

**TIME CORRELATED CHANGES
OF THE ALPHA DIVERSITY
IN THE MALE AGGREGATIONS OF *SARCOPHAGIDAE*
IN THREE TYPES OF CENTRAL EUROPEAN
ECOSYSTEMS**

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Abstract

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During approximately 10 years intensive studies were done in some selected male preconnubial aggregations of *Sarcophagidae* (*Diptera*) in three types of the Central European landscape: zone of deciduous forest, agricultural steppe, and cities. In all the three groups of the sarcophagid male aggregations studied a decreasing trend in the alpha diversity was observed. Irrespective of the fact that the alpha diversity represents only one and a possibly limited approach towards this problem and although a complex coincidence of various factors might be responsible for this trend, it is obvious that considerable changes take place at present in the landscape of Central Europe. These our results seem to confirm, thus, similar trends observed in some other kinds of ecosystems of Central Europe. Further studies of this phenomenon seem to be of essential importance and necessity.

The prognosis and the modelling of the anthropogeneous changes of the environment appears to be one of the most important ecological problems (e. g. Odum, 1977; Vacek, 1982) of the present time.

One of the possible approaches to its solution seems to be the evaluation of the temporary changes of the alpha diversity in the animal communities under the condition that strictly biological observation and interpretation of this phenomenon is respected. This approach makes it possible to express and to extrapolate the existing trends in the anthropogeneous pressure on such communities. The aim of the present paper is to examine such trends in the selected male preconnubial aggregations of *Sarcophagidae* in three types of representative habitats of the Central European country: zone of the deciduous forest, agricultural steppe and city. The dipterous family of *Sarcophagidae* and mainly its male preconnubial aggregations offer especially suitable object for such studies as could be emphasized yet in several papers (e. g. Povolný, Staněk, 1975; Povolný, Šustek, 1982a, b). For

this paper especially extensive material of *Sarcophagidae* collected during many years in numerous localities was concentrated. Irrespective of this fact the present paper is only a tentative treatment of this phenomenon.

Material and methods

The material of *Sarcophagidae* studied totals 65 560 individuals completed by additional about 2000 specimens offered to us kindly by Assoc. Prof. Dr. M. Slamečková, Nitra. It was collected in 27 localities (14 in forests, 8 in agricultural steppe, and 5 in cities) of Moravia and partly of southern Slovakia. With the exception of the 2000 specimens collected by Dr. Slamečková, our material was sampled by the senior

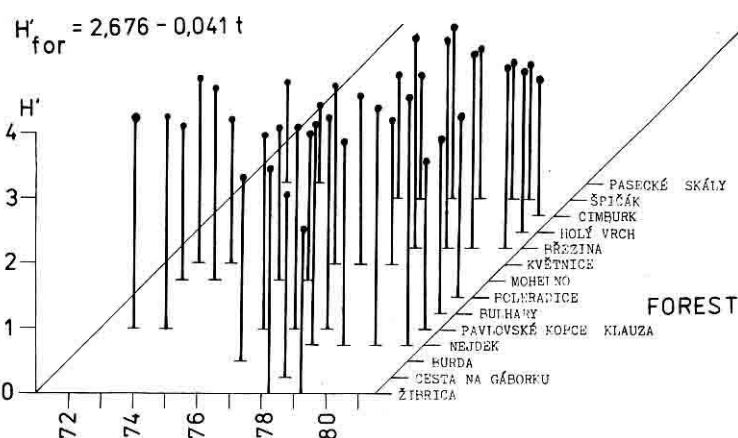


Fig. 1. Values of the alpha diversity (H_s) in fourteen forest habitats during the years 1972—1981. for = forest, t = time in years.

author (D. P.). The males were swept individually in their aggregations where they gather during their preconnubial display aiming at the final copulation (Povolný, Staněk, 1975; Povolný, Šustek, 1982a, b; Povolný, Šustek, in press). In such aggregations up to hundreds of males may concentrate on sunny and/or hot days. Their sampling took place either within a time unit (e. g. one hour) or as long as the obvious decrease in their numbers was visible. The sampling took place still on sunny days during the midday hours (10.00 h—14.00 h). The identification of species followed in the laboratory on the base of their genitalia morphology. The alpha diversity was computed by the application of the Shannon-Wiener-formula separately for each year in each of the individual localities. The extensive size of individual samples, exceeding 200 males in all cases was the reason for the choice of this formula. In such cases the values of the alpha diversity obtained by Shannon Wiener or Brillouin formula (Poole, 1965) are closely correlated. The binar logarithmi were applied during the mathematical treatment of the material. The values were finally plotted in three-dimensional representations (Figs. 1, 2) and the trend of their changes was analysed by the linear regression.

As for the general term "forest" (see Fig. 1) the individual localities included essentially the lower vegetation tiers of the Central European deciduous forest zone from the azonal formations of the lowground forests (Nejdek and Bulhary in southern Moravia), further on the representatives of the first

vegetation tier (e. g. Burda-Hill in southern Slovakia and Pavlovské vrchy (Klauza)-Hills in southern Moravia), then second vegetation tier (pathway near Gáborka in southern Slovakia, Boleradice-forest in southern Moravia) and its transitions to the fourth vegetation tier (Žibrica in southern Slovakia) with its typical Moravian representatives of both Carpatian (Březina, Holý vrch in central Moravia) and Hercynian (Špičák and Pasecké skály-Rocks in western Moravia) character. The higher vegetation tiers of the coniferous zone were not included in the present study. The manifestations of these changes in the sarcophagid male aggregations will be subjected to a special study as soon as the representative material will be available.

As for the term "agricultural ecosystem" such habitats were selected which are more or less surrounded by the agricultural steppe so that irrespective of their relatively natural (Drážovce and Plieška in southern Slovakia, Děvičky and Stránská skála or Hostěrádky in southern Moravia) or more or less changed to

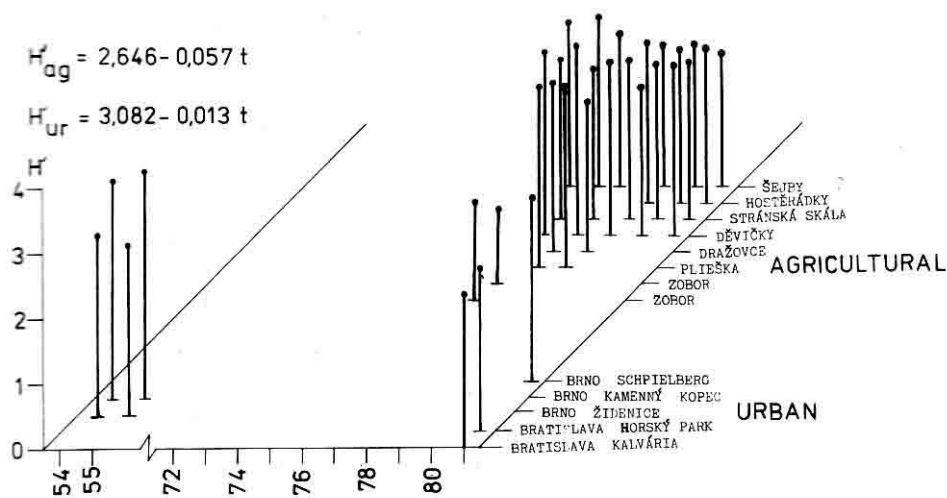


Fig. 2. Values of the alpha diversity (H_s) in eight agricultural (agr.) and four urban (urb.) habitats during the years 1972—1981 and/or 1954—1955 and 1981 respectively. t = time in years.

artificial character (Zobor I, II in southern Slovakia, Šejby in Western Moravia) they reflect relations existing in the secondary changed ecosystem of the Central European agricultural steppe. They include partly extrazonal formations of the surviving forest steppe in the first (Drážovce in southern Slovakia, Děvičky in southern Moravia), second to third (Plieška and partly Zobor in southern Slovakia, Stránská skála and Hostěrádky in southern Moravia) vegetation tiers respectively. The only purely secondary field-habitat of this group is represented by Šejby in the deforested territory corresponding originally to the fourth vegetation tier in western Moravia. All mentioned vegetation tiers here correspond to the definitions, 1966.

As the representatives of the "urban ecosystems" (Fig. 2) three habitats of *Sarcophagidae* in Brno and two habitats in Bratislava were studied. The problem of the sarcophagid male aggregations in cities meets with methodical difficulties due to the limited possibilities of their existence there generally and due to their temporary character specially. But this is yet one of the results of the solution of this problem treated in this paper.

Results

The alpha diversity of the sarcophagid preconnubial aggregations in the forest habitats fluctuates between 1.5—3.2 bit (Fig. 1). The majority of values concentrates within the limits of 2.5—3.0 bit (Fig. 1). Two decreasing trends were observed in the frame of this group of the forest aggregations. The first is the decrease in the alpha diversity in the aggregations of the beech-oak vegetation tier (2) towards the aggregations of the higher vegetation tiers, so especially towards the fir-beech tier (5). The second, and obviously less apparent, trend shows a decrease in the alpha diversity in comparison of its previous values with the values of the very recent years. The first trend seems to be doubtlessly a natural appearance in the populations of *Sarcophagidae* living under increasingly unfavourable conditions, especially in view of the abiotic pressure of the last seasons (e. g. lower temperatures, high humidity, shorter vegetation period) reflected in the individual species, especially in the mountain elevations. The other less apparent decreasing trend appears to be a result of the increasing purely anthropogeneous pressure on the environment combined with the generally unfavourable climatic development mentioned above. The analysis of the linear regression shows that the mean decrease in the alpha diversity amounted 0.04 bit yearly.

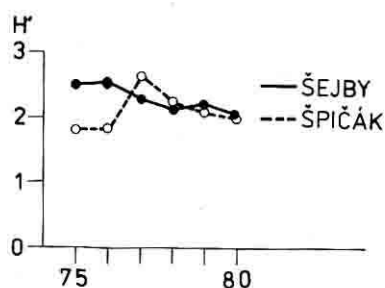
The trend in the alpha diversity of the aggregations of the cultural steppe (Fig. 2) is quite unambiguous showing a negative correlation with the time. That is why mostly the aggregations of the lowlands were included into this study. The decreasing trend in the agricultural aggregations in comparison with the trend of the forest habitats is consequently also due to the increased anthropogeneous pressure on the secondary habitats of fields and on the cultural steppe generally (see also Povolný, Šustek, 1982b). The linear regression analysis indicates that the mean decrease in the alpha diversity equals 0.057 bit, a value corresponding one and a half as much as in the forest habitats.

Concerning the alpha diversity in the sarcophagid male preconnubial aggregations of urban character (Fig. 2) the limited number of observations (Brno 1954—1955, Brno and Bratislava 1981) was due to the general difficulty of their detecting in an urban ecosystem irrespective of their strongly temporary character. It seems, moreover, that any objective trends in the male preconnubial aggregations of *Sarcophagidae* there are practically unpredictable because they are dependent from the liquidation of substrates for the maggots of synanthropic species, from the treatment of urban parks and gardens by their keepers and by similar partly artificial trends. Also the trends in the alpha diversity may change there unpredictably from season to season.

Discussion

A comparison of the figures 1 and 2 represents three various degrees in the decrease in the alpha diversity. If we consider that theoretically each of the three groups of aggregations studied is subject to individually different qualities of the anthropogeneous pressure, we might conclude that the values of the decrease in the alpha diversity observed in each of these groups should correspond to the quantitative degree of the concrete anthropogeneous pressure exerted and/or existing in these three groups of habitats. This conclusion accords well with a similar result observed in some similar communities of *Carabidae* (Šustek, in press). Such a conclusion should be, however, observed and examined very critically. The forest ecosystems of Central Europe represent namely a rather natural (zonal) ecosystem of this type of a landscape having, thus, a considerable stability. The agricultural steppe of Central Europe is, also from a purely biogeographical viewpoint, a strictly artificial, extrazonal habitat and ecosystem. This seems to be a very important reason of the different trends in their aggregations of *Sarcophagidae* (and *Carabidae*) as it reflects in the changes of their alpha diversity. Such different reactions may consequently reflect a very complex set and coincidence of pressures combining both the anthropogeneous, abiotic and other so far little known or unknown factors. Two intensively studied aggregations offer a very instructive example of this situation, viz. Špičák — a nature reserve of a beech forest, and Šejby — a today cultural steppe only two km distant from Špičák and formerly also a beech forest (Fig. 3). This figure

Fig. 3. A course of the alpha diversity in geographically close (2 km) but phytocenologically different habitats in the highland of Českomoravská Vysočina. Špičák — a natural beech forest. Šejby — an agricultural steppe at the same elevation, former a same forest. Hs — alpha diversity during the years 1975—1980.



shows that the sarcophagid aggregations of the agricultural steppe reacted, in this highland, very sensitively on the cold seasons of the years 1977—1980 than did the same aggregations in a natural forest of the same landscape. If the decrease in the alpha diversity in all the three groups of aggregations resulted from purely anthropogeneous pressure, it would be a serious warning for the future. If namely the decreasing trend should prove to be definitely of linear character and if the increase in the anthropogeneous pressure should keep its progressive trend, one might expect that the alpha diversity would decrease in the agricultural ecosystems to the level of

about 1 bit within about 17 years, and the same decrease would follow in the forest ecosystems within about 25 years to come.

As for the urban ecosystems one may expect according to the regression analysis (Fig. 2) that the alpha diversity may decrease correspondingly to 1 bit within about the next 100 years. The extrapolation of this slightly decreasing trend in the alpha diversity of the urban ecosystems is, however, impossible. It is generally known (Owen, 1978; Šustek, 1980) that in the strongly influenced ecosystems the alpha diversity may, as a purely mathematical index, increase due to the general decrease in the abundance of the individual species as well as due to a possibly considerable number of new immigrant (including synanthropical) species into such very secondary ecosystems. These two factors may be then responsible for a very balanced representation of species in such totally changed ecosystems and for their relative high values of the alpha diversity even shortly before a possible breakdown of such and of other ecosystems.

It seems from this viewpoint (see also Šustek, 1980) that the sinking trend in the alpha diversity should be generally interpreted as a still reversible phase in the change of an ecosystem. The comparatively constant index of the alpha diversity in the urban ecosystems admits two interpretations: either as a total disturbance of the aggregations studied (Povolný, Šustek, 1982), or as a manifestation of various degrees of anthropically influenced mutual exchanges and successions of species from originally arboreal, secondarily cultural and tertiary urban aggregations.

It should be finally mentioned that the above period of 17 or 25 years respectively, during which the decrease in the alpha diversity of the sarcophagid aggregations is expected to reach the level of about 1 bit, accords well with some prognostic studies on ecosystems of the northern Bohemia. According to these prognoses (e. g. Vacek, 1982 and personal communication) the coniferous woods and forests there would disappear within about 25—30 years from this territory.

It results that a far reaching agreement exists between various authors as far as certain trends of the Central European ecosystems are concerned, although the observations are done in not quite identical geographical and economic situations. In view of the fact that such prognoses presume a considerable destruction of a landscape and of nature the above quantificated data offered by this paper might be another serious warning.

On the other hand, such trends and appearances should be continuously studied. The critical examination in e. g. *Carabidae* and in other animal groups demonstrated yet that the alpha diversity might decrease very rapidly in rather intensified agricultural landscape and in other anthropically strongly influenced or changed habitats and yet it kept then, during the following years, its level.

As for the male aggregations in the *Sarcophagidae*, we cannot exclude that especially some minor changes in their natural habitats include some cyclical changes of the climate or that a slow natural development follows — in view of their general

stenoekey especially related to the intensity of sunshine, temperature and of other factors.

Conclusions

The alpha diversity in the male preconnubial aggregations of *Sarcophagidae* was studied in three representative types of the Central European landscape during the years 1954—1981, viz. in forests, in agricultural steppe and in the cities. The resulting changes of the alpha diversity in the individual groups of ecosystems seem to indicate that the continuation in the present trend of human activities in this landscape might result in a serious disturbance of the existing agricultural ecosystems within about 17 years and in similar disturbances of forest ecosystems within about 25 years. Since the *Sarcophagidae* reflect, as parasitoids of various invertebrates, also some other levels and chains of ecosystems, continuous studies of these relations are necessary. The authors are aware that in view of the so far limited experience and of the accessible trends any prognoses are not predictable exactly but some of the aspects studied are certainly warning.

Translated by the authors

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Povolný D., Šustek Z.: Dlhodobé zmeny alfa diverzity agregácií samcov čeľadi *Sarcophagidae* v troch typoch stredoeurópskych ekosystémov.

Počas ostatných desiatich rokov sme študovali zloženie prekonubiálnych agregácií samcov čeľadi *Sarcophagidae* (*Diptera*) v troch typoch stredoeurópskej krajiny, v pásme listnatého lesa, v kultúrnej stepi a v mestách. Vo všetkých typoch študovaných ekosystémov badať počas sledovaného obdobia klesajúci trend alfa diverzity prekonubiálnych agregácií samcov čeľadi *Sarcophagidae*. Hoci príčinou tohto poklesu bude súhra cieľho radu faktorov, môžeme konštatovať, že v študovaných ekosystémoch nastávajú výrazné zmeny. Tieto výsledky potvrdzujú podobné tendencie zistené na iných úrovniach ekosystémových štúdií v strednej Európe. Ďalšie štúdium takýchto zmien považujeme za žiadúce a nevyhnutné.

Поволны Д., Шустек З.: Длительные изменения альфа разнообразия агрегаций самцов семейства *Sarcophagidae* в трех типах средневропейских экосистем.

На протяжении остальных десяти лет мы изучали состав преконнубиальных агрегаций самцов семейства *Sarcophagidae* (*Diptera*) в трех типах средневропейского ландшафта, в поясе лиственного леса, в культурной степи и в городах. Во всех трех типах изучаемых экосистем можно отметить в течение обследованного времени падающий тренд альфа разнообразия преконнубиальных агрегаций самцов семейства *Sarcophagidae*. Хотя причиной этого снижения будет взаимодействие целого ряда факторов, можем констатировать, что в изучаемых экосистемах происходят выразительные изменения. Эти результаты подтверждают подобные тенденции обнаруженные на других уровнях экосистемных исследований в Средней Европе. Дальнейшее изучение таких изменений считаем нужным и необходимым.