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MONITORING PROPOSAL OF THE SPECIES *APORIA CRATAEGI* (LINNAEUS, 1758) IN POLAND

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Abstract. The *Aporia crataegi* (Linnaeus, 1758) is a large butterfly of the Pieridae family. Its range extends from northwest Africa in the west to the Transcaucasia and across the Palearctic to Siberia and Japan in the east. In the south, it occurs in Turkey, Cyprus, Israel, Lebanon and Syria, while it is not found in northern Scandinavia and is extinct in the British Isles. Although it is a fairly widespread species, its biology and population size are still poorly understood. In Poland, a decrease in its number was observed. Due to the lack of developed monitoring methods for the *Aporia crataegi*, the paper proposes an example of how to conduct such research. The main goal is to estimate the size of the species population and to assess the quality of the habitats it occupies. The research methodology is based on the counting of caterpillar nests on the designated transects and on the assessment of the quality of the habitat according to the indicated indicators. Such studies can provide valuable data on the species habitat requirements, as well as information on potential threats affecting the population, which could be used to implement appropriate conservation methods.

Key words: black-veined white, *aporia crataegi*, monitoring, conservation.

INTRODUCTION

Aporia crataegi, also known as black-veined white, is a butterfly from the family Pieridae, whose wings range from 51 to 70 mm. This makes it one of the largest of its family in Poland. Females are usually larger than males. The upperside of both forewings and hindwings is a translucent white boldly veined with black. The underside is similar in the male but the female has brown veining and also less covered with scales.

A species that can be confused with *Aporia crataegi* is *Parnassius mnemosyne* from the Papilionidae family. It is similar in size and also has black veins on the white background of the wings but the edges of its front wings are completely transparent, and there are two additional black spots on each of them. Another species similar to the *Aporia crataegi* is the *Siona lineata*, a day moth of the Geometridae family, which also has black veins on a white background. However, it is much smaller and its wings have a different shape – they are more angular.

The aim of this study was to propose methods of monitoring the species *Aporia crataegi* due to the lack of developed monitoring tools for the species. *Aporia crataegi* was classified as a 'least concern' (LC) species by the IUCN Red List of Threatened Species even though its biology, as well as the number of its population, are poorly understood. The purpose of the study is to determine the number of the species population and the quality of the environments in which it resides. The research approach is based on the counting of caterpillar nests along defined transects and the evaluation of habitat quality using the indicators provided.

BIOLOGY OF THE SPECIES

Aporia crataegi female lay eggs in large clusters (30–100) on the underside of the leaves of the host plants. The eggs are initially light yellow in color, then darken with age.

Hatching takes place after about three weeks in August. Caterpillars are greenish-gray with transverse stripes, densely hairy. They are very voracious and feed in groups. Just before the onset of winter, they create a characteristic nest and hibernate in it.

After hibernating, the caterpillars feed individually. Pupation occurs in pupae attached to the trunk or branch of the host plant. The pupa is creamy yellow with black spots. Imagines feed on nectar. The development period is 10 months, including wintering.

Aporia crataegi leads a daytime lifestyle. It is a companionable butterfly, alive and often appearing in numerous groups. There is one generation in the lagweed of *Aporia crataegi* a year. Adults in northern Europe appear in late May to June and in the south of the continent between April and July.

The host plants of the species include: blackthorn, peach, hawthorn, rowan, apple and buckthorn.

HABITAT REQUIREMENTS

Aporia crataegi is found in a wide variety of habitats: on the edges of forests, in dry meadows, barks, orchards, thickets, arable fields, gardens, rocky slopes. Usually it chooses dry and sunny places but it can also live in humid environments.

DISTRIBUTION OF THE SPECIES IN POLAND

In the old days, the genre was quite popular in Poland. Since the 1970s, it has been seen rather locally and infrequently. *Aporia crataegi* tends to fluctuate in numbers as it appears en masse every now and then. The species was found in the following voivodeships: Zachodniopomorskie, Pomorskie, Podlaskie, Lubelskie, Lubuskie, Podkarpackie, Dolnośląskie and Świętokrzyskie. At the moment, however, the highest density is observed in the following voivodeships: Podlaskie, Świętokrzyskie and Zachodniopomorskie. The decline in the number of the species may be due to the mass extermination of it by growers who plagued it due to the voracity of the caterpillars. Sometimes it was said that *Aporia crataegi* was a harbinger of misfortunes because during pupation the pupae secrete a characteristic red liquid, which is a product of metabolism. This phenomenon is called bloody rain.

CONCEPT OF THE SPECIES MONITORING

Aporia crataegi can be a fairly good object to monitor because it is easy to pinpoint the places of potential occurrence of the species (blackthorn thickets) and also to find the species in the field, especially in the larval stage. The method of monitoring *Aporia crataegi* (i.e. counting on

transects) proposed in this study results from the proposal of a similar method of monitoring for the *Eriogaster catax*, which, like *Aporia crataegi*, leads a community lifestyle and builds the nests inhabiting thermophilic shrubs.

Due to the species similarity to *Parnassius mnemosyne* and *Siona lineata*, as well as the species slight sexual dimorphism, genetic monitoring can also be used. If it is highly probable that the captured individual is *Aporia crataegi* and with the appropriate permission, it is possible to take one middle leg from the captured individual (tearing them off with tweezers) for identification using molecular methods. The legs should be placed in a container with 95% ethyl alcohol and stored in the freezer.

The suggested method of assessing the population status of the *Aporia crataegi* is based on summer counts of caterpillar nests on the transects.

On the other hand, the assessment of the habitat may be troublesome because the factors determining the colonization of the sites by the hawthorn tuft are not fully understood. Therefore, it was proposed to assess the condition of the habitat mainly on the basis of the area occupied by blackthorn thickets.

INDICATORS

Indicators of the population's state are shown in Table 1.

Table 1. Indicators of the state of population of *Aporia crataegi*

Indicator	Measurement	Way of evaluation
Abundance	number of nests/transects	evaluated based on the number of caterpillars nests on the research transect in the location

Adopted valorization of the status indicators of the population is presented in Table 2.

Table 2. Valorization of *Aporia crataegi* population status indicators

Indicator/Evaluation	FV	U1	U2
Abundance	>15 nests/transect	14–10 nests/transect	<10 nests/transect

The final assessment of the population's condition is determined by the lower of the assessments defined for individual indicators.

Indicators of the habitat are shown in Table 3.

Table 3. Indicators of the habitat of *Aporia crataegi*

Indicator	Measurement	Way of evaluation
The area covered by blackthorn thickets	%	determination of the area occupied by blackthorn thickets in the transect area (measurement in the field and based on an orthophotomap)
Exposition of the location	descriptive characteristics	determination of the track position display on one of the eight directions of the world (compass): N, NE, E, SE, S, SW, W, NW, flat area – 0

Valorization of the habitat state are shown in Table 4.

Table 4. Evaluation of indicators of the habitat of *Aporia crataegi*

Indicator/evaluation	FV	U1	U2
The area covered by blackthorn thickets	>50%	20–50%	<20%
Exposition of the area	SW, SW, W	NW, SE, flat area	N, NE, E

The assessment of the condition of the habitat corresponds to a lower assessment of one of the two indicators (the area covered by brush and exposure of the location).

PERSPECTIVE

The assessment of the conservation prospects should be based on the assessment of the population and habitat status, taking into account the diagnosed current and anticipated threats. In particular, the probability of strong transformations of a species habitat as a result of land use change, such as succession, development, mowing, should be taken into account. Such activities may lead to the rapid disappearance of local populations. The following criteria can be used to assess the protection prospects:

FV – very good or good prospects; it is expected that the current favorable condition of the population and habitat will be maintained or improved, e.g. as a result of the implementation of appropriate protective measures at a given site.

U1 – average prospects; the current favorable conservation status may deteriorate or, in the expert's opinion, the unsatisfactory condition will continue in the following years due to the lack of appropriate active protection measures.

U2 – bad prospects; the current poor state of conservation will persist, or due to the lack of appropriate protective measures, a serious deterioration of the population and habitat is expected.

GENERAL EVALUATION

When making the overall assessment, the condition of the population, the condition of the habitats and the conservation prospects of the *Aporia crataegi* should be taken into account. The lowest rated parameter decides about the overall rating.

THE METHOD OF PERFORMING THE RESEARCH

Selection of monitoring areas and their suggested size

In the case of the lagweed of *Aporia crataegi*, the monitoring station is a 300-meter-long transect that runs through the area covered with blackthorn thickets. Such a transect can be located wherever there are appropriate blackthorn thickets, e.g. in a ravine, along a road, railway track, slope or between a field. At sites with a diversified topography (e.g. slopes with a high relative height, exceeding 20 to 30 m), individual fragments of the transect should include various fragments of the terrain, e.g. at the base of the slope, in its middle and at the top, so that the transect gives an idea of the differentiation of the site. Tracks are counted in the 5 m zone along the transect (2.5 m on each side of the march line).

Monitoring should cover several sites in the main regions of the species occurrence in the country, i.e. in Podlaskie, Świętokrzyskie and Zachodniopomorskie voivodships. As the occurrence is better identified, it may be possible to supplement the monitoring network with locations in other regions of the country.

Before starting the field monitoring tests, if the tests are performed for the first time, the location of the transect should be determined based on the previous field investigation and available cartographic data. This does not mean that only those places where the presence of *Aporia crataegi* have been found should be selected for research, but due to the presence of suitable habitats and the decreasing number and spread of the species, there must be at least a shadow of a chance for its occurrence in a given area. The course of the transect should be mapped as accurately as possible using GPS.

To ensure repeatability of monitoring tests in the future, care should be taken to precisely define the boundaries of the test site. Objects existing in the field, such as roads, drainage ditches, railway lines, etc., can be helpful, in relation to which it is easy to determine the location of the transect in the field. It is recommended to mark the course of the transect (at least its beginning, end and turning points) with paint or other markings, however, it should be remembered that sometimes it will require the consent of the owner/manager of the area.

Determining population status indicators

The presence of the species is relatively easy to detect as the caterpillars of the early larval stages live in groups, building clearly visible organisms. However, monitoring may be hampered by the fact that the places of its occurrence are often difficult to access (e.g. thorny thickets, sometimes located on slopes). In order to estimate the relative size of the population, the method of double counting of the nests of young caterpillars on selected research transects with a length of approx. 300 m in the 5 m zone along the transect (2.5 m on each side of the march line) can be adopted. It is recommended to determine the transect in advance in the period preceding the research and to mark it appropriately in the field (e.g. attaching bright pieces of fabric: strings, ribbons, etc.), which will make it easier to find later. In addition, the location of the transect should be determined on the basis of accurate maps (optimal 1 : 10,000) and positioning by means of GPS, which will make it possible to repeat the work on the same sites in subsequent years of monitoring.

The first counting of the shoots should be carried out in the period just before the leaves develop on the blackthorn bushes, i.e. in the period when the larvae of the shoots are best visible. During this time, caterpillars in the first or second instar (L-1/L-2) are found in the nests. The position of the nests should be marked with a GPS receiver or on a detailed diagram of the transect and additionally in the field by tying a bright material (e.g. ribbon or string) on the bush in order to avoid double counting of the same nests and to facilitate their later finding. A second check should also be performed to find any skipped sockets during the first count. During this period, the caterpillars are usually in the third or fourth stage and are more often outside the nest.

Determination of habitat status indicators

The area occupied by shrubs of the *Rhamno-Prunetea* class in relation to the monitoring area (i.e. on the transect area $300 \times 5 \text{ m} = 1500 \text{ m}^2$) should be estimated. For this purpose, in addition to field measurements. For this purpose, in addition to field measurements, aerial photos can be used. For this purpose, apart from field measurements, you can use current aerial photos available on the Internet. A good method of assessing the coverage of the transect's surroundings is to put a sketch with a shrub arrangement on the printout. A GPS receiver may also be helpful (for example, to go around the bushed by recording a track).

Exposition of the area is defined as an exhibition of a slope to one of eight corners of the world: N, NE, E, SE, S, SW, W, NW, flat area = 0. In addition, it is recommended to collect data on shrubs with non-jagged nests during fieldwork, taking into account: GPS position of the bush (or the location of the bush in the transect diagram), the approximate number of caterpillars in the implement, the height of the bush placement above the ground, the species of the shrub (the

caterpillars usually feed on blackthorn but it is also possible to forage on other shrubs/trees), compact shrubs within 3 m around the bush (according to the scale: 1 = a solitary bush, 2 = max 1/3 of the area around the bush with a bush covered with brush, 3 = shrub coverage between 1/3 and 2/3, 4 = coverage greater than 2/3); sketch of the research area (to facilitate the localization of the transect in subsequent monitoring seasons).

Term and frequency of observations

Field studies should be performed in spring and summer, when caterpillars appear. The recommended inspection dates are the first half of April and August. With the current state of knowledge, it is difficult to determine how many years such surveys should be repeated, as the seasonal variability of the population size and the rate of changes in the habitat of the species are not known so far. However, due to the changes taking place in the agricultural landscape, as well as the decreasing number of the species, annual monitoring is proposed.

Equipment and materials for research

During the studies there is specific equipment required:

- GPS transmitter with spare batteries,
- compass,
- tape measure,
- a camera with a macro lens or a macro function,
- current orthophotomaps,
- pencil, pen,
- a notebook or cards with species observation,
- possibly a pair of tweezers and a small, sealed container with 95% ethyl alcohol (for the purpose of taking the leg alive for identification using genetic methods).

Regardless of the standard record sheet of the species monitoring results, an additional record sheet of data collected in the field has been proposed at the station:

Specimen observation sheet – *Aporia crataegi*

Position:

Date:

Observer:

No.	Nest coordinates	Shrub species	Height above the ground	Slope exposure	Number of caterpillars	Comments
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Species observation sheet at the location

Code and species name Species code according to the Habitats Directive; Polish and Latin name, author according to the currently binding nomenclature

Name of location Name of the monitored field

Type of location Enter: research or reference

Protected areas, on which it is located the position Natura 2000, nature reserves, national and landscape parks, ecological sites, documentation sites, etc.

Geographic coordinates Enter the geographic coordinates of the position (GPS)

Altitude Enter the altitude above sea level positions or range from ... to ...

Area of location Value in m²

Description of location	Description facilitating the identification of the position. The location and nature should be described the site and how to get to the site. Mark for which part of the position geographic coordinates are given.
Characteristics of the species habitat at the location	Description of the species habitat at the site: the presence of shallows, the nature of the shoreline, the share of rush in the shoreline, the percentage of coverage with water plants, the degree of shading of the reservoir, the degree of overgrowing the water surface, etc.
Observer	Name and surname of the monitoring contractor in the location
Dates of observations	Dates of all observations

The record sheet of data should also include “The conservation status of the species at the location” table with: parameter/indicators (with indicator value and evaluation comment), population, abundance, isolation, habitat, share of the area covered by blackthorn thickets, perspectives and overall assessment with appropriate comments. “Current threats” table can also be added, with the list of the most important current and anticipated impacts (threats) on the species and its habitat at the site studied (including the current use, planned investments, planned changes in management and use); impact/threat coding in accordance with Annex E to the Standard Data Form for Natura 2000 sites, with intensity and description.

Species with similar ecological requirements for which the developed methodology can be applied

The proposed monitoring, after optimization of control dates, can be used for other species of butterflies, the caterpillars of which live in clusters located on the branches of shrubs and low trees, e.g. other species of the genus *Eriogaster*.

PROTECTION OF THE SPECIES

Due to the limited amount of data on the biology, habitat preferences and the exact abundance of *Aporia crataegi*, it is impossible to establish precise protection methods.

In addition to introducing an effective method of monitoring, in the areas where the occurrence of this species has been found, additional protective measures can be taken, which should include: avoiding the use of spraying and the use of repellants in orchards, limiting or not mowing meadows and grasses, striving to leave free spaces at the edges forests, preservation of the persistence of plant species constituting a food base for caterpillars, or covering and monitoring the habitats of the *Aporia crataegi*.

CONCLUSIONS

It is quite difficult to predict the future of the population of this species, however, in order to prevent a further decline in the abundance of the *Aporia crataegi*, it is necessary to undertake constant monitoring attempts and cover the species with at least partial protection.

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PROPOZYCJA MONITORINGU NIESTRZĘPA GŁOGOWCA *APORIA CRATAEGI* (LINNAEUS, 1758)

Streszczenie. Niestrzęp głogowiec *Aporia crataegi* (Linnaeus, 1758) jest dużym motylem z rodziny bielinkowatych. Jego zasięg rozciąga się od północno-zachodniej Afryki na zachodzie po Zakaukazię i przez Palearktykę po Syberię i Japonię na wschodzie. Na południu występuje w Turcji, na Cyprze, w Izraelu, Libanie i Syrii, natomiast nie występuje w północnej Skandynawii i wyginął na Wyspach Brytyjskich. Choć jest dość rozpowszechnionym gatunkiem, jego biologia, a także wielkość populacji są wciąż słabo poznane. W Polsce zaobserwowano spadek jego liczebności. Ze względu na dotychczasowy brak opracowanych metod monitoringu dla niestrzępa głogowca w pracy zaproponowano przykładowy sposób prowadzenia takich badań. Głównym celem jest oszacowanie liczebności populacji gatunku oraz ocena jakości zajmowanych przez niego siedlisk. Metodologia badań oparta jest na zliczaniu oprzędów na wyznaczonych transektach i na ocenie jakości siedliska według podanych wskaźników. Badania tego typu mogą dostarczyć cennych danych dotyczących wymagań siedliskowych gatunku, a także informacji o potencjalnych zagrożeniach wpływających na populację, dzięki którym można by wdrożyć odpowiednie metody ochrony.

Słowa kluczowe: niestrzęp głogowiec, *aporia crataegi*, monitoring, ochrona.