Organismal and natural history oriented research (part II) ; Germination, microsites and frugivores

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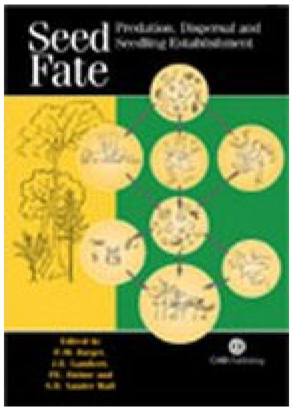

To evaluate the importance of dispersal mutualisms, it is important to know whether regeneration absolutely depends on handling by the frugivore. Frugivores can affect regeration in various ways, including changing the timing and amount of germination, altering the microsites that seeds are deposited in, and changing rates of attack by seed predators or pathogens. In this symposium we hope to review the range of effects on plant germination and establishment that result from the actions of frugivores (or their absence).

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2	Wongsriphuek, C.	Liana seed dispersal by white-handed gibbons (*Hylobates lar*) in the seasonal evergreen forest, Thailand: Dispersal distance, germination rates, and dispersal quality
3	Chapman, H.	Post-dispersal seed removal and seed germination of *Cercopithecus nictitans* dispersed seed in a West African montane forest.
4	Culot, L.	Linking tamarins' behaviour with spatiotemporal pattern of seed dispersal and seedling recruitment
5	Cordeiro, N.	Giant African rats and an endemic tree: dispersal and harvesting pressures
6	D'Arcy, L.	High levels of seed predation for three important primate food species, within the tropical peat swamp forests of Central Kalimantan. A gap in the loop?
7	Robertson, A.	Germination consequences of non-dispersal in fleshy fruited plants

Interannual variability in fruiting affects the diet of frugivores

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The diets of gibbons and other frugivores have been studied on the Mo Singto Forest Dynamics Plot, central Thailand, for many years, and the phenology of a sample of 60 tree species has been studied since 2003. The gibbon diet includes the fruit of at least 105 species of trees and lianas, and leaves of about 50 species. The diet includes about 30 species of high quality "preferred" species, less preferred occasional species, and "fallback" species that are widely available but eaten when preferred species are not available. A six-year record of phenology shows that most of the preferred species have high interannual variability in fruiting, or masting behavior, which is not synchronized among species. An intensive study of feeding and ranging of the gibbons was made during April-May in each year from 2006-2009 to study dietary variability. During year 2006-2008, the top ten species in the diet changed about 50% per year, and half of the species on the lists were present in only one year's list. Gibbons, as well as other frugivores, must constantly change their diet from year to year, which is the reason that gibbons (as well as most other frugivores) are dietary generalists. On the other hand, fruiting plant species may be either dispersal generalists or specialists. Several fruit species depend mostly or entirely on gibbons for dispersal, and appear to have staggered fruiting periods. Gibbons provide dependable and stable dispersal services for these species, regardless of their rarity or the interannual variability.

Liana seed dispersal by white-handed gibbons (*Hylobates lar*) in the seasonal evergreen forest, Thailand: Dispersal distance, germination rates, and dispersal quality

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Seed dispersal is the most important ecological process in a plant's life cycle. Past research provides answers mainly for tree species, ignoring lianas even though they are obviously important structures in forest ecosystems**.** I studied seed dispersal of liana species eaten by White-handed gibbon (*Hylobates lar*). I investigated feeding behaviour of gibbons on trees and lianas during the year 2004, with one year's further monitoring of germination and seedling survival of liana seeds dispersed by gibbon. In this study, gibbons are good potential seed dispersers for some liana species in both quantitative and qualitative aspects—liana fruit formed a significant component of gibbon diet, especially in the cool dry season (Dec-Jan) and seeds were usually dispersed away from fruiting crowns. Liana recruitment is likely to be limited in the dispersal process since gibbons dropped seeds in a relatively small region of the area they use each day. However, early life stage recruitment of lianas is not limited only by gibbon behaviour, but also by fruit production and seed germinability. In addition, this is the first study to highlight the potential importance of lianas during periods of food scarcity for gibbons and probably other animals.

Post-dispersal seed removal and seed germination of *Cercopithecus nictitans* dispersed seed in a West African montane forest.

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Factors that determine the effectiveness of primates as seed dispersers include i) the microsite into which they deposit seed ii) secondary removal of seed by other taxa and iii) the effect of gut passage and/or spitting on subsequent seed germination. This contribution evaluated these factors in the little studied putty-nose monkey, *Cercopithecus nictitans* in a Nigerian montane forest. Field experiments showed that C. *nictitans* has greatly increased in its importance as a disperser of medium-sized seed (>5 mm) because other large primates have been hunted to near extinction. *C. nictitans* disperses seed across habitats through spitting and defecation. Rates of secondary seeds removal were high for all seed species irrespective of the presence or absence of *C. nictitans* faecal matter, size or microsite variables. Gut passage enhanced germination relative to hand-cleaned seed, while spitting had either no effect, or decreased the germination rate.

Linking tamarins' behaviour with spatiotemporal pattern of seed dispersal and seedling recruitment

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The incorporation of animal behaviour data into seed dispersal models can help to better understand the spatiotemporal pattern of seed deposition, and hence the seedling recruitment. Feeding and ranging behaviours of the animal seed disperser are now usually studied while resting behaviour has, until now, attracted little attention. However, the resting sites and their use by seed dispersers could affect the spatial seed deposition: repeatedly used sites are related to repeated defecations and increased seed density. We studied the spatial pattern of seed deposition by analyzing the feeding, ranging and resting behaviours of a mixed-species group of tamarins and monitored the fate of dispersed seeds to compare the seedling recruitment and survival within and outside the resting areas. Tamarins dispersed a high percentage of large seeds involved in later stages of regeneration in the secondary forest when they balanced their time eating a high diversity of fruit species in primary forest and pioneer species in secondary forest. They dispersed significantly more seeds within the resting areas than away of them and the seed density per quadrant (50 x 50 m) increased with the resting time. Feeding, ranging and resting behaviour of tamarins affected the spatial distribution of seeds dispersed in faeces. We assume that resting sites could be potential seedling recruitment centres playing an important role in forest regeneration.

Giant African rats and an endemic tree: dispersal and harvesting pressures

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Non-timber forest products, such as fruits and seeds, are becoming important economic incentives to local human communities, especially in tropical regions. Studies focusing on seed dispersal and on the impacts of harvesting fruits and seeds for local and global markets are numerous for the Neotropical region, whereas native forest trees in Africa have received little to no attention. We here examine the relationship between the Giant pouched rat Cricetomys gambianus and an endemic African tree species. Using a preliminary study, we first show the importance of this rodent species in the dispersal of seeds during peak and low fruiting periods. We then relate these results to comprehensive harvesting data from three different protection regimes in a forest-agriculture landscape in Tanzania.

High levels of seed predation for three important primate food species, within the tropical peat swamp forests of Central Kalimantan. A gap in the loop?

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Throughout the tropics, studies have repeatedly identified the pivotal roles small mammals, play in secondary seed dispersal. In response to this a preliminary study of seed fate, was carried out in the lowland tropical peat swamp forests of Central Kalimantan, Borneo. Three species *Parartocarpus venenosus* (Moraceae), *Tetramerista glabra* (Tetrameristaceae) and *Blumeodendron tokbrai* (Euphorbiaceae), were identified as favoured food trees, by dominant primate species; the Orangutan (*Pongo Pygmaeus*) and Southern bornean gibbon (*Hylobates Albibarbis*). This study was carried out during the dry season creating favourable ground conditions for predation and caching. Vegetation structure around *T. glabra* was measured to identify the effects seed predation, as previous studies shown seedlings aggregation inferring potential caching. Results of a time series analysis showed insect predation rates lagged vertebrate predation rates for *T. glabra* and *B. tokbrai* spp. Previous seed-fate studies found much higher removal rates than *in-situ* predation, however both *In-situ* predation and removal rates were found to be similar. When removal was observed, distances were found to be low (maximum 8.4m), with little evidence of caching. *T. glabra* showed vegetation surrounding the parent tree had no significant impact on seed predation. The low levels of secondary removal found places a further emphasis on primary seed dispersal, or on an unidentified secondary seed dispersal strategy. To date this lack of seed removal and caching differs from findings in other tropical forests, has potential implications for the forests regenerative capabilities, and further suggests tropical peat swamp forests are an unusual or unique forest ecosystem.

Germination consequences of non-dispersal in fleshy fruited plants

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There has been much interest in the consequences for fleshy-fruited plants of dispersal failure. Consumption of fruits by frugivores can affect germination by removal of the fruit flesh (the deinhibition effect) and by other effects on the seed coat (the scarification effect). If frugivores become rare or absent because of human actions such as hunting or habitat clearance, it is important to know whether undispersed fruits can still allow regeneration of the plant. We examined this for the New Zealand flora with field germination trials on 19 woody species, including 16 of the 18 largest-fruited species (with mean fruit diameters 8–21 mm), many at several sites or years. Four conclusions emerged. (1) Germination sometimes failed in particular sites or years, due to environmental factors such as drought or outbreaks of seed predators. (2) There was no consistent difference between hand-cleaned and bird-excreted seeds, showing that the scarification effect was inconsistent and generally small. (3) Final germination percentages were significantly lower for seeds in intact fruits than for cleaned seeds (bird or hand-cleaned), but by such a small amount as to be biologically unimportant (59 vs 66% respectively). (4) Four New Zealand trees have thick endocarps, which has been speculatively linked to protection of the seeds from crushing in the gizzards of now-extinct flightless moa species. We found three of these four plants had low final germination percentages, possibly the first known “anachronistic” dispersal effects of the extinction of moa. However, for most of these woody species the net effects of non-dispersal on germination are small and unlikely to cause regeneration failure.