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Fewer species of animals on Earth

Some scientists claim that there are between 30 and 100 million species, but that number is probably too high according to the NINA-researcher Frode Ødegaard's Ph.D. thesis at the Norwegian University of Science and Technology NTNU. Probably, there are not more than 5 million species of animals on Earth.

The Smithsonian Tropical Research Institute (STRI) has erected a construction crane in the Metropolitan national park of Panama. The crane is 42 m tall and has a horizontal boom of 51 m, thus, it facilitates the study of approximately 0.8 ha of tropical forest. The crane provides access to the outer branches of all levels of the forest, allowing species to be studied in their natural habitats. Photo: STRI

The study is based on arthropods (e.g. insects, spiders and crustaceans) which make up more than 90% of the animal species on Earth. One method for assessing the number of arthropod species in an area is based on measurement of the species specificity to host plants.

This method has been the basis for assuming 30 million species of arthropods on Earth. The main aim of Ødegaard's doctoral thesis has been to revise this estimate and to provide new data for improving the certainty of such estimates.

Fieldwork in the canopy

Fieldwork involved an investigation of 50 species of trees and lianas in a tropical forest in Panama. The purpose was to assess how many beetle species feed on the different plant species and how many plant species each beetle species feeds on in order to elucidate the host specificity of the beetle fauna. The work was carried out from a canopy-crane that is permanently situated in the forest.

The study has shown that tropical insects are less specific to their host plants than earlier expected, and that lianas are very important host plants for tropical insects.

Five million

A revised version of the estimate of the number of arthropod species on Earth derived from this work indicates ca. 5 million species, a result in agreement with other independent methods of estimation. However, the host-specificity-based method is still attended with high level of uncertainty.

Lianas as host plants for insects have hitherto received little attention by scientists. More than 70 species of beetle appeared to specialize on scraping the tendrils of lianas. This feeding method was not previously known. Photo: STRI

One of the ca. 750 undescribed beetle species collected in the canopies in Panama is this weevil belonging to the genus Achia. Photo: FRODE ØDEGAARD

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750 species new to science

Phytophagous beetles of the families jewel beetles, long horns, leaf beetles and weevils were studied. A total of 35,479 individuals belonging to 1167 species were collected. Of these, host associations were found for 697 species. Fewer than 35% of the species belonged to described species i.e. about 750 species were new to science. This high proportion of new species is normal for samples collected in tropical canopies.

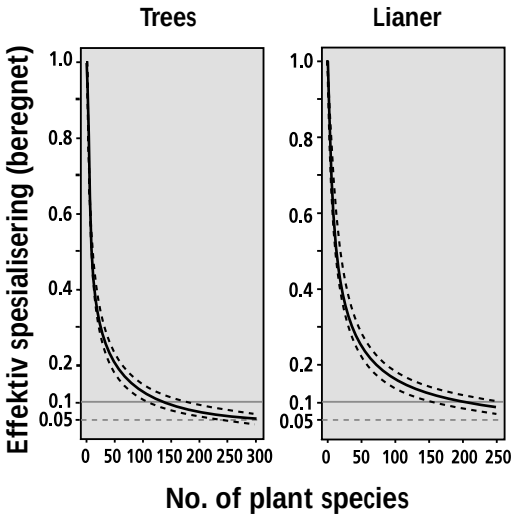
Beetles and their host plants

The American entomologist Terry Erwin estimated about 30 million species of arthropods on Earth in 1982, based on samples of 1200 beetle species collected in the canopy of one tropical tree species in Panama. To make this assessment, he utilized an estimate of the insects' specificity to their host plant. Host specificity means the proportion of insect species feeding on a plant species that feed exclusively on that plant species. Erwin assessed that 20% of the species were host specific. This is one of the most critical assumptions of the calculation.

New mathematical method

The results in Ødegaard's thesis show that the magnitude of host specificity is dependent on the potential number host plant species. The tropical forest in Panama, where the study was carried out, consists of between 300 and 550 species of trees and lianas. Host specificity of beetles was estimated to be 7-10%, less than half of that assumed by Erwin.

These calculations are based on a new mathematical model for estimating host specificity in local communities of phytophagous insects. The method enables one to estimate the host specificity for the community as a function of the number of potential host-plant species.



Estimated host specificity as a function of the number of plant species in the forest. Host specificity is expressed as an index where the most specialized species, the monophagous, have host specificity equal to 1 (100%). A polyphagous species that feeds on all plant species would have a host specificity equal to 0. The figure shows that species associated with lianas are more specialized than those associated with trees. If the forest consists of 300 species of trees and 250 species of lianas, host specificity for beetles associated with trees and lianas would be 6% and 9%, respectively. The uncertainty is indicated by the dotted lines as 95% confidence belts.

Lianas of great importance

A comparative study of the relative importance of trees and lianas as hosts for phytophagous beetles is presented in the thesis. A total of 26 liana species and 24 tree species were compared with regard to host specialization and to the number of species of phytophagous beetles. A total of 1,339 host associations of 424 beetle species were determined for trees, while 1,222 host associations of 441 beetle species were determined for lianas. On average 55.8 ± 6.8 beetle species were found associated with each tree species, while the comparable number for lianas was 47.0 ± 6.1.

Phytophagous beetles associated with lianas were significantly more specialized than the tree associates (figure), a phenomenon mostly due to a higher degree of specialization among the species feeding on green plant parts of lianas. Particularly many species were feeding on the tendrils of lianas (Photo page 1, down to the left).

The results show that lianas are at least as important as trees for the maintenance of local species richness of phytophagous beetles in this forest.

The number of arthropod species

The growing number of studies of tropical arthropods has provided data that served as a basis for the improvement of Erwin's estimate. The structure of some of the steps of the estimate has been altered somewhat to utilize the existing data in the best way. Some steps are also added. For instance, the species associated with lianas were not considered originally. To correct for differences in host specificity at different spatial and temporal scales, a correction factor was utilized. Estimates of 30-100 million species on Earth depend heavily on estimates of host specificity. There are no empirical data to support the figure. The revised version of the estimate indicates a tropical arthropod species richness of ca. 5 million species. However, there are still great uncertainties attended with the estimate. On the other hand, the result compares nicely with estimates derived from other estimation methods, a fact that strengthens the certainty of the revised estimate. If we ever are to work out the real number of species, we are totally dependent on the application of independent estimation methods.

Source of information

Frode Ødegaard, NINA:

«Host specificity as a parameter in estimates of arthropod species richness.»

Doctor dissertation at Norwegian University of Science and Technology NTNU, Trondheim 1999.

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