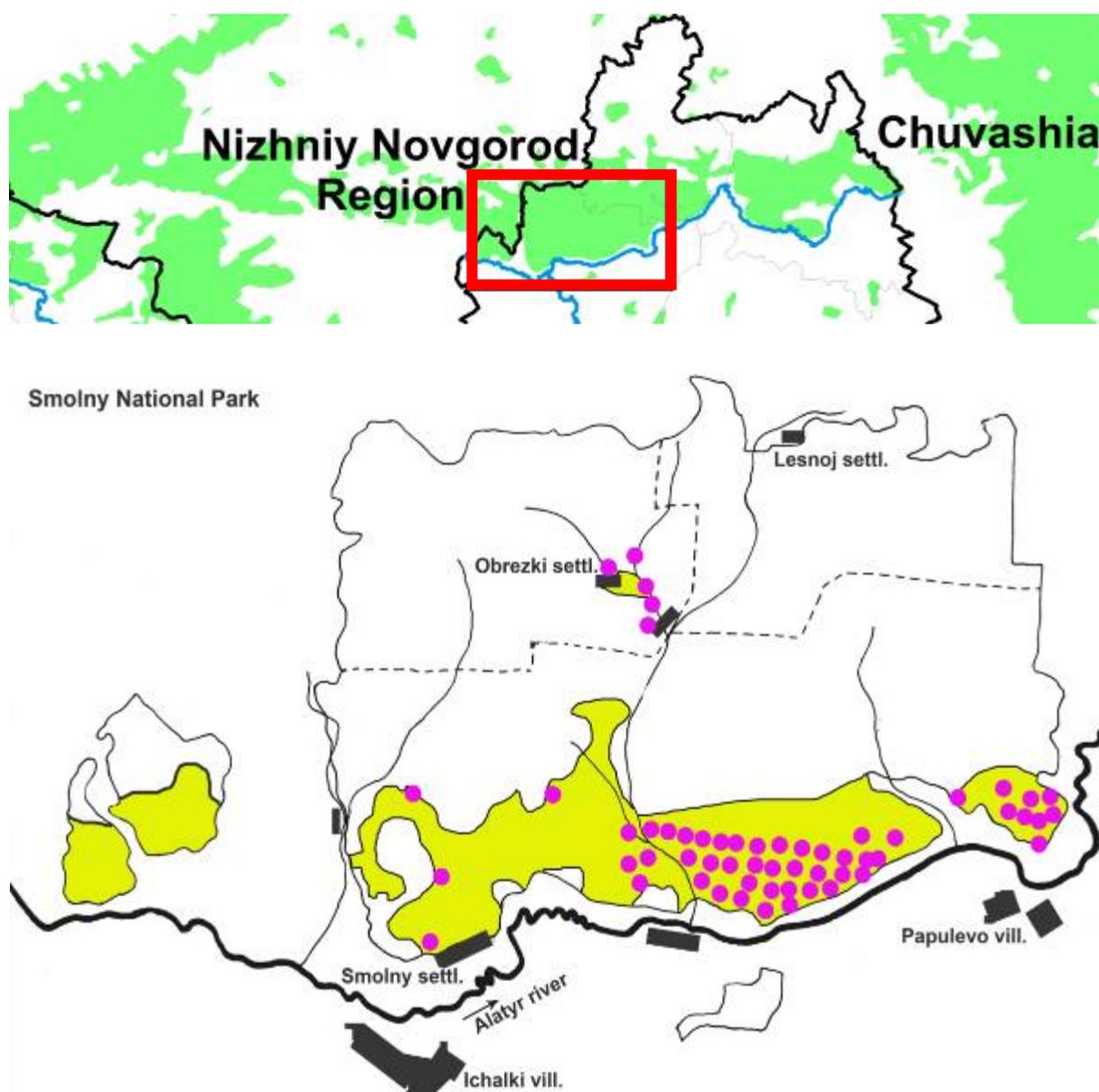
factors of butterfly population reduction in Mordovia include overgrowing of glades and clearings by small-leaved forest, fragmentation of landscapes, and isolation of butterflies habitats.

The overgrowth of Apollo habitats (glades, open forest areas, meadows with *Sedum*) with forest vegetation leads to a decrease in the populations of *Sedum*. This is the main reason for the decrease in the number of Apollo in the Mordovia Reserve. Apparently, it happened near the Inor cordon, where the *Sedum* was supplanted by dense meadow vegetation, and its population gradually deteriorated (Ruchin and Egorov 2017). Livestock grazing can help (Sanchez-Rodriguez and Baz 1996; Nakonieczny et al. 2007) to keep meadows from overgrowing, but excessive grazing adversely affects vegetation and, as a result, the Apollo population can degrade (Dabrowski 1981).

Earlier, cows and sheep were grazed on the cordons of the reserve. The number of grazed animals usually was quite low. Domestic animals fed on meadow vegetation and controlled the emerging woody shoots of forest plants, avoiding *Sedum*. Thus, they were of some use, preserving meadow biotopes from overgrowing with forest and high meadow grasses. Since 1980s the cattle are no longer grazed on the cordons of the reserve, large glades began to overgrow, *Sedum* populations were gradually replaced by high meadow vegetation, and the populations of Apollo degraded. There is an evidence that stable groups of Apollo are formed in habitats with an abundance of *Sedum* (from 100 to 1,000 or more stems) (Fred and Brommer 2003). In conditions of the reserve, this indicator did not exceed several dozens of specimens since 2000s. *Sedum maximum* is widely distributed in Smolny National Park and it is quite abundant there. As can be seen in Fig. 3, Apollo is the most abundant in such places. At the same time, imago butterflies were found outside the growth of *Sedum* at a distance of 800-1200 m from the large populations of this plant. According to Brommer and Fred (1999), the Apollo can fly to maximum distances of up to 1800 m.

There is information (Nieminen et al. 2001) that the decrease in the number of Apollo is due to soil contamination with heavy metals, as was the case in Finland. In the conditions of Mordovia, all the populations are located far from large industrial enterprises and motor roads, i.e. from potential sources of pollution. Thus, pollution could not affect the size of butterfly populations. Other factors (fires, collection, tourism, parasites, and predators), as well as pollution, are unlikely to have an impact on the Apollo populations in Mordovia.

Apollo is a very stenotopic, local and sometimes critically small-numbered species, it is not prone to dispersal and it disappears at significant disturbances of habitats. Currently, in Mordovia there are only 3 isolated populations of Apollo. One of them, found in Mordovia Nature Reserve, is in a sad state and requires urgent protection measures, and, possibly, reintroduction of this butterfly. The second largest population lives in Bolshie Berezniki district. Butterflies from this population are locally found on glades, cuttings, floodplain meadows, located in 1200-2000 m from each other. These habitats are isolated from each other by mixed forests, i.e.



**Figure 3.** The distribution of *Sedum maximum* (L.) in the national park Smolny (shaded yellow) and the sites of Apollo finds (purple circles).

fragmentation (mosaic structure) of findings and a low number of adults are characteristic for this cenopopulation. Such a mosaic pattern can eventually be dangerous for the species.

Third, the largest and most significant population inhabits Ichalki district (the bulk of the population lives in Smolny National Park, where it is protected). Irruption typically occurs in this population every few years and, as a result, it extends to a certain degree. The most significant negative impact on the population of Apollo in Mordovia is caused by overgrowing of habitats by small-leaved forests, fragmentation of landscapes, isolation of populations.

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