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TROPICAL FORESTS: THEIR RICHNESS IN COLEOPTERA AND OTHER ARTHROPOD SPECIES

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ABSTRACT

Extrapolation from data about canopy insects collected by fogging methods together with estimates of tropical plant host specificity indicate that one hectare of unrich seasonal forest in Panama may have in excess of 41,000 species of arthropods. Further extrapolation of available data based on known relative richness of insect Orders and canopy richness leads to the conclusion that current estimates of Arthropod species numbers are grossly underestimated; that there could be as many as 30 million species extant globally, not 1.5 million as usually estimated.

Since the early days of naturalists, there has been the question of how many species there were in the forests of the tropics. Bates (1892) wrote of collecting more than 700 species of butterflies within an hour's walk of his home in Para, Brazil. Many have guessed that the arthropod fauna of the world today contains between 1.5 to 10 million species. No hard data are available however, and these estimates are less than reliable and as a result misleading. In a recent paper, Erwin and Scott (1980) provided the first hard data with regard to the Coleoptera fauna of a single species of tree in the tropical seasonal forest of Panama. Also recently, Peter Raven of the Missouri Botanical Gardens wrote me with the same inquiry that Bates had pondered—"How many species are there in one acre of rich tropical forest?" With the hard data available from the Panama study, I set out to give as close an estimate as possible and was shocked by my conclusions.

The tropical tree *Luehea seemannii* is a medium-sized seasonal forest evergreen tree with open canopy, large and wide-spaced leaves. The trees sampled (n = 19) had few epiphytes or lianas generally, certainly not the epiphytic load normally thought of as being rich. These 19 trees over a three season sampling regime produced 955+ species of beetles, excluding weevils. In other samples now being processed from Brazil, there are as many weevils as leaf-beetles, usually more, so I added 206 (weevils) to the *Luehea* count and rounded to 1,200 for convenience. There can be as many as 245 species of trees in one hectare of rich forest in the tropics, often some of these in the same genus. Usually there are between 40 to 100 species and/or genera, so I used 70 as an average number of genus-group trees where host-specificity might play a role with regard to arthropods. No data are available with which to judge the proportion of host-specific arthropods per trophic group anywhere, let alone the tropics. So conservatively, I allowed 20% of the *Luehea* herbivorous beetles to be host-specific (i.e., must use this tree species in some way for successful reproduction), 5% of the predators (i.e., are tied to one or more of the host-specific herbivores), 10% of the fungivores (i.e., are tied to fungus associated only with this tree), and 5% of the scavengers (i.e., are associated in some way with only the tree or with the other three trophic groups) (Table 1).

Table 1. Numbers of host-specific species per trophic group on *Luehea seemannii* (Figures from Erwin and Scott, 1980).

Trophic group	# Species	% Host-specific (estimated)	# Host-specific (estimated)
Herbivores	682	20%	136.4
Predatores	296	5%	14.8
Fungivores	69	10%	6.9
Scavengers	96	5%	4.8
	1,200+		162.9

Therefore, *Luehea* carries an estimated load of 163 species of host-specific beetles, a rather conservative estimate of 13.5%. I regard the other 86.5% as transient species, merely resting or flying through *Luehea* trees. If one hectare has 70 such genereic-group tree species, there are 11,410 host-specific species of beetles per hectare, plus the remaining 1,038 species of transient beetles, for a total of 12,448 species of beetles per hectare of tropical forest *canopy.*

Beetles make up an estimated 40% of all Arthropod species, therefore there are 31,120 species of Arthropods in the canopy of one hectare of tropical forest. Based on my own observation, I believe the canopy fauna to be at least twice as rich as the forest floor and composed of a different set of species for the most part, so I added ⅓ more to the canopy figure to arrive at a grand total of *41,389 species per hectare* of scrubby seasonal forest in Panama! What will there be in a rich forest? I would hope someone will challenge these figures with more data.

It should be noted that there are an estimated 50,000 species of tropical trees (R. Howard, via R. Eyde, pers. comm.). I suggested elsewhere (Erwin and Adis 1981) that tropical forest insect species, for the most part, are not highly vagile and have small distributions. If this is so, and using the same formula as above starting with 162 host-specific beetles/tree species then there are perhaps as many as *30,000,000* species of tropical arthropods, *not* 1.5 million!

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