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# THE NUMBER OF SPECIES PER GENUS IN DIFFERENT ANIMAL CLASSES IN ILLINOIS

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The practice among descriptive zoologists of comparing concepts of taxa in their specific group with the concepts of their fellow taxonomists working on other groups is probably of some value. This practice encourages an interchange of ideas, increases the specialist's familiarity with animal groups outside his principal field of interest, and exerts a stabilizing influence on systematics as a whole. One of the more frequent comparisons made between groups is the relative size of genera (number of species included). Since the genus is a subjective category, the specialist who works with organisms having extremely large genera may be critical of the specialist in another animal group who assigns generic rank to smaller assemblages of species. Obviously, the criteria for erecting and recognizing genera vary in different kinds of organisms, and no absolute uniformity of generic concepts is possible. It is generally recognized, however, that the designation of too many small and monotypic genera indicates excessive generic splitting and thus tends to destroy the usefulness of the taxon.

To determine the degree of difference in relative size of the genus in different groups of animals, the number of species known to occur in Illinois has been divided by the number of genera represented:

$$\frac{\text{number of species in Illinois}}{\text{number of genera in Illinois}} = \text{mean number of species per genus}$$

The quotient is the average number of species per genus for each group. This formula has been applied to those animal groups of Illinois that have been recently surveyed.

For each of the vertebrate classes, the number of species occurring in Illinois is known within narrow limits of error, but the number of genera varies somewhat with the personal attitudes of different specialists. For each of the invertebrate classes, both the number of species and the number of genera are incomplete inasmuch as they are based on the few groups which have been well studied in Illinois. Moreover, although some of the studies are recent, others are old enough to contain genera that have since been subdivided. Thus, the averages obtained are not absolute, but they do provide a fairly reliable indication and an index for comparison of relative size of genera. For both vertebrate and invertebrate classes, it should be emphasized that the values obtained are comparable only to those computed for another geographic area of similar size and not to values derived for the fauna

TABLE 1.—Average Size of the Genus in Ten Animal Classes in Illinois.

| Class | Species / Genera | Mean | Coverage |
|---|---|---|---|
| Mammalia | 59 / 42 | 1.4 | complete |
| Aves | 262 / 166 | 1.5 | Complete (Smith and Parmalee, 1955) |
| Reptilia | 58 / 36 | 1.6 | complete |
| Amphibia | 35 / 16 | 2.2 | complete |
| Osteichthyes | 157 / 69 | 2.2 | complete |
| Cyclostomata | 5 / 3 | 1.6 | complete |
| Insecta | 2367 / 584 | 4.0 | representative families among nine orders (Table 2) |
| Arachnida | 372 / 174 | 3.0 | spiders (Kaston, 1955) and pseudoscorpions (Hoff, 1949) |
| Crustacea | 47 / 17 | 2.7 | ostracods (Hoff, 1942) and decapods |
| Gastropoda | 91 / 32 | 2.8 | slugs and land snails (Baker, 1939) |

of an entire country or continent.

For information on those groups with which I am least familiar (the plants, invertebrate classes, and the birds), I have relied on the publications cited and the unpublished estimates of the following specialists: L. K. Gloyd, T. E. Moore, H. H. Ross, M. W. Sanderson, R. B. Selander, and L. J. Stannard.

The general impression among taxonomists that vertebrate groups tend to have smaller genera than do groups of invertebrates and that insects outrank other kinds of animals in average number of species per genus is substantiated by the means shown in Table 1. There is not,

however, the degree of difference suggested by a comparison of the total number of species in each of these groups or by a comparison of their maximum-sized genera. The ten indices fall within fairly narrow limits, and no one value is conspicuously out of alignment with the others. The general agreement of these averages indicates a remarkable uniformity of generic concepts among zoologists. It is equally noteworthy that the 2,200 species of ferns and flowering plants known in Illinois (Jones, 1950) average 3.0 species per genus, perhaps reflecting a uniformity among biologists in general.

## Factors Regulating Average Size of Genus

The average size of the genus appears to be governed by a combination of factors. A conceivable correlation is that the number of species per genus is influenced by the general habits of the type of animal or its ability to utilize diverse habitats. If such a correlation exists, predominantly terrestrial organisms could be expected to have a greater variety of niches available for occupation than animals restricted to an aquatic environment, and the lampreys, which are mostly fish parasites with little host specificity, would have the least variety of available habitats. An examination of the mean values in Table 1 does not bear out this assumption. The higher vertebrates and terrestrial arthropods have a general ecological similarity, but they show little relationship to each other in average size of their genera.

The average number of species per genus would seem to be related to the degree of taxonomic refinement in the various groups, and the well-studied animals do appear to have smaller genera. Because of their size, the larger classes have not received the detailed attention and amount of time that have been devoted to the smaller classes, and it is reasonable to expect that poorly studied animals might have numerous, large "catch all" genera and some species which would ultimately be reduced to subspecific rank. In actual practice, however, the average number of species per genus, at least among the fishes, amphibians, and reptiles known in Illinois, has not decreased appreciably as their taxonomy became more refined.

The average size of the genus shows a general correlation with the total number of species within a prescribed geographic area. Thus, the two groups with the greatest and next greatest number of species (insects and arachnids) also exhibit first and second place rank in average number of species per genus. In the remaining eight classes, however, the total number of species in the class shows little relationship with average size of the genus, and number of species thus appears to be no more than a minor contributing factor to average genus-size.

An inverse correlation between average size of the genus and the size of the individual organism is indicated. The average size of the individuals in the invertebrate classes is appreciably smaller than that of the vertebrate animals. Conversely, average genus-size is greater among the invertebrates than among the vertebrates. The extremes in average body size among the ten

TABLE 2.—A Comparison of the Average Size of the Genus in the Amphibia and Reptilia.

| | Amphibia | | Reptilia | |
|---|---|---|---|---|
| | Species / Genera | Mean | Species / Genera | Mean |
| Canada | 37 / 19 | 1.9 | 40 / 20 | 1.5 |
| United States | 142 / 38 | 3.7 | 236 / 88 | 2.6 |
| Mexico | 224 / 44 | 5.0 | 653 / 147 | 4.4 |

Data from the official check-lists of Logier and Toner, 1955; Schmidt, 1953; and Smith and Taylor, 1945, 1948, and 1950.

classes in Table 1 are represented by the mammals and, probably, the insects. These two classes also exhibit extremes in average number of species per genus. A given geographic area can support more small than large animals, inasmuch as the size of the individual shows at least a general relationship with the size of the niche, the home range, and the territory. It is probable that a given area contains a greater variety, as well as a greater number, of niches for organisms of small size than for large animals, and the area should support more and larger assemblages of related species as well as more individuals if organisms are small than if they are large.

The average size of the genus within a small geographic area seems to be primarily contingent upon the evolutionary and ecological success of the group of organisms in the region. Thus, in the so-called "headquarters" of an animal group not only are there more species and genera represented, but the average number of species per genus is also greater than in peripheral areas. This is illustrated in Table 2 by data for the classes Amphibia and Reptilia, both of which are, generally speaking, tropical groups.

In certain instances a class may not have one geographic area that can be recognized with certainty as the principal headquarters of the group, but within orders or families one or more such geographical centers may be discernible. If two centers are present a geographically intermediate locality is thus peripheral to both headquarters areas. Assuming that both headquarters have some genera in common, the group at the intermediate locality should have a higher species per genus aver-

TABLE 3.—A Comparison of Average Size of the Genus in Nine Orders of Insects in Illinois.

| Order | Species / Genera | Mean | Coverage |
|---|---|---|---|
| Orthoptera | 179 / 79 | 2.2 | complete (Hebard, 1934) |
| Coleoptera | 75 / 32 | 2.3 | Meloidae and four subfamilies of Chrysomelidae |
| Plecoptera | 49 / 19 | 2.4 | complete (Frison, 1942) |
| Odonata | 104 / 40 | 2.6 | complete |
| Thysanoptera | 172 / 62 | 2.7 | complete |
| Trichoptera | 265 / 77 | 3.4 | complete (Ross, 1944) |
| Ephemeroptera | 124 / 30 | 4.1 | complete (Burks, 1953) |
| Heteroptera | 325 / 72 | 4.5 | Miridae (Knight, 1941) |
| Homoptera | 1074 / 173 | 6.2 | Aphidae (Hottes and Frison, 1931), Cercopidae, and Cicadellidae (DeLong, 1948, and Ross, pers. comm.) |

age than a group at a locality marginal to only one center. Theoretically, an unusually high ratio then would indicate that the area in question is more or less centrally located in relation to the group headquarters; a slightly smaller value would suggest that the region studied is a slight distance from the center or that it is within the area of overlap of two separate centers; and a very small ratio would indicate that the area studied is on the periphery of a single headquarters region. The existence of two or more headquarters within some animal groups is virtually certain in nature as well as in theory.

## THE CLASS INSECTA

Although the average number of species per genus of insects is based

on data from only a small fraction of the insect fauna of Illinois and is therefore subject to revision, it is of interest to tabulate the total genera, species, and means for each of the few orders represented. This information is summarized in Table 3.

The general relationships of these orders to one another, as indicated by the sequence in Table 3, are probably reliable, but data for two groups require qualification as they may not be representative of their respective orders in Illinois. The ratio for the Coleoptera, based on one predominantly western family and on only four subfamilies of a more typically Illinois family, may be too low. The ratio for the Homoptera, based on three families one of which (Cicadellidae) includes the exceptionally large genus *Erythroneura*, may be unduly high. With these possible sources of error in mind, the values for the various orders may be scrutinized in light of the factors discussed in the preceding pages.

The general habits of the groups and the degree of taxonomic refinement probably have negligible effects on the average size of the genus within the class Insecta. For example, it may be seen in Table 3 that the Orthoptera and Homoptera are distinctly unlike in average generic size, although both contain plant-eating insects with complete metamorphosis, terrestrial habits, and other ecological similarities. Similarly, it is apparent in Table 3 that the average size of the genus is not related to the degree of coverage or the publication date of the study cited. Average body size and total number of species in the different orders are probably related to average size of the genus, but neither is directly correlated with the various ratios. Disregarding the problematical data for the Coleoptera and examining the means in relation to the headquarters areas of the various groups, we can account for the relatively low values for the Orthoptera, Plecoptera, Odonata, and Thysanoptera by assuming that these groups flourish with greater success somewhere outside of Illinois. The Orthoptera could, in fact, be regarded as primarily a southern and western order, the Plecoptera as a boreal and eastern group, and the Odonata and Thysanoptera as predominantly tropical groups. At the other extreme, we would deduce that the Homoptera, Heteroptera, and Ephemeroptera are near their optimal environment in Illinois; although values for these orders in other regions are not available for comparison, their means in Illinois are above the mean for the class Insecta. The caddisflies have an intermediate ratio which would suggest either that Illinois is not on the extreme periphery of optimal environment for caddisflies or that Illinois is situated in a zone of overlap of two or more different caddisfly faunas.

Of the five factors which appear to influence the relative size of the genus, data provided by the insects suggest that for categories below the rank of class the order of importance is: 1) spatial relation of the area studied to the group headquarters; 2) average body size of individuals in the group; 3) total number of species in the area studied; 4) degree of taxonomic refinement in the group; and 5) habits of the

group or diversity of habitats available.

## Summary

The genus is a subjective taxon but it is regulated by fairly uniform concepts among biologists. In 10 animal classes studied in Illinois, its average size varies from 1.4 species (mammals) to 4.0 (insects); the ferns and flowering plants in Illinois average 3.0. In general, vertebrate classes tend to have smaller genera than do invertebrate groups. The most probable factors affecting average size of the genus are: 1) spatial relation of the area studied to the geographic center of success for the group; 2) average body size of the organisms within the group; 3) total number of species represented in the area studied; 4) degree of taxonomic refinement in the group; and 5) habits of the group of animals or the diversity of habitats the component species may occupy. The relative importance of these factors may vary from group to group. An analysis of nine orders of the class Insecta indicates that for categories below the class, the factors rank in importance in the order given.

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