Tropical ecology

Long-term rainforest studies

from Jared M. Diamond

MOST biologists have their permanent homes in the temperate zones. The most species-rich biological communities are in the tropics, the rainforests of which are often described by stereotypes such as 'seasonally constant' and 'complex'. Dr. Harry Bell of the University of New England in Armidale, Australia is responsible for one of the few uninterrupted and intensive ecological studies by biologists resident in the tropics and his recent papers provide a wealth of quantitative information for tropical bird communities of New Guinea.

Following a series of studies that began in 1964, Bell devoted 1975–1978 to a census of the 165 bird species on a 2.5 hectare plot of rainforest[1,2] and on a nearby 1-km transect across savanna[3]. He estimated the diet, body weight, population density, vertical distribution, and the seasonal changes in status of each species.

Although New Guinea is near the equator and 80 per cent of the rainforest bird species show no significant seasonal changes in abundance, their breeding is as markedly seasonal as in the temperate zones, although geared to changes in rainfall rather than day-length[1,3,4]. Most carnivores and omnivores breed in the drier season, before the onset of the heavy rains that would damage their nests[1]. Most ground-feeders breed in the wetter season, when the ground is soft and food more easily extracted[1,4]. The grass warbler *Cisticola exilis* starts calling and displaying within three days of a single rain, and ceases again in a few days if there is no more rain[3].

Compared with temperate-zone birds, those of New Guinea have low nesting success, low recruitment of young, and are long-lived[1,4,5]. Open nests contain only 1.4 eggs on average (4–6 in temperate zones), and an astonishingly high number (88 per cent) of the clutches fail[1]. Of young paradise kingfishers that leave the nest, most disperse, starve and die in their first year without having obtained a territory[4]. Conversely, annual mortality of adults is only 10–20 per cent[5].

Bell estimates there to be 69 birds per hectare, between 3–30 times more than in most temperate-zone forests[1]. Bird biomass is about 5 kg per hectare. Even compared with other tropical areas, New Guinea has a high species diversity and biomass of obligate frugivores (especially, large pigeons and parrots) — probably an evolutionary result of the paucity of fruit-eating mammals on the island.

Some of Bell's observations highlight two under-appreciated factors in habitat selection by rainforest species. First, some insectivores of the dark understory with large eyes refuse to cross even small sunlit paths[1], whereas other species of the forest canopy seem to need strong sunlight. Second, the parrot *Pseudeos fuscata* will never cross a mountain pass through which a stream runs, in its daily commuting of up to 50 km from roosting to feeding sites across the lofty Central Cordillera of New Guinea[1].

Bell's papers abound with examples of the complex interspecies relations for which the tropics are famous. Kingfishers and pygmy parrots excavate their nests in arboreal termite nests[4,6,7]. Different kingfisher species use different-sized nests, and the density of termite nests probably limits kingfisher abundance in second growth[7]. Ground pigeons that swallow pebbles, and thereby can grind up hard seeds in their stomachs, collect seeds defecated or regurgitated intact by frugivorous bird species with weak-walled stomachs[6]. The male and female of the flycatcher *Arses telescophthalmus* are each more similar ecologically to other fly-catcher species than to one another. Compared with the female, the male has longer and more curved claws and a more slender bill, for gleaning insects off understory vertical trunks and vines, whereas the female has a longer tail, wider bill, and more rictal bristles, for catching insects in midair[8].

One of the most interesting examples of group behaviour involves the babbler *Pomatostomus isidori*[1]. This species lives in groups of about eight, which jointly build one nest, roost in the nest, and rear and feed one or two young. They forage together and exchange incessant contact calls and an all-clear 'yahoo' call, with one individual acting as leader and giving a distinctive 'leader call'. The babbler flock is followed by rusty pitohuis (*Pitohui ferrugineus*), and both the babblers and pitohuis are followed by bird species of several other families (including birds of paradise), all of which mimic the babbler's and pitohui's rusty colour, and some of which also mimic the calls.

Until recent decades, tropical ecology was regarded as hopelessly complex, and graduating ecologists were advised to study simpler communities like the desert and the arctic. Bell's papers set new standards for quantitative long-term tropical work and show that rainforest studies are complex and fascinating but not hopeless. □

1. Bell, H.L. *Emu* **82**, 7; 24; 65; 143; 217; 256 (1982).
2. Bell, H.L. *Emu* **84**, 142 (1983).
3. Bell, H.L. *Ibis* **124**, 252 (1982).
4. Bell, H.L. *Corella* **4**, 113 (1980).
5. Bell, H.L. *Corella* **6**, 77 (1982).
6. Bell, H.L. *Aust. Bird Watcher* **10** 209 (1984).
7. Bell, H.L. *Ibis* **123**, 51 (1981).
8. Bell, H.L. *Aust. J. Ecol.* **7**, 137 (1982).

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Biotechnology

Cancer toxin genes cloned

from Karol Sikora

CLINICAL research into cancer treatment badly needs new leads. The major stumbling block is the poor discrimination of systemic agents for common solid tumours. Some immunological mediators are known to have specific anti-tumour effects but the mechanisms involved are poorly understood. Ultimately, it is only through molecular cloning that the individual proteins will be characterized and their functions elucidated. Interferons, the first to be cloned, are now undergoing extensive, if rather disappointing, clinical trials[1]. On page 721 and 724 of this issue the cloning of two other molecules of great clinical potential, lymphotoxin and tumour necrosis factor, is reported[2,3].

The discovery of cancer toxins dates back at least to 1891 when a New York physician, William Coley, began giving patients mixtures of toxins from various bacteria[4]. His rationale was that cancers sometimes regressed in patients after a severe bacterial infection. The dramatic tumour reponses he saw were later reported with evangelical zeal[5] and the whole subject of the anti-tumour effects of bacterial endotoxins heralded in the era of active immunotherapy. But the bacterial products themselves were not found to destroy tumour cells *in vitro*. This paradox was resolved by the discovery that endotoxins, when injected into suitably primed animals, stimulate macrophages to produce a 'tumour necrosis factor' (TNF) that causes haemorrhagic necrosis in tumors[6]. But even before this, tumour immunologists had demonstrated that sensitized lymphocytes could also destroy tumour cells through soluble mediators — the lymphokines, including lymphotoxin (LT)[7].

Antibodies to partially purified TNF and LT provided evidence of structural differences between the two cancer toxins, both of which are able to distinguish between tumour cells and normal cells, and destroy only the former[8,9]. But although an intriguing new pair of selective tumour-destroying agents had been discovered, experimentalists were plagued by their impurity. Batch-to-batch variation, tedious bioassays and the lack of molecular characterization precluded further analysis. Indeed,