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Ups and downs of *Parnassius apollo* (LINNAEUS, 1758) in the Tatra National Park/ Poland and problems of its reintroduction

(Lepidoptera: Papilionidae)

by

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Abstract: The author by comparing past reintroductions of *Parnassius apollo* (L.) in the Sudeten Mountains, vicinity of Biecz, and the Pieniny Mountains discusses the chances of carrying out the treatment of its active protection aiming at its reintroduction in the Polish part of the Tatra Mountains, where this species became extinct in its known localities at the end of the 20th century. He proposes to use the methods which are free of mistakes committed during the past reintroductions and which probably contributed to their failure.

Key words: Apollo butterfly; active protection; reintroduction; Tatra National Park; Pieniny National Park; Awadhara nature reserve (Caucasus Mountains, Abkhazia); Mt. Aragac, (Armenia); Vallis Valley (Swiss Alps).

Preface: The Apollo butterfly, due to its unusual beauty, at a considerable individual variation, thus having the inclination to form local races and subspecies (CAPDEVILLE,1978), has become a symbol of endangered mountain nature[1]. This fact has been mentioned in literature, and on popular picture postcards from the Tatra and Pieniny national parks its image may still be found as an element of their fauna.

The trials of reintroduction of Apollo in the Sudeten Mountains (BORKOWSKI, 1998; MASLOWSKI, 2005), and in the vicinity of Biecz, situated in the Ropa river valley, by CHROSTOWSKI (1954, 1957a, and personal information), were initially successful. However, the populations, introduced in selected sites, after several years of successful development have become extinct. Presently, the reintroduction of Apollo is under monitoring in the Pieniny National Park .

Problem: The decreasing numbers, and then extinction of Apollo in various localities in Poland (fig. 1), including those in the Polish Tatra, have been observed since the end of the 19th century. Since the beginning of the 20th century some authors have been alarmed that mass collecting of this attractive butterfly species will cause its extinction (NOWICKI, 1865; JACZEWSKI, 1932). At first, a passive protection was practiced. Correctly the individual and commercial collecting was considered to be the main cause of danger (DABROWSKI, 1987). In July of 1957 the director of the Pieniny National Park made an indictment to the public prosecutor against a poacher from Warsaw who for several years collected Apollo in the Pieniny Mountains and reared its caterpillars for commercial purposes. The Warsaw Public Prosecutor's office dismissed this claim "because of a negligible social harmfulness of this deed". At that time this legal statement secured impunity to poachers and dealers. Between 1950 and 1970 large series of Apollo and Clouded Apollo were offered for sale in Warsaw zoological stores. The data on this procedure were obtained by

[1] The process of liquidation of the largest locality of Apollo on a xerothermic slope of Zar in the Western Tatra is described on p. 129 (DABROWSKI, 2007).

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A. W. SKALSKI in two Warsaw stores and reported at the meeting of the Cracow's branch of the Polish Entomological Society (DABROWSKI, 2007: 130).

In the middle of the 20th century the causes of disappearance of Apollo were also looked for among unfavorable ecological factors. Also the trials of active protection through the reintroduction of this species in its historic sites were undertaken (BORKOWSKI, 1985, 1998; CHROSTOWSKI, 1954, 1957, 1957a, 1958; DABROWSKI, 1977a, 1978, 1978a, 1979, 1979a, 1980, 1980a, 1981, 1981a, 1982, 2004; DABROWSKI & KRZYWICKI, 1982; IRZYKOWICZ, 1996; WITKOWSKI, 1992; WITKOWSKI, KLEIN & KOSIOR, 1992; WITKOWSKI, PAONKA & BUDZIK, 1992).

The extinction of local populations of the Apollo butterfly, first at the lowest localities in the Pieniny Mountains (fig. 2), was also connected with conversion of mountain meadows, the main feeding base of butterflies, into pastures. Apollo adults mainly took advantage of the flower nectar of thistles (*Carduus* L. and *Cirsium* MILL. em. SCOP.) and clovers (*Trifolium* L.). The intensive fertilization of meadows in the Pieniny, mainly with nitrogen fertilizers, favored the development of grasses (DABROWSKI, 2007; ZARZYCKI & DABROWSKI, 1968) and soon eliminated the past rich plant diversity. Because of a simultaneous disappearance of conglomerations of *Sedum maximum* SUT., a food plant of Apollo caterpillars, on xerothermic sites being afforested, it was a double trophic catastrophe for this butterfly species (DABROWSKI, 1977a). Besides, at that time, a complex of meteorological conditions, especially unfavorable to the species of such a high protandry, occurred in that area. Early emerging ♂♂ were dying in great numbers, while ♀♀, emerging much later, produced no progeny because they were unfertilized.

In the Tatra, the forest management was the factor reducing resources of mountain meadows and pastures. After several centuries of regional sheepherding, sheep and cow grazing was eliminated from the Tatra National Park. This was accompanied by artificial afforestation of so called "wastes" such as xerothermic clearings in the forest, mountain pastures, sunny slopes, and avalanche gullies full of *Sedum* patches, a food base of caterpillars. Between 1955 and 2005, only in the Western Tatra part of the Tatra National Park, over 200 ha of living space of Apollo and other species living in xerotherms was reduced[2]. Devoid of its biotopes and necessary food base Apollo was undertaking long "dispersion" flights from its last localities in the Western Tatra (fig. 3). Single specimens were seen on flowers in the town of Zakopane, and even further away on a southern slope of Gubalówka (DABROWSKI, 1981). These flights were most intensive in the mid-1950s. Accidentally this coincided with creation of the Tatra National Park. These problems have been discussed in numerous publications (compare references cited)[3].

The process of extinction of Apollo did not spare localities in Slovakia, a country situated south of Poland. Czech and Slovak lepidopterologists have contributed much knowledge concerning this problem on southern slopes of the Tatra and Carpathian Mountains (CAPUTA, 1976; HRUBY, 1964; MOUCHA, 1972; REIPRICH, 1971; SLABY, 1954, 1954A, 1956, 1957, 1964; SOLDÀT, 1987; SVESTKA, 1977; TESAR, 1974).

Let us, however, concentrate on chances of reintroduction of Apollo in the Tatra National Park against a background of reintroduction trials that have been carried out in Poland hitherto.

[2]These butterflies according to historical data also occurred at lower elevations, e.g. in Sweden near the Baltic seacoast, central and northern Poland, near Warsaw, and in vicinity of Kiev in Ukraine.

[3]Under a specific arrangement of mountain chains in the Polish Tatra National Park the northern slope exposure prevails (in contrast to the Slovak Tatra National Park on the Slovak side of the Tatra Mountains). Therefore, the afforestation of even relatively small areas of xerothermic mountain meadows, providing the refuge for qualitatively and quantitatively rich flora and fauna, has very significantly impoverished the biodiversity of the Tatra National Park by elimination of scientifically valuable species which are listed in the Red book (Photos.. 1, 2, 3, and 4).

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Discussion: The negative effects of the introduction of foreign genes into local ecotypes of plants and animals are well known. This contributes to undesirable mixing of the gene pool of subspecies which have been adapting to local conditions over thousands of years. There are documented examples of this problem in the Tatra Mountains. For example, the Alpine ecotypes of *Picea abies* have been introduced to the Tatra in the 19th century using seed imported from Austria. Presently, this introduction of foreign ecotypes of spruce is considered to be responsible for a substantial part of damages caused by wind and insect pests in forests of the Tatra National Park. At the turn of the 19th century such animals as deer, chamois, and ibex were introduced, mainly from the Alps, to the hunting area of count CHRISTIAN HOHENLOE in the Jaworzynskie Tatra. Even the American bison (!) was introduced in order to "enrich" the Tatra fauna. From that area these animals spread over the entire Tatra Mountains. Some of them, e.g. Alpine ibex, did not endure local climatic conditions, but some other interbred with local ecotypes. These experiments had dramatic consequences for the quality of phenotypes. Thus the Tatra ecosystems have been "littered" with unwanted crosses, and the Tatra National Park inherited the worst, in respect of quality, herd of interbred deer in the Carpathians.

The examples mentioned above expressively warn against "polluting" the Tatra population of Apollo by introduction of foreign gene pool, for example of the Alpine population, as it has happened during the reintroduction of this species in the Pieniny.

In the case of the Pieniny, according to information of R. ZUKOWSKI, S. TOLL, M. KRZYWICKI, and R. SZPOR, Apollo populations during 1940-1950 communicated with one another through "dispersion" flights, although they were at that time already small and local.

IRZYKOWICZ (1996) reported a low vitality and genetic defects of the material obtained from crosses of the Carpathian and Alpine Apollo reared ab ovo, and then used for reintroduction in the Pieniny National Park. The factors of a lethal nature, including disappearance in some ♀♀ of a substance necessary for egg gluing, a relatively high per cent of caterpillars not hatched from eggs, or wing defects in adults, began to appear right at the beginning of reintroduction in the Pieniny, and presently they are still observed there.

In the Vallis Valley in the Swiss Alps, during emergence of Apollo adults (July 1972), we found during three days several specimens unable to fly normally because of an asymmetric underdevelopment of wings, more often of forewings (col. pl. 24: 7, 7a). In the case of some individuals all four wings failed to develop after their emergence from pupa scales. Our guide P. BOVEY confirmed that he had seen such underdeveloped specimens earlier. On the other hand, when penetrating localities of Apollo in the Awadhara reserve in the Caucasus (July 1969), we found not a single specimen with wing underdevelopment among hundreds of emerging adults. Our companion E. S. MILANOVSKIJ, a scientist concerned with lepidopterofauna of Abkhazia, also had never found Apollo specimens with underdeveloped wings. Similarly, on Mt. Aragac in Armenian Transcaucasia (Zakavkazye) (July of 1976 and 1977), where biotopes were smaller and more dispersed, we found no specimens with underdeveloped wings.

Also in the Tatra populations no specimens with wing underdevelopment were observed according to data of S. F. ADAMCZEWSKI, S. BATKOWSKI, J. FUDAKOWSKI, M. KRZYWICKI, S. TOLL, R. SZPOR, and R. J. WOJTUSIAK.

The problems of the gene pool impoverishment, unfavorable genetic drift, accumulation of lethal characteristics (FORD, 1967), and also the biochemical interaction between periodic toxicity of the food plant and feeding caterpillars (MOSER & OERTLI, 1980), or a toxic role of

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heavy metals (NUORTEVA, WITKOWSKI & NUORTEVA, 1993) should be taken into account. Long-term observations showed that these factors may significantly limit the numbers of Apollo.

However, the threats mentioned above could be minimized by the removal of the negative factors over which we have a direct control. For example, we can restore and enlarge meadows, and remove trees and shrubs from xerothermic slopes with patches of *Sedum fabaria* KOCH. Such treatments would increase the chance of population survival in reintroduced localities. Nature itself helps in this respect since there are frequent wind damages, snow avalanches, and falling rocks which clear mountain xerothermic meadows and gullies from artificial forest stands.

In no case the rearing material should be transferred from the Pieniny to the Tatra. These are different trophic populations because Apollo caterpillars in the Pieniny mainly feed on *Sedum maximum* SUT., while those in the Tatra on *S. fabaria* KOCH. Besides, it would be a foreign ecotype for the Tatra, which at the present time is mixed with unfavorable characteristics of the Alpine genotype in the population reintroduced in the Pieniny National Park.

ADAMCZEWSKI (1992: 151) concluded that " the efficiency of the dispersion flights in many directions from a gradually dying population is small, but at the total effort of the number of successive generations it is sufficient to conquer new areas, and to secure a moderate expansion of the species..." Therefore, theoretically it would be possible to restore in natural way the old sites of Apollo by removing unwanted artificial forest cover and planting the food plant of caterpillars (*Sedum fabaria* KOCH.) as well as food plants of adults (*Cirsium* sp. and other), also on mountain pastures and meadows in the forest interior, and then wait for dispersion flights of females from populations still existing in the Slovak Tatra. However, the examples of reintroduction of Apollo in the Pieniny National Park (WITKOWSKI, 1992) and also two other butterfly species (DABROWSKI, 1980, 2004) carried out under the program of active protection of these endangered species, seem to point out that the active method of Apollo reintroduction in the Tatra National Park is very promising. However, in such a case, the future reintroduction sites, of size at least equal to those present in the Koscieliska and Chocholowska valleys in the 1940s, should be prepared by radical removal of the forest on selected slopes as well as by widening of overgrown screes of avalanche gullies, restoration of meadows, and planting of food plants of caterpillars and adult butterflies. There already exist examples of such treatments in the Pieniny (IRZYKOWICZ, 1996) as well as elaborations for the Tatra National Park including methodical recommendations (DABROWSKI, 1979, 1979a, 1981).

So far, the trial of active protection carried out in the Pieniny National Park has been successful (WITKOWSKI & ADAMSKI, 1992). On the other hand, there is no interest of the authorities of the Tatra National Park in restoration of Apollo. It must be remembered that in localities where this species has become completely extinct its reintroduction is much more difficult and costly, while a permanent success is not certain. This has been proved by reintroductions undertaken in Biecz and the Sudeten.

The present state of knowledge permits us to conclude that protection of disappearing populations should be concentrated on preservation and active protection of their natural habitats being devastated by anthropopression. The restitution should be based on preparation and restoration of localities in the most natural way. Such action would also increase the chance of survival of other valuable concurrent species which create the biodiversified, resistant, and healthy ecosystems.

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Suggestions

If the reintroduction of Apollo is undertaken in the Tatra National Park the repetition of the following former mistakes should be avoided:

1) Genetic: in order to maintain the Tatra ecotype the rearing material for the reintroduction should be collected only in the Slovak Tatra, to prevent the introduction of unwanted genes. This rearing material should originate from localities with ecological conditions close to those present in the Polish Western Tatra.
2) Silvicultural: the reintroduction in specially prepared localities should be conducted in the following order:
   a) Adequately large areas should be selected on southern slopes in the Western Tatra for creation of optimal habitats for caterpillars and adult butterflies.
   b) In these areas trees and shrubs growing on xerotherms should be removed and the basic food plants of caterpillars and adults should be planted and sown.
   c) The caterpillars reared ab ovo should be protected against parasitic hymenopterans and dipterans in order to secure successful development of a new population.
   d) For the release of ♂♂ as well as ♀♀ ready to lay eggs in the prepared places the most favorable weather conditions in a given year should be chosen during the period of mating flights. [Under natural conditions ♀♀ lay eggs in the most favorable ecological niches, thus securing the establishment of a durable population (Photo. 5)].

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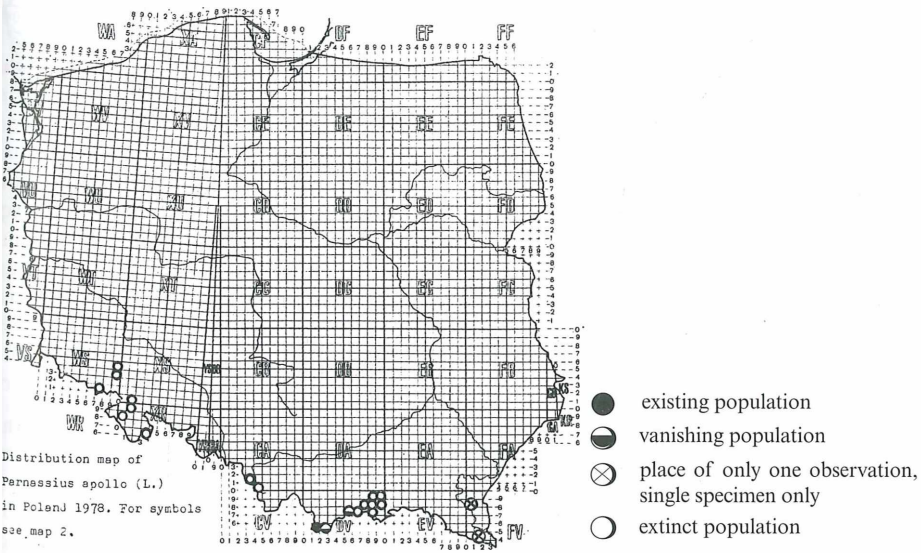

Fig. 1: Distribution map of *Parnassius apollo* (L.) in Poland (condition in 1978).

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Fig. 2: Distribution map of *Parnassius apollo* (L.) in the Pieniny National Park (condition in 1970). For symbols see fig. 3.

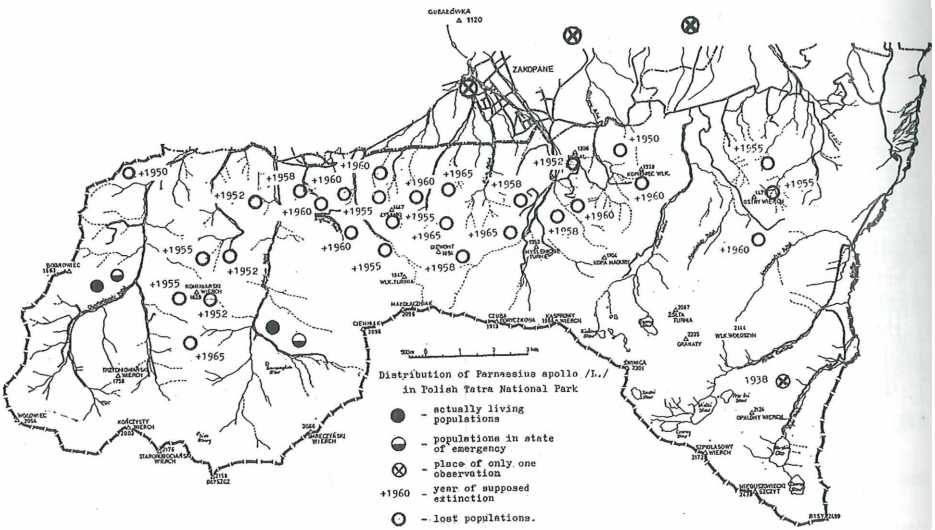

Fig. 3. Distribution map of *Parnassius apollo* (L.) in the Tatra National Park (condition in 1978).

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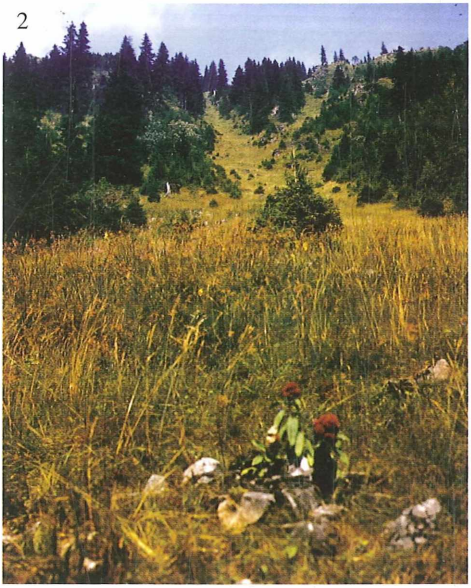
Colour plate 23/ Farbtafel 23



Phot. 1: Biotopes of *P. apollo* (L.): Polana Chocho Bowska, about 1150 m above sea level, ChochoBowski Regiel, about 1350 m, MaB' Kopisko and Wielkie Kopisko, 1400'– 1450 m, the Western Tatra (VII.1960).

Phot. 2: Wielkie Kopisko, about 1350 m above sea level. A small biotope of *Parnassius apollo* (L.) situated in the avalanche gully (VIII.1968).

Phot. 3: Tomanowa Valley, 1200 m a. s. l., southern slope of Mt. Zar, 1350-1600 m , the Western Tatra. The biotop of *P. apollo* (L.) and species from genera *Erebia* and *Lycaena*, and families Hesperiidae and Zygenidae. Effects of artificial afforestation with spruce are evident (IX.1976).

Phot. 4: ♀ of *P. apollo* (L.) feeding on thistle flowers, Polana Chocholowska, 1150 m above sea level (VIII.1965).

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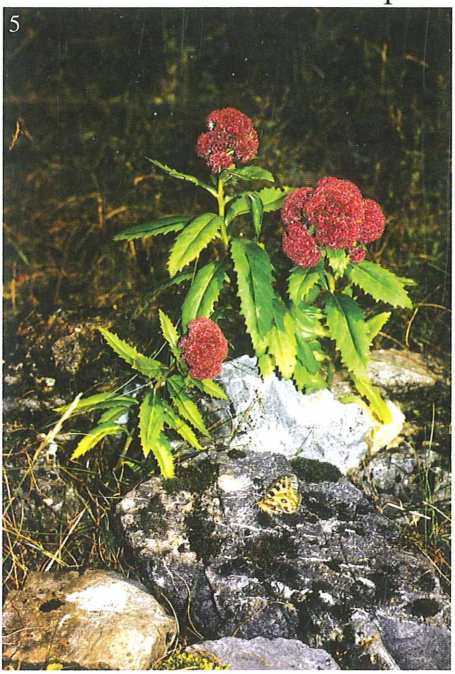
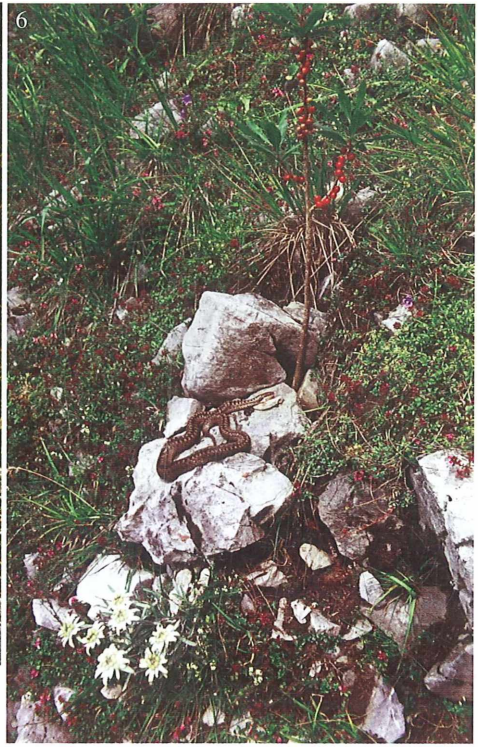
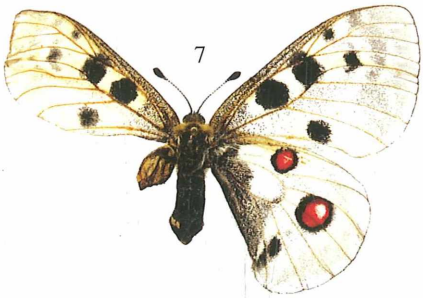
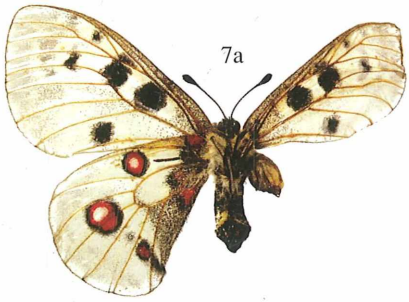
Colour plate 24/ Farbtafel 24









Phot.. 5: ♀ of *Parnassius apollo* (L.) laying eggs on the rock with *Sedum fabaria* Koch. Male Kopisko, about 1400 m above sea level. (VIII.1968).

Phot. 6: Xerothermic grass on Mt. Zar, 1350 m above sea level. The biotope plentiful of rare and protected plant and animal species. Actually destroyed by the artificial spruce forest (VIII.1975).

Phot. 7, 7a.: ♀ of *Parnassius apollo* (L.) with underdeveloped wings (dorsal and ventral view). Vallis Valley (Swiss Alps), 1550 m above sea level. 25 June 1968 (leg. P. Bovey). All photos made by the author.

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