

The Subarctic *A. frigida* Species has Disappeared in Europe; Is it the Effect of Global Warming?



Zakharov Ilia A*

Vavilov Institute of General Genetics, Russia

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*Corresponding author: Zakharov Ilia A, Vavilov Institute of General Genetics, Moscow, 119133, Russia

Abstract

The composition of populations of beetles of the *Adalia* genus in the northern regions of Europe and Siberia has been investigated. In Europe, the subarctic species *Adalia frigida* is currently not found; it has been replaced by the species *Adalia bipunctata*, common for the temperate zone of Eurasia. The change in the composition of ladybird populations is considered to be a consequence of global warming.

Keywords: *Adalia bipunctata*; *Adalia frigida*; Climate; Global warming; Temperature

Introduction

Three species of ladybirds belonging to the *Adalia* genus are found in Europe, in temperate and Mediterranean climate zones: *A. bipunctata* (L.), *A. decempunctata* (L.), *A. conglomerata* (L.) (the latter species is rare) [1]. In addition to these three species, as well as *A. alpina* Villa and *A. revelyerie* Muls. (in the Alpine zone and on the islands of the Mediterranean Sea, respectively), G.G. Jacobson also notes *A. frigida* Schneid as a species distributed in the north: in Norway, Sweden, Lapland, Kola Peninsula, near the Pechora River [2]. S.M. Iablokoff-Khznorian [3] considers this species as a form of *A. bipunctata* [3].

To clarify the taxonomic status of *A. frigida* species, the nuclear and mitochondrial DNA of some individuals of this ladybird species compared to other *Adalia* species were analyzed. The results of studies indicated that *A. frigida* was an independent species, although being very close to *A. bipunctata* [4].

This study presents the results of observations over the past 40 years on the distribution of *A. frigida* in northern Europe and Siberia, showing that this ladybird species has practically disappeared in Europe and has been replaced by *A. bipunctata*, which is considered to be the consequence of global warming.

Materials and Methods

Ladybirds of the *Adalia* genus were sampled in August (in Transbaikalia in September) at the stage of imago and pupa. In

the latter case, adult ladybird beetles were bred under laboratory conditions.

All sampling of ladybird beetles was conducted in the cities; outside the cities, especially in the northern regions, the species of *Adalia* genus were practically not found. Ladybird beetles were collected on willows (*Salix sp.*), elms (*Ulmus sp.*), Tatar honeysuckle (*Lonicera tatarica*), and in Alta (Norway) they were collected on bird cherry (*Prunus padus*).

Individuals of the *A. frigida* and *A. bipunctata* species are clearly distinguished by the pattern on the elytra. The ladybird beetles of European populations of *A. bipunctata* species are represented by two forms: with red elytra and one black dot on each elytron, and with black elytra and red spots. *A. frigida* ladybird beetles have five black spots on the red elytra, in two rows (3+2), the spots often merge and are often surrounded by light halos.

Results

The Table 1 shows the places where *A. frigida* ladybird beetles were found, as well as the areas where the presence of this species could be expected (Scandinavia, Kola Peninsula). The northernmost points surveyed were the polar cities of Alta in Norway and Murmansk in the Russian Federation. The southernmost point was Ulan-Ude in Transbaikalia, where individuals with a pattern on the elytra characteristic of *A. frigida* species were occasionally found in a very polymorphic population of the *A. bipunctata fasciatopunctata* subspecies.

Table 1: Sampling of *A. bipunctata* and *A. frigida*.

Sampling Place	Coordinates	Sampling Time	<i>A. bipunctata</i>	<i>A. frigida</i>
Trondheim, Norway	63.4305/10.3946	08.2014	78	-
Tromso, Norway	69.6514/18.9569	08.2014	234	-
Alta, Norway	69.9678/23.2682	08.2014	32	-
Oulu, Finland	65.0124/25.4710	08.2018	126	-
Murmansk	68.9707/33.0745	08.2013	101	-
Apatity	67.5680/33.4068	08.2013	125	-
Arkhangelsk	64.5398/40.5155	08.1984	35	110
Arkhangelsk	"	08.2003	170	-
Arkhangelsk	"	08.2005	270	10
Arkhangelsk	"	08.2010	306	-
Arkhangelsk	"	08.2011	237	-
Arkhangelsk	"	08.2012	186	-
Arkhangelsk	"	08.2014	117	-
Arkhangelsk	"	08.2022	134	-
Veliky Ustyug	60.7611/46.2977	08.1983	106	1
Syktvykar	61.6688/50.8364	08.1983	533	1
Salekhard	66.5299/66.6143	08.2021	3	23
Ulan-Ude	51.8347/107.5834	09.2016	144	3
Yakutsk	62.0269/129.7325	08.2015	-	41

The results of studies show that after 2005 *A. frigida* ladybird beetles were not found anywhere in Europe. In Arkhangelsk in the 1980s, *A. frigida* was the predominant species, after 20 years it was in the minority, and since 2010 it had not been found even once.

The results of crossing between *A. frigida* and *A. bipunctata* species demonstrated that the hybrids of the first generation showed signs of *A. bipunctata*. Segregations in the backcross and in the second generation indicated that the elytral pattern characteristic of *A. frigida* species was determined by an allele that was recessive to the alleles of *A. bipunctata*, which determined the coloration and pattern on the elytra typical of this species (the data will be presented in another publication).

Discussion

The current absence of *A. frigida* species in Scandinavia and the Kola Peninsula, i.e., in the regions included in its habitat [2], and the disappearance of this ladybird species in Arkhangelsk after 2005 are considered to be a consequence of global warming. *A. frigida* species has been replaced by another species, *A. bipunctata*, inhabiting territories with temperate climate.

It is known that over the past four decades (1979-2021) the increase in the average annual temperature in the Arctic, in the sector from Svalbard to the Novaya Zemlya Islands, was about 1.25° per decade [5].

In Arkhangelsk, where *A. frigida* ladybird beetles have disappeared, the average annual temperature increased from 0.7° in 1979 to 2.8° in 2021. The average annual temperatures of the three decades, in which the sampling of coccinellids was conducted, increased as follows: +1.20° during 1981-1990, +1.44° during 1991-2000, +1.97° during 2001-2010 [6].

Under the conditions of global warming, the area of *A. bipunctata* habitat expanded, and in the subarctic territories, this species replaced the *A. frigida* species that previously inhabited them.

There could be two mechanisms of such substitution: the reproductive advantage of *A. bipunctata* during global warming compared to the more "cryophile" *A. frigida* ladybird species and the displacement of the latter, or genetic merger. The ladybird beetles of these two species are freely crossed and their hybrids are fertile, and the pattern on the elytra, which is the diagnostic feature distinguishing these two species, is represented by dominant variants of *A. bipunctata*. Accordingly, hybrids of the first generation look like *A. bipunctata*, and in subsequent crossings of hybrids with each other and with individuals of both parental species, the offspring will also be phenotypically similar to *A. bipunctata* species in most cases.

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References

1. Nedved O (2015) Ladybird beetles (Coccinellidae) of Central Europe. Praha. Academia, p. 304.
2. Yakobson GG (1905-1915) Beetles of Russia and Western Europe. Guide to the definition of beetles. St. Petersburg. Edition of A.F. Devrien. Issues I-XI. Tables 1-83, pp. 1-1024.
3. Iablokoff Khnzorian SM (1982) Les Coccinelles. Tribu Coccinellini des regions Palearctique et Orientale. Paris, Societe Nouvelle des Editions Boubee, p. 566.
4. Zakharov IA, Shaykevich YV (2014) Molecular study of geographic races of ladybird beetles *Adalia bipunctata* and *A. frigida*. Ecological Genetics 12(3): 52-59.
5. Rantanen M, Karpechko AY, Lipponen A, Nordling K, Hyvarinen O, et al. (2022) The Arctic has warmed nearly four times faster than the globe since 1979. Commun Earth Environ 3: 168.
6. <https://www.meteoblue.com/ru/climate-change/>



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