change. Similar (and statistically indistinguishable: $\chi^2 = 1.99$, df $= 2$, $P = 0.57$) proportions of respondents thought that publishing for ecologists in general had become either easier or harder. Nevertheless, a scientist's view is still related to their success. Publishing was more likely to be considered harder by respondents who had a smaller proportion of papers accepted without rejection ($\chi^2 = 19.12$, df $= 1$, $P < 0.001$), and a greater proportion of papers submitted multiple times before publication ($\chi^2 = 22.83$, df $= 1$, $P < 0.001$).

## Is rejection fair?

We asked our respondents to comment on why they thought their papers were rejected: poor referee/editorial process, scientific grounds, insufficient importance, or inappropriate subject matter for the journal. Respondents with a higher proportion of papers accepted without rejection were of the opinion that the rejections that they did experience were on scientific grounds, whereas respondents with a lower proportion were more likely to blame poor refereeing or editorial processes ($\chi^2 = 25.07$, df $= 1$, $P < 0.001$). Thus, rejection is still not easily taken among even the most successfully publishing ecologists, and appears to be swallowed with sour grapes.

## Is rejection a handicap?

Apparently not. Rejection does not seem to have deterred our respondents, or to have hampered their career advancement. Ecologists who published more papers had a lower proportion accepted without rejection ($\chi^2 = 50.09$, df $= 1$, $P < 0.001$). Those who are currently full professors have had a lower proportion of papers accepted without rejection than have current lecturers (77% versus 87%: $\chi^2 = 4.76$, df $= 1$, $P = 0.029$), and a higher proportion of papers submitted multiple times before acceptance ($\chi^2 = 4.53$, df $= 1$, $P = 0.033$).

Although our respondents are undoubtedly successful in their field, the evidence suggests that a thick skin is as useful for a scientist as it is for an artist. We hope that this will be a source of solace for young ecologists experiencing rejection for the first time, or the more experienced researcher who is still having trouble coming to terms with it. Scientific peer review is a necessary and well established part of the publication process, but it can also be daunting and disheartening (and it is not free of criticism [1–5]). However, manuscript rejection is not indicative of scientific inadequacy. It is a fact of life for even the most successful of publishing ecologists. The moral seems to be that if at first you don't succeed, try try again.

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# Not so quiet on the high frontier

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**In 1997, *TREE* announced the creation of the International Canopy Crane Network, which would link a set of large construction cranes, erected all over the globe and providing access to a previously poorly known part of terrestrial ecosystems: the forest canopy. What did it all result in? A new booklet published by UNEP summarizes recent findings from the 11 crane sites and draws up visions for future collaboration.**

During the past few decades, ecologists have directed an increasing number of questions towards the forest canopy [1]. Is this where the main part of biodiversity is hiding? What species can be found there, and what roles do they play in the forest? How do the treetops interact with the atmosphere, and how will this affect global climate change? Yet, solid answers have been hard to come by. A main obstacle to answering such questions is for researchers to get up to the forest roof without risking their lives in the process. There are several ingenious solutions, including hauling a construction crane into the forest and hitching a ride with the hook, a method that is now used at 11 sites across the globe.

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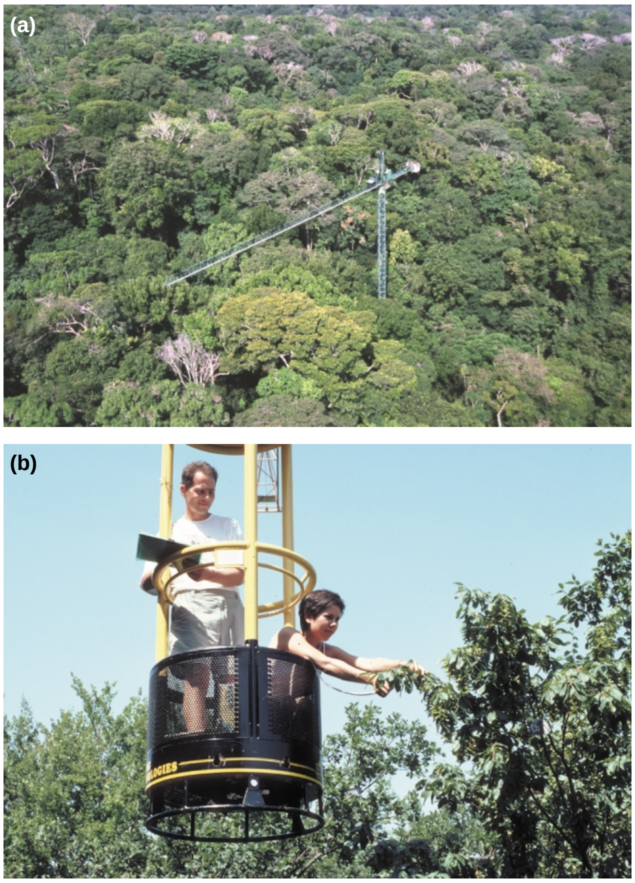

**Fig. 1**. Canopy cranes. (a) The San Lorenzo crane towering over the Panamanian rainforest canopy; (b) The cranes can conveniently be used to take precise measures high up in the tree crowns. Here, Olivier Bignucolo and Sonja Keel measure leaf conductance from the Swiss Canopy Crane. Reproduced with permission from Marcos Guerra (a) and Christian Körner (b).

In 1997, the International Canopy Crane Network (ICCN) was born to promote the exchange of scientists, ideas and expertise [2], allowing for rapid advances in one of the most spectacular and exciting fields of ecology. Six years later, a volume published by the UNEP [3] identifies key scientific findings at each crane facility, and provides a platform for further collaboration.

The cranes are an assorted lot. Some have hardly begun to operate, whilst others are over a decade old and have already generated a wealth of scientific information. In spite of the odd impression that cranes might offer in the midst of forests (Fig. 1a), selected results from four of them identify just why they are so handy.

## The two towers: Panamanian cranes

In 1990, the first canopy crane was constructed in Panama as a brainchild of the late Alan Smith and the Smithsonian Tropical Research Institute. In 1997, it was joined by a twin tower at the other side of the isthmus, and the two have been used to produce an impressive amount of scientific results. Among other things, they have given us a new perspective of the arthropods of the tropical canopy roof. Whereas earlier entomologists were largely confined to fogging tropical tree crowns with insecticides and examining the raindown of corpses, researchers can now examine arthropod behaviour *in situ*. For example, Frode Ødegaard became one of the first researchers to observe what live arboreal insects actually feed upon [4,5]. In contrast to earlier views, his observations suggest that tropical beetles are rather unfaithful to their host tree species. This might lower our perception of global species richness to a tenth of earlier guestimates [4,5].

Later work by Yves Basset and Héctor Barrios has focused on the vertical stratification of arthropods within tropical forests. Whereas adult trees are often assumed to infect their saplings with pest insects, Basset [6] and Barrios [7] showed that trees of different ages share little of their fauna. Hence, cross-infection with insects between parents and seedlings might not explain why conspecific tropical trees tend to be rather sparsely distributed within the forest, as was originally proposed by Janzen [8] and Connell [9].

## Hauling your stuff along: the Swiss canopy crane

One advantage offered by the cranes is the potential to install heavy equipment for manipulative experiments high up in the canopy (Fig. 1b). A Swiss canopy crane, erected in 1999, has already enabled the development of exciting new techniques. In September 2000, scientists working from the crane gondola wove a system of thin tubes into the canopy, exposing 14 adult trees of six different species to augmented $CO_2$ levels [10]. Recent measurements indicate that elevated $CO_2$ enables the leaves to keep their stomata less open for more of the time, thereby reducing their loss of water. However, the exact response varies among species (P.G. Cech *et al.*, unpublished). Global atmospheric change might therefore affect forest stands differently, depending on their species composition. This is an important lesson for future events. It also shows the value of large-scale experiments in mature forest stands. To understand how trees work, we must not treat them as mere collections of leaves, but rather as the large, integrated organisms that they actually are.

## Beyond flowers and bees: the Malaysian crane

It is often difficult to know how flowers in the high canopy are pollinated, and by whom. At Lambir Hills National Park (Malaysia), researchers have used a crane as a base from which to investigate the pollination biology of huge dipterocarp trees, some as tall as 18-storey skyscrapers. These forests are characterized by the spectacular phenomenon of general flowering. At irregular intervals, averaging five years, both dipterocarps and hundreds of other plant species suddenly burst into flower. Just why so many plants adhere to such an irregular flowering regime is an intriguing question. Satiation of predators has often been regarded as a plausible explanation: by simply flooding the forest with fruits, the trees might ensure that some of their offspring survive. Recent research now suggests that the promotion of pollination through increased pollinator activity is a strong selective agent [11]. Giant honeybees migrate into forests as soon as the plants start flowering, and pollinate several plants [12,13]. Species might also take advantage of each other: the wide-spread flowering of one species might increase population densities of generalist insects, which then serve as the primary pollinators of other species [12].

Shoko Sakai is an active researcher at the Lambir Hills and has also worked from the Panamanian cranes, discovering trees pollinated by thrips [14], by flies breeding on decomposing flowers [15] and by gall midges feeding on fungi infecting the flowers [16]. Variations on the flower–bee theme seem endless, and the exploration of them has only just begun.

## The crane that failed – or did it? The Venezuelan crane

One crane has already ceased operation. With its mission complete, we can now calculate the in- and outputs of the Venezuelan crane in both scientific and monetary units. In spite of the massive investment in logistics and material, a scientific paper produced at this site was surprisingly affordable: ~US$13 000 [3]. This cost appears no higher than for most ecological projects, and it will decrease further as manuscripts now in preparation are published. The key is probably in synergy effects: even if the crane facility itself is costly, it is shared by several teams making good use of their joint resource. This should be soothing news for potential funding agencies flinching at the investments needed to set up a crane.

## Prospects

In spite of strong scientific output from existing cranes, it is still premature to think that we have achieved a comprehensive understanding of canopy processes and patterns. The area covered by current cranes is <12 ha. Anyone feeling too comfortable with this might consider the scale of the phenomena under investigation. Probing the canopies of the world from the cranes is equivalent to examining a single grass stem within a soccer field (2 mm$^2$ or $3 \times 10^{-7}$% of the area). Clearly, one should not jump to conclusions based on this representation of the system. There are also large gaps in regional coverage, with Africa still to receive a crane of its own.

Although working from the cranes is certainly convenient, it does have many limitations. In particular, a fixed crane provides access to only a small forest plot (typically <1 ha). To improve on this, sampling at the crane sites could be expanded through supplementary techniques. Such a project is soon to be implemented in Panama. In the autumn of 2003, an international team of 25 entomologists will access the canopy by a variety of methods, including a crane, the Canopy Raft (a movable platform of 400 m$^2$, placed on top of the tree crowns [17]) and the Canopy Bubble (a manned helium balloon that runs along a fixed line set up in the canopy [17,18]). Through these versatile approaches, the entomologists will evaluate where in the forest most of its arthropod species are hiding (*cf.* [19–21]).

Another way to validate the results obtained from individual cranes is to repeat the studies at as many different crane sites as possible. With the maturation of the International Canopy Crane Network, joint programs and techniques will hopefully become a reality. But, although ideas should be validated at a general level, some science is necessarily highly specific. The study of what individual canopy inhabitants actually do and how they interact has only just begun. To obtain such detailed information should be another key objective for future work at the crane sites [3].

By facilitating the access to tree crowns worldwide, the Canopy Crane Network has enabled a major part of terrestrial ecosystems to be studied by a wealth of techniques. This view from above is likely to influence both ecology as a science and the wider society around us. The interim work report by Basset *et al.* [3] shows the scope of what has already been achieved, and the potential for so much more to come.

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Letters

# The resource dispersion hypothesis and the 'future value' of food

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Johnson *et al.* [1] presented a stimulating account of the resource dispersion hypothesis (RDH) and its potential significance for the evolution of group living. The RDH postulates that, if resources are heterogeneously distributed, then the minimum territory size necessary to satisfy a pair of animals will be sufficiently large to sustain secondary animals most of the time, and thus favour group living. Box 3 of Johnson *et al.* lays out the assumptions underlying the RDH. However, we feel that an important assumption underlying both descriptive [2] and mathematical [3] representations of the RDH was missed: the food supply from the territory in one foraging period is independent of the amount of food that was consumed in previous foraging periods.

This assumption is probably unjustified in many cases. Many, if not all, resources are available for more than one foraging period if they are not consumed in the first foraging period. Thus, consumption in one foraging period has consequences for food availability in the next. To cite examples from Johnson *et al.*, fruiting trees, mounds of termites and patches of worms in a meadow would all be expected to last longer than one foraging period, although the food availability from each in a given period will depend on depletion owing to any foraging in previous periods. Even an individual insect, if not consumed, would be expected to have a high probability of being available in multiple foraging periods. For most food resources, increased consumption in one foraging period will reduce the food available in the next.

What sources of food might fit the RDH requirements? A prey patch that is very short lived (e.g. a swarm of mating insects) or a prey animal that passes through the territory (a migrating ungulate, perhaps) might fit. Most others do not. Even prey that occasionally pass through a territory will have some 'future value' to the resident pair if they are likely to return. If most resources are potentially long lived, the RDH as an explanation for group living might be greatly reduced in power. To assume that the presence of secondary animals has no effect on the future availability of food will often be unrealistic because, in many cases, a food item consumed today by a secondary animal would otherwise be available tomorrow to the residents. Often, the presence of additional foragers in a territory will depress the future yield of patches on that territory to the detriment of the resident animals. We argue that considerations of the future value of food sources require reappraisal of the importance of the RDH as a factor explaining the evolution and maintenance of group living.

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