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Niche and species diversity in temperate zone bats (*Chiroptera*)

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Nisza ekologiczna a liczba gatunków nietoperzy w klimacie umiarkowanym

Экологическая ниша и видовое разнообразие летучих мышей в умеренном климате

Abstract: The length ratios of the upper tooth row were compared within individual genera of European bats. The results obtained resemble those given by TAMSITT (1967) for bats living in tropical stable environments. It follows that this index is not useful in comparisons of bats with respect to the severity of their competition for food, assuming that in the tropical stable environments this competition is more severe than in the temperate climate. The severity of food competition is the result of too many factors to be measured by this method.

I. INTRODUCTION

A number of authors have recently dealt with the causes of the increase in the quantity of animal and plant species in tropical stable environments, which for brevity I shall refer to as the tropics. These studies were usually carried out on birds. Regarding this group of animals, KLOPFER and MACARTHUR (1961) and SCHOENER (1965) concluded that the cause is not an increase in the number of ecological niches in the tropics, but, instead, the increase in the similarity of ecological demands which results in a greater degree of overlap of niches. As one of the arguments supporting this theory they set forth the fact that beak lengths of competing congeneric species are 1:1.2—1.4 in the temperate climate (HUTCHINSON, 1959) and 1:1.19—1.28 in the tropics (KLOPFER and MACARTHUR, 1961; SCHOENER, 1965), for it is believed that the nearer this ratio comes to 1, more severe the is the competition for food between 2 species.

TAMSITT (1967) examined these relations in 6 pairs of bats of the family *Phyllostomidae* in the tropics of Colombia. Five of them depend chiefly on vegetable food, and in the sixth pair *Ph. discolor* is a vegetarian and *Ph. hastatus* an omnivorous species. TAMSITT compared the mean lengths of the upper tooth row and mandible and as the evidence of food competition he noted the fact of catching the species being compared with a net in banana groves. The measurements given by TAMSITT are original, taken by himself. The results obtained by him for the first 5 pairs are 1.07—1.15 for the mandible and 1.06—1.16 for the upper tooth row, whereas the relations found in the species of the genus *Phyllostomus* cannot be taken into consideration, because the competition between them is very small (differences in food). TAMSITT states that these relations in the bats of the tropics resemble those found for the birds of the same zone and, based upon this observation, he claims that, as in these last animals, „in stable environments there seems to be some overlap of niches occupied by Chiroptera“.

Thinking it worthwhile to examine these relations in bats of the temperate climate, I calculated them for the European bats.

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II. MATERIAL AND METHOD

The present study is based exclusively on data obtained from literature. The length of upper tooth row is used as a basis for comparisons, because the measurements of the other parts of the food ingestion apparatus are less available in the literature and I was in a position to employ them in only a few cases. The bats examined belong to the families *Rhinolophidae* and *Vespertilionidae* and are all insectivorous. I thought it would be good not only to give the ratios of the species standing nearest to each other in respect of size, but also to take into consideration all the combinations possible within the given group, for it is a common phenomenon that owing to an unsuitable environment a given species is lacking locally in an area, though this area is situated within its geographical range. Moreover, different species have different geographical ranges. These facts together give the result, in a given region Species A may not compete with Species B, nearest to it in size, but with species C or even D, according to the number of missing intermediate links.

Determination of the geographical distribution of bats is according to BRINK (1967) and potential competition for food was established using the data from literature concerning the biology of individual species. The species are arranged in order of length of their upper tooth rows, from the largest to the smallest one. The term „size“ is used for brevity; it refers to the length of upper tooth row, which is not always proportional to the body size. The length of upper tooth row was calculated as the arithmetic mean from the

minimum and the maximum measurement. This is also true of the other measurements. The species whose name is printed in bold-faced italics is successively compared with the smaller and smaller species. Thus, in order to find the length ratio between, *e. g.*, the upper tooth row of *Rhinolophus blasii* and that of *R. euryale*, one must look it up in the list under the heading *Rhinolophus blasii* printed in bold-faced italics.

By competition I always mean competition for food. I assume tentatively that it is expressed by the length ratio of upper tooth rows between two species under comparison. I use the term „tropical competition“ when the length ratio of, *e. g.*, upper tooth row between two species is smaller than 1:1.2 (in short: 1.2), and so it is, *e. g.*, 1.19. I have fixed the figure 1.2 on the basis of TAMSITT's results. If I state that a species has no competitor, I take into account the given group of comparisons without excluding the possibility of competition with species belonging to another group of comparisons, even though they are from another family.

III. RESULTS

Rhinolophidae: Rhinolophus

Sequence of upper tooth row lengths from the largest to the smallest one: *ferrumequinum*, *mehelyi*, *blasii*, *euryale*, *hipposideros*.

Rhinolophus ferrumequinum (SCHREBER, 1774): *mehelyi* MATSCHIE, 1901 — 1.21 (LANZA, 1959), 1.28 (KUZYAKIN, 1950); *blasii* PETERS, 1866 — 1.27 (LANZA, *l. c.*), 1.32 (KUZYAKIN, *l. c.*); *euryale* BLASIUS, 1853 — 1.34 (LANZA, *l. c.*), 1.37 (KUZYAKIN, *l. c.*); *hipposideros* (BECHSTEIN, 1800) — 1.57 (LANZA, *l. c.*), 1.62 (ABELENTSEV *et al.*, 1956), 1.59 (KUZYAKIN, *l. c.*), 1.57 (GAFFREY, 1961), lower tooth row 1.62 (GAFFREY, *l. c.*).

Rhinolophus mehelyi: *blasii* — 1.04 (LANZA, *l. c.*), 1.03 (KUZYAKIN, *l. c.*); *euryale* — 1.10 (LANZA, *l. c.*), 1.07 (KUZYAKIN, *l. c.*); *hipposideros* — 1.24 (LANZA, *l. c.*), 1.25 (KUZYAKIN, *l. c.*).

Rhinolophus blasii: *euryale* — 1.05 (LANZA, *l. c.*), 1.04 (KUZYAKIN, *l. c.*); *hipposideros* — 1.24 (LANZA, *l. c.*), 1.21 (KUZYAKIN, *l. c.*).

Rhinolophus euryale: *hipposideros* — 1.17 (LANZA, *l. c.*), 1.16 (KUZYAKIN, *l. c.*).

Vespertilionidae

Water Myotis

Sequence of upper tooth row lengths from the largest to the smallest one: *dasycneme*, *capaccinii*, *daubentoni*, *mystacinus*.

Myotis dasycneme: (BOIE, 1825): *capaccinii* (BONAPARTE, 1837) — 1.10 (ABELENTSEV *et al.*, *l. c.*) 1.10 (LANZA, *l. c.*); *daubentoni* (LEISLER in KUHLM, 1819) — 1.17 (KAISILA and NYHOLM, 1967), 1.17 (LANZA, *l. c.*), 1.23 (ABELENTSEV

et al., *l. c.*), 1.17 (KUZYAKIN, *l. c.*), lower tooth row 1.23 (KAISILA and NYHOLM, *l. c.*); *mystacinus* (LEISLER in KUHLM, 1819) — 1.23 (KAISILA and NYHOLM, *l. c.*), 1.18 ABELENTSEV *et al.*, *l. c.*), 1.18 (KUZYAKIN, *l. c.*), 1.18 (LANZA, *l. c.*), 1.21 (GAFFREY, *l. c.*), lower tooth row 1.20 (KAISILA and NYHOLM, *l. c.*), 1.24 (GAFFREY, *l. c.*).

***Myotis capaccinii*:** *daubentoni* — 1.07 (LANZA, *l. c.*), 1.05 Western Europe (GAISLER, HANAK and KLIMA, 1957), 1.07 Eastern Europe (GAISLER, HANAK and KLIMA, *l. c.*), lower tooth row 1.14 (GAISLER, HANAK and KLIMA, *l. c.*), mandible 1.08 Western Europe (GAISLER, HANAK and KLIMA, *l. c.*); *mystacinus* — 1.08 (LANZA, *l. c.*), 1.05 Western Europe (GAISLER, HANAK and KLIMA, *l. c.*), 1.08 Eastern Europe (GAISLER, HANAK and KLIMA, *l. c.*), lower tooth row 1.18 (GAISLER, HANAK and KLIMA, *l. c.*), mandible 1.11 Western Europe (GAISLER, HANAK and KLIMA, *l. c.*).

***Myotis daubentoni*:** *mystacinus* — 1.01 (LANZA, *l. c.*), 1.01 (KUZYAKIN, *l. c.*), 1.04 but body of *mystacinus* is larger! (ABELENTSEV *et al.*, *l. c.*), 1.05 (KAISILA and NYHOLM, *l. c.*), lower tooth row 1.02 (KAISILA and NYHOLM, *l. c.*)

Terrestrial *Myotis*

Sequence of upper tooth row lengths from the largest to the smallest one: *myotis*, *blythi*, *bechsteini*, *emarginatus*, *nattereri*, *mystacinus*.

Myotis myotis (BORKHAUSEN, 1797): *blythi* (TOMES, 1857) — 1.17 (LANZA, *l. c.*), 1.12 (ABELENTSEV *et al.*, *l. c.*), 1.15 (KUZYAKIN, *l. c.*), 1.14 (GAISLER, HANAK and KLIMA, *l. c.*), lower tooth row 1.11 (GAISLER, HANAK and KLIMA, *l. c.*); *bechsteini* (LEISLER in KUHLM, 1818) — 1.47 (LANZA, *l. c.*), 1.43 (ABELENTSEV *et al.*, *l. c.*), 1.46 (KUZYAKIN, *l. c.*), 1.46 (GAFFREY, *l. c.*), lower tooth row 1.45 (GAFFREY, *l. c.*); *emarginatus* (E. GEOFFROY, 1806) — 1.61 (LANZA, *l. c.*), 1.53 (ABELENTSEV *et al.*, *l. c.*), 1.56 (KUZYAKIN, *l. c.*), 1.64 (GAFFREY, *l. c.*), lower tooth row 1.62 (GAFFREY, *l. c.*); *nattereri* (KUHLM, 1818) — 1.73 (LANZA, *l. c.*), 1.69 (KUZYAKIN, *l. c.*), 1.71 (GAFFREY, *l. c.*), lower tooth row 1.70 (GAFFREY, *l. c.*); *mystacinus* — 1.94 (LANZA, *l. c.*), 1.89 (ABELENTSEV *et al.*, *l. c.*), 1.92 (KUZYAKIN, *l. c.*), 1.96 (GAFFREY, *l. c.*), lower tooth row 1.94 (GAFFREY, *l. c.*).

***Myotis blythi*:** *bechsteini* 1.26 (LANZA, *l. c.*), 1.26 (KUZYAKIN, *l. c.*), 1.28 (ABELENTSEV *et al.*, *l. c.*); *emarginatus* — 1.37 (LANZA, *l. c.*), 1.35 (KUZYAKIN, *l. c.*), 1.37 (ABELENTSEV *et al.*, *l. c.*), 1.39 (GAISLER, HANAK and KLIMA, *l. c.*), lower tooth row 1.39 (GAISLER, HANAK and KLIMA, *l. c.*); *nattereri* — 1.48 (LANZA, *l. c.*), 1.46 (KUZYAKIN, *l. c.*), 1.48 (GAISLER, HANAK and KLIMA, *l. c.*), lower tooth row 1.52 (GAISLER, HANAK and KLIMA, *l. c.*); *mystacinus* — 1.66 (LANZA, *l. c.*), 1.69 (ABELENTSEV *et al.*, *l. c.*), 1.67 (KUZYAKIN, *l. c.*), 1.70 (GAISLER, HANAK and KLIMA, *l. c.*), lower tooth row 1.75 (GAISLER, HANAK and KLIMA, *l. c.*).

***Myotis bechsteini*:** *emarginatus* — 1.09 (LANZA, *l. c.*), 1.07 (KUZYAKIN, *l. c.*), 1.12 (GAFFREY, *l. c.*), lower tooth row 1.12 (GAFFREY, *l. c.*); *nattereri* — 1.18 (LANZA, *l. c.*), 1.16 (KUZYAKIN, *l. c.*), 1.17 (GAFFREY, *l. c.*), 1.18 (KAISILA

and NYHOLM, *l. c.*), lower tooth row 1.17 (KAISILA and NYHOLM, *l. c.*), 1.17 (GAFFREY, *l. c.*); *mystacinus* — 1.37 (KAISILA and NYHOLM, *l. c.*), 1.32 (LANZA, *l. c.*), 1.32 (KUZYAKIN, *l. c.*), 1.34 (GAFFREY, *l. c.*), lower tooth row 1.31 (KAISILA and NYHOLM, *l. c.*), 1.35 (GAFFREY, *l. c.*).

Myotis emarginatus nattereri — 1.08 (LANZA, *l. c.*), 1.08 (KUZYAKIN, *l. c.*), 1.04 (GAFFREY, *l. c.*), lower tooth row 1.05 (GAFFREY, *l. c.*); *mystacinus* — 1.21 (LANZA, *l. c.*), 1.24 (KUZYAKIN, *l. c.*) 1.19 (GAFFREY, *l. c.*), lower tooth row 1.20 (GAFFREY, *l. c.*).

Myotis nattereri mystacinus — 1.16 (KAISILA and NYHOLM, *l. c.*), 1.12 (LANZA, *l. c.*), 1.14 (KUZYAKIN, *l. c.*), 1.15 (GAFFREY, *l. c.*), lower tooth row 1.12 (KAISILA and NYHOLM, *l. c.*), 1.15 (GAFFREY, *l. c.*).

Plecotus

Plecotus austriacus FISCHER, 1829: *auritus* (LINNAEUS, 1758) — 1.13 (RUPRECHT, 1965).

Pipistrellus

Sequence of upper tooth row lengths from the largest to the smallest: *kuhli*, *nathusii*, *savii*, *pipistrellus*.

Pipistrellus kuhli (NATTERER in KUHLM, 1819): *nathusii* (KEYS. et Blasius, 1839) — 1.01 (LANZA, *l. c.*), 1.00 (ABELENTSEV *et al.*, *l. c.*), 1.01 (KUZYAKIN, *l. c.*); *savii* (BONAPARTE, 1837) — 1.03 (LANZA, *l. c.*), 1.03 (ABELENTSEV *et al.*, *l. c.*), 1.02 (KUZYAKIN, *l. c.*); *pipistrellus* (SCHREBER, 1774) — 1.11 (LANZA, *l. c.*), 1.21 (ABELENTSEV *et al.*, *l. c.*), 1.18 (KUZYAKIN, *l. c.*).

Pipistrellus nathusii savii — 1.02 (LANZA, *l. c.*), 1.03 (ABELENTSEV *et al.*, *l. c.*), 1.02 (KUZYAKIN, *l. c.*), 1.00 (GAFFREY, *l. c.*), lower tooth row 1.05, but body of *savii* is larger! (GAFFREY, *l. c.*); *pipistrellus* — 1.10 (LANZA, *l. c.*), 1.21 (ABELENTSEV *et al.*, *l. c.*), 1.16 (KAISILA and NYHOLM, *l. c.*), 1.17 (KUZYAKIN, *l. c.*), 1.13 (GAFFREY, *l. c.*), 1.13 (GAISLER, HANAK and KLIMA, *l. c.*), lower tooth row 1.08 (GAFFREY, *l. c.*), 1.08 (GAISLER, HANAK and KLIMA, *l. c.*).

Pipistrellus savii pipistrellus — 1.08 (LANZA, *l. c.*), 1.17 (ABELENTSEV *et al.*, *l. c.*), 1.14 (KUZYAKIN, *l. c.*), 1.13 (GAFFREY, *l. c.*), lower tooth row 1.13 (GAFFREY, *l. c.*).

Nyctalus

Sequence of upper tooth row lengths from the largest to the smallest one: *lasiopterus*, *noctula*, *leisleri*.

Nyctalus lasiopterus (SCHREBER in ZIMMERMANN, 1780): *noctula* (SCHREBER 1774) — 1.27 (LANZA, *l. c.*), 1.23 (ABELENTSEV *et al.*, *l. c.*), 1.24 (KUZYAKIN, *l. c.*); *leisleri* (KUHLM, 1818) — 1.49 (LANZA, *l. c.*), 1.53 (ABELENTSEV *et al.*, *l. c.*), 1.45 (KUZYAKIN, *l. c.*).

Nyctalus noctula leisleri — 1.17 (LANZA, *l. c.*), 1.24 (ABELENTSEV *et al.*, *l. c.*), 1.17 (KUZYAKIN, *l. c.*).

Eptesicus

Eptesicus serotinus (SCHREBER, 1774): *nilssoni* (KEYS. and BLASIUS, 1839) — 1.43 (LANZA, l. c.), 1.43 (ABELENTSEV *et al.*, l. c.), 1.38 (KAISILA and NYHOLM, l. c.), 1.32 (KUZYAKIN, l. c.), 1.44 (GAFFREY l. c.), 1.44 (GAISLER, HANAK and KLIMA, l. c.).

IV. DISCUSSION

Rhinolophidae: This family is lacking in Northern and, partly, Middle Europe. Since authors (see LANZA, l. c. and BLACKMORE, 1964) differ in opinion as to the validity of various subspecies of *R. ferrumequinum* and *R. hipposideros*, distinguished mostly on the basis of differences in size, I have not included them in this study. The species distributed farthest to the north are successively: *hipposideros*, *ferrumequinum* and *euryale*; *mehelyi* and *blasii* have the smallest and discontinuous ranges. As a result, *hipposideros* has no competitor in large areas, and in other regions, situated farther to the south, its only competitor is *ferrumequinum*. Competition between them is small, because they are species at opposite size extremes in this genus. Where, still farther to the south, they are accompanied by *euryale*, intermediate in size, the competition may become more severe, but it is of the temperate type between *euryale* and *ferrumequinum*, as the values 1.34—1.37 exceed the limit 1.2; the tropical competition occurs between *euryale* and *hipposideros* (1.16—1.17). The geographical distribution of *blasii* and *mehelyi* is such that they hardly compete with each other, but they do with some other species.

Taking into consideration the whole of Europe and applying the rule that only the species standing nearest to each other in respect of size should be compared, we find that the competition is of the temperate type in a single case (*ferrumequinum-mehelyi*) and strongly tropical in the other three cases.

Vespertilionidae

Myotis: On account of the fact that some species hunt mostly close above the water surface, it appeared necessary to divide this genus into 2 groups.

Water Myotis. *M. dasycneme* (BOIE, 1825) hunts exclusively above the water surface and *M. daubentoni* (LEISLER in KUHLE, 1819) is somewhat less closely associated with water. The biology of *M. capaccinii* (BONAPARTE, 1837) is not equally well known; however, it is emphasized that like the preceding species it hunts just above the water surface. Somewhat hesitatingly I include *M. mystacinus* (LEISLER in KUHLE, 1819) in this group, because it is more loosely connected with water than the previous bats and often flies much higher than they do; consequently, its competition with them is probably relatively weak. The first three species are sometimes distinguished as the subgenus *Leuconoë*, and *mystacinus* is placed in the subgenus *Selysius*.

In the analysis of these bats I move from the northern boundary of their distribution southwards, beginning with the Scandinavian Peninsula and Finland. *Mystacinus* reaches farthest to the north, being followed in this respect by *daubentoni*, whereas *dasygneme* occupies a very small southernmost portion of Sweden. Thus, in a certain area *daubentoni* is the only competitor of *mystacinus*. It is striking that even at the northern boundary of the distribution of these bats the competition is tropical. In the southernmost part of the Scandinavian Peninsula where *dasygneme* appears in addition to them, its competition with *daubentoni* is intermediate between the tropical and the temperate type (1.17—1.23). Farther to the south *dasygneme* is lacking in Southern and almost all of Western Europe and *daubentoni* does not occur in a considerable part of Italy and in South-Eastern Europe. *Capaccini*, the fourth and last species of this group, occurs in Southern Europe. Its range hardly overlaps that of *dasygneme*, and *daubentoni* is missing in its remarkable part.

Summing up, no increase in the number of species is observed in Southern Europe. Between the species which most resemble each other in size, the competition is highly tropical in all three cases, though the concomitance of *dasygneme* and *capaccinii*, its neighbour in size, takes place only over a very small area. Therefore, when omitting this last species, we find 1 case of tropical-temperate competition (*dasygneme-daubentoni*) and 2 cases of tropical competition (*capaccinii-daubentoni* and *daubentoni-mystacinus*).

TERRESTRIAL *Myotis*: Considering the dual amphibious biology of *mystacinus*, I thought it fit to include it also in this group. Here, too, it reaches farthest to the north. It is only in the southernmost part of the Scandinavian Peninsula that this species meets a competitor, *nattereri*, and their competition is tropical in character. Still farther to the south, a small tip of the peninsula is occupied by *bechsteini*, which is larger than the two preceding species. Its competition with *nattereri*, next in size, is also tropical. In contradistinction to water *Myotis*, in this group the number of species increases as we move southwards; to be sure, the ranges of some species (*emarginatus*, *bechsteini*) are greatly discontinuous and *nattereri* does not occur in South-Eastern Europe.

To sum up, between the species neighbouring directly on each other in respect to size there are 4 cases of tropical competition and only 1 case of temperate competition (*blythi-bechsteini*).

Plecotus

The smaller species of this genus, *auritus*, has no competitor in the Scandinavian Peninsula. Its competition with *austriacus* is typically tropical in character.

Pipistrellus

The smallest species, *pipistrellus*, reaches farthest to the north in the Scandinavian Peninsula and only in a very small area of the southernmost part of the peninsula it is competed by *nathusii*. The figures presented in literature

qualify the competition between them as tropical; only ABELENTSEV *et al.* give the value which slightly exceeds the limit 1.2. This value is, however, somewhat uncertain, since it differs markedly from the figures reported by other investigators. The other species appear only in Southern Europe (*nathusii* is lacking in southern Italy and in the greater part of Western Europe); here the competition is of the tropical type to the extent observed in no other group. Nevertheless, it must be emphasized that the upper tooth row lengths do not indicate the true size relations at all. *Savii*, the penultimate species regarding its upper tooth row length, is in fact the largest in this group. Only *pipistrellus* differs considerably in body size from the other species of the group, which in this respect resemble each other so much that, for instance, it is not certain whether *kuhli* is actually larger than *nathusii*.

In conclusion, the competition is tropical in all the three cases.

Nyctalus

Only *noctula* occurs in the Scandinavian Peninsula and therefore it has no competitor in this part of Europe. *Leisleri*, which has a discontinuous range, appears in Central Europe, but is missing, among other places, in nearly whole Western and Southern Europe. The competition between these species is intermediate between temperate and tropical. *Lasiopiterus* is confined to Southern Europe except for the east, where it extends fairly far to the north, but everywhere is rather rare. Its competition with *noctula* is of the temperate type.

Eptesicus

In this group I have not included *sodalis* BARRETT-HAMILTON, 1910, because its factual systematic position is still enigmatic (BAUER, 1968). Probably, it is one of the species that come visiting the region under study from the south and it has been described as quite a new species.

Nilssoni, the form that reaches farthest to the north of all bats, has no competitor in Scandinavia except in Denmark, which is partly occupied by the northern range of *serotinus*. Their competition is highly temperate. These two species coexist, above all, in a part of Eastern Europe, because *nilssoni* is missing in the greater part of Europe.

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If we sum up all the results together, we find 5 cases of tropical and 1 case of temperate competition in Scandinavia whereas considering all of Europe the results are as follows: 14 cases of tropical competition, one of tropical-temperate, and 4 of temperate. These results quite disagree with what we might expect from TAMSITT'S observations. Particularly instructive are the results for the Scandinavian Peninsula on account of the decidedly cool climate of this region, where the bats reach the northern boundary of their distribution.

TAMSITT's opinion on the usefulness of comparison of upper tooth row lengths for obtaining an index of feeding competition size would be supported if it appeared that the arithmetic mean for the length ratios of the upper tooth rows for the 5 pairs of the bat species examined by him is significantly lower than the mean for the 19 pairs of the European bats. In view of the differences between the methods used by TAMSITT and me it should, however, be considered first whether such means are comparable at all. This would be the case if the species compared by TAMSITT stood next to each other in respect to size in those areas, as the species which I have selected for my comparisons. It might be judged on the basis of CABRERA's Catalogue (1957) that this condition is fulfilled in most, if not all, of the cases. It is, however, necessary to keep in mind that Colombia, like the other parts of South America, is far less explored in respect to the bat fauna than Europe, which is nearly 9 times as large. This is evidenced by the fact that even new genera are described from this region and the data pointing at the extension of the ranges of the known species are presented in constantly increasing numbers. Hence, there is no certainty as to whether the species compared by TAMSITT come next to each other in respect to size. In spite of these qualifications the comparison was too attractive to be given up. As a basis for the European bats I used the work by LANZA (*op. cit.*), which I supplemented with the data presented for *Plecotus* by RUPRECHT (1965). The mean is 1.12 (1.06—1.16) for the 5 species (after excluding *Phyllostomus*) examined by TAMSITT and 1.13 (1.01—1.43) for the European bats. Being very small, the difference is not significant; the more so, because the standard error is very high owing to the great deviation from the mean in the European bats. As has been mentioned, it may have happened that TAMSITT did not catch some species intermediate in size, in which case there would be no grounds to carry out the foregoing comparisons. Taking this possibility into account, I performed a survey of the competitions between every other species. The following 12 pairs have been compared: *ferrumequinum-blasii*, *blasii-hipposideros*, *mehelyi-euryale*, *dasyeneme-daubentoni*, *capaccinii-mystacinus*, *myotis-bechsteini*, *bechsteini-nattereri*, *blythi-emarginatus*, *emarginatus-mystacinus*, *kuhli-savii*, *nathusii-pipistrellus* and *lasiopterus-leisleri*. However, even then we find 6 cases of competition of the tropical type and 6 of the temperate type (see Section „Results“), whereas the mean is conspicuously higher: 1.23. In turn, I compared every third species and obtained 7 pairs in this way: *ferrumequinum-euryale*, *mehelyi-hipposideros*, *dasyeneme-mystacinus*, *myotis-emarginatus*, *blythi-nattereri*, *bechsteini-mystacinus* and *kuhli-pipistrellus*. Even then in 1 case the competition is tropical, in one temperate-tropical, and in 5 cases temperate, and therefore I did not manage to void them completely of tropical relations. The mean calculated for these 7 pairs is 1.33.

On the other hand, there are several monotypic genera in the Scandinavian Peninsula. Their species do not meet any competitors as far as Central Europe (*Plecotus*, *Nyctalus*). I was unable to demonstrate this fact in my lists, since it cannot be expressed by an appropriate figure. Moreover, in all the groups

analysed, except for water *Myotis*, there occurs a distinct increase in the number of species, as we move to the south, resulting in the competition between these species becoming enhanced, if the number of ecological niches does not grow at an adequate rate. Consequently, the general biological rule that competition increases towards the equator seems to find confirmation in so far as the European bats are concerned. Nevertheless, in the light of the results obtained in the present study the use of the above criteria as indices of food competition is rather unreliable. These criteria might possibly be defended if we managed to point out that the species compared by TAMSITT did not stand next to each other in respect to size; besides, the use of arithmetic means presages better than the formation of numerical limits. However, it must be kept in mind that Europe has not had enough time to fill up biocenotically since the Pleistocene which came to an end hardly 10.000—12.000 years ago, and the southern species are still shifting northwards. New species of bats will probably come to Europe and then the competition between particular species will become more severe. It is only on this stipulation that we may compare Europe with biocenotically stabilized Colombia in this respect.

The question arises whether two species of the same genus must compete keenly with each other, even if their tooth rows are the same length. One of them may hunt only early in the evening whereas the other one may fly out late but hunt throughout the night; in this case they probably hunt different species of insects. Similarly, one species may hunt only sitting prey and the other one flying prey. Various heights and other characteristics of flight may also reduce competition between two species considerably, even though TAMSITT's index does point to its remarkable severity. In consequence I must associate myself with Simpson's (1964) censure of similar methods applied in studies of food competition in birds.

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STRESZCZENIE

Porównywano stosunki długości górnych rzędów zębów u europejskich nietoperzy. Do każdego porównania brano pary gatunków należących do tego samego rodzaju. Porównywano gatunki najbliższe sobie pod względem długości górnych rzędów zębów. W innej grupie porównań przekakiwano co drugi gatunek a w następnej grupie brano co trzeci gatunek. Otrzymane wyniki bardzo były podobne do tych, jakie otrzymał TAMSITT (1967) dla tropikalnych nietoperzy w Kolumbii. Wynika stąd, że — wbrew wnioskowi TAMSITTA — powyższych stosunków nie można uważać za wskaźnik ostrości konkurencji pokarmowej, jeśli przyjąć, że konkurencja ta jest w tropikach ostrzejsza, niż w klimacie umiarkowanym.

РЕЗЮМЕ

Сравнивались отношения длины верхних рядов зубов у европейских летучих мышей. К каждому сравнению взято по паре различных видов, принадлежащих к одному роду. Сравнивались виды наиболее близкие друг другу в отношении длины верхних рядов зубов. В другой группе сравнений сопоставляли через одного, а в третьей взято каждый третий вид. Полученные итоги были очень похожи к тем, которые получил Tamsitt (1967) для тропических летучих мышей в Колумбии. Отсюда следует, что вопреки заключениям Тамистта — выше упомянутых отношений нельзя считать указателем степени кормовой конкуренции, если принять во внимание, что эта конкуренция в тропиках является более резкой, чем в умеренном климате.

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