

Dear colleagues,

You all had to wait quite long for this new *Maculinea* Newsletter was ready to publish. To compensate for the long time waiting, this issue is longer than the older ones. Many contributions reached us and we would like to thank everybody who send an addition to this special newspaper. In the past year, obviously many efforts were done to study *Maculinea* alcon. Not only studies on the ecology were conducted, but also two national inventories were started. Furthermore, a lot of work has been done on *M. nausithous* and *M. teleius*. The last two candidates were also not forgotten. Furthermore, and very important to all of us, the establishment of a *Maculinea* Action Plan for the whole continent of Europe has proceeded rapidly. We hope that this Newsletter will give you a good overview on the studies going on recently. We hope that you enjoy reading it!

**Special issue of the Journal of Insect Conservation 1998, Volume 2
number 1: Ecology and Conservation of *Maculinea* butterflies.**

The proceedings of the International *Maculinea* Workshop, which took place in November 1996 in Wageningen, are finished. They have been published as a Special Issue of the "Journal of Insect Conservation" by Chapman and Hall in April 1998. Many participants of the workshop have written a contribution to the proceedings, and we would like to thank them all for their work. Many of you have probably already been reading one or more of the papers. For all the others, a list of the published contributions follows.

- Wynhoff, I., J. van der Made & G. Ooster-meijer: Why a *Maculinea* special issue? (p. 1)
- Fiedler, K.: *Lycaenid*-ant interactions of the *Maculinea* type: tracing their historical roots in a comparative framework. (p. 3-15).
- Wynhoff, I.: The recent distribution of the European *Maculinea* species. (p.15-29).
- Clarke, R.T., J.A. Thomas, G.W. Elmes, J.C. Wardlaw, M.L. Munguira & M.E. Hochberg : Population modelling of the spatial interactions between *Maculinea rebeli*, their initial foodplant *Gentiana cruciata* and *Myrmica* ants within a site. (p. 29-39).
- Thomas J.A., D.J. Simcox, J.C. Wardlaw, G.W. Elmes, M.E. Hochberg & R.T. Clarke: Effects of latitude, altitude and climate on the habitat and conservation of the endangered butterfly *Maculinea arion* and its *Myrmica* ant host. (p. 39-47).
- Wynhoff, I. : Lessons from the reintroduction of *Maculinea teleius* and *M. nausithous* in the Netherlands. (p. 47-59).• Hochberg, M.E., G.W. Elmes, J.A. Thomas & R.T. Clarke: Effects of habitat reduction on the persistence of *Ichneumon eumerus* (Hymenoptera: Ichneumonidae), the specialist parasitoid of *Maculinea rebeli* (Lepidoptera: *Lycaenidae*). (p.59-67).
- Elmes, G.W., J.A. Thomas, J.C. Wardlaw, M.E. Hochberg, R.T. Clarke & D.J. Simcox: The ecology of *Myrmica* ants in relation to the conservation of *Maculinea* butterflies. (p. 67-79).

- Wardlaw, J.C., G.W. Elmes & J.A. Thomas: Techniques for studying *Maculinea* butterflies: I. Rearing *Maculinea* caterpillars with *Myrmica* ants in the laboratory. (p. 79-85).
- Dolek, M., A. Geyer & R. Bolz: Distribution of *Maculinea rebeli* and hostplant use on sites along the river Danube. (p. 85-91).
- Kolev, Z.: *Maculinea arion* (L.) in Finland - distribution, state of knowledge and conservation. (p. 91-93).

Work at the Furzebrook/Paris group in 1998

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Conservation of *Maculinea arion* in the UK

This project has continued to expand, thanks to a 3-year sponsorship funded by the UK Government, English Nature and ICI, brokered by the Butterfly Conservation Society. As previously, it is led by Jeremy Thomas and David Simcox, but involves many others who provide time and sites, including Butterfly Conservation, English Nature, County Wildlife Conservation Trusts (for Somerset, Gloucestershire, Devon, Cornwall) and the National Trust. As described at Wageningen 1996, the aim is to recreate suitable habitat on about 15 former sites, if possible in each of the four main former regions for this butterfly, focusing on large sites that historically supported core (mainland?) populations and on networks of neighbouring sites to create a metapopulation structure. This progressed well in 1998. Thanks to altered management, high densities of *M. sabuleti* have recolonised 12 of the former sites that are deliberately being managed for *M. arion*. In addition, under the sponsorship we employed three temporary staff (Adrian Spalding, Adrian Goodhand, Robin Curtis) to survey and bait all (about 100) former UK sites for *M. arion*, for the first time since 1985 and 1973-5. The results showed that many sites were again being grazed due to the recovery of rabbits, resulting in a (natural?) return of *M. sabuleti* to many former sites on calcareous soils. None has as high densities as on the conservation sites, but the results are encouraging as we can expect additional small or temporary colonies to form on land adjoining the main sites. However, apart from the conservation areas, none of the sites in Devon and Cornwall (which have acid soils) has regained the host ant, because these are still dominated by *Ulex* scrub. The introduced populations did not do as badly as was reported to you (while I was on holiday!) in 1997, although numbers were disappointingly low that year, mainly because of the worst possible combination of weather conditions for this species: severe drought followed by excessive rain during the egg-laying season. We have probably lost two small colonies in the Cotswolds which never became fully established. Elsewhere, numbers recovered, with populations on six sites in 1998. Most are small (as is typical of *M. arion*) but one in Somerset is large (500-1500 adults), and has spread in two directions onto neighbouring land, so that it currently occupies a continuous strip about 1.5 km long. A large grassland restoration project in this area is in progress (not just for *M. arion*), and it is hoped that in about 10 years there will be a string of about 8-10 suitable sites in these hills, stretching 8 km from each end, with site within flight range of the next.

***Maculinea*'s in Belgium**

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A Species Action Plan for *Maculinea alcon*

In Flanders (N-Belgium), *M. alcon* has been categorized as threatened, but the decline continues and also in the last few years several colonies went extinct even on nature reserves. Therefore, it is good news that the Nature Division of the Ministry agreed on the financing of a two-year research project to prepare a recovery plan. The project started in december 1998 and is executed by the Laboratory of Animal Ecology of the University of Antwerp (Hans Van Dyck) in co-operation with the Institute of Nature Conservation (Dirk Maes) and the Flemish butterfly working group. A full-time research assistant (Wouter Vanreusel - wouter.vanreusel@uia.ua.ac.be) is engaged and an extra technician will be contracted for field assistance. The purpose of the project is to collect a sound data base on the actual state of all *alcon*-populations, the host plant and ants in all occupied sites, but also all potential sites (formerly occupied sites or apparently suitable sites for which the presence of *alcon* was not documented). To end up with a practical plan all relevant management and policy information will be used as well. Therefore, not only scientists, but also reserve managers and people involved in conservation policy participate in the project (through a workshop-system). So, after two years there should be a detailed recovery program with proposals for all areas regarding the management of habitat patches and local landscape (including issues as habitat creation and repair, and possibilities for translocation). We will report on results in next issues of this newsletter. In the last few years we have collected data on the distribution of eggs in relation to the presence of *Myrmica* ants and how these patterns may shift during the flight season, and on adults movements by mark-recapture studies. As soon as analyses have been finished, we will report on these aspects as well, but if someone wants to discuss on the issue of egg-distribution (and how this may vary), we are surely interested.

Public attention for *Maculinea alcon*

It is nice to notice that interest in the *Maculinea* system is not limited to academics and reserve managers. During the last few months the problems and problematic situation of these rare butterflies have captured quite a lot of attention in the press. But also nature conservation organisations (like Natuurreservaten and De Wielewaal) pay attention to the *alcon*-system in several educational exhibitions.

Habitat restoration for *M. teleius* - the beginning of a re-introduction program?

In Belgium, *M. teleius* occurred in two regions (the valley of river the Zenne in Mechelen-Vilvoorde and the valley of the river Mark in Hoogstraten), but the species is considered extinct since 1980. However, in Hoogstraten there are still some remnants of hay meadows with the hostplant *Sanguisorba officinalis* left. Moreover there is a network of verges with high densities of the hostplants as well. The Nature Division of the Ministry and nature organisation De Wielewaal have prepared a joint first outline for the restoration of this landscape in the valley of the Mark and Merkske (co-ordinator: Tom Verschraegen - Vijvergebied.ml@skynet.be). Moreover, the area continues at the other side of the border in the Netherlands, which provides an even larger opportunity. In this context, the question whether it makes sense to re-introduce *M. teleius* has to be addressed. A first report on this for the Belgian area is in progress. Although it seems too early to consider a re-introduction on the very short run, the knowledge on the butterfly may provide useful guidelines to restore the landscapes.

Present situation of the Kostrza populations in the Wisna valley near Krakow

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Last year the weather was rather good with limited rainfall and no flooding of the meadows, so the populations of *Maculinea nausithous*, *M. teleius* and *M. alcon* in Kostrza still exist and are doing quite well. However the place Kostrze is endangered because in this region of the city a big student campus is going to be built. This will surely affect the valley and the butterfly populations occurring there. In our opinion within the next few years something has to be done to save the *Maculinea* populations. We are probably the only people who can and should do something about it. We haven't done any fieldwork last year, but we have used the time for publishing, as you can see in the list at the end of this Newsletter.

Action Plan for the *Maculinea* butterflies in Europe

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List of Authors of Country Reports (alphabetic order): E. Balletto, J.J. Boomsma, T. Elik, Centre Suisse de Cartographie de la Faune, H. van Dyck, K. Fiedler, E. Figurny, R.M.E. Gadeberg, P. Goffart, P. Ivinskis, Z. Kolev, J. L'Honoré, D. Maes, A. Richard, J. Settele, P. S. Nielsen, M. Woyciechowski, I. Wynhoff

The five butterfly species of the genus *Maculinea* (large blues) have received a major attention from European lepidopterists because of their unusual life cycles and declining status in most of their range. All the species of this genus have a phytophagous larval phase in which they feed specifically on plants of the Rosaceae, Gentianaceae or Lamiaceae. When they reach the fourth larval instar, they are adopted by ants of the genus *Myrmica*, living nine to ten months inside the nests of ants of particular species within the ant genus, of which they are obligate parasites. Their habitat consists on grasslands or heath kept traditionally by grazing or mowing, and that must have the foodplant and the proper host ant in enough densities for the persistence of the population.

All the species of *Maculinea* are widespread in Europe except *M. rebeli* that is only present in ten European countries. *M. arion* is the most widespread and is found at present in 33 countries. The status analysis shows that, although globally they are less threatened than previously thought, they are in a critical situation in some areas, particularly of Northern Europe. Some of the species have gone extinct in Belgium, The Netherlands and the United Kingdom. The situation seems less dramatic in Southern Europe and most of Central Europe, but in some of these areas there is a lack of studies on the recent distribution and status of the species of the genus.

The causes of decline of large blue butterflies in Europe are mainly due to changes in agricultural practices. In most countries agricultural intensification is the main threat, and most of the habitat has been lost because of modern agricultural practices. The other main cause of decline is the abandonment of previously grazed or mown grasslands, with the subsequent growth of shrubs and trees that causes important changes in the grassland dynamics. Added to this important and generalized threatening factors some populations have disappeared due to local or specific impacts such as urbanization, tourism related activities or the

building of roads or other major infrastructures. The causes of decline are detailed for each species and country.

An action plan has been developed for the conservation of *Maculinea* butterflies in Europe. Global actions are oriented towards gathering information and coordination of actions at a European level that will result in land uses compatible with modern agricultural practices, and the conservation of large blue populations and overall biodiversity in rural areas. Besides, 93 more proposals are made to favour the conservation of each of the five species in a set of 14 countries from which we have gathered information. Most of the actions are centred in i) studies on aspects that are important for further conservation actions, ii) guidelines for the adequate conservation management for each species and country and iii) reintroduction programs for those countries or areas in which particular species have disappeared.

Maculinea studies in Denmark

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The *Maculinea* group in Aarhus has had a productive year in 1998, continuing investigation into the specificity of interactions between *Maculinea alcon* and *Myrmica* ants in Denmark. Field work this year has confirmed that *M. alcon* uses both *Myrmica rubra* and *M. ruginodis* as hosts in Denmark, but not *M. scabrinodis*. Populations of the butterfly exist which simultaneously use both ant hosts, as well as populations that use exclusively *M. rubra* or *M. ruginodis*. A laboratory experiment on adoption of *M. alcon* caterpillars from these different types of population has revealed interesting differences in adoption time depending on both ant and caterpillar populations which suggest that the butterfly becomes locally adapted to its host ant populations. Data is also being gathered on the growth and survival of caterpillars in this experiment, which although not yet completed, are also showing interesting host ant population effects.

Chemical analysis (In collaboration with the Chemistry department at the University of Keele) of the surface hydrocarbons of *M. alcon* caterpillars and *Myrmica* ants from these same populations has shown that different populations of *M. alcon* are chemically distinct, and match more closely the surface hydrocarbons of their host ants than non-host ants. Work continues on the genetics of *M. alcon*, and we expect to have a number of variable micro-satellite markers available for *Maculinea* within the next few months, which should allow us (and other members of the *Maculinea* community) to investigate the population genetics of *Maculinea* in greater detail than has hitherto been possible using allozymes.

Maculinea studies by the UFZ-group Leibzig

Josef Settele and colleagues (settele@pro.ufz.de)

Publication of metapopulation study

In 1998 results of a long term study on *Maculinea nausithous*, *M. teleius* and *L. dispar* have finally been published in the book "Metapopulationsanalyse auf Rasterdaten-basis", published by Teubner, Stuttgart & Leipzig, Germany (interested colleagues may ask for a copy of the book via e-mail: there are still some free copies available; caution: book unfortunately is written in German language). The study focusses on

the estimation of metapopulation parameters based on grid square data; using the three Lycaenid butterflies mentioned.

The abstract of the book is given in the list of publications.

Field work in Upper Rhine Valley

Field work that formed the basis for the above mentioned book, was continued as in the previous years (see last newsletter); this time however there is no preliminary analysis available. Impression from the field work has been, that *M. nausithous* was a bit more abundant than in average years; *M. teleius* was as rare as usual, however a new locality with *M. teleius* was discovered.

Joint field and laboratory study on the ecology of *Maculinea rebeli* by Michael Hochberg and our group

In 1998 samples of larvae of populations of *M. rebeli* as well as samples of host ants have been taken in the Southern Black Forest and in the French Alps, to study the adaptation of the ant-butterfly system on a larger geographical range. Exchange experiments are now performed by Michael Hochberg's group (black forest ants with alpine butterflies; black forest butterflies with alpine ants; black forest butterflies with black forest ants; alpine ants with alpine butterflies).

Field work was supported by South-West German authorities (Bezirksstelle für Naturschutz und Landschaftsplanung in Freiburg: Dr. J.-U. Meineke) and colleagues with profound knowledge of local and regional conditions (Stefan Hafner, Axel Hoffmann, Günter Ebert), for which we are extremely thankful! First results can be expected for 1999. We intend to do further related research in 1999.

Monitoring *Maculinea* populations in France

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The Ministry of Environment has approved the idea to establish a National Monitoring Scheme, which will be coordinated by myself. Realisation has still to get started.

Until now, *Maculinea* populations have been monitored at six locations in Normandia, Brittany, the Loire region, the Dordogne, the valley of the Isere and the Savoie. On the three of these sites, the flight period of the populations was delayed. By the end of August, high numbers of *Maculinea alcon* and *M. teleius* were on the wing. It has been the second time in the past ten years that such a delay in the flight period was observed. It was surely no second generation. At the middle of august we thought that the flight period was over, but one week later new adults emerged (really new, fine and pretty) in great numbers and during the 15 next days. For us it was a surprise and we wondered what had happened. Probably the new adults emerged from pupae ready in the ants' nests which where in "quiescence" and could have waited until the next year. However, the difficulty is that the observations concern two species at different places with various climatology. More details on the population sizes and dynamics will be calculated by students.

***Maculinea teleius* and *M. nausithous* in South-East France**

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Populations of *Maculinea teleius* and *M. nausithous* are found in two large remnant wetlands of South-East France where both its host plant, *Sanguisorba officinalis*, and its host ant, *Myrmica*, are found. We found several *Myrmica* species : the common *M. scabrinodis* in habitats dominated by shorter herbaceous vegetation, *M. rubra* in woodland or low scrub and more rarely *M. ruginodis*.

The "Marais de Lavours" and "Chautagne" marshes are located in the upper Rhône basin, about 50 kilometers south of Geneva. As for most wetlands in Europe, they are rapidly disappearing by the decline of traditional agricultural activities or by the hydrological changes caused by the environment of the river valley for the production of electric power. The remaining areas of the marshes are practically abandoned and have evolved by autogenic processes towards damp woodlands. In Lavours, a national reserve was created in 1984 which allow to the conservationist to check the different management regimes, grazing or haying. In the end of the 80s, on a part of the reserve, management by extensive grazing had been adopted to check the spontaneous development of the vegetation and to maintain herbaceous units in places where the interest of flora and fauna was high. Over five years, two pastoral parks have been submitted to grazing pressure by Highland Cattle and Camargue Horses. Five years after the introduction of these large herbivores, the extensive grazing has induced changes in the abundance and the composition of the plant community. *Sanguisorba officinalis* which is often present together with frequently grazed plants seems to be very sensitive to grazing. Thus, decrease in the host plant populations inside the pastoral parks is a long term threat for the preservation of the butterflies. On the other part of the reserve, haying is used to prevent recolonization by trees. In Chautagne, it is the only management regime and depends on farmers. The frequent or intensive mowing of sites seems to discourage some *Myrmica*. The haying period is also a big threat because in Chautagne farmers mow when the eggs are on the plants. Different management regimes might result in decline either for the plant or the ant species, so conservation management can reduce of local extinction. Accurate estimate of abundance are required to monitor the changes induced by different management strategies. On different test areas, we try to estimate the density of the host ant nests and host plants as well as their spatial distribution to determinate the more suitable habitat for the conservation of *Maculinea*. Last summer, during our survey, the third species related to wetland areas *M. alcon* has been observed in the Marais de Lavours.

Maculinea populations in Transcarpathian Ukraine: monitoringdata 98'

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A second year of butterfly monitoring according to the British Scheme has been carried out in the Transcarpathian region of Ukraine. Since March 1998, 47 butterfly sites were monitored. We used to ride a bike for this purpose. The monitoring sites are situated on a line of at least 320 km from NW to SE.

From 13 of 47 sites, 64 individuals of *Maculinea arion* were registered. From 4 sites 243 individuals of *M. teleius* were registered too. We have plans to visit the populations of *M. alcon* & *M. nausithous* in Prikarpatie in the following years. It will be possible with additional money for a wide *Maculinea* monitoring project in Ukraine. For details about the butterfly monitoring project please look at our homepage:<http://www.tcom.uzhgorod.ua/~alexanor>

Populations of *M. alcon* in SW region of the Czech Republic during years 1996 - 1998

Zdenka Veronika Křenová (gentiana@tix.bf.jcu.cz)

More than 45 populations of *Gentiana pneumonanthe* were studied in the south-west region of the Czech Republic during the years 1996 -1998. Besides many other biotic and abiotic characteristics, the occurrence of *Maculinea alcon* on the locations was also recorded. Both observation of adults and eggs on buds of the marsh gentian were considered as evidence of *Maculinea alcon* occurrence. A few new localities were found each year. Several statistical analyses were done and a strongly significant correlation (1996: $p < 0.001$, 1997: $p < 0.005$, 1998: $p < 0.005$) was found between *alcon* blue occurrence and number of flowering gentian plants in location. The *alcon* blue butterflies were found in 14 out of the 32 known gentian locations in 1996 while they were found only in 8 locations out of 37 studied locations in 1998. During two seasons (1997 and 1998) neither butterflies nor eggs were observed in five new locations of year 1996 although the butterfly populations were stable in 1996 and no observable changes of environmental conditions were recorded. Causes of extinction are not clear.

Populations of *Maculinea alcon* and *M. teleius* in Italy

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We are still working on a biotope shared by *Maculinea alcon* and *M. teleius* in a site near to Torino in the North of Italy. There are probably one or two other sites with those butterflies. Two students (Silvia Ferretti and Giorgio Ganiere) are working there for their masters theses. Silvia will probably complete her research by the end of February. We work on the dynamics of the populations by means of a mark-recapture-study. We have also spent attention to the ants.

Studies on *Maculinea* species in the Netherlands Reintroduction of *Maculinea nausithous* and *M. teleius*

Irma Wynhoff (Dutch Butterfly Conservation)

In the past summer the populations of both species have done quite well. We hoped for dispersal of *Maculinea teleius* which is still restricted to only one meadow. On another meadow very close to the occupied one, oviposition was observed the year before. By coincidence, the oviposition site was not mown, and this year, a freshly emerged adult was found there. It could be that earlier trials of the butterfly to disperse were frustrated by the mowing regime. The one meadow with *Maculinea teleius* is never mown between mid June and mid September. On all others the date of mowing depends on the farmers, but is mostly between mid July and mid August. Although 20 to 30% of the meadows are left unmown, this does not seem to be enough to enable successful dispersal on the butterfly. Now we try to arrange that a higher fraction of the meadows will not be mown. We hope that it will help *Maculinea teleius* to disperse and establish a metapopulation.

Maculinea nausithous still occurs in three subpopulations. One of these was supposed to be extinct this summer, but although very small it still exists. The population along the road verges has not increased in numbers, but has colonized more verges last summer. The Province of Northern Brabant has taken the initiative to develop an agreement

between the public communities, the owners of the nature reserves, the farmers in the region and Dutch Butterfly Conservation that the management in a certain region around the nature reserve is changed to benefit nature, and especially *Maculinea nausithous*. Now, the road verges and canal borders within the reach of the *Maculinea*'s are not longer mown on both sides of the road or canal at the same time. The occupied area will not be mown between mid June and Mid September. As the limited occurrence of *Myrmica rubra* seems to be the greatest problem for good dispersal (Gerard Oostermeijer has shown this), the development of stable areas with more rough vegetation will be allowed. We hope that the butterfly can colonize more verges and other nature reserves. Within the next years, the area of this agreement will be enlarged.

Oviposition preferences of *Maculinea nausithous* and *M. teleius*

Irma Wynhoff (Dutch Butterfly Conservation and Wageningen Agricultural University)

As a part of my study, I am trying to elucidate the relationship between the oviposition behaviour of *Maculinea nausithous* and *M. teleius* and the presence of the host ant species *Myrmica rubra* and *M. scabrinodis*. It started with field research, then an experiment in an open-air-insectory was conducted, and now we are back to the field to test results. The field research (mainly done by Marcel van der Heijden and Simon Plat) has shown that the factors determining whether a phenologically suitable *Sanguisorba* will be taken for oviposition differ between the *Maculinea* species. For *M. teleius*, vegetation structure characters are important, while for *M. nausithous* it is the presence of its host ant *M. rubra*.

In the insectory, where the butterflies had to choose between vegetation plots with or without ants, Maarten van Steenis was able to show that *M. nausithous* prefers plots with *M. rubra* above those with *M. scabrinodis* or without ants. *M. teleius* however seems not to make a difference between the *Myrmica* species, as long as they are present. Plots without any *Myrmica* receive much less eggs. These results are still preliminary, and at the moment we can only conclude strong trends because the experiment suffers from an unbalanced design. Due to this the statistics is much more complicated than expected.

In the field, data on the oviposition of both butterfly species and the presence of their host ants were collected by Asun Hidalgo Lopez and Mark Grutter. For *Maculinea nausithous* it was time-consuming but relatively easy to do egg-counts as a direct measurement for oviposition, and the oviposition is clearly linked to the presence of *Myrmica rubra*. In the case of *Maculinea teleius*, things were much more difficult. Although the area occupied by this species is very limited, the number of flowerhead of *Sanguisorba* is so high that the chance to find eggs is only small. Next year we will fill this gap by oviposition observations.

National inventory of *Maculinea alcon*

Coordination: Robert Ketelaar (Dutch Butterfly Conservation)

In the summer of 1998, a national inventory research of *Maculinea alcon* the Netherlands started which was kindly funded by the Ministry of Agriculture, Nature Conservation and Fisheries. From the past 10 years in total 141 populations are known, of which 98 were visited in 1998. Per population three plots of 10 x 10m² were studied, with emphasis on the

vegetation composition and -structure, the ant nest density, the butterfly population by means of egg-counts and the management.

We found out that in the past 10 years 34% of these populations have gone extinct. It is alarming that in the province with the highest number of populations, the decline has been strongest. Furthermore, many of the existing populations have decreased in butterfly numbers and are much more endangered by stochastic extinction than they have been in former times. The still preliminary results show that an increase in the size of the nature reserve and the size of the gentian population reduces the extinction probability. Isolation however is of minor importance. A positive relation was found between the size of the gentian population, the number of flowering gentians, the number of *Myrmica ruginodis* and the humidity of the habitat expressed as mean Ellenberg value. On sites where the butterflies had gone extinct, not only the number of gentians but also the number of host ants was significantly lower.

In the next summer the inventory will be completed. We hope to have visited all Dutch populations by the end of August. Of course, afterwards the data have to be re-analyzed.

Furthermore, we will inform wardens and land-owners of the best solutions to protect and conserve this butterfly in their reserve.

Do females of *Maculinea alcon* prefer host plants close to host ant nests?

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In a cooperation between the University of Amsterdam and Dutch Butterfly Conservation, two M.Sc. students - Anne van der Hidde and Vivian Feenstra - tried to find evidence for our hypothesis that females of *Maculinea alcon* will oviposit preferably on host plants close to host ant nests, as this should increase the probability of adoption of the larvae. In our traditional study site in the National Park Hoge Veluwe, different permanent plots were relocated and all host plants and host ant nests were mapped. The distances of marked plants to the nearest host ant nest were recorded and oviposition on these marked plants was counted each day. This repeated counting was done because a preference for plants close to ant nests might be negatively affected if there is already a high number of eggs present. Such a negative effect could arise if there is a higher larva mortality due to food competition on plants that are more crowded with eggs. To study the mortality of larvae in relation to the number of eggs per flower, we bagged flowers with different numbers of eggs and counted the number of larvae leaving the flower. The hypothesis of a higher probability of a larva encountering a host ant worker (and being adopted) if the host plant was nearer to a host ant nest was tested by placing sugar baits under a large number of plants on varying distances from ant nests, and counting the number of *Myrmica*-workers after different time-intervals.

Based on the (still preliminary) results of these experiments, we did not find any evidence for a preference of ovipositing *M. alcon* females for host plants growing closer to ant nests. However, the results thusfar concern the number of eggs deposited in relation to *Myrmica*-nest distance, and not the probability of oviposition. This will be tested later on. Instead of a negative effect of the presence of large numbers of eggs on additional oviposition, we found a positive correlation between the number of eggs present and the number deposited additionally. This suggests that some plants are found more suitable than others, for some reason(s) still

unknown to us. Our observations on larva mortality indicated no significant effects of high egg number, which suggests that there is no strong selection on females to avoid plants which already have eggs.

Despite the absence of any preference for plants close to ant nests, the sugar bait experiments clearly showed a higher activity of ant workers closer to the nests. Hence, a larva ending up closer to a nest probably has a higher probability of adoption and subsequent survival. Possibly, all the (examined) gentian plants were growing close enough to a nest (within the worker activity radius) to ensure a sufficiently high adoption probability.

Apart from our experiments, it appeared that population size of *M.alcon* had decreased considerably in comparison to our earlier study years (1993, 1994). There was no difference between the years in the number or density of host plants, nor in host ant nests (both *M. ruginodis* and *M. scabrinodis* occurred in the area). However, the number of non-host ant nests, mainly of the rare *Formica transcaucasica*, increased somewhat. Together with a very high abundance of workers of this species on the sugarbaits, this could mean that *Maculinea* larvae are more severely predated by *Formica*. We can only speculate about the effects that this might have had on the population size of *M.alcon*.

Papers on *Maculinea*

- Elfferich, N.W. (1998) Is the larval and imaginal signalling of Lycaenidae and other Lepidoptera related to communication with ants? *DEINSEA* 4: 91-95.

The larval instars, pupae and adults of ant-associated lycaenid butterflies have to integrate into the ants' communication system in order to appease the normal aggressive behaviour of the ants and hence to profit from protection from predators. The vibration signalling of caterpillars, pupae and adults (imagines) was studied and its impact on the appeasement of ant aggressiveness after the emergence of the butterfly from the pupal skin was tested. As the vibration signalling in the larval instars and the emerging butterfly is only found in lycaenid species, which are at the same time the species with ant-attendant relationships in their life-cycle, the vibration might play a role as manner of communication. During emergence, the communication only works well in the Polyommataini, while other lycaenids evoke aggressive behaviour in the ants and get killed easily. In case of adults a pheromonal substance might also be involved.

- Elfferich, N.W. (1998) New facts on the life history of the dusky large blue *Maculinea nausithous* (Lepidoptera: Lycaenidae) obtained by breeding with *Myrmica* ants in plaster nests. *DEINSEA* 4: 97-102.

Caterpillars of *Maculinea nausithous* were bred in plaster nests with a colony of *Myrmica ruginodis* ants. Sound records were made and the behaviour of the ants and the various stages of the caterpillars was recorded with a video-camera. As for food, the caterpillars were critical and only fed on ant larvae in a specific stage of development. During all stages (including the pupation) the caterpillars produced vibration signals. Also the butterflies migrated during the emergence.

- Figurny, E. & M. Woyciechowski (1998) Flowerhead selection for oviposition by females of the sympatric butterflies *Maculinea teleius*

and *M. nausithous* (Lepidoptera: Lycaenidae). *Entomologia Generalis* 23(3): 215-222.

The butterflies *Maculinea teleius* and *M. nausithous* often inhabit the same meadows and lay eggs on flowerheads of the same host plant, *Sanguisorba officinalis*. The flowerhead preferences of ovipositing females of both species were studied and found to be different. *M. teleius* females oviposited on younger flowerheads which were closer to the ground, shorter, with fewer flowers and usually with none or at most one other conspecific egg already present. *M. nausithous* females chose older flowerheads which were taller, larger, and with more eggs of each and both species. These differences caused partial segregation of the eggs of the two species, as the host inflorescences were used by females of one species when young and by the others when more mature. It appears that previously laid eggs are not recognised. Females searching for oviposition sites apparently select flowerheads visually according to their developmental stage.

- Figurny-Puchalska, E., R.M.E. Gadeberg & J.J. Boomsma (under review) Comparison of genetic population structure of the large blue butterflies *Maculinea nausithous* and *M. teleius* in Poland.

We investigated the genetic population structure of two rare myrmecophilous lycaenid butterflies, *Maculinea nausithous* and *M. teleius*, which often live sympatrically and have similar biology. In Europe, both species occur in highly fragmented populations and are vulnerable to local extinction. The proportion of variable allozyme loci, average heterozygosity and genetic differentiation among populations were higher in *M. nausithous* than in sympatrically living *M. teleius* populations. We hypothesize that these differences in heterozygosity are mainly due to the known higher efficiency of typical host ant nests in rearing *M. nausithous* pupae compared to *M. teleius* pupae. This implies a larger probability of larval survival in *M. nausithous*, which buffers populations against environmental and demographic stochasticity. In contrast, the lower carrying capacity of ant nests in rearing *M. teleius* pupae requires higher nest-densities and makes *M. teleius* populations more prone to losing genetic variation through drift if this condition is not fulfilled. The single investigated Russian population of *M. teleius* showed much higher levels of heterozygosity than any of the Polish populations, suggesting a more viable and still intact metapopulation structure.

- Gadeberg, R.M.E. & J.J. Boomsma (1997) Genetic population structure of the large blue butterfly *Maculinea alcon* in Denmark. *Journal of Insect Conservation* 1: 99-111.

We have investigated the genetic population structure within and the genetic differentiation between local populations of the large blue butterfly *Maculinea alcon* throughout the Jutland peninsula. Samples were collected as eggs on foodplants (*Gentiana pneumonanthe*), and reared to fourth instar caterpillars in the laboratory. A significant excess of homozygotes was found for all the investigated allozyme loci in most of the populations. A North-South cline was observed for the allele frequencies at some of the loci and for several linkage groups. Because some of the allele frequency clines were parallel to clines in adult morphological variation, we interpret our results as evidence for the co-existence of at least two gene-pools within the Danish *Maculinea alcon* populations. Multilocus electrophoretic data revealed highly positive but variable F_{ST} values, which under this

scenario would reflect varying frequencies of the *Maculinea* gene pool across the local populations. The significantly positive F_{IS} values indicate that these gene pools are at least partly reproductively isolated (Wahlund effect). The co-occurrence of several *Maculinea* gene pools on many local sites in Jutland is of great importance for conservation of the fragmented *Maculinea* populations. Our results show that there is probably more *Maculinea* biodiversity to conserve than was previously thought, and suggests that extant populations are more fragmented and vulnerable than counts of flying adults or eggs on foodplants indicate.

- Park, K.T. & S.S. Kim (1997) Atlas of butterflies (Lepidoptera), 381 pp. in: KT Park & HY Park (eds.) Insects of Korea, Series 1. Korea Research Institute of Bioscience and Biotechnology & Center for Insect Systematics A recent publication from South Korea gives distributional records for *M. teleius*, *arionides*, and *kurentzovi* (on grid maps), as well as the first hostplant record (to my knowledge) for *kurentzovi* (*ob Sanguisorba officinalis*), thus confirming its taxonomic relatedness to the *teleius* group.

Together with the previous work done by Japanese and Russian systematists, it seems now clear that diversity of *Maculinea* is at least as rich in the Eastern Palearctic as in Europe.

- Rozier, Y. (1998) Les *Maculinea* (Lepidoptera, Lycaenidae) des zones humides: l'exemple de la Réserve naturelle du Marais de lavours (Ain, France).

The decline of wetlands imply the decrease of many species. The myrmecophilous butterflies *Maculinea* are endangered. They have a complex life cycle, because they depend on specific plant-host and specific ant-host. During the population dynamics survey of the Scarce Large Blue (*Maculinea teleius*) and the Dusky Large Blue (*M. nausithous*) the third species related to wetland areas, Alcon Blue (*M. alcon*) has been observed for the first time in the nature reserve "Marais de Lavours".

- Settele, J. (1998) Metapopulationsanalyse auf Rasterdatenbasis. Teubner Verlagsgesellschaft Stuttgart, Leipzig.

Distribution and habitat size of most butterfly species can hardly be assessed with sufficient accuracy on a larger scale. However, such data are desirable as a basis of most approaches to the analysis of metapopulation parameters. To overcome this problem, we Hanski's incidence function model was modified for applications based on grid squares (500 x 500 m² on the finest resolution). This was used for the analysis of several years' distribution data (semiquantitative; presence/absence; 1989-1995) of three lycaenids in an area of nearly 2000 km² in the Upper Rhine Valley (South-West Germany; lycaenids: *Maculinea nausithous*, *M. teleius*, *Lycaena dispar*).

Results of simulations are presented in the book, which show the relative importance of several metapopulation parameters for the different species, namely colonisation (composed of mobility and specific colonisation factors) and extinction of local populations.'

- Thomas, J.A., Elmes, G.W. & Wardlaw, J.C. (1998) Polymorphic growth in larvae of the butterfly *Maculinea rebeli*, a social parasite of

Myrmica ant colonies. Proceedings of the Royal Society of London B 265: 1895-1901.

We have completed and now published field and lab analyses showing that a combination of annual and biennial (2-year) larval growth forms exist within the same populations of *M. rebeli*. We interpret this as having evolved primarily because it is the most energetically-efficient way of exploiting the ant resource, at least for a cuckoo-feeding (trophallactic) species of ant social parasite. However, bet-hedging advantages also accrue.

- Thomas, J.A. & Elmes, G.W. (1998) Higher productivity at the cost of increased host-specificity when *Maculinea* butterfly larvae exploit ant colonies through trophallaxis rather than by predation. *Ecological Entomology* 23: 457-464.

In this analysis, we have drawn upon 20-years field data collected often opportunistically to compare some ecological consequences of the life-styles (cuckoo, predacious + nausithous showing attributes of each system) for all 5 European species. We show that each of the individual populations of *M. rebeli*, *M. alcon* and *M. nausithous* we have sampled across Europe is more strictly host-specific on a single *Myrmica* species than is the case with *M. arion* and *M. teleius*, although we are of course aware that *M. alcon* switches host across its European range, and that Koos research group have found a few intermediate *alcon* populations in the transitional zone in Denmark. We argue that since cuckoo-feeders are more socially integrated with their hosts, they are likely to evolve greater host-specificity. We show field data showing that individual *Myrmica* nests produce about 5-times as many pupae of *alcon* and *rebeli* than *arion* or *teleius*, and that populations of the first two species are often supported on sites that contain much lower densities of their host ant. Although *M. nausithous* falls between these two groups, its feeding efficiency closely matches that of *arion* and *teleius* when account is taken of the butterfly's slightly lower biomass and the much average greater size of its hosts (*M. rubra*) colonies. Contrary to several opinions expressed at Wageningen 1996, we conclude *M. nausithous* is wholly or predominantly a predator of ant brood. Since writing this paper, Nico Elfferich has of course published excellent direct observations that establish *M. nausithous* as a predator.

- Akino, T., J. Knapp, J.A. Thomas & G.W. Elmes (under review) Chemical mimicry and host specificity in the butterfly *Maculinea rebeli*, a social parasite of *Myrmica* ant colonies.

We finally completed analyses and wrote up the 1996-97 chemical mimicry experiments on *M. rebeli*, which some will remember discussing with us at Wageningen. Bioassays and chemical analyses were made by Dr Jenny Knapp (Southampton university) and Dr T. Akino, a Japanese postdoc visitor to Southampton in 1996-1997, with whom we are still collaborating. Behavioural bioassays showed that *M. rebeli* caterpillars - after leaving their gentians and before encountering ants - contain cuticular substances which, when extracted in solvent and placed on glass dummies, invoke similar (eg pick-up) responses from workers of *M. schencki* to extracts obtained from their own larvae. Chemical analyses showed that these substances contain a range of hydrocarbons and other chemicals, and include several chemicals that are common to all spp. of *Myrmica* larvae. However, they much more closely resemble the cocktail of

secretions produced by its host *Myrmica schencki* than those of the other *Myrmica* species that frequently adopt *M.rebeli* in the field. The chemical cocktail found on *M.rebeli* after leaving its gentian is much simpler than that of the host ants. However, after 7 days with *M. schencki* the caterpillar has acquired almost all the missing chemicals, making it an almost perfect mimic of the particular host colony that adopted it.

More Maculinea papers

- Nygaard Kristensen, T. & M. Diaz (1998) Sortplettet blafugl, *Maculinea arion* L.. genfundet på Bornholm. *Lepidoptera* 7(6): 176.
- Thomas, J.A., Elmes, G.W., Clarke, R.T., Kim, K.G., Munguira, M.L. & Hochberg, M.E. (1997) Field evidence and model predictions of butterfly-mediated Apparent Competition between Gentian plants and Red ants. *Acta Oecologica* 18: 671-684 .
- Wardlaw, J.C., Elmes, G.W. & Thomas, J.A. (1998) Techniques for studying *Maculinea* butterflies: II. Identification guide to *Myrmica* ants found on *Maculinea* sites in Europe. *Journal of Insect Conservation* 2: 119-127.
- Thomas, J.A., Clarke, R.T., Elmes, G.W. & Hochberg, M.E. (1998) Population dynamics in the genus *Maculinea* (Lepidoptera: Lycaenidae). In *Insect population dynamics: in theory and practice*. Ed by J.P. Dempster & I.F.G. McLean. *Symposia of the Royal Entomological Society* 19: 261-290. Chapman & Hall, London.