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Biology and behaviour of a Hungarian population of *Parnassius mnemosyne* (LINNAEUS, 1758)

by

András M. VOJNITS & Eszter ÁCS

Key Words: Lepidoptera: Rhopalocera: Papilionidae: *Parnassius mnemosyne* (LINNAEUS, 1758); Hungary: Mts. Börzsöny; Population biology; Behaviour; Butterfly conservation.

Abstract: The paper presents a complex study of a Hungarian population of *Parnassius mnemosyne* (Linnaeus, 1758) aimed at the conservation of the species in the Börzsöny Mts. North of Budapest: population size, activity, spatial pattern, foodplant preference, copulation, oviposition and state of endangerment. The population studied is the individually strongest of the species in Hungary.

Authors' addresses:
Dr. A.M. Vojnits, Haller utca 88-V/20, H-1091 Budapest (Hungary). — Dr E. Ács, Erdöaljasor 1, H-2021 Tahitotfaln (Hungary).

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1 Introduction

Parnassius mnemosyne (Linnaeus, 1758) is a legally protected species listed also in the Hungarian Red Book. Its theoretical value in Hungary (penalty when collected without permission) is 10.000 Ft (about 100 DM). The species has significantly decreased in numbers or has become extinct in some areas of Central Europe. In Hungary it is not seriously endangered at present, but some of its isolated populations, important from a genetical point of view, and its localities are subject to increased pressure; they require territorial protection. We consider *P. mnemosyne* to be potentially threatened in Hungary; further more its individual numbers fluctuate considerably (RAKONCZAY 1990). In the frame of the zoological survey of the proposed Danube-Ipoly National Park, we have studied, primarily for the aims of biological conservation, the conditions of the vigorous population of *Parnassius mnemosyne* in the Nagy-Hideg-hegy area of the Börzsöny Mts. (North Hungary, between Duna and Ipoly, Northern Mountain range, about 50km north of Budapest).

2 Study area

2.1 General information

The upper woodland clearings and mountain meadows of the Nagy-Hideg-hegy (High Börzsöny) are in a favoured position from several points of view. There ere very few open places in the Börzsöny, and those which there are are either steep grassy slopes or formerly deforested areas: not too old and in the state of reafforestation or rather in an advanced state of bushiness. The few 'true' mountain meadows are of small extent, and that of the Nagy-Hideg-hegy is one of the largest ones and, concerning its fauna, it is one of the most valuable. The vegetation of forests and meadows is diverse in its composition and the meadows are also rich in mountain insect species. Many insect species rare in other localities appear here in large numbers; for some insect species the Nagy-Hideg-hegy area is the sole site of their occurrence in Hungary (VOJNITS 1967).

The Nagy-Hideg-hegy on the whole and above all the meadows themselves are widely exposed to civilisation pressure. The causes are evident. Near the top of the mountain of Nagy-Hideg-hegy is situated the sole tourist hotel of Börzsöny, with several of the mountain walking paths converging there. Also, among the few skigrounds of the country, the one with the best snow conditions, is found here. However, treading damage is not intolerable at present. Considerably more dangerous is construction rubble and the deposition of refuse (rubble, rubbish, sand and scrap-iron), and even more so certain future plans concerning the area. Indirectly, damage caused by wild animals can also be mentioned here; the unnaturally high game population maintained here causes lasting damage to a significant proportion of flora including many insect food plants.

It should also be emphasised that since the imago of *Parnassius mnemosyne* is of large size and appears in great individual numbers during its main period of flight, it is really one of the 'landscape features' characterising the distinct landscape of the Nagy-Hideg-hegy in the early summer.

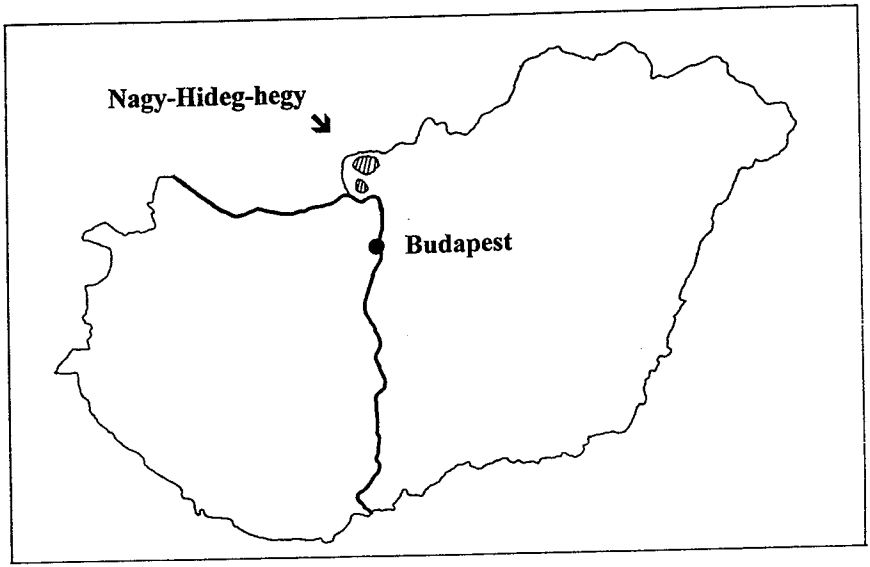

Fig. 1. The study area.

2.2 Butterfly species of Nagy-Hideg-hegy

In all 68 butterfly species have been found in the study area, among them several rare and/or protected species.

Hesperiidae
Pyrgus malvae (LINNAEUS, 1758)
P. alveus (HÜBNER, 1803)
Erynnis tages (LINNAEUS, 1758)
Carterocephalus palaemon (PALLAS, 1771)
Thymelicus acteon (ROTTEMBURG, 1775)
T. lineola (OCHSENHEIMER, 1808)

Papilionidae
Papilio machaon (LINNAEUS, 1758)
Parnassius mnemosyne (LINNAEUS, 1758)

Pieridae
Pieris brassicae (LINNAEUS, 1758)
P. napi (LINNAEUS, 1758)
P. rapae (LINNAEUS, 1758)
P. edusa (FABRICIUS, 1777)
Colias crocea (GEOFFROY, 1758)
C. hyale (LINNAEUS, 1758)
Gonepteryx rhamni (LINNAEUS, 1758)

Lycaenidae

Favonius quercus (LINNAEUS, 1758)
Satyrium acaciae (FABRICIUS, 1787)
S. pruni (LINNAEUS, 1758)
S. spini (DENIS & SCHIFFERMÜLLER, 1775)
Satyrium w-album (KNOCH, 1782)
Callophrys rubi (LINNAEUS, 1758)
Lycaena phlaeas (LINNAEUS, 1761)
L. hippothoe (LINNAEUS, 1758)
L. tityrus (PODA, 1761)
L. virgaureae (LINNAEUS, 1758)
Celastrina argiolus (LINNAEUS, 1758)
Cupido argiades (PALLAS, 1771)
Maculinea arion (LINNAEUS, 1758)
M. alcon (DENIS & SCHIFFERMÜLLER,1775)
Plebejus argus (LINNAEUS, 1758)
P. argyrognomon (BERGSTRASSER, 1799)
Polyommatus icarus (ROTTEMBURG, 1775)
P. dorylas (DENIS&SCHIFFERMÜLLER,1775)
P. semiargus (ROTTEMBURG, 1775)

Nymphalidae (Nymphalinae)

Apatura iris (LINNAEUS, 1758)
Vanessa atalanta (LINNAEUS, 1758)
V. cardui (Linnaeus, 1758)
Nymphalis io (LINNAEUS, 1758)
N. urticae (LINNAEUS,1758)
N. polychloros (LINNAEUS, 1758)
N. antiopa (LINNAEUS, 1758)
N. c-album (LINNAEUS, 1758)
Araschnia levana (LINNAEUS, 1758)
Argynnis paphia (LINNAEUS, 1758)
A. adippe (Denis & Schiffermüller, 1775)
A. niobe (LINNAEUS, 1758)
A. aglaja (LINNAEUS, 1758)
Issoria lathonia (LINNAEUS, 1758)
Boloria dia (LINNAEUS, 1758)
B. euphrosyne (LINNAEUS, 1758)
B. selene (DENNIS&SCHIFFERMÜLLER,1775)
Melitaea didyma (ESPER, 1779)
M. phoebe (DENIS&SCHIFFERMÜLLER,1775)
M. cinxia (LINNAEUS, 1758)
M. athalia (ROTTEMBURG, 1775)
M. britomartis (ASSMANN, 1847)

Nymphalidae (Satyrinae)

Hipparchia fagi (SCOPOLI, 1763)
H. semele (LINNAEUS,1758)
H. circe (FABRICIUS, 1775)
Aphantopus hyperantus (LINNAEUS,1758)
Pararge aegeria (LINNAEUS, 1758)
P. megera (LINNAEUS,1758)
Maniola jurtina (LINNAEUS, 1758)
M. lycaon (KÜHN, 1774)
Coenonympha arcania (LINNAEUS, 1758)
C. pamphilus (LINNAEUS, 1758)

3 Material and methods

According to SOUTHWOOD'S (1966) summary, the capture-recapture (CR) method plays a favoured role in the study of population parameters. Whatever marking method is applied, the main prerequisite is that it must not disturb the marked insect, that the mark must stick as required and be easy readable. In the Hungarian Natural History Museum we have worked for some time with marking methods and have developed some suitable variations (VOJNITS 1976, 1977, 1985, 1993). In the present case we have applied individual markings, by writing numbers with waterproof ink with a fibre tip pen on the wings of the imago. This has the advantage – in an ideal case – of ensuring the tracing of every member of the population and thus receiving the maximum of information.

The release of the insect is the important moment of the CR method. The individuals marked must be able to intermingle perfectly with the other members of the population. The butterflies are released either in the approximate centre of the study area (EHRLICH & DAVIDSON 1960) or at the site of capture (BRUSSARD

1971). We found the latter method the best applicable. According to some authors, the activity of the specimens suddenly increases after release and this also helps mingling. In our experience this cannot be generalised so simply. Adults of certain species will settle within some meters (*Melitaea*) while others, for instance the large-sized fritillaries (*Argynnis* spp.), fly upwards. *Parnassius mnemosyne* revealed both behavioural patterns. It can be said in general that the males proved to be more agile than females, and were also more lively in warm and sunny weather than at other times. The effects of wind are not clear. The wind may blow butterflies away for lesser or greater distances, in other cases the imago will try to settle on the ground as fast as possible – it almost lets itself fall – and then to hold fast there.

In the study year of 1993 we have marked and numbered 1181 adults. The following data were entered on the survey forms: date, serial number of the imago (in the case of recapture by additional entries), sex (male or female specimen), state of condition (fresh or worn, rated 1to 3), site of recapture (from 1 to 6), activity (F = flying, R = resting, Fd = feeding, C = copula, H = Hiding among plants, O = ovipositing), state of the female (F = if already mated), weather (S = sunny, C = clouded, O = overcast) and the time of capture (between 8 and 10 a.m. = m, between 10 and 12 a.m. = f, between 12 and 14 p.m. = n, between 14 and 16 p.m. = af, between 16-18 p.m. = la, after 18 p.m. = e). The first day of emergence fell on 12 May, the last on 16 June.

As to evaluating the CR method, many mathematical formulae exist; they have recently been surveyed by DEMETER & KOVÁCS (1991). The majority of the calculations connected with the CR method are bound to the process expounded by LINCOLN (1930), but which had originally been published by PETERSEN (1896). (1896). Its most frequent area of applictions refers to the determination of population size. A number of authors deduced their methods from Petersen's estimation among which we have successfully applied – among others – Jackson's positive method (JACKSON 1937). Spatial distribution (one of the most important population studies) can in the course of surveys of this type be calculated relatively simply with reference to Morisita's dispersion index. POOL (1974) advises, for the control of the association, Cole's rate and the "chi2" test. The basis of Cole's rate is the 2X2 convergence table based on the sample areas. The calculation of Cole's dispersion coefficients is also made according to the convergence table.

4 Results

4.1 Population size

The study concerned solely the conditions of the upper clearing of the Nagy-Hideg-hegy. The area is well delimitable and according to our preliminary (and subsequently partially disproven) assumptions there is only a slight possibility of contact – towards the ski-ground – with other populations.

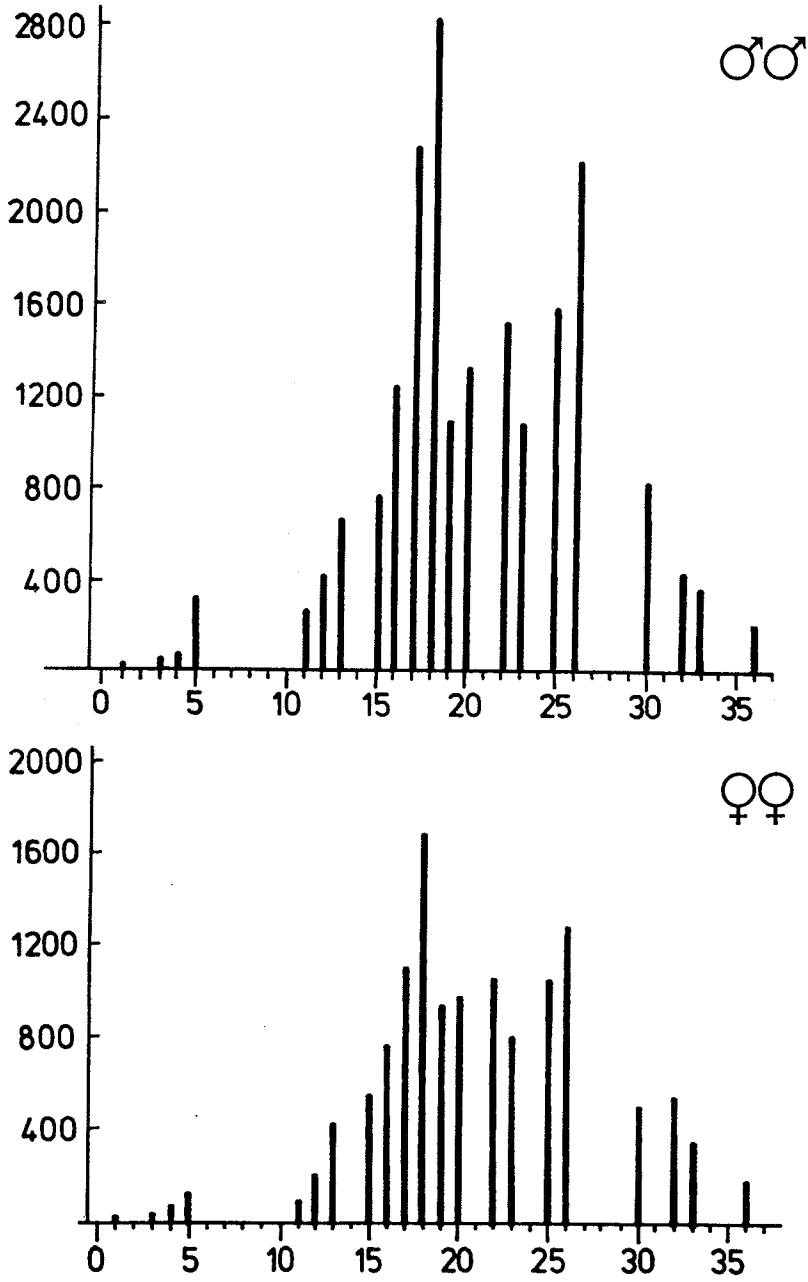

Fig. 2. Population size: males (top) and females (bottom) in 1993.

The average daily individual numbers characterising the *Parnassius mnemosyne* population of the Mt. Nagy-Hideg during the three research periods in 1992 were as follows:

Between 28-31 May	350 individuals
Between 4-6 June	404 individuals
Between 14-18 June	162 individuals.

It is to be noted that in the survey made by KUDRNA & SEUFERT (1991), submitting the results of such most detailed researches made in Germany, the highest daily individual number was 290, and in the decrease period during the middle of June merely 80 (the average values were naturally even lower than these).

According to the surveys, the year 1993 was extremely favourable for *Parnassius mnemosyne* in every part of the country. Very high numbers of individuals were registered and the appearance of the imagines was almost contiguous, since it was not repeatedly interrupted by periods of adverse weather conditions as in the previous year (Figs 1-2). The swarming which began in the middle of May (12) showed individual numbers up to 100 which, two days later, attained values of around 300, and slowly increased to the fourteenth day of the observation period. This was followed by a very steep increase – with occasional breaks but never with significant relapse – of the individual numbers until the end of May (29 May) the eighteenth day of the observation period. By then individual numbers reached 4500, the significance of which should be superfluous to emphasise (we only wish to refer to our value hardly above 400 during the preceding year), and the German maximum value never even reaching 300. Then for a few days (until 2 July), the twenty-third day of the observation period, a relatively low state of affairs followed, but the individual number once jumped above 2600 and still continuously exceeded 1900. The second peak fell on 6 July, the twenty-sixth day of observation, again with very high individual numbers approaching 3500. Subsequently the individual numbers nearly evenly decreased until 16 July, the thirty-sixth day of observation. According to the calculations, there still existed nearly 400 specimen in the area, but by the following days not a single individual was to be recorded.

The comparison of the individual numbers of the two years of investigation allows most interesting inferences. Regardless of the fact that imagines appeared in individual numbers of a higher order in 1993 than in 1992 and that fundamentally different weather conditions prevailed, the swarming was basically the same. The 1992 flight period was interrupted by a longer bad weather, with very cold and rainy days, whereas in 1993 just the opposite happened: the warm and dry weather was nearly continuous and drought conditions evolved even in mountainous regions. That is, the initial increase of a relatively lower rate is followed by an intense multiplication of the population and the zenith of the swarming is reached by a steep increment. A recession then follows with more or less stagnant individual numbers. The most surprising element of the survey is – at least as the data of our researches to date seem to imply – that in the second half of the swarming there appears to be an additional peak, independent of weather conditions. This observation differs from the developments described

by KUDRNA & SEUFERT (1991). This second peak, even if it does not reach the first one, is still significant. The declining in numbers is then gradual until the end of the flight period. The end is quite sudden. Emigration (quasi-open population) can only be meagre, it rather seems as if the droughty weather (owing to which the nectar plants are hard to find in the areas) carries off the imagines like a period of bad weather does.

4.2 Metapopulations

In the course of our researches we have considered the possibility of the intermingling of the Börzsöny populations. The species occurs, beside the Nagy-Hideg-hegy, also in several other places, but in much lower individual numbers. It is rather frequent in the clearings of the ridge extending from the Nagy-Hideg-hegy towards the Csóványos of the High Börzsöny. These less numerous populations may theoretically be in contact with each other, if by nothing else than the weather conditions – the ridge drops steeply northwards and uplifting winds are frequent – single butterflies may get blown away further than usual. The ski track of the Nagy-Hideg-hegy represents a possible connecting channel between the small populations of the ridge and the large one of the upper meadow. However, we have not registered even a single 'vagrant' specimen in this direction or, conversely, we failed to observe imagoes presumably arriving from the higher clearing of the Nagy-Hideg-hegy. The situation is different concerning the swaths and deforested areas SW of the upper clearing. In the populations of small individual numbers inhabiting these localities there were regularly registered marked specimens deriving from the upper meadow, but we have failed to observe even a single specimen belonging to the 'lower' population in the upper meadow. We thus presume that the intermingling of populations (metapopulation sensu KUDRNA & SEUFERT 1991) is essentially unidirectional. Some few specimen of the vigorous population with great individual numbers inhabiting the upper clearing of the Nagy-Hideg-hegy may – especially at the time of increased swarming, its "gradation" – "migrate", but never or hardly ever vice versa. This is also substantiated by the fact of having registered the *Parnassius mnemosyne* hardly or not at all in the lower clearings in 1992, nor did we observe vagrant specimens in the closed forest, contrary to the year 1993 when we have met such individuals even in closed woods in a SSW direction.

4.3 Sex ratio

The sex ratio of a population reveals much about its state, momentary situation and conditions. The sex ratio of 1992 was as follows:

Between	28 and 31 May:	male : female 1:2
Between	4 and 6 June:	male : female 1:5
Between	14 and 18 June:	male : female 1:6

The above figures differ from the data given by KUDRNA & SEUFERT (1991), namely that the male : female sex ratio was 37:1 on 24 May in their study year; this decreased to 11:1 in two days, to 3,3:1 on the third day and finally reached the ratio 1:1 on June. On the Nagy-Hideg-hegy the flight period was protracted in 1992, and there were very long, wet and cold periods even in the second half of June. Some specimens were yet flying by the end of July. The situation altered to some extent in 1993, namely that – presumably owing to the warm and dry weather – the swarming was less extended, the sex ratio corresponded largely to that of the preceding year.

4.4 Activity, flight, dispersal and condition of adults

The main activity of both males and females is feeding (males = 40.6 %, females = 40.5 %; the nearly identical values are most interesting); then the males are on the wing in 37.6 % whereas the females are resting in 26.1 %; the females, being less agile than the males fly considerably less (15.7 %), a value nearly identical with the resting rate of the males (14.4 %). Copulation values are naturally identical (the minute difference 4.8% and 4.7 % derives from a sampling mistake). It should, however, be considered that the high resting rate of the females may naturally contain some of the ovipositing animals, too – it is very difficult to establish whether a given specimen is actually ovipositing or not.

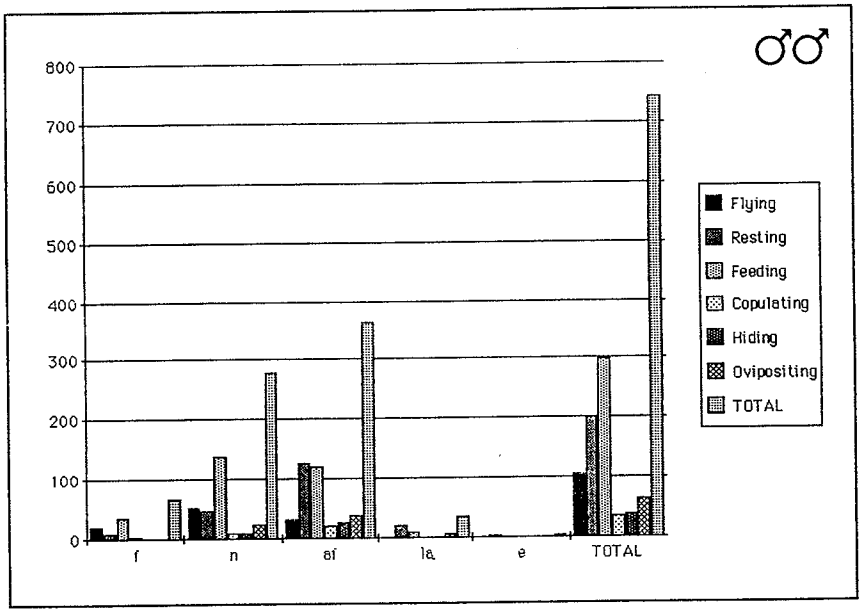

Fig. 3. Daily activities of males (forenoon = f, noon = n, afternoon = af, late afternoon = la, evening = e).

For both the male and female activity the most favourable condition is sunny (S) weather. 71.1% of male activity happens in such conditions, and the rate of that of the females is still higher (75.5 %). In cloudy (C) weather the male activity is 27.4 %, that of the females 24.3 %. When overcast (O) they hide so perfectly – aside from some "conspicuous" specimens settling on high weeds, a recurrent behaviour for a small part of the population and which should yet be studied, especially because they then fall prey to insectivorous birds – that they can hardly be discovered. There are no striking differences in these activity rates between males and females. However, an essential difference between the activities of the males and females appears in sunny (S) weather: the females preponderantly feed (47 %), while the male value is much lower (24 %). The flight value of sunny (S) weather is just the opposite, more than half of the males are on the wing (58.5 %), the female value is only 17.4 %. If not of the same rate, yet a similar difference was found between the activity values also in cloudy (C) weather: more males fly (18 %) than females (10.3 %) in such conditions. It naturally follows that the resting values are opposite in sunny (S) weather a greater percentage of the females (23 %) are resting, while considerably fewer of the males do so (15.6 %). The difference between the sexes in cloudy (C) weather is still higher: nearly twice as many females (38 %) are resting than the males (21 %).

Copulation takes place mostly in sunny (S) weather (63-64 %), but also more than one-third of pairing (36-37 %) happens in cloudy (C) weather. No copulation was observed when the sky was wholly overcast (O). The differences according to the weather conditions are greater in oviposition than in pairing: it is much more characteristic to sunny (S) than to cloudy (C) weather (77 % - 23 %).

To sum up, it can be stated that the males are more agile and longer on the wing than the females: males: feeding/resting/on the wing = 3.2 : 1 : 3.7
females: feeding/resting/on the wing = 2.6 : 1.3 : 1

As in the surveys the sampling work was not carried out with the same frequencies or intensities in the various periods of the day (morning, forenoon, noon, afternoon, late afternoon and evening); the data obtained must therefore be handled with same caution. In spite of this we believe to have obtained useful data (Figs 3-6).

Males are most active during noon (n) and the afternoon (af), and these values are practically identical. Female activity peaks also fell in the noon (n) and the afternoon (af) periods, but the afternoon values are much higher. They rest during this time, if resting is here referable to activity. Males fly more during noontime (n) than in the afternoon (af), and the same can be said of the females, indeed, for the latter the difference is rather significant. For resting (as against flying) the situation is the opposite: they fly more during the afternoon (af) than in the noontime (n); this difference is conspicuous also in the case of the females. Feeding and pairing fell to the noon and afternoon (n, af) periods for both sexes, the noon priority (n) for feeding and the afternoon peak (af) for copulation. Gravid females fly mostly during noon (n) and (slightly more) in the afternoon (af), and they oviposit significantly more in the afternoon.

Comparing forenoon (f) and afternoon (af) data, the adults can be found more during the former period (but the not wholly corresponding distribution of the samplings should here be taken into consideration):

Males: forenoon/afternoon = 16.7 : 4.9
Females: forenoon/afternoon = 9.5 : 4.4

The adults covered in 1992 relatively short distances. The longest measured distances – based on marked specimens – were about 100 and 150 m; the year 1993 yielded different results in this respect: flight distances – in a straight line – approximated 1 km. The adults covered in reality longer distances, because most of them arrived at the lower clearing through from various directions.

The condition of the adults, that is the rate of fresh, presumably recently emerged specimens and the worn ones provide information on the state of the swarming. It was initially a striking experience that the 'usual' advance of emergences, namely that the fresh individuals predominate at first with the subsequent and then preponderance of the worn ones, was several times and especially during the last third disturbed by the abrupt hatching of fresh imagines. The population, by that time comprised mostly of worn specimens, was suddenly 'freshened': 30-40 % of the population were 'faultless' individuals. By the middle of June, 1992, the rate was as follows: fresh individuals 10 %, worn individuals 40 %, very worn and injured 20 %. It was clear by 1993 that the bimodal swarming cannot be ascribed to the adverse weather conditions. The 'ageing' showed a more even picture, perhaps due to the weather.

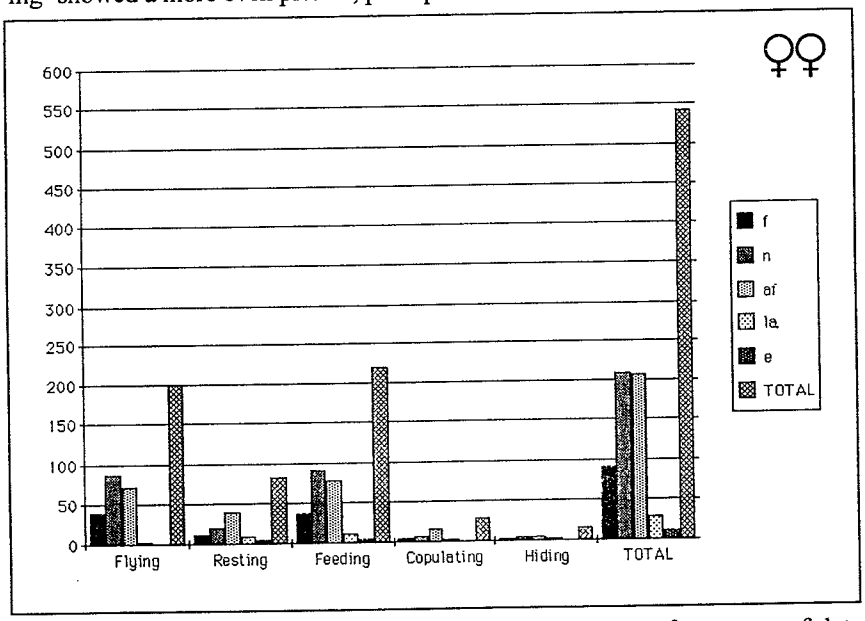

Fig. 4. Daily activities of females (forenoon = f, noon = n, afternoon = af, late afternoon = la, evening = e).

4.5 The spatial pattern: dispersion, association and aggregation

Large-bodied imagines require rich nectar sources, the males because they fly so much and the females because ovipositing is energy-consuming and takes a long time. It can be stated that for the survival of the population, nectar plants of suitable quantity and quality are just as essential as the larval foodplant. Under "quality" we mean not only the quality of the nectar, but also the colour of the flowers. Other authors have also already established that the imagoes of *Parnassius mnemosyne* prefer certain flower colours. The specimens observed on the Nagy-Hideg-hegy in 1992 preferred at the rates of 90-95 % the colours purple-mauve/violet/red, although the rate of these colours, depending on the period in the clearing which harbours the imagoes, was nearly identical (1:1) with those of the white/yellow flowers. More detailed studies were made in 1993.

The most visited flowers in Central Europe on the basis of literature are :
Purple-mauve/blue: *Ajuga reptans, Knautia arvensis, Salvia pratensis, Verbascum phoeniceum, Vicia* spp.
Red: *Cirsium eriophorum, Trifolium* spp., *Viscaria vulgaris.*
KUDRNA & SEUFERT (1991) listed partly the above flowers, or similar species (*Ajuga, Trifolium, Vicia*), but in general the population they studied displayed a more balanced colour preference (although the most frequently visited flowers were in their case also purple-mauve/blue):

Geranium silvaticum (purple-mauve/blue)
Ranunculus repens (yellow)
Taraxacum officinale (yellow)
Tragopogon pratensis (yellow)
Vicia sepium (purple-mauve/blue)
Ajuga reptans (purple-mauve/blue)
Knautia arvensis (purple-mauve/blue)
Melandrium rubrum (red)
Trifolium pratense (red)
Epilobium angustifolium (red)
Allium ursinum (white)
Rubus idaeus (white)
Chrysanthemum leucanthemum (whitish-yellow)

KUDRNA & SEUFERT (1991) assume that the flower colour plays a smaller role in preference, more important is the preponderance of a plant in the given place. Our investigations again contradict this: a positive correlation can be demonstrated between flower colour and the frequency of nectar uptake.

We have established already in 1992 that as the flight of the imagoes becomes prolonged with the advance of the vegetation period one can observe a certain preference alteration, and in this year the most sought-after nectar source was the flowers of *Cirsium eriophorum* in the second half of the period. Assumably – depending on either the configuration of the flower or its nectar content – the imagoes stay longer on one flower or spend a shorter time on another even in the case of identical (weather) conditions. However, for this first year of study we can not submit statistical data. In any case, they stay preferably on this *Cirsium* species. If weather is unfavourable and they do not fly, but feed clambering from one flower to the other, this too happens on this plant.

In the course of our investigations made in 1993, we registered 590 flower visiting. The nectar plants were as follows:

Ajuga reptans (purple-mauve)
Cirsium sp. (purple-mauve)
Euphorbia cyparissias (yellow)
Hieracium cymosum (yellow)
Ranunculus polyanthemos (yellow)
Thymus pannonicus (blue)
Trifolium montanum (white)
Valeriana officinalis (white)
Veronica austriaca (blue)
Viscaria vulgaris (purple-mauve)

Flower colour preference was as follows: purple-mauve/violet: 300 = 50.8 %, blue: 244 = 41.4 %, yellow: 36 = 6.1 %, white: 10 = 1.7 %. These values speak for themselves. The picture becomes even more conspicuous if the distribution is given in colour groups: purple/mauve/blue: 544 = 92.2 %
yellow/white: 46 = 7.8 %

Three purple-mauve/blue plant species proved to be indisputably dominant: *Cirsium* sp., *Thymus pannonicus, Viscaria vulgaris.*

There was a rich yellow/white flower assortment available especially in the first part of the flight period in the area. Doubtless more specimens selected flowers of these colours at that time than later, but the ratios were even then not so markedly different than at subsequent periods. In the second half of the flight period – which in 1993 fell on especially warm and mainly dry days – the imagines concentrated primarily on the flowers of *Thymus pannonicus*, a plant which they had also visited readily previously. The prolonged flowering of this plant in the area invariably guarantees the nectar uptake of the imagines, since it blossoms in masses during nearly the entire flight period. The *Cirsium* plants appeared in smaller numbers in 1993 than in 1992 and their flowers characterised rather the second half of the flight. *Viscaria vulgaris* is widely distributed in the clearings of the Nagy-Hideg-hegy, but owing presumably to the dry weather its presence was delimited to a smaller territory and we counted fewer plants than in 1992. It can also be ascribed to the dry weather that flowering was over earlier than in the previous year, thus feeding on this plant characterised principally the second and the third one-fifths of the flight period.

It was a striking fact that certain plants whose flowers are – according to literature data – especially preferred by the imagines were not visited at all in the study area of the Nagy-Hideg-hegy. Such was *Verbascum phoeniceum*. Manifestly, if there is an abundance of "even better" food in the given period, the butterflies will prefer it. On the other hand, in certain smaller clearings where factually only two plant species was flowering concurrently, namely *Euphorbia cyparissias* and *Viscaria vulgaris*, the imagines preferred *Viscaria vulgaris* without exception, and in places which harboured only Viscaria the butterflies naturally visited this one. However, on the great clearing of our investigations there were, in a not insubstantial part of the study period, actual possibilities of selection, hence we may justifiably infer, from the surveys made at that time, nectar plant preferences.

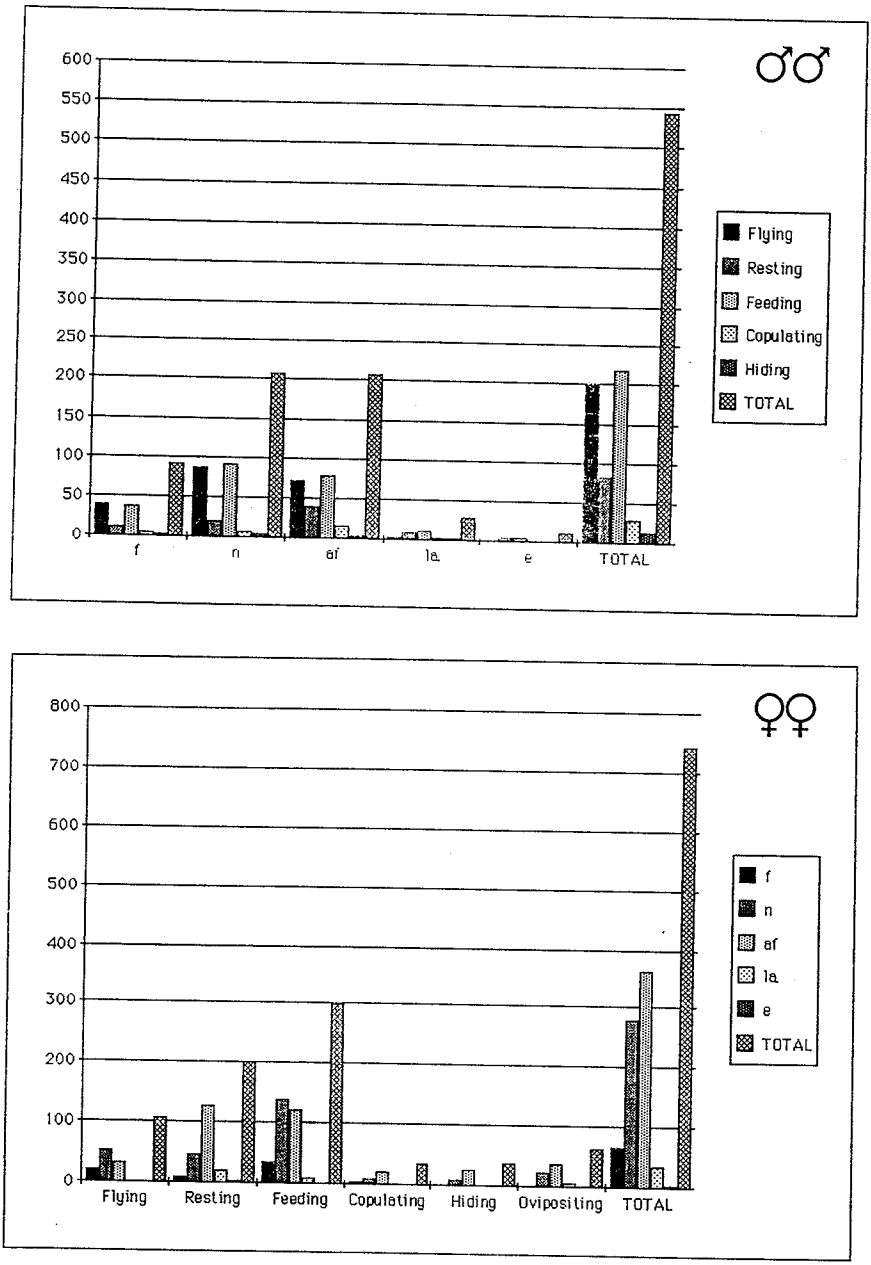

Fig. 5. Activity of males (top) and females (bottom).

It was obvious already from the investigations made in 1992 that the imagoes are not evenly distributed in the research area. We have already discussed the nectar plants: they form more or less well delimitable sites which change with the passing of the vegetation period and which are followed by the butterflies. The pattern becomes strikingly uneven by the second half of the flight period when the imagines gather in large groups around some plants and merely pass over the major part of the locality, but also reveals the vulnerability of the population. (Presumably the disappearance of the 'favoured' nectar plants would considerably set back the population.) It can be said for the whole of the flight period, but especially for its first half, that the males fly more and higher than the females while these latter may best be found hidden in the grass. The coverage of the area depends, besides the flowering plants, mostly on the wind. In windy and generally bad weather they stay rather in the lower, deeper and protected part of the clearing, while in favourable weather they fly repeatedly between the same places above the ridge, about a half meter above the ground. We have planned already in the first year to continue the aggregation and association investigations in the future, with special regard to the interconnections demonstrable by the spatial distribution of the various plant species. We have also decided on the mapping of the population movements and spatial pattern. At first, we drew a simplified map, dividing the area into six squares and marking them from 1 to 6.

According to the investigations made in 1993 (and the considering that only 40.62 % of the males feed, 37.67 % fly, 14.4 % rest, 4.8 % copulate and 2.4% hide away, but that some activities can happen simultaneously, e.g. feeding and pairing, and that a certain percentage of error must also be taken in to account) the male activity falls mainly in square 6: they fly there in 36.4 %, feed in 35.04 %, pair in 35.7 %, and also rest there in 26.5 %: As compared to the entire number of the population, they hide preponderantly in square 5.

The females prefer mainly squares 6 (26.9 %) and 1 (29.7 %). They mostly fly (35 %), rest (30.5 %), feed (28.3 %), and pair (33.3 %) in square 6, while they oviposit (65.5 %), hide(54.8 %), feed (24.5 %), and rest (28 %) in square 1. Exactly 67.5 % of the females had already copulated before capture. The highest number of gravid females appear naturally in square 1 (they oviposit and feed there in 36.17 % and in square 6 where they mainly feed (28.3 %), ovipositing there is negligible (2.9 %).

Square 2 showed much fewer nectar plants in 1993 than in 1992. This site is rocky, the thin layer of soil dries out easily, there were hardly any numbers of the preferred nectar plants owing to the droughty summer – while 1992 was characterised by the numerous *Cirsium* and *Viscaria vulgaris* plants – and the less frequented white- and yellow- flowered plants, e.g. *Euphorbia cyparissias,* were rather frequent). Its number of points can still be defined as medium.

The qualities of square 3 are also interesting: while the males visit it more frequently than square 4, it can be important – despite the meagre ratio – for the

females (oviposition). Square 3 could originally be a favoured place – though we found no larvae here, the *Corydalis cava* stand seems suitable and the preferred plants with purple-mauve/blue flowers occur there – if not in great numbers, but it is 'damaged' by spadework (i.e. redistribution of clay taken from removed areas) the vegetation is gradually being degraded. However, it is still an important site for female activity, because of its number of imagines.

Square 4 is absolutely the last, its number of points being 0. This area lies near the tourist hostel, a damaged site where only vagrant specimens pass through.

Square 5 excels with the richness of individual numbers especially in the 2nd-4th time, sixths of the flight period. There are many nectar plants during this time, nourishing a great number of imagines. Besides this, the rates of flight and hiding are also strikingly high which probably derives from exposure to wind. As a breeding locality, that is, where the caterpillars develop, it plays no role. In the third of the flight period, individuals numbers fall back drastically, parallel with the end of the flowering of the nectar plants. Subsequently, its number of points is relatively high, but not so much as one might think on the basis of the density of the initial population.

Square 6 yielded the absolute highest individual numbers. It is here that the most frequented nectar plants occur in extraordinary richness, and in such a favourable distribution that – except for the last period – one of the plant species was always flowering in abundance. In the lee of the wind it is a site where the imagines assembled periodically. Its number of points is therefore the highest, but it should be pointed out again that square 1 is not far behind which, though showing essentially lower values as regards absolute individual numbers, is a very important site from other points of view.

Summarising the interconnections between activity and the area into a table according to the sequence of importance, the characteristics and the differences for females (left) and males (right) are as follows:

Square no.	1 2 3 4 5 6	1 2 3 4 5 6
Flying	6 1 5 2 3 4	6 5 2 1 3 4
Resting	6 1 5 2 3 4	6 5 1 2 3 4
Feeding	6 1 5 2 3 4	6 2 1 5 3 4
Pairing	6 1 5 2 3 4	6 2 1 5 3 4
Hiding	1 3 5 2 6 4	5 2 1 3 6 4
Ovipositing	1 3 2 6 5 4	

We have compared the significance of all squares scoring points: 1st place = 5, 2nd place = 4, 3rd place = 3, 4th place = 2, 5th place = 1 point, 6th place = 0). The following sequence of preference was obtained:

1. square 6 = 44
2. square 1 = 38
3. square 5 = 33
4. square 2 = 27
5. square 3 = 19
6. square 4 = 0

Square 1 is the site with suitable stands of *Corydalis cava* for the *Parnassius mnemosyne*: at the meeting of the forest and the clearing, they even extend onto

it, the roots and stems abound in a half-shade position, and it is only here that caterpillars are to be found. As a feeding site for the imagines, it plays the main role during the second half, and especially by the end of it: besides *Cirsium* it was here that the stands of *Thymus pannonicus* blossomed for the longest time. This part of the area has a deeper soil and the imagines also favour it as a resting place in the high grass. In the last section of the flight period we found most females here; the great majority of ovipositing females was observed here, too. It

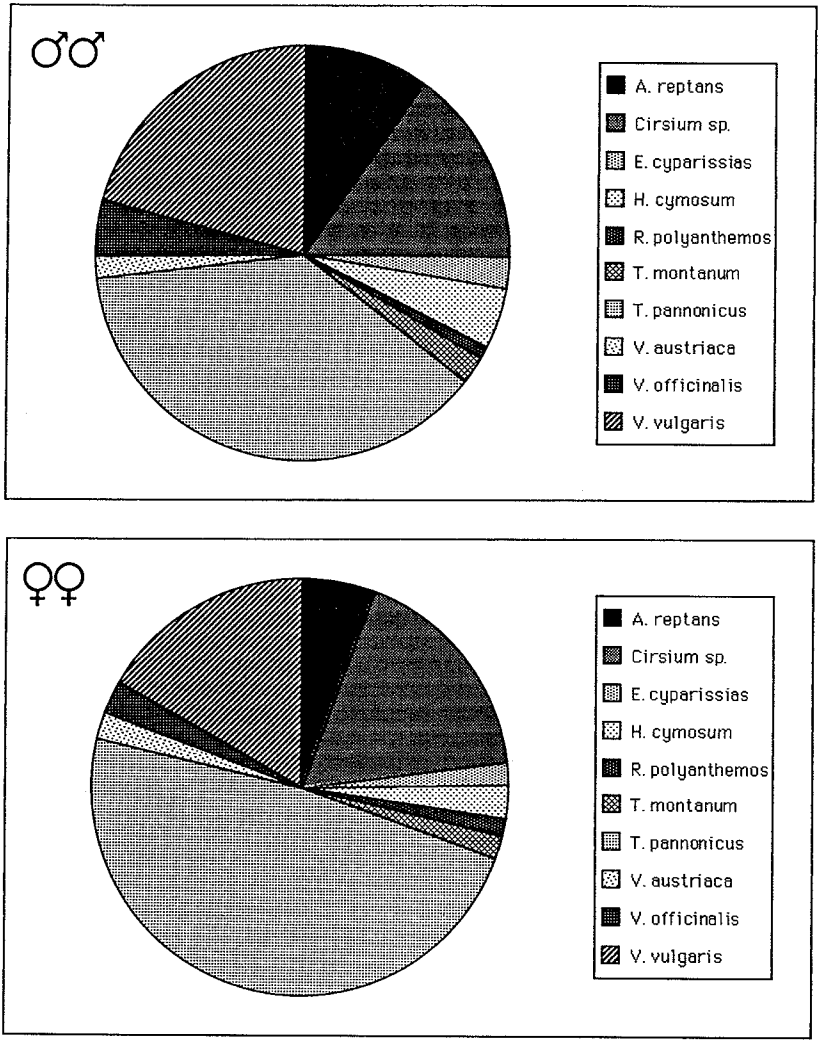

Fig. 6. Nectar source preferences of males (top: 100 % = 234) and females (bottom: 100 % = 307).

should here also be emphasised that swarming also began in square 1, but at the middle of the swarming, only a few imagines were observed in this square. The number of points established for it was despite the fact that the total number of individuals was not exceedingly high, only slightly behind that of square 6.

5 The alleged defence behaviour of adults

Imagines whose body temperature is too low at given moments and which are thus unable to escape danger by quick flight often assume alarming postures. They spread their wings to their body. Concurrently they rub the 2nd and the 3rd pairs of legs producing sound detectable also by the human ear. This phenomenon was known long since (GEIGER 1987, RICHARD et al. 1989, SCHURIAN 1975) for a number of *Parnassius* species, e.g. *P. apollo* (LINNAEUS, 1758), *P. phoebus* (FABRICIUS, 1793). Similarly, this was published also for the imagines of *Parnassius mnemosyne.* German authors point out that V-shaped excisions can often be found on the wings of *Parnassius apollo* and *P. phoebus* (GEIGER 1987, PEKARSKY 1975, RICHARZ et al. 1989, WEIDEMANN 1988); this is not characteristic of the *Parnassius mnemosyne*, although several hundreds of specimens had been handled during the investigation period (KUDRNA & SEUFERT 1991). These injuries originate from insectivorous lizards or birds picking at the sitting butterfly and they only 'bite out' a bit from the hind wing while the insect takes to flight. An explanation of the failure to find such damages on *Parnassius mnemosyne* consists of the proposal of the imago containing toxic substances, thus being "protected". According to this notion the alkaloids of the *Corydalis cava*, namely corydaline, corycavine, bulbocapnine and others (SCHÖNFELDER & SCHÖNFELDER 1988) enter the body of the imago via caterpillars' food (this possibility has already been proven for several other species) so that the potential prey becomes toxic or at least unpalatable for the insectivores. This idea might also be inspired by the spectacle of the large-bodied and conspicuous *Parnassius mnemosyne* adults sitting free and apparently wholly defenceless on plants, exposed to the preying animals. But the predators shun these butterflies.

This hypothesis, though pleasing, fails to hold, because we succeeded in proving the opposite. We found that in certain sites with high-stalked vegetation, torn off wings of *Parnassius mnemosyne* were lying on the ground, indeed, many in certain places. No bodies were found. On the assumption that we were dealing with the activity of insectivorous birds, we made some tests. It was established that flocks of 4-6 specimens of the Grey Wagtail (*Motacilla cinerea*) and of 8-12 individuals of the Goldfinch (*Carduelis carduelis*) eat imagines of *Parnassius mnemosyne*. These birds attack the imagines which sit in groups on the higher plants: several birds swoop down and with great precision eat the bodies of the butterflies, concurrently divesting them of the wings. In no case did we observe the birds pecking at the wings to cause V-shaped excisions.

We have also conducted experiments in the field, both in 1992 and in 1993. Hundreds of butterflies were fabricated from tracing paper and placed on the sites of investigations. It could be proven that the birds pounced on the butterflies grouped on high-stalked plants, but never on single specimens resting in the grass. The model experiments worked well in windy weather when – assumably – the paper butterflies appeared to be more 'alive'.

6 Conservation

The *Parnassius mnemosyne* population of the upper clearing in the Nagy-Hideghegy is, as regards the overall population of the Carpathian Basin, of a favoured significance. This population, one with the definitely highest individual numbers in Central Europe and of an accurately delimitable habitat, must be one of the most safeguarded specialities of the future Danube-Ipoly National Park.

There is no doubt that the area is under considerable civilisation pressure, and it is also perceptible that certain concepts concerning the future of the Nagy-Hideg-hegy region would summarily spoil the area, indeed, in certain respects they already maim it. But it is also clear-cut that a solution must be found which reconciles nature tourism and sport (held within reasonable limits) with the requirements of nature conservation. If, however, no decisions are taken in time and the necessary steps are not taken, the clearing will be rapidly degraded and the negative processes hardly reversible at a later date.

As outlined above, the population of *Parnassius mnemosyne* inhabiting the area represents – thanks to the beauty, size, flight characteristics and individual numbers - a fundamental part (like the flowering plants) of the landscape and will give pleasure to all lovers of nature. Yet besides *Parnassius mnemosyne* also many insect species, protected or listed in the Hungarian Red Book, also occur in this part of the Nagy-Hideg-hegy; we point out only one taxon: the endemic subspecies of *Gnophos pullatus kovacsi* VOJNITS, 1967, of the Börzsöny range. The rich flower cover, especially during the late spring and in the first half of summer is truly fascinating. It is not within the scope of this paper to list plant species, but it should be emphasised that the varied vegetation of the montane meadows, so rare in Hungary, is characteristic of the territory. The comparatively confined area is mosaic, with the occurrence of several associations from the moist montane meadow on a deep soil to the rocky swards.

If an area be considered from nature conservation views it should also be evaluated according to image. The upper clearing of the Nagy-Hideg-hegy is especially pleasing, either for its configuration and morphology or its direct environment – nor should the exquisite panorama be forgotten. This in itself invites, of course, the possibility of damage by treading if the tourist traffic is not regulated within reason.

All in all it can safely be stated that the clearing under investigation on the Nagy-Hideg-hegy belongs to the prominent natural assets of the Börzsöny and in general of the entire Northern Mountain Range of Hungary, and that within this *Parnassius mnemosyne* represents a special, individual value. It should be a primary task of nature conservation authorities to protect this rich population. We have already submitted some maintenance and management advice concerning some acute problems. In the future we propose, as well as the repetition of investigations, to study the early development stages and to elaborate a proposal for the overall upkeep of the area.

7 Discussion

The results of our investigations concur, in many cases, with those of other researchers, but visibly contradict them, wholly or partially in several cases. There is nothing strange in this, and the differences do not imply that certain workers were "right" while other ones worked badly: the behaviour of more or less delimited populations is divers; weather conditions, especially in montane habitats, are not uniform but may essentially differ from year to year; and, finally, one can never know, at the beginning of investigations, at what point one enters the long-run evolvement of the genetically determined population (not to mention the fact that this latter problem had only been studied in detail in the case of some pest species – population dínamics s.l.). Obviously therefore any such investigation is expedient only when conducted for a long time – and we are still at the very beginning.

The distribution and characteristics, according to sex, daily period and weather conditions, of flight, resting, feeding, mating and hiding (and of oviposition of the females), as well as their occurrence in the habitat types under consideration showed the expected overall picture. Roughly the same can be said concerning the connections between the flower colour of the nectariferous plants and their selection, although the very marked preference shown for the blue and violet colours – which prevailed even when flowers of other colours were present in large numbers in the territory – fails to agree with the findings of other authors; in any case, colour 'precedence' was unambiguous and evident. Causes of these deviating results may rest in the asynchronous development of the divers flowers, or in the ample or meagre amount of nectar yield. Namely, if the nectar supply of the blue and the violet flowers is sufficient, the imagines will select these even if there are also concomitant flowers of different colours. If, however, the nectar supply of the 'favourites' is small, the imagines will "resign themselves" to other flowers. Individual numbers were rather surprising, too, namely the great number of butterflies inhabiting the not so large area. This signifies unambiguously the importance of the quality of the territory: both the larvae and the imagines found plentiful food in the area. The peculiar development of swarm-

ing belongs also to the less anticipated results; the emergence of imagines in several waves is surely accountable for by varying weather conditions.

Perhaps one of the least expected – but astonishing – findings concerns the evolment of the sex ratios. We cannot explain, either by results of other workers or on the basis of our own rearing experiments, why the number of females exceeded significantly that of the males in the field. Survey errors can be excluded. Nor does another fact agree with previous investigations, namely that, according to our own observations, certain bird species are predatory on, or at least attack, the imagines. We cannot state though that they also consume the bodies.

The fact that we observed only unidirectional movements among the several partial populations is of no special significance. The problem of metapopulations is highly complex, wherein also the given terrain relief and the rate of afforestation play an important role. In this respect our observations are still inadequate.

Comparing the results of our studies with the latest, most extensive investigation (KUDRNA & SEIFERT 1991), both agreements and differences appear. This fact demonstrates that a highly stenoetious butterfly species can have very different divers regional (area specific) preferences and illustrates the necessity of detailed studies for their conservation.

8 Acknowledgements

The listing of everyone who had so effectively promoted our investigations in the Börzsöny would be lengthy. Some, however, should without fail be mentioned. Thanks are above all due to Dr S. SZABÓ, Head of the regional nature conservation directorate, as well as to his colleagues: Mrs. M SINKÓ and Mr. C. Teszáry, the chief of the conservation district, to its dilligent guard Mr. Á. BEZECKY, as well as to the foresters, Mr. I. HOMOKI-NAGY and Mr. L. SCHINDLER. I have a pleasure in thanking Miss E.J.M. WARREN and Dr. O. KUDRNA who have kindly corrected the English (the latter has also rewritten some parts of the manuscript and references) as well as Dr. E.M. WOLFRAM who has kindly rewritten the German summary redrawn figs. 1 and 2.

9 Zusammenfassung

Parnassius mnemosyne (LINNAEUS, 1758) ist eine in Ungarn verhältnissmäßig weitverbreitete, jedoch nach Heath (1981) in KUDRNA & SEUFERT (1991) 'endangered' Tagschmetterlingsart. Die zahlenmässig größte ungarische Population kommt im Raum der ungarischen Mittelgebirge vor, nicht weiter als 50 km nördlich von Budapest, in den zentralen Höhenlagen des Börzsöny-Gebirges, 880 m ü.NN. Dies ist aus Sicht des Naturschutzes ein äusserst problematisches Mosaik-Terrain, wo einerseits interessante und wertvolle Tier- und Pflan-

zenarten leben, aber Tourismus (hier müsen das Touristenhaus mit dem dazugehörenden Verkehr und besonders den Skiliften genannt werden) sowie Jagdsport, Aufforstung und nicht zuletzt die natürliche Sukzession eine permanente Gefahr darstellen.

Das Ziel des Projekts war die Untersuchung der biologischen, ökologischen und ethologischen Verhältnissen von *Parnassius mnemosyne* sowie die Erarbeitung wissenschaftlicher Grundlagen, die später zu einem wirksamen Schutz der Art führen sollen. Die Feldarbeiten beruhten auf einem CR-Verfahren; die Methoden bezüglich der Bestimmung der Populationsgrösse und Assoziation wurden unter anderen von LINCOLN (1950), JACKSON (1937) und POOL (1974) entwickelt bzw. empfohlen.

In den Jahren 1992 und 1993 zeigten die Populationsgrössen ein ziemlich durchschnittliches Bild. Während 1992 die Durchschnittszahlen pro Tag unter 500 Exemplaren blieben (28-31. Mai: 350; 4-6. Juni: 404; 14-18. Juni: 162 Exemplare), wurden 1993 am 18. Tag der Flugperiode mehr als 4500 Exemplare registriert. Die Flugkurve zeigt zwei Spitzen, eine Ende Mai, die andere Anfang Juli. Dann nimmt die Zahl der Falter abrupt ab.

Neben der auf der höchsten Waldwiese lebenden Population gibt es noch einige kleinere Biotope, wo *Parnassius mnemosyne* vorkommt (Metapopulationen, Kolonien?). Nach den bisherigen Ergebnissen der Untersuchungen ist der Populationstausch nicht ausgeglichen.

Das Geschlechtsverhältnis von ♂♂ : ♀♀ verlief unerwartet mit 1:2 (Anfang) durch 1:5 (Mitte) bis 1:6 (Ende der Flugperiode).

Was die Aktivität betrifft, sowohl bei den Männchen als auch den Weibchen, ist die Nahrungsaufnahme von erstem Rang (40,6 bzw. 40.5 %). Die Flugaktivität bei den Männchen hat einen Anteil von 37,6 %, bei den Weibchen von nur 15,7 %. Bei den Weibchen umfasst die Rast 26,2 %, bei den Männchen nur 15,4 %. Besonders typisch sind die Aktivitäten Nahrungsaufnahme und Fliegen bei Sonnenschein (71,1 bzw. 75,5 %), aber die Männchen fliegen mehr umher als zur Ernährung notwendig; bei den Weibchen ist es umgekehrt. Die Paarung erfolgt vorwiegend bei Sonnenschein (64 %), ebenso die Eiablage (77 %). Sowohl die Männchen als auch die Weibchen sind mittags und nachmittags besonders aktiv; eine auffällige Nachmittagsaktivität charakterisiert die Weibchen. Die Paarung und die Eiablage erfolgt mittags und nachmittags, mit einer Priorität für den Nachmittag.

Die durchschnittlich gemessenen Flugdistanzen reichten nicht weiter als 100-150 m, aber in einigen Fällen erreichten sie auch 1 km.

Die großen, langlebigen und oft fliegenden Imagines – jedenfalls was die Männchen betrifft – müssen viel Nektar aufnehmen. Aber nicht nur das Vorhandensein von Nektar, sondern auch die Farbe der Blumen ist von grösster Wichtigkeit. Obwohl an den untersuchten Wiesen das Verhältnis zwischen den lila/blauen und gelben/weissen Blumen 1 zu 1 war, zeigt die Präferenz fol-

gendes: lila 50,8 %, blau 41,4 %, gelb 6,1 % und weiss 1,7 %. Die dominanten Arten sind die *Cirsium* spp., sowie *Thymus pannonicus* und *Viscaria vulgaris*.

Das Biotop wurde nach dem Vorkommen der Nektar- und Raupennahrungspflanzen in 6 verhältnismässig gleichgrosse Partien geteilt und die Aktivitäten wurden mit Punkten von 0 bis 5 charakterisiert. Es ergaben sich grosse Unterschiede: die Gesamtpunktzahlen der Partien reichten von 0 bis 44. Mit dieser Methode kann man sehr gut die Bedeutung der einzelnen Partien bezüglich der Fortpflanzung der Population dokumentieren.

Obwohl mehrere Autoren über V-förmige Flügelbeschädigungen berichten, wies bei anderen *Parnassius* -Arten kein einziges *Parnassius mnemosyne* -Exemplar solche Schäden auf. Nach anderen Autoren wäre es möglich, dass durch die Toxizität von *Corydalis cava* die Imagines ungenießbar oder giftig werden; aber die Theorie widerspricht der Tatsache, dass in den untersuchten Gebieten die Vogelarten Gebirgstelze (*Motacilla cinerea*) und Stieglitz (*Carduelis carduelis*) ohne weiteres die Imagines verspeisen. V-förmige Flügelbeschädigung sieht man nicht: die Vögel fressen nur den Körper und es bleiben weitgehend unbeschädigte Flügel zurück.

Das ganze Areal wird in nächster Zukunft als Duna-Ipoly Nationalpark ausgewiesen. Zusätzlich, damit die wertvolle Pflanzen- und Tierwelt erhalten bleibt, soll die Lebensweise und Populationsökologie der übrigen Arten gründlich studiert werden. Die Untersuchung der Art *Parnassius mnemosyne* ist ein positiver Schritt in diese Richtung; die diesbezüglichen Arbeiten werden fortgesetzt und auch andere Arten in das Projekt einbezogen.

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Hinweis der Gesellschaft für Schmetterlingsschutz e.V.

Das 12. Rhöner Symposium für Schmetterlingsschutz wird am Samstag den 29. September 2001 in Münnerstadt im Hotel-Cafe Tilman von der Gesellschaft für Schmetterlingsschutz und der BAG Schmetterlinge des NABU veranstaltet. Anmeldungsformulare und weitere Informationen können schriftlich vom Herausgeber dieser Schriftenreihe angefordert werden. Sowohl Haupt- als auch Kurzvorträge werden gesucht.

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Walter de Gruyter, Berlin 1999. Handbook of Zoology, vol. IV, pt. 35. ISBN 3 11 015704 7.
491 pp., numerous b/w ill. Price 398,-- DM. Hardback 21 × 30 cm.

Das vorliegende Buch stellt einen Teil der neuen Bearbeitung der von W. Kükenthal gegründeten renommierten Buchserie „Handbuch der Zoologie" als Naturgeschichte der Stämme des Tierreichs dar. Insgesamt 29 international anerkannten Wissenschaftler aus Europa, Nordamerika, Australien und Afrika haben unter der Leitung des Herausgebers einzelne Themen bzw. Familien der Ordnung Lepidoptera bearbeitet. Es sind: P.R. Ackery, D.J. Carter, D.R. Davis, J.S. Dugdale, E.D. Edwards, M.E. Epstein, B. Farrel, P. Gentili, H. Geertsema, R.W. Hodges, J.D. Holloway, M. Horak, R. de Jong, I.J. Kitching, N.P. Kristensen, C. Lamaire, J. Minet, C. Mitter, E. Munroe, C.M. Naumann, E.S. Nielsen, J. Powell, J.E. Raelins, G.S. Robinson, M.J. Scoble, A.W. Skalski, M.A. Solis, G. Tarmann und R.I. Vane-Wright. Der Hauptteil des Buches ist der systematischen Bearbeitung der einzelnen Familien der gesamten Lepidoptera, zumeist nach ihren phylogenetischen Verwandschaft in größere, aber nicht immer den Supperfamilien entsprechende, Gruppen gefaßt. Am Anfang und Ende des Buches befinden sich allgemeine Kapitel: Historische Einleitung, Phylogenie und Palaeontologie, Klassifikation und Bestimmungsschlüßel zur höheren Taxa, Evolution der larvalen Nahrungspräferenzen, und Biogeographie. Umfang und Spektrum der Themen der allgemeinen Kapitel scheinen dabei im Vergleich zum speziellen Teil stark „unterdimensioniert" zu sein; dies kann aber absichtlich sein und mit dem geplanten Inhalt des nächsten Bandes zusammen hängen. Ein umfassendes Verzeichnis zitierter Literatur rundet jedes Kapitel ab.
Das Kapitel Tagfalter soll stellvertretend für den systematischen Teil des Buches näher vorgestellt werden. Nach einer Einleitung (in der das Bilderbuch von D'Abrera überraschender weise ganz ernst genommen wurde!) folgt ein sorgfältiger, umfangreicher Schlüssel bis zu den Unterfamilien. Alle Superfamilien, Familien und Unterfamilien werden ausführlich beschrieben und ihre Klassifikation sowie phylogenetischen und systematischen Beziehungen dargestellt; Triben und einige Genera werden als Auswahl berücksichtigt. Die Lepidopterologen, die sehr gerne und zumeist leichtfertig taxonomische Entscheidungen „phylogenetisch" begründen, sollten das Kapitel unbedingt lesen, um zu erfahren, wie mühsam und schwierig ist es, eine phylogenetischen Klassifikation zu erarbeiten.
Das vorliegende Buch stellt zweifelsohne das gegenwärtige Wissen über die Systematik der Ordnung Lepidoptera – insbesondere im Hinblick auf die höhere Taxonomie – in kompakter, dennoch umfassenden Form dar. Der Preis des Buches erscheint dabei außerordentlich hoch, zumal die Buchgestaltung keineswegs als anspruchsvoll bezeichnet werden kann. Viele Fotos und Strichzeichnungen könnten in derselben Qualität genauso gut vor 50 Jahren publiziert worden sein; es ist schwer zu verstehen, warum beispielsweise die Abbildungen der Tagfalter so lieblos und amateurhaft zusammen gebastelt wurden. Warum gerade von einer häufigen Art wie *Hamearis lucina* ein abgeflogenes Exemplar als Abbildungsvorlage (Fig. 16.4.C) dienen mußte, ist auch rätselhaft. Bei einem ehrgeizigen Buch mit diesem Qualitätsanspruch ist das sicher schade; wer für dieses Buch fast 400 DM bezahlt hat, der hat Anspruch auf professionell gestaltete Farbtafeln, die bei den Schmetterlingen und vor allem bei den Tagfaltern die eine wichtige, nicht nur ästhetisch bedingte, Rolle spielen. Und gerade dieser unüberlegte

Leichtsinn wird wahrscheinlich auch dem Verkauf dieses Buchs nicht dienlich sein; die Hersteller und Besitzer von Kopiergeräte werden sich freuen und dem Verlag sicher entsprechend dankbar sein. Denn auch die Lepidopterologen, die nicht über üppige finanzielle Mittel verfügen, sollten dieses Buch in der eigenen Fachbibliothek unbedingt haben.

Otakar Kudrna (Februar 2000)

J. SETTELE, R. FELDMANN & R. REINHARDT (Eds.):
Die Tagfalter Deutschlands.
Verlag Eugen Ulmer, Stuttgart 2000. ISBN 3-8001-3519-1. 452 pp., 28 col. pls., numerous b/w ill. Price 98,-- DM. Hardback 18 × 24 cm.

Nach vielen Jahren ist nun endlich eine neue Bearbeitung der Tagfalterarten Deutschlands erschienen, und zwar in dem renommierten Ulmer-Verlag. Die Bedeutung des vorliegenden Buches kann durchaus mit der Bedeutung der 1952-55 erschienenen ersten zwei Bänden des Werkes „Die Schmetterlinge Mitteleuropas" von W. Forster & T.A. Wohlfahrt verglichen werden. Das neue Buch setzt sich die folgenden vier Hauptziele: 1. Übersicht über die Verbreitung und Gefährdungseinstufung aller Tagfalter Deutschlands. 2. Einführung in die Ökologie der Tagfalter unter besonderer Berücksichtigung der Populationsökologie. 3. Darstellung der Bedeutung systematisch-taxonomischer Arbeiten und der Anlage von Belegssammlungen für die ökologische Forschung (einschließlich rechtlicher Aspekte). 4. Umsetzung neuer systematischer Erkenntnisse. Um diese Ziele zu erreichen, haben die Herausgeber 13 Autoren (darunter wohl auch einige profilsüchtige Trittbrettfahrer) zur Mitarbeit eingeladen: S. Brunzel, R. Feldmann, K. Henle, G. Hermann, G. Kaule, M. Kleyer, K. Kockelke, H. Plachter, H.-J. Poethke, H. Reck, R. Reinhardt, J. Settele und R. Walter. Wenn aber der Leser das in der Zielsetzung verwendete Wort „alle" ernst nimmt, wird er enttäuscht: die alpinen Arten fehlen (an anderer Stelle beschränkt man den Begriff „alle" exakter nur auf die „außrealpinen" Tagfalterarten Deutschlands). Diese Einschränkung dürfte jedoch die Bedeutung dieses Buchs nicht schmälen. Der auf sechs Seiten musterhaft übersichtlich und didaktisch gegliederte Inhalt ermöglicht dem Leser zuverlässig schnelle Orientierung im Buch; ein umfassendes Stichwortregister ergänzt am Buchende das Inhaltverzeichnis. Das vorliegende Buch verdient die Bezeichnung „Multizweck-Tagfalterbuch". Es ist einerseits ein Nachschlagwerk und Bestimmungsbuch und andererseits ein Lehrbuch der Tagfalterkunde. Dabei stört ein wenig, daß einige Abschnitte etwas zu umständlich verfaßt sind – simple is beautiful. Verbreitungskarten werden leider schmerzlich vermißt; es gibt bereits Verbreitungsatlanten für alle an Deutschland grenzenden Staaten, für Deutschland, einer der „Wiegen" der Lepidopterologie, leider nicht; es wäre nicht fair, die Schuld für diesen Zustand den deutschen Lepidopterologen zuzuschieben! Die Schuldner sind in erster Linie die verschiedensten höheren und hohen Naturschutzmachthaber, die durch nur für die „Ämtler" vorteilhafte Gesetze und Verordnungen die Tagfalterfauna „schützen" und notwendige Forschungsaufgaben verhindern. Es spricht nicht gerade positiv für große systematische Kenntnisse und Erfahrungen der Autoren, daß sie so leichtfertig die von W.A. Nässig als „modern, phylogenetisch orientiert" bezeichnete Klassifikation der Tagfalter (samt Nomenklatur) akzeptieren und weiter empfehlen; auch die Behandlung der Systematik folgt fast wörtlich Nässig's Ausführungen. Viel besser als die Klassifikation sind allerdings die einzelne Artenbesprechungen, Bestimmungshinweise und Begriffserklärungen. Das Literaturverzeichnis ist umfassend. Die fotografisch erstellte Farbtafeln sind zweckmäßig, aber nicht herausragend. Die Abbildungen der Genitalien sind höchstens ausreichend. Hingegen sind methodische Aufsätze über Erfassung, Kartierung, Populationsuntersuchungen, Transektzälung, Bioindikation, Monitoring etc. bis hin zu Populationsmanagement besonders wertvoll und in einem deutschsprachigen Buch in

dieser Form wohl einmalig. Sehr wichtig ist, daß die Autoren auch das in Deutschland heikle Thema des Fangs und des Sammeln der Tagfalter sachlich ansprechen und objektiv beurteilen. Ob das die deutschen Naturschutzmachthaber lesen und den sachlich formulierten Empfehlungen folgen würden, ist leider sehr fraglich; die Naturschutzmachthaber können gerade mit der gegenwärtigen Vorschriften viel besser leben als mit einer Forschungsfreiheit. Verbietet man die lepidopterologische Forschung (s.l.), ist es für die Behörden leichter, politisch motivierte Subventionen als Naturschutzmaßnahmen zu vergeben und sehr schwer, Fehlentscheidungen und Misserfolge der „Ämtler" zu entdecken und beweisen. Das dies zu Verlusten an Lebensräumen und Arten führt, spielt dabei nur sehr untergeordnete Rolle: Schmetterlinge haben doch keine Stimmen und können nicht wählen. Dennoch: Die Autoren des Buchs haben diesbezüglich alles getan was in ihren Möglichkeiten war. Es ist sehr erfreulich, daß es endlich in Deutschland ein modernes Tagfalterbuch gibt, das (beinahe) alle Wünsche erfüllt und lange seines gleichen suchen wird – und das alles zu einem günstigen Preis. Die Herausgeber, die Autoren – natürlich die Trittbrettfahrer ausgenommen! – und der Verlag haben sich dafür ein „Danke schön" verdient.

Otakar Kudrna (April 2000)

C. VAN SWAAY & M. WARREN:
Red data book of European butterflies (Rhopalocera).
Council of Europe Publishing, Strasbourg 1999. Nature and Environment 99 : 1-260. ISBN 92-871-4054-5. Price not stated. Softback 21 × 30 cm.

Der erste Versuch die Tagfalterarten Europas im Hinblick auf ihre Gefährdungssituation zu beurteilen ist beinahe 20 Jahre alt. Auch damals war der Auftraggeber der Europarat in Straßburg. Der damalige Kompilator – J. Heath – verfügte weder über ausreichende Kenntnisse der europäischen Tagfalterarten noch über Sprachkenntnisse; er hat sich auf oft fragwürdige Informationen seiner zufällig gewählten Mitarbeiter verlassen und diese entsprechend zusammenwürfelt weiter gegeben hat. Das gewagte Experiment endete mit einem Fiasko; unter den gegebenen Voraussetzungen war auch nichts anderes zu erwarten.
Bedauerlicherweise dauerte es fast 20 Jahre, bis der Europarat die Erarbeitung eines neuen Red Data Books der Tagfalter Europas in Auftrag gegeben hat. Diesmal wurden mir dem Vorhaben zwei auf dem Gebiet des Tagfalterschutzes anerkannten Experten aus zwei auf diesem Gebiet führenden Staaten – Großbritannien und den Niederlanden – beauftragt. Den Autoren ist es gelungen in jedem Staat Europas mindestens einen Experten zu finden, der bereit war, seine umfassende Erkenntnisse über die Tagfalterfauna des Staates dem Projekt zur Verfügung zu stellen; darüber hinaus waren den Autoren etwa 20 weitere Experten in Spezialfragen behilflich. Erstaunlicherweise konnten sogar Originalinformationen aus Ländern wie Albanien, Moldawien und Weißrußland gesichert werden. Das nun vorliegende besteht aus einem allgemeinen Teil und einem speziellen Teil.
Das Bearbeitungsgebiet deckt das gesamte Europa von den Azoren bis zum Uralgebirge – leider noch ergänzt durch die gesamte Türkei. Für jeden Leser, der mit der europäischen Geographie vertraut ist, kommt die durch den Europarat politisch erzwungene Einbeziehung der Türkei als ein Schock vor. Haben die Europolitiker aus Straßburg keinen Zugang zur elementaren Fachliteratur um sich dort über die geographische Abgrenzung Europas und Asiens zu informieren? Die Beurteilung der Arten erfolgt nach der von D. Maes & C. van Swaay zur Feststellung des artpezifischen Trends erarbeiteten Methode, wobei alle europäische Arten zuerst nach der Arealaffinität (nach O. Kudrna 1986) in vier Gruppen – europäisch-endemisch, fast europäisch, und europäisch-alikontinetal eingestuft wurden. Die Methode von Maes & Swaay ist ohne Zweifel die beste bisher entwickelte Vorgehensweise für die Beurtei-

lung des Trends der Tagfalterarten in den jeweiligen Staaten Europas. Allerdings setzt die Anwendung dieser Methode das Vorhandensein hervorragender Kenntnisse über die gegenwärtige und historische Verbreitung der entsprechenden Arten voraus. Im Augenblick ist diese Methode in Großbritannien, in den Niederlanden und mindestens z.T. in Belgien ohne Zweifel anwendbar; in diesen Staaten lebt aber weniger als ein Viertel der Tagfalterarten Europas. Die Beurteilung des Trends in den übrigen Staaten Europas erfolgt „über den Daumen" – wird aber als wissenschaftliches Erkenntnis stilisiert. Wie konnte z.B. P. Pretscher den Trend der Bestandsentwicklung der Tagfalterarten Deutschlands nach dieser anspruchsvollen Methode wissenschaftlich beurteilen, wenn es überhaupt keinen Verbreitungsatlas der Tagfalter Deutschlands bzw. keine Datenbank gibt? Über den Daumen? Dabei reicht ein guter Verbreitungsatlas allein nicht aus; es müssen ergänzende Daten über die der Verbreitung ausreichend vorliegen. Es ist sehr fraglich daß diese interessante Methode jemals für alle Tagfalterarten und in allen Ländern Europas ernsthaft angewendet werden kann. Die „species of European conservation concern" – abgekürzt SPEC – werden weiter in fünf Gruppen unterteilt. Zur Beurteilung des „conservation status" werden die vor wenigen Jahren modernisierten IUCN Gefährdungskategorien verwendet; allerdings sind die Definitionen der Gefährdungskategorien dermaßen abgeändert, so daß sie für Schmetterlinge (und wohl alle andere Insektenarten) nun überhaupt anwendbar gemacht worden sind. Die Nomenklatur – und damit auch das Artkonzept – richtet sich nach dem neuen von O. Karsholt & J. Razowski kompilierten Katalog. Diese Lösung kann zumindest wegen seiner Unausgewogenheit kaum einen Systematiker zufrieden stellen. Gelernte Naturschützer, die zumeist aus der wildbiologischen Forschung kommen, lassen sich durch taxonomische Details oder Feinheiten der Nomenklatur und ähnliche „Nebensächlichkeiten" aber bestimmt nicht stören; sie werden kaum merken, wie großzügig die Autoren auch mit den internationalen Nomenklaturregeln umgehen. Der allgemeine Teil wird durch Verzeichnisse gefährdeter Arten, Beurteilung der Gefährdungsursachen, Entwurf einer Schutzstrategie, Vorschläge zur Änderung der Arten der Berner Konvention, Zusammenfassung der wichtigsten Empfehlungen und ausführlichem Verzeichnis zitierter Literatur abgerundet. Die Gesetzgeber und die höheren „Naturschutzämtler" sollten sich gut merken, daß die lepidopterologischen Sammelaktivitäten als unbedeutende Gefährdungsursache und das „Fangverbot" als erheblicher Hindernis lepidopterologischer Forschung verurteilt werden. Ob das die Entscheidungsträger – für die das „Fangverbot" auf einen Schlag gleich mehrere wichtige Alibifunktionen erfüllt – diese Empfehlung zur Kenntnis nehmen werden?

Der Spezialteil beinhaltet auf etwa 140 Seiten Datenblätter (data sheets) für alle 71 in Europa und in der asiatischen Türkei gefährdeten Tagfalterarten; ohne Türkei sind es nur 60 Arten. Natürlich spiegelt die Anzahl der Arten den verwendeten, etwas unausgewogenen Artenkonzept wieder. Jedes Datenblatt erhält Informationen zu folgenden Aspekten: Taxonomie, Naturschutzstatus in Europa, Verbreitung und Naturschutzstatus in den relevanten Staaten, Beschreibung des Biotops (gesamt und in den relevanten Staaten), Gefährdungsursachen, durchgeführte Schutzmaßnahmen, empfohlene Schutzmaßnahmen und zitierte Literatur. Drei z.T. umfangreiche Anhänge – biogeographische Disposition, Kalkulation des Trends, tabellarische Übersicht des Trends für alle Arten und Staaten – rundet den speziellen Teil ab.

Das vorliegende Buch – trotz einigen Schwachpunkten – ist zweifellos die wichtigste Publikation auf dem Gebiet des Schmetterlingsschutzes der letzten Jahre. Kein engagierter Lepidopterologe darf sich leisten, dieses Buch in seiner Bibliothek nicht zu haben. Die Autoren dürfen mit dem Ergebnis zufrieden sein. Es ist nun zu wünschen, daß alle Schutzempfehlungen durch die zuständigen Entscheidungsträger schleunigst umgesetzt werden.

Otakar Kudrna (Mai 2000)