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Bionomic strategies in Lepidoptera, risk of extinction and nature conservation projects

Karel Spitzer * & Jan Lepš **

* Institute of Entomology, ČSAV, Branišovská 31, CS-370 05 České Budějovice, Czechoslovakia
** Department of Biomathematics ČSAV, Branišovská 31, CS-370 05 České Budějovice, Czechoslovakia

Summary

A short review of some theoretical aspects of the risk of extinction and conservation of Lepidoptera is given. Bionomic strategies and habitat conservation are discussed.

The nature conservation and bioindicator values of the world fauna of vulnerable taxa of Lepidoptera are very high. About 50-60% of species are bound to natural ecosystems that are endangered. The theoretical criteria for risk of extinction and conservation should follow ideas of bionomic (selection) strategies and ecological succession. The only way of preserving diversity of vulnerable species of Lepidoptera is the complex "in situ" conservation in reserves of natural and seminatural landscapes. The most important taxa for habitat conservation seem to be K-strategists associated with climax ecosystems having a small range of geographical distribution (cf. Spitzer & Lepš 1988). The migratory species, mostly r-strategists, are less threatened. Entomological and conservation aspects of "stress tolerant" or "adversity" species (Grime, 1974 ; Southwood, 1977 ; Holm, 1988) are little known, but the risk of extinction might be high in most cases.

What is a risk of extinction in Lepidoptera ?

We would like to consider the theoretical problems of risk of extinction and conservation of Lepidoptera based mainly on results of our field studies :

Extinction is a scale-dependent concept. The distinction between extinction of a local population and decrease in the number of subpopulations is quite arbitrary and depends on the scale considered. Pimm, Jones & Diamond (1988) consider only local extinction of birds, whereas the priority of conservation biology is to protect all species prone to global extinction. Species that frequently exhibit local extinctions may rarely experience global extinction.

For many species, local extinction and recolonisation of a new site is part of their bionomic strategy. It would be interesting to know the association between recolonization rates and bionomic strategy. Those species categorised as r-selected, usually exhibit pronounced population fluctuations and many of them are migrants and good colonisers (MacArthur & Wilson, 1967 ; Pianka, 1970 ; Southwood, 1977).

Our data on noctuid moths (Table 1, 2) show that population variability (expressed as the temporal coefficient of variation) is positively correlated with the potential population growth rate (Spitzer, Rejmánek & Soldán, 1984) and with geographic range (Spitzer & Lepš, 1988). The same conclusion was reached by Glazier (1987). Species with a large geographic range rarely become extinct. After outbreaks, many important migratory pests may become locally extinct, e.g. the cosmopolitan black cutworm *Agrotis ipsilon* Hfn. (Spitzer, 1972 ; Kaster & Showers, 1982).

Non-migratory butterflies and moths with small geographical ranges usually exhibit low population variability, low population growth rate and typically occupy climax habitats (Spitzer & Lepš, 1988 ; Lepš & Spitzer, 1990). For such species (cf. some papilionids, Table 3), local extinction (even at a very low rate) may have fatal consequences, because their vagility and ability to recolonize new sites is low, e.g. *Papilio hospiton* Gn. (Table 3, Collins & Morris, 1985). Most locally endangered species fall into this category (Wells, Pyle & Collins, 1983 ; Collins and Morris, 1985).

It is highly probable, that low vagility and small geographical range carries a high risk of global extinction. But for conservation a careful analysis of the ecological determinants and life history traits of each vulnerable species is necessary : the species at risk of global extinction mostly occupy limited climax habitats that are being destroyed by man.

Our analysis of data for moths and butterflies and that of Pimm *et al.* (1988) for birds reveal similar correlations. However, unlike Pimm *et al.* (1988) we stress the scale dependence of the extinction concept. Conservationists are mainly concerned with preventing the global extinction of a species or a subspecies.

References

Collins, S. M. & Morris, M. G., 1985. Threatened swallowtail butterflies of the world. The IUCN Red Data Book. IUCN, 401 pp., Gland.

Glazier, D. S., 1986. Temporal variability of abundance and the distribution of species. *Oikos* 47 : 309-314.

Grime, J. P., 1974. Vegetation classification by reference to strategies. *Nature* 250 : 26-31.

Holm, E., 1988. Environmental restraints and life strategies : a habitat template matrix. *Oecologia* 75 : 141-145.

Table 1

Relationships between certain life history traits of populations of noctuid moths, based on 17 years light trapping data from South Bohemia
PGR — potential population growth rate, GR — size of geographical range, scaled 1 to 6, see Spitzer & Lepš (1988),
CV — coefficient of year to year variation in abundance

Correlation between PGR and GR	0.75**	n = 31
Correlation between GR and CV	0.33**	n = 67
Correlation between PGR and CV	0.30	n = 28
Mean value of CV of migratory species	1.31*	n = 8
Mean value of CV of sedentary species	0.91*	n = 58

** Value significant at $P < 0.01$.
* The two values differ at $P < 0.05$, t-test.

Table 2

The migratory status of noctuid moths in South Bohemia that have extremely high ($CV > 1.5$) and extremely low ($CV < 0.65$) coefficients of variation
Only species with a mean annual catch greater than 6 individuals are considered

Species	Migratory status	Mean annual catch	Coefficient of variation
Orthosia cruda D. & S.	sedentary	89.5	2.597
Diarsia rubi View.	sedentary	240.9	2.254
Opigena polygona D. & S.	migratory	19.7	1.970
Agrotis ipsilon Hfn.	migratory	21.9	1.909
Cosmia trapezina L.	sedentary	11.0	1.892
Diarsia brunnea D. & S.	sedentary	6.9	1.601
Phlogophora meticulosa L.	migratory	10.4	1.557
Tholera decimalis Poda	sedentary	82.4	0.648
Photodes pygmina Hw.	sedentary	14.3	0.626
Apamea ophiogramma Esp.	sedentary	18.0	0.620
Agrotis exclamationis L.	sedentary	313.0	0.615
Autographa gamma L.	mixed *	65.4	0.611
Orthosia gothica L.	sedentary	127.1	0.605
Photodes fluxa Hb.	sedentary	8.7	0.602
Charanyca trigrammica Hfn.	sedentary	49.8	0.582
Hoplodrina alsines Brahm.	sedentary	197.2	0.573
Mythimna pudorina D. & S.	sedentary	87.2	0.546
Photodes minima Hw.	sedentary	18.0	0.540
Oligia strigilis L.	sedentary	34.5	0.537
Hoplodrina blanda D. & S.	sedentary	118.0	0.536

* *A. gamma* is polyvoltine and each population consist of migratory and sedentary forms that compensate for the year to year fluctuations (Novák and Spitzer 1972). Migratory populations fluctuate more than sedentary (autochtonous) ones. The fluctuations of the Central European mixed populations are usually low with outbreaks at intervals of 20-30 years (last one in 1963) caused by immigrations from southern Europe.

Table 3

European swallowtail butterflies of the genus *Papilio* and their risk of extinction

Species	Migratory status	No. of families of food plants	Distribution	Risk of extinction	
				global	local
P. machaon L.	migratory	3	most of Palaearctic and part of Nearctic	none	vulnerable
P. hospiton Gn	sedentary	1	endemic to Corsica and Sardinia	high	endangered
P. alexanor Esp.	sedentary	1	southwest Palaearctic only	small	vulnerable or endangered

From Collins & Morris (1985), Wells *et al.* (1983), Spitzer (unpublished).

Kaster, V. L. & Showers, W. B., 1982. Evidence of spring immigration and autumn reproductive diapause of the adult black cutworm in Iowa. *Environ. Entomol.* 11 : 306-312.

Lepš, J. & Spitzer, K., 1990. Ecological determinants of butterfly communities (Papilionoidea, Lepidoptera) in the Tam Dao Mountains, Vietnam. *Acta Ent. Bohemoslov.* 87 (2) : 182-194.

MacArthur, R. H. & Wilson, E. O., 1967. The theory of island biogeography. Princeton University Press, 203 pp., Princeton, N. J.

Novák, I. & Spitzer, K., 1972. The relationship between migration and diapause during phylogeny and ontogeny of some Lepidoptera. *J. Res. lepid.* 10 : 181-184.

Pianka, E. R., 1970. On r- and K-selection. *Am. Nat.* 104 : 592-597.

Pimm, S. L., Jones, M. L. & Diamond, J., 1988. On the risk of extinction. *Am. Nat.* 132 : 757-785.

Southwood, T. R. E., 1977. Habitat, the template for ecological strategies ? *J. Anim. Ecol.* 46 : 337-365.

Spitzer, K., 1972. Seasonal adult activity of *Scotia ipsilon* Hfn. (Lep., Noct.) in Bohemia. *Acta Ent. Bohemoslov.* 69 : 396-400.

Spitzer, K. & Lepš, J., 1988. Determinants of temporal variation in moth abundance. *Oikos* 53 : 31-36.

Spitzer, K., Rejmánek, W. & Soldán, T., 1984. The fecundity and long-term variability in abundance of noctuid moths (Lepidoptera, Noctuidae). *Oecologia* 62 : 91-93.

Wells, S. M., Pyle, R. M. & Collins, N. M., 1983. The IUCN invertebrate Red Data Book. Publ. IUCN, 632 pp., Gland.