Picky Eaters Rare Among Tropical Insects:
High Biodiversity Estimates Down for the Count

The long-held belief that more than ten percent of tropical insect species feed on a specific plant host is revised by a team of researchers led by Vojtech Novotny of the Czech Academy of Sciences and Biological Faculty, University of South Bohemia. The team, including Scott Miller from the Smithsonian’s National Museum of Natural History and Yves Basset, at the Smithsonian Tropical Research Institute, report findings from six years of research in Papua New Guinea in the April 25, 2002 edition of the journal Nature. Previous estimates of global biodiversity may be as much as ten times too high because closely related plants tend to share insect herbivores.

Early in the 1980s, Terry Erwin of the Smithsonian’s National Museum of Natural History (NMNH) gathered data on tropical forest insects by fogging trees with insecticide and collecting the specimens that fell from the canopy. According to Erwin: “Peter Raven, Missouri Botanical Gardens director, asked me how many insect species were in one acre of tropical forest. I said I would get back to him. Using my data from trees fogged in Panama in 1974, I calculated about 46,000 insects per hectare. But then I had another idea.” Erwin’s idea, to estimate the total number of insect species worldwide based on a chain of field-testable hypotheses, was the pistol shot that started the race to understand global biodiversity.

Erwin established a high-end estimate of 30 million insect species on Earth, based on 955 species of beetles collected by fogging 19 individuals of a single tree species in Panama. He used a guestimate that 13.5% of the beetles were monophagous, that is, they depend upon one tree species for survival and multiplied the estimated total number of herbivores by the estimated number of total tree species. He then added in the fungivores, predators and other insects to arrive at the 30 million total. Erwin concluded his one-page publication by stating: “I would hope that someone will challenge these figures with more data.”
Scott Miller, NMNH insect taxonomist, remarked: “It is amazing how few of the original assumptions have been tested in the last 20 years, despite a great number of general papers discussing the overall numbers.” The work published this week in *Nature* estimates 3.7 to 5.9 million insects, much closer to estimates based on total numbers of insects represented in regional collections. The PNG study found very few species of moths, butterflies, beetles or grasshoppers and their relatives restricted to a single host plant species, but instead, so-called specialized species ranged across a plant genus.

The study emphasizes host-herbivore relationships with respect to phylogenetic relationships between host plants. Closely related tree species share around 50% of their insect herbivores. Large, speciose genera supported more distinct herbivore communities than did smaller genera. Even distantly related plant hosts shared up to a third of their leaf-feeding insects. Because species-rich genera dominate extremely biodiverse tropical forests, the group postulates that specialist herbivores are probably rare. Therefore, they regard genera rather than species as the preferred unit to use in biodiversity calculations and choose to multiply the numbers of insects collected per tree by the estimated total number of genera in New Guinea, rather than by total number of tree species to arrive at the grand total.

Between one and two million insects have been identified to date (funding for a complete catalog to summarize information from collections worldwide is lacking). Only about 10,000 are added each year. At this rate, it will take another 200-400 years to identify the rest (assuming their habitat is not destroyed in the meantime).

In order to understand life on this planet, there is an urgent need to speed up the process of identification. Miller, who develops databases for big collections, said: “If you can create and maintain a phone book for New York City, you can catalog five million insects. But the fieldwork involved in verifying even the most basic assumptions about the role that insects play in the forest is a Herculean task.” This team, who began their work in PNG six years ago, put in 1000 person-days to collect the biggest data set of its kind to date: 50,734 leaf-chewing insects, representing more than 900 species from 51 plant species, *by hand*. This is the largest data set on host-herbivore interactions currently available.

“We collected from the canopy level down to the forest floor over an entire year, and fed living insects with leaves from the plants where they were found. This way, we were sure which insects actually feed on a given species over time,” commented Yves Basset, currently Tupper Fellow at the Smithsonian Tropical Research Institute (STRI) in Panama. The participation of
parabiologists, local residents in New Guinea who collected and photographed insects and entered data into a computerized database, is crucial for obtaining the extensive data necessary for the analysis of complex rainforest ecosystems.

For more information about Smithsonian work in New Guinea, see [www.nmnh.si.edu/new_guinea](http://www.nmnh.si.edu/new_guinea).

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