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Rainforests at risk from altered ant ecology
 28 March 2003 15:00 GMT

by *William F. Laurance*



[Caption]

The contrasting activities of a vast array of ant species are central to rainforest ecology, but worrying data from research groups in Brazil and Germany suggest that the balance is under threat.

Ants are extraordinarily diverse in tropical forests, as evidenced by biologist E. O. Wilson's famous discovery that a single Amazonian tree contained more species of ant than occur in all of Great Britain. In rainforests, ants play many ecological roles, but perhaps none are more important than those of army ants and leaf-cutting ants. Unfortunately, as revealed by recent studies presented at the Tropical Ecology Society meeting in Rostock, Germany (19-22 February 2003), both groups are seriously affected by forest fragmentation.

Leaf-cutting ants are unique among non-human animals in being true farmers, cutting and harvesting leaves that they use to cultivate a specific, coevolved garden fungus. For the leafcutters, the fungus provides food and decomposes many defensive compounds (e.g. terpenoids, phenols, and alkaloids) in leaves, markedly increasing their potential dietary diversity.

Leafcutters normally occur at low densities in rainforests, but their populations can explode in agricultural lands where they kill or damage young cultivated trees and other crops. The ants also increase sharply on small (<10 hectares) land-bridge islands in Venezuela and along the margins of Amazonian forest remnants, suggesting that they can achieve atypically high densities in fragmented forests.

Studies led by Ranier Wirth and his graduate student Pille Urbas of Kaiserslautern University in Germany, and by Inara Leal of the Federal University of Pernambuco in Brazil, reveal that fragmented forests at Usina Serra Grande in Brazil's highly degraded Atlantic coastal region also have exceptionally high leafcutter densities. The

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 William F. Laurance, George Powell and Lara Hansen
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David M. Wilkinson
 The fungus-growing leaf-cutter ants (Attini: Formicidae) are well known from textbooks and television programmes^{1,2}, and from field experience for some lucky biologists. The Attini are an American group comprising around...
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authors studied forest fragments ranging from 500-3500 hectares (1 hectare = 2.5 acres) in areas that were surrounded by sugarcane plantations, and found that smaller fragments and fragment margins had nearly six times more leafcutter colonies than did forest interiors.

The authors suggest that both top-down and bottom-up processes could account for the super-abundance of leafcutters. As a result of microclimatic stresses and increased windthrow, the margins of forest fragments suffer chronically elevated tree mortality, leading to a proliferation of young 'pioneer' trees. These pioneers are favored by leafcutters because their leaves are often palatable and poorly defended against herbivore attack.

Urbas and colleagues found that colonies near fragment edges had much shorter foraging trails than those in forest interiors, indicating that they traveled less to find suitable food plants, and the diversity of their food plants was lower near edges, suggesting that the ants focused on a few superabundant pioneer species. The ants also occasionally fed on sugarcane in fields adjoining the fragments. Thus, bottom-up processes (greater food availability) clearly influenced the leafcutters in these fragmented forests.

The evidence for top-down control of leafcutters, by predators or parasites, is less compelling at present, although field experiments are still preliminary.

Regardless of the ecological mechanisms involved, the superabundance of leafcutters could have serious repercussions. By attacking and perhaps killing many pioneer trees near fragment edges, leafcutters may exacerbate the already-high rates of tree turnover in forest fragments, which affect forest structure and rates of nutrient cycling. The abundances of ecologically linked predator, prey, and parasite species are also likely to change in response to elevated leafcutter densities.

Of the countless number of tropical ant species, perhaps the most ecologically important of all are army ants. They are comprised by taxonomically diverse species that have converged ecologically to forage in large marauding swarms that attack any live animal they encounter. In the degraded Kakamega Forest of western Kenya, graduate student Marcell Peters and his advisor Manfred Kramer at the Alexander Koenig Research Institute in Bonn, Germany are studying the effects of rainforest fragmentation on the dominant army-ant species in east Africa, *Dorylus molestus*, whose massive swarms can involve up to ten million workers.

Army ants are believed to decline rapidly in Amazonian forest fragments, and Peters and Kraemer's results confirm these trends in east Africa. In forest fragments ranging from 100-1500 hectares in area, *D. molestus* colonies were less than half as abundant as in intact forest. The reasons

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Terborgh, J. et al. (2001)
Science 294, 1923-1926.

for their reduced numbers are still unclear, but it is known that *D. molestus* rarely use agricultural fields surrounding fragments and may therefore suffer from the deleterious effects of population isolation in fragmented forests.

The decline of army ants could have large ecological reverberations. Their random foraging raids are thought to help maintain the remarkable diversity of rainforest invertebrates by creating areas of different species make-up and by preventing the dominance of forests by a few highly competitive species. Peters and Kraemer are currently sampling leaf-litter invertebrates to determine whether forest fragments are in fact more species poor than intact forests.

Army ants also sustain other species, such as specialized insectivorous birds that follow the marauding swarms in order to capture fleeing insects. Peters and Kraemer found that certain bird species, including ant-thrushes, greenbills, bristlebills, and illadopsis, show strong associations with ant swarms and thus are likely to be vulnerable should the ants disappear. In the Amazon, specialized ant-following birds vanish from most smaller (<100 hectares) forest fragments.

Collectively, these new studies suggest that two of the most ecologically important ant groups in the tropics are strongly affected - albeit in opposite ways - by habitat fragmentation, with leafcutters increasing and army ants declining in isolated forest remnants. In both cases, the trends appear similar across different continents or regions, suggesting that the observed changes are general in nature. The disruption of keystone ant assemblages and resulting ecological upsets reveal just how pervasive are the effects of habitat fragmentation on complex tropical rainforests.

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An army-ant column crossing a road in Gabon, central Africa (photo: William F. Laurance)

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