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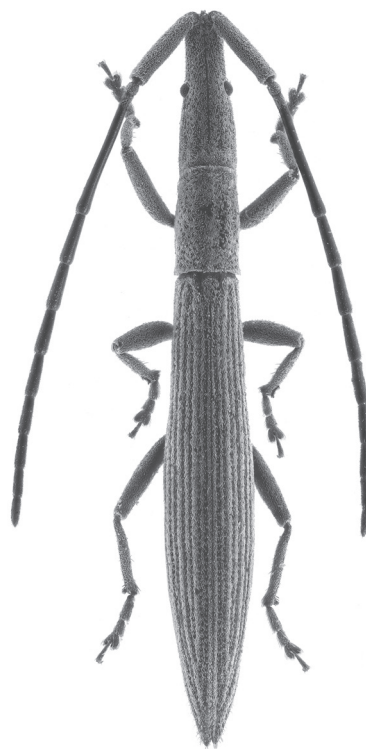


# Кавказский Энтомологический Бюллетень

CAUCASIAN ENTOMOLOGICAL BULLETIN

Том 17. Вып. 1

Vol. 17. No. 1



Ростов-на-Дону  
2021

## The first record of *Danaus chrysippus* (Linnaeus, 1758) (Lepidoptera: Danaidae) in Russia in the context of the contemporary distribution of this species in the Western Palaearctic

© D.V. Morgun<sup>1</sup>, E.V. Ilyina<sup>2</sup>

<sup>1</sup>Moscow Centre of Environmental Education, Regional Research and Tourism, Odesskaya str., 12A, Moscow 117303 Russia. E-mail: d\_moth@mail.ru

<sup>2</sup>Precaspian Institute of Biological Resources of the Daghestan Federal Research Centre of the Russian Academy of Sciences, M. Gadzhiev str., 45, Makhachkala 367000 Russia. E-mail: carabus@list.ru

**Abstract.** *Danaus chrysippus* (Linnaeus, 1758) (Lepidoptera: Danaidae) is recorded for the Great Caucasus and Russia (Dagestan) for the first time. The peculiarities of the species distribution in the Caucasus are discussed and records in Azerbaijan (Nakhichevan) are confirmed by a new material. Trends of its distribution changes in the Western Palaearctic are analyzed. The paper provides the analysis of the factors influencing the establishment of resident populations of this migrant species (larval food plants, temperature conditions etc). The possibilities of forming of stable populations of this species in the Great Caucasus are discussed: the climatic features in Dagestan are significantly different from those in the localities of resident populations of *D. chrysippus* in Europe, while the larval host plant is widely distributed in the East Caucasian region. The ecological valence and migratory activity of this species suggest that in the future it can form resident populations in the east of the Great Caucasus. The climate change impact on the distribution and migratory activity of *D. chrysippus* in Europe and the Caucasus is discussed.

**Key words:** *Danaus chrysippus*, distribution, Dagestan, Caucasus, Western Palaearctic.

### Первое нахождение *Danaus chrysippus* (Linnaeus, 1758) (Lepidoptera: Danaidae) в России в контексте современного распространения вида в Западной Палеарктике

© Д.В. Моргун<sup>1</sup>, Е.В. Ильина<sup>2</sup>

<sup>1</sup>Московский детско-юношеский центр экологии, краеведения и туризма, ул. Одесская, 12А, Москва 117303 Россия. E-mail: d\_moth@mail.ru

<sup>2</sup>Прикаспийский институт биологических ресурсов – обособленное подразделение Федерального государственного бюджетного учреждения науки Дагестанского федерального исследовательского центра Российской академии наук, ул. М. Гаджиева, 45, Махачкала 367000 Россия. E-mail: carabus@list.ru

**Резюме.** Впервые на территории России и на Большом Кавказе найден *Danaus chrysippus* (Linnaeus, 1758) (Lepidoptera: Danaidae). Обсуждаются особенности распространения вида на Кавказе, подтверждено его нахождение в Азербайджане (Нахичевань). Проанализированы тенденции изменения ареала вида в Западной Палеарктике и факторы, влияющие на формирование резидентных популяций данного вида, имаго которого являются активными мигрантами (кормовые растения гусениц, температурные условия и др.). Обсуждаются возможности формирования стабильных популяций вида на Большом Кавказе: климатические особенности местности существенно отличаются от таковых в местообитаниях резидентных популяций вида в Европе, при этом в регионе широко распространено кормовое растение личинок. Экологическая валентность и миграционная активность вида позволяет предположить, что в перспективе он может сформировать резидентные популяции на востоке Большого Кавказа. Обсуждается вопрос о влиянии изменения климата на распространение и миграционную активность данного вида в Европе и на Кавказе.

**Ключевые слова:** *Danaus chrysippus*, распространение, Дагестан, Кавказ, Западная Палеарктика.

## Introduction

*Danaus chrysippus* (Linnaeus, 1758) (Lepidoptera: Danaidae) is a widespread species with tropical and subtropical distribution including tropical Africa, Asia and Australia. In the Western Palaearctic it is found in sporadic areas in Madeira, Canary Islands, coastal Mediterranean region, Eastern Turkey, Azerbaijan, Syria, Israel, Jordan, Egypt and Saudi Arabia [Hesselbarth et al., 1995; Tolman, 2000; Tschikolovets, Nekrutenko, 2012]. The species is known as one of the most active butterfly migrants, which expands its distribution in different directions.

This species was reported repeatedly for the Transcaucasian region. However, the only reliable data on

occurrence of the species in the Caucasus was obtained by Christoph [1886] during his expedition to the Astara vicinities in Talysh (now Lenkoran Province of Azerbaijan). This paper was subsequently cited multiple times by many authors (the distribution is mentioned as “Talysh” due to its territorial proximity) [Nekrutenko, 1990; Tuzov, 1993; Didmanidze, 2004; Korb, 2005; Korb, Bolshakov, 2011]. According to Effendi [1970], the species range includes Talysh, Astara, Sarak and Artupa. In addition, Murzin [2000] reported the presence of this species in Nakhichevan, while Tschikolovets and Nekrutenko [2012] claimed that its Caucasian range incorporates Talysh as a whole, as well as the Araks and Kura rivers valleys. However, among the images of the collection material no specimens from the region were presented in their review. Snegovaya and

Petrov [2019] compiled data from all the above mentioned works in the catalogue of butterflies of Azerbaijan without any critical analysis of the references and without new material collected by the authors of this catalogue.

## Material

In August 2016 we confirmed the presence of the species in Nakhichevan on the border with Iran (butterflies were observed in the vicinity of Djulfa), but our research in the Lenkoran Province of Azerbaijan did not give new results.

In October 2020, near Miatli (43.074755°N / 46.834346°E, Kizilyurt District, Republic of Dagestan, Russian Federation) five specimens of *D. chrysippus* were observed feeding on flowers (Fig. 1). One specimen was collected and mounted (Fig. 2). Imagines were found on the Sulak River bank on decorative flowering plants grown in flower beds (Figs 3, 4). *Danaus chrysippus* is known to be cultivated for aesthetic and commercial purposes, but according to the data obtained, nobody had let the butterflies out in this area. Thus, this is the first known record of the species in nature on the Greater Caucasus and Russia.

## Discussion

**The analysis of the distribution trends in the Western Palaearctic.** In some Western Palaearctic regions where the species forms permanent populations, adults are found either year-round (Canary Islands) or from April until November (Morocco, Algeria, Tunisia). In Europe, its populations in southern Spain (Málaga and Almería provinces) are also resident. The status of populations in Algarve in Portugal, where the biology of preimaginal stages was thoroughly studied in 1998, is unclear [Aguiar et al., 2003]. Tolman [2000] suggested that establishment of temporary resident populations in other areas of the European range is possible. The first author of this paper registered the species in late phenological periods on the northern coast of Tenerife, where *D. chrysippus* is a migrant (while on the Islands of La Palma, Gomera and Fuerteventura it has permanent populations). He also observed resident populations of *D. chrysippus* in the Sousse Massa National Park in Morocco in May and July 2010 as well as in Gafsa (Tunisia) and Biskra (Algeria) in April 2019, and many migratory individuals of *D. chrysippus* in urban landscapes of Agadir (Morocco). At the same time, the sustainability of resident populations is verified only for the Sousse River valley (Taroudannt, Aït-Yazza, Morocco), basing on year-round occurrence of the species in this area since 1947 [Rungs, 1956; TARRIER, Delacre, 2008].

The history of the distribution of this species throughout the Maghreb countries is described by Tennent [1995, 1996], who indicated similar trends in the movement of the species range to the north, extending to European countries. We suppose that the species uses resident populations to gradually extend its range and to adapt to new habitats in similar landscape and climatic conditions. Tennent discovered permanent populations in the Maghreb from which butterflies migrate. The

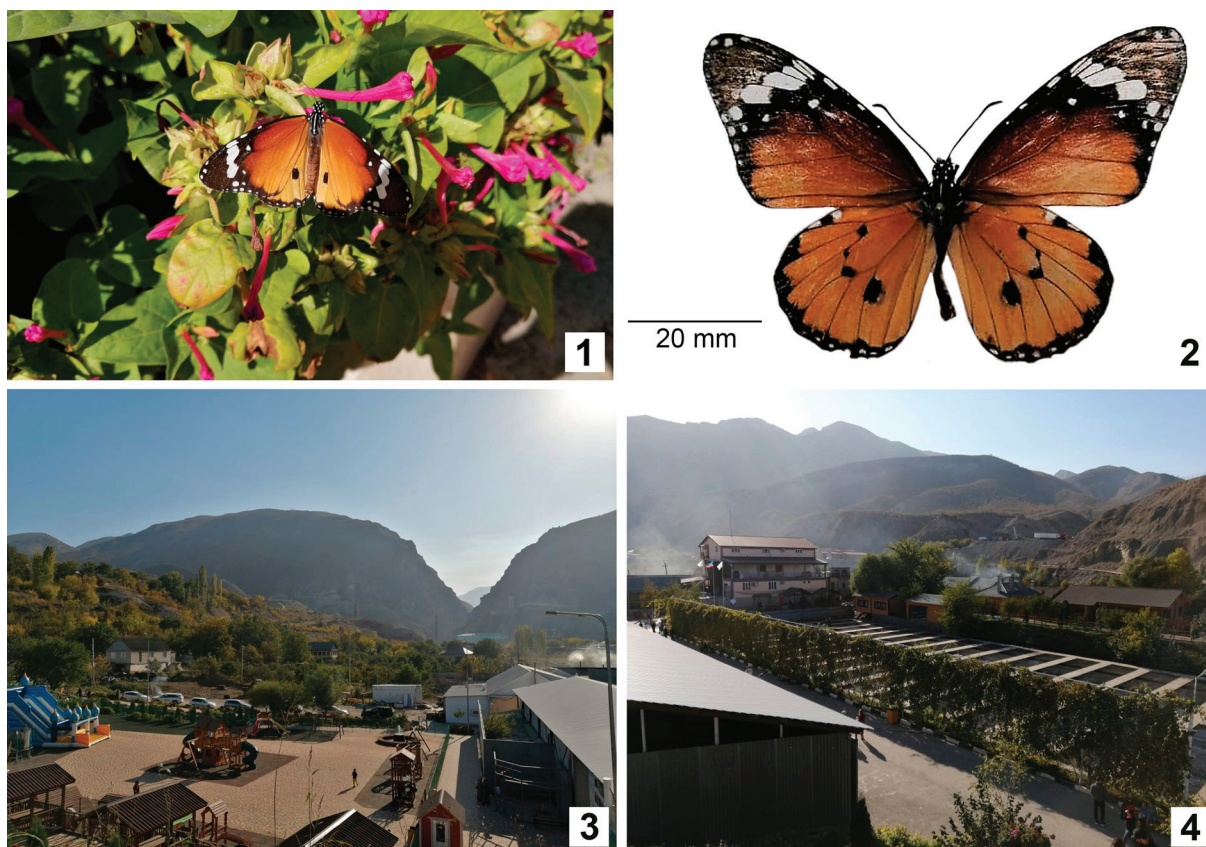
history of the northward expansion of *D. chrysippus* in the Western Palaearctic was described in detail in several works. The earliest records of the species were made for Crete (1843), Cyprus (1853, 1888), Greece (1875), Turkey (Mersin Province, 1895) (the chronology of this findings is given according to Staudinger [1878] and Hesselbarth et al. [1995]). The vast majority of regular records on the European territory (southern Spain, Corsica, Albania, etc.) has been made since 1970s and 1980s [Maso I Planas, Perez de Gregorio, 1983; Zilli, 1988; Luquet, Misja, 1989; Hesselbarth et al., 1995].

The record of the species in Dagestan in late October corresponds to the predominant number of *D. chrysippus* observations on the northern edge of its range, which are also made in this time of a year. Most of the observations in regions where the species does not form permanent populations (Cyprus, Greece, Turkey) were made from September to November. The first author of this paper registered migratory individuals on the Mediterranean coast of Turkey only in November 2013, while Pamperis [2009] reported observations of migratory butterflies in Greece in January and from April to December.

Worth mentioning that individuals of resident populations of *D. chrysippus* were observed mainly in natural habitats (the first author of this paper registered them in shrubs among sand dunes in Morocco and Algeria and in oases in Tunisia), while migrants mostly in anthropogenic landscapes (gardens, parks, open grassland).

In recent years changes in the range boundaries of several species of diurnal Lepidoptera with tropical and subtropical distribution in the Western Palaearctic have become a stable trend. Since the mid-2000s, the invasive *Cacyreus marschalli* (Butler, 1897) (Lycaenidae) has become increasingly widespread in the Mediterranean region. Currently it was found over the Mediterranean coast, forming sustainable populations from the Canary Islands and Morocco to the Peloponnese [Tennent, 1996; Tolman, 2000; Pamperis, 2009]. In 2012, the first author found *Papilio demoleus* Linnaeus, 1758 (Papilionidae) in Europe for the first time. This species, which is known as a pest on citrus, was regularly observed in Portugal in orange orchards and various anthropogenic biotopes [Morgun, Wiemers, 2012]. However, in case of *Danaus Klug*, 1780 butterflies, a significant migratory capability can be stated, which is accompanied by a gradual climate change dynamics [Settele et al., 2008; Advani, 2015] that contributes to the intrusion of subtropical and tropical fauna elements in the more Northern Palaearctic regions. These butterflies migrate systematically, while many other migratory species occur in Europe only occasionally (e.g. *Hypolimnas missipus* (Linnaeus, 1764) (Nymphalidae) mimics *Danaus chrysippus* and *Deudorix livia* (Klug, 1834) (Lycaenidae)). Nevertheless, the general trend on the northward extension of the southern species ranges in Europe is becoming more prominent and is mostly associated with climate change [Settele et al., 2008].

**The analysis of the ecological factors of *D. chrysippus* distribution.** The feasibility of forming stable populations in regions where migratory butterflies occur is debatable. Pamperis [2009] reported findings of preimaginal stages at two localities in Greece. However,



Figs 1–4. Observed and collected specimens of *Danaus chrysippus* (Linnaeus, 1758) and their locality in the North Caucasus, 24 October 2020.

1–2 – imagos: 1 – on a flowerbed, 2 – mounted specimen; 3–4 – locality, 'Glavryba' ecotourism complex near Miatli village, Kizilyurt District, Republic of Dagestan, Russia.

Рис. 1–4. Особи *Danaus chrysippus* (Linnaeus, 1758), наблюдавшиеся и собранные 24.10.2020 на Северном Кавказе, и их местонахождение.

1–2 – имаго: 1 – на цветочной клумбе, 2 – расправленный экземпляр; 3–4 – местонахождение вида, экотуристический комплекс «Главрыба» у села Миатли, Кизильюртовский район, Республика Дагестан, Россия.

there is no available information whether permanent population has since been established. He found caterpillars and pupae of *D. chrysippus* in the Northern Peloponnese and in the Igoumenitsa Region in early October 2004. In addition, populations from Corfu and Crete Islands may be temporarily resident.

According to current data, the northernmost resident populations of the species are those from the southern regions of Spain (Málaga, Almería), located at a latitude of approximately 36.722°N. The observation from Dagestan is one of the northernmost finds of this species (latitude 43.074°N). The latitude corresponds to the southern coast of France in Narbonne, where the species was previously recorded, but does not form permanent populations. It is important to mention that the most of records in the Western Palaearctic belongs to regions located to the south of the 40<sup>th</sup> latitude of the Northern Hemisphere. Besides, the average climate conditions in these regions vary significantly. The average annual temperature in the Málaga Province is +18.4 °C with insignificant precipitation (520 mm per year), Narbonne is colder (+14.9 °C) and wetter (627 mm per year). The average annual temperature in Kizilyurt (Dagestan, Russia) is lower (including in summer), +10.9 °C, and this area is drier, in terms of precipitation it is comparable to the southern coast of Spain (524 mm per

year). It is also important to note that in southern Spain, the difference in average monthly temperatures comprises 13 °C, in Narbonne it is about 16 °C. In the mentioned locality in Dagestan, the difference in average monthly temperatures is close to that in Spain, but it has longer winter period with daytime temperatures of +2.6 °C and night temperatures below zero. Thus, according to present microclimatic conditions and ecological requirements of the species, it is unlikely that *D. chrysippus* will be able to form resident populations in Dagestan. At the same time, *D. chrysippus*, being an active migrant, is highly environmentally valent and quickly adapts to new conditions.

According to Settele et al. [2008: 618], "in areas with cold winters, populations can therefore only be temporary. It is difficult to establish whether the species is present as a resident the whole year, or as a migrant, only breeding in the summer". Worth mentioning that the authors underline a strong correlation between climate change and changes of the *D. chrysippus* range in Europe. The risk for this species that arises from the climate change is described as "very high climate change risk" and present distribution can be well explained by climatic variables.

The occurrence of temporary resident populations on the north of the species range is explained by favorable

weather conditions of a particular year and by the presence of foodplants. Throughout its range *D. chrysippus* feeds on more than 50 plant species [Ackery, Vane-Wright, 1984]. The most common foodplants are species of the family Asclepiadaceae, in particular *Asclepias curassavica* Linnaeus, 1753 (in Europe and Maghreb), *Pergularia tomentosa* Linnaeus, 1767 and *Cynanchum acutum* Linnaeus, 1753 in Algeria and Tunisia, and *Calotropis procera* (Aiton) Dryander (1811) in West Africa. Preimaginal stages were found on *Cynanchum acutum* in Cyprus in September – October 1998 [Makris, 2002]. This host plant species is suggested to be the most possible one in Turkey [Hesselbarth et al., 1995]. Nekrutenko [1990] listed *Cynanchum acutum* as a host plant of the species in Transcaucasia. This plant species is rather widely distributed in Dagestan, occurring both in anthropogenic and natural habitats (from the Sarykum Barkhan to the Samur River valley, reaching middle altitudes in the mountains). The family Asclepiadaceae in Dagestan is also represented by several Vincetoxicum Wolf, 1776 species and by *Periploca graeca* Linnaeus, 1753 [Murtazaliev, 2009].

In recent years, the butterfly fauna of Dagestan has been actively studied [Morgun, 2004; Ilyina, Morgun, 2010, 2011], which resulted in record of many resident Transcaucasian and Mediterranean species, new taxa have been described, including those of the species rank – *Turanana mystica* Morgun et Tikhonov, 2010 (Lycaenidae). The specimen of *Gegenes nostradamus* (Fabricius, 1793) (Hesperiidae) found in September of 2009 in Dagestan can be a migrant from Transcaucasia. In our opinion, discovery of such active migratory species as *D. chrysippus* in the eastern part of the Greater Caucasus is an important contribution to the study of butterfly fauna of Dagestan.

The record of *D. chrysippus* in the North Caucasus is interesting from the position of faunistics and ecology, as it may indicate the influence of climate change on the butterflies fauna. The trends shown here indicate the formation of conditions for the penetration of tropical Lepidoptera species with strong migration activity further north. In this regard, it is promising to study the territory of Dagestan and some other regions of the Caucasus, where new encounters of butterflies with a more southern distribution are most likely. Taking it into consideration, during several years and under favorable weather conditions, *D. chrysippus* may form temporary populations in this region. Consequently, further monitoring of localities of the species will be continued.

## Acknowledgements

The authors are grateful to B.A. Gavrilov (Moscow State Institute of International Relations, Moscow, Russia) for the technical assistance in preparing the article.

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Received / Поступила: 1.11.2020

Accepted / Принята: 25.02.2021

Published online / Опубликовано онлайн: 21.06.2021