
Record 101 of 129**Author(s):** Hoshizaki, K; Suzuki, W; Nakashizuka, T**Title:** Evaluation of secondary dispersal in a large-seeded tree *Aesculus turbinata*: a test of directed dispersal**Source:** PLANT ECOLOGY, 144 (2): 167-176 OCT 1999

Abstract: Among the several hypotheses on selective advantage of seed dispersal, the directed dispersal hypothesis explains the advantage of non-random seed transportation by animals to particular patch type suitable for offspring establishment. We tested this hypothesis in dispersal of a large-seeded, rodent-dispersed tree (*Aesculus turbinata*) in a temperate forest. We investigated the change in location of seeds through secondary dispersal, and the survival and growth of seedlings at their destinations. Hemispherical photographs taken at the seed locations both before and after secondary dispersal were used to evaluate the consequence of dispersal. Survival and growth rates of seedlings were measured to evaluate the responses of seedlings to light, the most important factor for seedling establishment in *A. turbinata*. Survival and growth rates of the seedlings were both positively correlated with light conditions, indicating the advantage of dispersal to the microsites with more light available. However, light levels at seed destinations were not significantly different from those at the locations of seeds before secondary dispersal nor those of the surrounding background forest floor. Survival of newly-emerged seedlings varied as a function of light level but not seedling density. This suggests that the effect of density-dependent mortality was small relative to light-dependent mortality during the seedling stage. Therefore we conclude that the directed dispersal hypothesis for this species is rejected, and that the role of rodents in dispersing large seeds secondarily is more important for finding suitable sites merely by enlarging seed shadow (mean dispersal distance = 12.2-44.7 m during the 3 years studied, max. = 41.5-114.5 m) and relatively less important for escaping natural enemies.

ISSN: 1385-0237

Record 102 of 129**Author(s):** Forget, PM; Mercier, F; Collinet, F**Title:** Spatial patterns of two rodent-dispersed rain forest trees *Carapa procera* (Meliaceae) and *Vouacapoua americana* (Caesalpiniaceae) at Paracou, French Guiana**Source:** JOURNAL OF TROPICAL ECOLOGY, 15: 301-313 Part 3 MAY 1999

Abstract: The spatial distribution of two rain forest tree species, *Carapa procera* (Meliaceae) and *Vouacapoua americana* (Caesalpiniaceae) was analysed within and between plots of different sizes (6.25 and 25 ha) at Paracou, French Guiana. The $L(d)$ function was used to characterize spatial patterns, and the $L_{ij}(d)$ intertype to study independency between young and adult trees. Although both species are known to be dispersed by caviomorph rodents within short distances (c. 10-20 m and up to 50 m) of parent tree crowns, the analysis of tree positions led to different spatial patterns between species depending on soil drainage characteristics. Overall, while *V. americana* showed a strongly aggregated spatial distribution, *C. procera* had a weaker propensity to depart from complete spatial randomness (CSR). A complex distribution, sometimes clustered in areas with hydromorphic soils (swamps and around streams) and sometimes very near CSR outside these areas characterized the *C. procera* population. When *C. procera* tree aggregation occurred, there was a slight attraction between juveniles and adults. The aggregation of *V. americana* trees was evidenced at different levels depending on the scale of investigation. Within small plots (6.25 ha), a first level of aggregation with short distance radii of c. 10-25 m giving small clusters, and a second level which is composed of small clusters aggregated at c. 40-50 m distance radius, were observed. A third level of aggregation was suggested by analysing the tree population at the larger scale (25 ha) whose boundaries outside the plot were not delimited. Aggregation of *V. americana* trees at all levels was enhanced by a strong attraction between juveniles and adults. These results were discussed in light of seed and seedling ecology, especially with regard to seedling and sapling gap-dependence and soil drainage, which likely affected the recruitment of juvenile trees, and henceforth final tree spatial pattern.

ISSN: 0266-4674

Record 103 of 129**Author(s):** Ganzhorn, JU; Fietz, J; Rakotovo, E; Schwab, D; Zinner, D**Title:** Lemurs and the regeneration of dry deciduous forest in Madagascar**Source:** CONSERVATION BIOLOGY, 13 (4): 794-804 AUG 1999

Abstract: We sought to assess the role of lemurs for seed dispersal in the dry deciduous forest of western Madagascar and the possible consequences of the demise of lemurs for forest regeneration. Forest regeneration primary forest (1 plot per fragment). In 4 of the 15 study plots, the abundance of saplings was negatively and significantly correlated ($p < 0.05$) with the abundance of mature individuals of the same tree species. In another 10 study plots there were negative correlations, although these were not significant at the community level. Second-order statistics were significant with $p < 0.001$ and indicated that seed dispersal away from the parent trees is important for successful establishment of saplings. Apart from possibly the bush pig (*Potamochoerus larvatus*), only one vertebrate species of the dry forest, the brown lemur (*Eulemur fulvus*), ingested seeds >11 mm long and passed them through its digestive tract unharmed. These results for lemurs were based on direct observations and fecal analyses. To

evaluate the role of *E. fulvus*, we compared regeneration in forest plots with and without *E. fulvus*. In forest fragments without *E. fulvus*, fewer lemur-dispersed tree species regenerated than would be expected based on the presence of mature tree species that are lemur-dispersed ($p < 0.05$). No such effect was seen in primary forests with *E. fulvus* or for trees whose seeds can also be dispersed by other vertebrates. Thus, regeneration of the dry deciduous forest of western Madagascar with the complete set of primary forest tree species seems to depend upon the presence of *E. fulvus*.

ISSN: 0888-8892

Record 104 of 129

Author(s): Hammond, DS; Brown, VK; Zagt, R

Title: Spatial and temporal patterns of seed attack and germination in a large-seeded neotropical tree species

Source: OECOLOGIA, 119 (2): 208-218 MAY 1999

Abstract: It has long been argued that seed dispersal enhances recruitment in tropical trees by allowing offspring to 'escape' strong density/distance-dependent attack by insects, pathogens and rodents. Here we examined the effects of canopy openness and parent-offspring distance upon the frequency and timing of *Chlorocardium rodiei* seed attack and germination within a 15-ha plot of Guyanan tropical rain forest. Seeds were artificially dispersed beneath parent trees, in the understory away from trees and in gaps. Analysing our data from an 85-week period of regular monitoring, we found that the main spatial gradients, canopy openness and distance to nearest adult conspecific, do not lead to differences in the final number of seeds attacked by infesting scolytid beetles or rodents. The timing of beetle attack, however, varied along the distance gradient and this difference affords seeds at further distances a 'window' in which to germinate and produce a seedling before attack. Canopy openness was not a good predictor of rooting success, but distance was strongly associated with root and shoot formation success and the mean time to shoot formation. There was a strong negative effect of distance on the likelihood of a seed being colonised by scolytid beetles prior to removal by rodents and shoot failure was strongly associated with prior infestation. We believe these results bring a key point to bear on the well-established notion of distance-dependent attack on seeds in tropical rainforests, viz. that seed characteristics (size, germination syndrome) and the timing of attack may be more important in explaining patterns of early seedling recruitment than distance. Our studies suggest that advantages accrued through dispersal in species like *Chlorocardium* will depend heavily on the 'race' between seed germination and attack. In the case of *Chlorocardium*, the 'race' can be lost at considerable distances due to its prolonged dormancy and the temporal fluctuations in fruitfall and rainfall which influence attack and germination. The results presented here suggest that the lag between seed attack and germination in tropical trees can regulate the influence of parent-offspring distance on cohort recruitment at this life history stage.

ISSN: 0029-8549

Record 105 of 129

Author(s): Brewer, SW; Rejmanek, M

Title: Small rodents as significant dispersers of tree seeds in a Neotropical forest

Source: JOURNAL OF VEGETATION SCIENCE, 10 (2): 165-174 APR 1999

Conference Title: 40th International-Association-for-Vegetation-Science Symposium

Conference Date: AUG 18-SEP 23, 1997

Conference Location: CESKE BUDEJOVICE, CZECH REPUBLIC

Abstract: Through seed dispersal and predation, terrestrial mammals should be an important component of the mechanisms that determine patterns of tree recruitment in tropical forests. Despite their great abundance and ubiquity in Neotropical forests, small rodents as seed predators and dispersers remain largely forgotten. To investigate the fates of seeds in a hunted primary forest in Belize, we tagged seeds of *Astrocaryum mexicanum* (Palmae), *Ampelocera hottlei* (Ulmaceae), and *Pouteria sapota* (Sapotaceae) and placed them into open plots, exclosures accessible only to small mammals, and exclosures accessible to medium-sized and small mammals. The exclosure experiments and fates of the seeds show that the spiny pocket mouse, *Heteromys desmarestianus* (Heteromyidae), was the dominant handler of seeds of the first two species and also removed a significant proportion of the very large-seeded *Pouteria*. Most of the seeds were killed immediately upon removal, but many of the seeds (3 - 18 %) of the first two species were scatterhoarded (dispersed and buried in the soil) by *Heteromys*. Some of the scatterhoarded seeds (29 %) remain buried and therefore protected from predation by other animals. *Agoutis* (*Dasyprocta punctata*), a caviomorph rodent, buried 13 % of the seeds of *Pouteria*, and *Heteromys* consumed and dispersed but did not bury *Pouteria* seeds. Results of this study support predictions by some researchers that small rodents are dominant terrestrial granivores in Neotropical forests. The role of small rodents as seed dispersers, however, has never been fully appreciated.

ISSN: 1100-9233

Record 106 of 129

Author(s): Hulme, PE; Hunt, MK

Title: Rodent post-dispersal seed predation in deciduous woodland: predator response to absolute and relative abundance of prey

Source: JOURNAL OF ANIMAL ECOLOGY, 68 (2): 417-428 MAR 1999

Abstract: 1. The response of post-dispersal seed predators to changes in the absolute and relative abundance of seeds of two tree species: ash (*Fraxinus excelsior*) and wych elm (*Ulmus glabra*) was studied in seminatural woodland in County Durham, UK. 2. Analysis examined two components of seed predation: seed encounter (the probability of at least one seed being removed) and seed exploitation (the proportion of seeds removed once encountered). Exclosure studies identified small mammals, particularly the woodmouse (*Apodemus sylvaticus*) as the principal post-dispersal seed predators and revealed a marked preference (almost four-fold difference in encounter) for seeds of *Ulmus* over *Fraxinus*. 3. For both *Fraxinus* and *Ulmus*, a 3 linear regression model described the relationship between seed density and the number of seeds removed by rodents more successfully than non-linear models. These relationships were maintained whether the species were presented singly or together with neither the slopes of *Fraxinus* or *Ulmus* changing significantly. These results indicate that, over the range of seed densities used, rodents consumed a constant proportion of seeds irrespective of seed density or frequency. The high rates of exploitation for *Ulmus* seeds suggests the slope of the relationship primarily reflects rates of encounter, whereas for *Fraxinus* it is a result of both low encounter and exploitation. 4. Linear regression identified seed removal by rodents to be frequency-independent both over the woodland as a whole and within each of six micro-habitats. This appeared to be a result of the marked preference for *Ulmus* over *Fraxinus* which was not reversed even when *Ulmus* was rare. Frequency-dependent seed predation by rodents is predicted to be most likely when both prey have similar low palatabilities. 5. When encountered by rodents, patches of *Ulmus* seeds were exploited almost completely, irrespective of seed density or frequency which suggests rodents have the potential to cause local extinction of *Ulmus* Seed populations. In contrast, the lower rates of encounter and exploitation of *Fraxinus* seeds implies ample opportunities for prey escape.

ISSN: 0021-8790

Record 107 of 129

Author(s): Andresen, E

Title: Seed dispersal by monkeys and the fate of dispersed seeds in a Peruvian rain forest

Source: BIOTROPICA, 31 (1): 145-158 MAR 1999

Abstract: Primary seed dispersal by two species of monkeys and the effects of rodents and dung beetles on the fate of dispersed seeds are described for a rain forest in southeastern Peru. During the six-month study period (June-November 1992) spider monkeys (*Ateles paniscus*) dispersed the seeds of 71 plant species, whereas howler monkeys (*Alouatta seniculus*) dispersed seeds of 14 species. Spider and howler monkeys also differed greatly in their ranging behavior and defecation patterns, and as a consequence, produced different seed rain patterns. Monkey defecations were visited by 27 species of dung beetles (*Scarabaeidae*). Dung beetles buried 41 percent of the seeds in the dung, but the number of seeds buried varied greatly according to seed size. Removal rates of unburied seeds by rodents varied between 63-97 percent after 30 d for 8 plant species. The presence of fecal material increased the percentage of seeds removed by seed predators, but this effect became insignificant with time. Although seed predators found some seeds buried in dung balls (mimicking burial by dung beetles), depth of burial significantly affected the fate of these seeds. Less than 35 percent of *Brosimum lactescens* seeds buried inside dung balls at a depth of 1 cm remained undiscovered by rodents, whereas at least 75 percent of the seeds escaped rodent detection at a depth of 3 cm and 96 percent escaped at 5 cm. Both dung beetles and rodents greatly affected the fate of seeds dispersed by monkeys. It is thus important to consider postdispersal factors affecting the fate of seeds when assessing the effectiveness of frugivores as seed dispersers.

ISSN: 0006-3606

Record 108 of 129

Author(s): Edwards, GR; Crawley, MJ

Title: Rodent seed predation and seedling recruitment in mesic grassland

Source: OECOLOGIA, 118 (3): 288-296 MAR 1999

Abstract: Seedling recruitment of two grasses (*Arrhenatherum elatius* and *Festuca rubra*) and two herbs (*Centaurea nigra* and *Rumex acetosa*) was measured in areas with and without rodents to which seeds of each species were sown at three seed densities (1000, 10,000 and 50,000 seeds m⁻²) in two seasons (spring and autumn 1995). Seed removal was measured for 10-day periods and the fate of seedlings was followed for 15 months after sowing. The proportion of seed removed ranged from 6 to 85% and increased with increasing seed density for each species. Rodents had no effect on seedling emergence or survival in the spring sowing. In the autumn sowing, rodents reduced seedling emergence of all four species sown at 1000 and 10,000 seeds m⁻² but had no impact at 50,000 seeds m⁻², presumably because of microsite limitation. We suggest the difference between spring and autumn arose because emergence was seed limited in autumn but microsite limited in spring; microsite availability was higher in autumn because a summer drought killed plants, reduced plant biomass and opened up the sward. Fifteen months after the autumn sowing, fewer *A. elatius* and *C. nigra* seedlings survived on plots exposed to rodents. This result reflected not only the reduced seedling emergence but also increased seedling mortality (seedling herbivory) in sites exposed to rodents. In contrast, *F. rubra* and *R. acetosa* showed density-dependent seedling survival which compensated for initial differences in seedling emergence, so that no effect of rodents remained after 15 months. The results suggest that rodent seed predation and seedling herbivory exert strong effects on seedling recruitment of *A. elatius* and *C. nigra* when recruitment conditions are favourable (conditions that lead to high microsite availability) and may contribute to both species being maintained at low densities in the grassland. The results also demonstrate that highly significant impacts of rodent seed predation at the seedling emergence stage can disappear by the time of plant maturation.

ISSN: 0029-8549

Record 109 of 129**Author(s):** Greene, DF; Johnson, EA**Title:** Seed mass and early survivorship of tree species in upland clearings and shelterwoods**Source:** CANADIAN JOURNAL OF FOREST RESEARCH-REVUE CANADIENNE DE RECHERCHE FORESTIERE, 28 (9): 1307-1316 SEP 1998

Abstract: We examined recommended sowing densities of 25 North American tree species (26 observations) to measure the relationship between juvenile survivorship and seed mass in large clearings and shelterwoods. Two models for expressing the relationship (simple power law or a cumulative negative exponential adjusted to account for rodent-repellent application and seedbed type) all showed that survivorship is highly dependent on seed mass. For a small seed, mineral soil and thin humus confer roughly equally high survivorship. Leaf litter is very poor, and undisturbed thick moss appears to be the worst possible organic seedbed on upland sites. An examination of 30 records of *Picea glauca* (Moench) Voss survivorship (3- to 6-year-old cohorts) on mineral soil revealed substantial intraspecific variation with only 50% of the values within twofold of the predicted value.

ISSN: 0045-5067

Record 110 of 129**Author(s):** Blate, GM; Peart, DR; Leighton, M**Title:** Post-dispersal predation on isolated seeds: a comparative study of 40 tree species in a Southeast Asian rainforest**Source:** OIKOS, 82 (3): 522-538 SEP 1998

Abstract: Many studies of post-dispersal seed predation have focused on density and distance dependent mortality, while relatively few have examined the fates of isolated seeds. Yet, scatter-dispersed seeds (*sensu* Howe) are commonly deposited singly or in small groups. Furthermore, even in species with highly aggregated seed distributions, the fates of the most widely dispersed individuals may be critical for recruitment. We compared predation rates on single, isolated seeds, among 40 species of trees in lowland tropical rain forest at Gunung Palung, West Kalimantan, Indonesia. Seeds were placed along four replicate transects and monitored for damage by predators, removal and germination in four trials, each lasting at least 30 days. Tethering of seeds did not affect removal rates, indicating that removals were attributable to seed predators and not merely to physical disturbance by animals or abiotic factors. After 30 days, mortality due to seed predation, averaged over species, was more than 50%; among species, predation losses ranged from 0 to 100%. Over the range of seed sizes we examined (0.1 g to 11.6 g fresh weight) predation rates were negatively associated with seed size and with the thickness and hardness of the seed coat. Lower predation on larger seeds is contrary to theoretical predictions and some prior empirical finding, and may be partially explained by the scarcity of predators capable of penetrating the physical defenses of large seeds with hard seed coats. Large, soft seeds with low predation rates may have poor nutrition or may be protected by chemical defenses. Species differed greatly in 30-day germination rates, ranging from 0 to 47%. Some species with low predation rates also had low germination rates; the implications for the overall risk of predation during the seed stage are discussed. Predation rates were not associated with species' natural dispersal mode (clumped vs scatter-dispersed), contrary to theoretical predictions. Spiny rats (*Maxomys* spp.) were the most abundant seed eating rodent. Caged spiny rats avoided large, hard seeds and preferred soft, medium sized seeds. The substantial rates of post dispersal predation on isolated seeds that we measured may be sufficient to influence strongly the population dynamics and life history evolution of trees in this rain forest community.

ISSN: 0030-1299

Record 111 of 129**Author(s):** Manson, RH; Ostfeld, RS; Canham, CD**Title:** The effects of tree seed and seedling density on predation rates by rodents in old fields**Source:** ECOSCIENCE, 5 (2): 183-190 1998

Abstract: Seed and seedling predation by rodents along forest-field edges can influence the dynamics of tree invasion into old fields. As predicted by the Janzen-Connell escape hypothesis and the predator satiation hypothesis, the effects of rodents on tree propagules may be modified by variation in the distribution and abundance of tree propagules. We tested these hypotheses in old-fields using a series of U-shaped enclosures in southeastern New York State. We maintained two densities (high versus low) of meadow voles (*Microtus pennsylvanicus*), which are the principal seedling predators and dominant rodent competitors at our sites. High density of voles significantly reduced density of white-footed mice (*Peromyscus leucopus*), which are the primary seed predators. Within enclosures we manipulated the density and spacing of red maple (*Acer rubrum*) seeds and black birch (*Betula lenta*) seedlings. We used three densities of red maple seeds (1500, 750, and 150 seeds/2 m²) arranged to mimic natural leptokurtic declines in seed density with distance from a hypothetical seed source. The density of black birch seedlings was also manipulated at three levels (50, 20, and 10 seedlings/2 m²). Seed predation was uniformly high overall (approx. 99%) in three adjacent plots irrespective of seed density. However, predation was significantly lower in isolated, low-density plots. These results suggest that mice were not satiated by the range of seed densities typical for old fields and instead foraged in a distance-responsive manner consistent with predictions of the escape hypothesis. In contrast, seedlings in high density plots experienced significantly lower predation than those in medium- and low-density plots, suggesting that voles were satiated by plots of high seedling density. These patterns were dearest within enclosures having high vole density, highlighting the importance of

competitive interactions in modifying the foraging decisions of rodents in old fields.

ISSN: 1195-6860

Record 112 of 129

Author(s): Sanchez-Cordero, V; Martinez-Gallardo, R

Title: Postdispersal fruit and seed removal by forest-dwelling rodents in a lowland rainforest in Mexico

Source: JOURNAL OF TROPICAL ECOLOGY, 14: 139-151 Part 2 MAR 1998

Abstract: This study examined whether postdispersal fruit and seed removal by terrestrial mammals of common plant species was affected by the type of item, item density (low, medium, high), and habitat (gap, mid-succession, mature). Fruits of *Brosimum alicastrum* and *Ficus yoponensis* (Moraceae), *Astrocaryum mexicanum* (Palmae), and *Nectandra ambigens* (Lauraceae), and seeds of *Omphalea oleifera* (Euphorbiaceae) and *Cymbopetalum baillonii* (Annonaceae) were tested at the Los Tuxtlas rainforest in Mexico. Item removal from 108 experimental patches (N = 2340 fruits or seeds for each plant species tested) after 5 d was lower for *F. yoponensis* (6.6%) than for *N. ambigens* (68.0%), *B. alicastrum* (67.8%) *C. baillonii* (64.0%) and *A. mexicanum* (60.0%). No seeds of *O. oleifera* were removed. A higher fruit or seed removal was observed from high density than low density food patches in *A. mexicanum*, *C. baillonii* and *N. ambigens*, but not in *B. alicastrum* and *F. yoponensis*. A higher fruit or seed removal was observed from food patches in mature forest than in gaps in all plant species tested. Similar removal values between open (open to all terrestrial mammals) and caged (open to small rodents) fruit and seed patches, abundant rodent live-trapping, and a scarcity of large terrestrial mammals, indicated that forest-dwelling small rodents were the main postdispersal removal agents. Differences in plant species seedling recruitment resulting from small rodent food choices can partially determine long-term forest floristic composition at the Los Tuxtlas rainforest.

ISSN: 0266-4674

Record 113 of 129

Author(s): Forget, PM

Title: Effect of microhabitat on seed fate and seedling performance in two rodent-dispersed tree species in rain forest in French Guiana

Source: JOURNAL OF ECOLOGY, 85 (5): 693-703 OCT 1997

Abstract: 1 The establishment probabilities, short-term survival, growth rates and biomass allocation patterns of seedlings in two large-seeded tree species, *Carapa procera* (Meliaceae) and *Vouacapoua americana* (Caesalpiniaceae), were studied in contrasting microhabitats at Paracou, French Guiana.

2 Seeds (100 per habitat per species) were buried to simulate rodent caches into gap and understorey microhabitats (n = 20 of each) surrounding mature parent trees. The experiment was replicated in *Carapa procera* (in early March and May) to investigate the effect of temporal variation in seed dispersal on the establishment process.

3 Surviving seeds and sprouting seedlings were repeatedly censused during 2 years after establishment, and the causes of mortality determined. Growth and biomass parameters were calculated for surviving seedlings after 2.5 years.

4 A greater proportion of seeds and germinating seedlings were dug up but less seedlings suffered from damping-off in *C. procera* than in *V. americana*. For both species, short-term survival of seedlings was lower in the understorey where predation by mammals and damping-off occurred more frequently than in gaps,

5 Damping off killed more *Carapa procera* seedlings when buried in March than in May, whereas mammal predation caused more deaths in May planted seeds.

6 Although survival and growth were enhanced in gaps for both species, seeds and seedlings were much more intolerant to the understorey microhabitat in *Carapa procera* (almost 100% mortality in shaded habitat) than in *Vouacapoua americana*.

7 Seedling biomass allocation was consistent with previous data for large-seeded species but differed markedly between the two study species.

ISSN: 0022-0477

Record 114 of 129

Author(s): Pizo, MA

Title: Seed dispersal and predation in two populations of *Cabralea canjerana* (Meliaceae) in the Atlantic Forest of southeastern Brazil

Source: JOURNAL OF TROPICAL ECOLOGY, 13: 559-577 Part 4 JUL 1997

Abstract: The seed dispersal system of a neotropical tree, *Cabralea canjerana* (Meliaceae), was studied in two forested areas in southeastern Brazil. The first study site, Parque Estadual Intervales (PEI), is a 49,000-ha reserve composed mostly of old-growth Atlantic rain forest. The second site, Mata de Santa Genebra (MSG), is a 250-ha fragment of old-secondary semideciduous forest whose present bird fauna differs markedly from the original, in part as a consequence of forest fragmentation. At PEI 35 bird species ate the diaspores of *C. canjerana*. Black-railed tityra (*Tityra cayana*, Tyrannidae) was the main seed disperser, but several other species were also important seed dispersers. In contrast, at MSG *C. canjerana* diaspores were eaten by 14 bird species. At this area, the red-eyed vireo (*Vireo olivaceus*, Vireonidae) was the most important seed disperser, but it was also a 'waster' which dropped seeds beneath parent plants, or carried them to sites unsuitable for germination. At PEI, exposed seeds on the forest floor were heavily preyed upon by rodents and insects. Insects destroyed mainly seeds deposited near to parent plants.

Insect predation was less intense at MSG than at PEI. The rodent density at MSG was unusually small, and part of the post-dispersal seed predation may be done by terrestrial birds, such as doves and tinamous, which are especially common at MSG. Some of the differences recorded between the seed dispersal systems of *C. canjerana* at PEI and MSG may have been the result of the fragmentation and isolation of the latter area.

ISSN: 0266-4674

Record 115 of 129

Author(s): Maron, JL; Simms, EL

Title: Effect of seed predation on seed bank size and seedling recruitment of bush lupine (*Lupinus arboreus*)

Source: OECOLOGIA, 111 (1): 76-83 JUN 1997

Abstract: Whether seed consumers affect plant establishment is an important unresolved question in plant population biology. Seed consumption is ubiquitous; at issue is whether seedling recruitment is limited by safe-sites or seeds. If most seeds inhabit sites unsuitable for germination, post-dispersal seed consumption primarily removes seeds that would otherwise never contribute to the population and granivory has minimal impacts on plant abundance. Alternatively, if most seeds ultimately germinate before they lose viability, there is greater potential for seed consumption to affect plant recruitment. Of the many studies on seed consumption, few ask how seed loss affects seedling recruitment for species with long-lived seed banks. We examined postdispersal seed predation and seedling emergence in bush lupine (*Lupinus arboreus*), a woody leguminous shrub of coastal grasslands and dunes in California. We followed the fate of seeds in paired experimental seed plots that were either protected or exposed to rodent granivores in grassland and dune habitats. Significantly more seeds were removed by rodents in dunes than grasslands. In dunes, where rodent granivory was greatest (65% and 86% of seeds removed from plots by rodents in two successive years), there is a sparse seed bank (6.6 seeds m^{-2}), and granivory significantly reduced seedling emergence (in the same two years, 18% and 19.4% fewer seedlings emerged from exposed versus protected plots), suggesting seed rather than safe-site limited seedling recruitment. In contrast, rodents removed an average of 6% and 56% of seeds from grassland plots during the same two years, and the grassland seed bank is 43-fold that of the dunes (288 seeds m^{-2}). Even high seed consumption in the second year of the study only marginally influenced recruitment because seeds that escaped predation remained dormant. Burial of seeds in both habitats significantly reduced the percentage of seeds removed by rodents. Results suggest that granivores exert strong but habitat-dependent effects on lupine seed survival and seedling emergence.

ISSN: 0029-8549

Record 116 of 129

Author(s): Hulme, PE

Title: Natural regeneration of yew (*Taxus baccata* L): Microsite, seed or herbivore limitation?

Source: JOURNAL OF ECOLOGY, 84 (6): 853-861 DEC 1996

Abstract: 1 This study integrates results of field experiments with historical data to determine the extent and circumstances under which regeneration of English yew (*Taxus baccata* L.), a long-lived tree, may be seed-, microsite- or herbivore-limited. 2 Native yew populations within Fraxinus-Acer woodlands in two coastal denes, (Castle Eden Dene and Hawthorn Dene) and two limestone gorges (Greta Gorge and Horsleyhope Ravine) all in County Durham, north-east England were selected for study. 3 The coastal denes reflect a unimodal age-distribution with peak regeneration occurring between 150 and 250 years ago. In contrast, the age-distribution of trees in Greta Gorge appeared to show low but relatively constant levels of regeneration over the last 550 years. Too few yews were found to provide comparable data for Horsleyhope Ravine. 4 The sites differed considerably in patterns of recent regeneration but patterns were consistent with the dynamics depicted by the age-distributions. Over 30% of individuals in Greta Gorge were saplings, while in Hawthorn Dene this figure was only 8% and no saplings were found in either of the two remaining sites. Yew seedlings were only found in the coastal denes. Comparison with other tree species in these sites reveal yew to be the only species which suffers consistently poor seedling recruitment. 5 Rates of seed predation were similarly high across all four sites. However, there was significant variation between microsites with seed predation twice as intense beneath shrubs as in the open. 6 Examination of the age-distribution revealed regeneration to become increasingly microsite limited as the yew population developed. Therefore, although sites with the highest rates of seed predation had fewest yew seedlings, these were also the oldest sites and the pattern could be better explained by limitation of regeneration by microsites rather than herbivores. 7 A continuum was found to exist with sites where current regeneration is primarily herbivore-limited (Hawthorn Dene) to sites which were microsite limited (Greta Gorge) with regeneration in intermediate sites (Castle Eden Dene) being limited by both microsites and seed predators. The problems of extrapolating results from shortterm experiments to the dynamics of long-lived plant species are discussed.

ISSN: 0022-0477

Record 117 of 129

Author(s): Forget, PM

Title: Removal of seeds of *Carapa procera* (Meliaceae) by rodents and their fate in rainforest in French Guiana

Source: JOURNAL OF TROPICAL ECOLOGY, 12: 751-761 Part 6 NOV 1996

Abstract: Experiments were performed to investigate monthly variations in seed fate of *Carapa procera* (Meliaceae), a rodent-dispersed subcanopy tree species in French Guiana. A total of 600 thread-marked seeds were placed on the ground in mature forest under 20 adult trees during different months (March, April and May 1991) of the species' fruiting season. In 1991 the seed crop reached 1536 seeds in the study area, with a majority of seeds being produced in March and May. On average, seed removal rate steadily increased from March (23%) to May (96%). Of the seeds removed, the proportion cached almost doubled between March (28%)-April (25%) and May (48%), whereas the proportion eaten (gnawed) steadily declined between March (43%) and May (9%). Approximately 75-100% seed removal was therefore associated with intense scatterhoarding and low seed predation, especially in May. Greater seed dispersal rates occurred during the late wet season when fruit diversity decreased but when overall fruit biomass peaked because of fruiting occurrence of large-seeded species. The seasonal hoarding behaviour of rodents is discussed.

ISSN: 0266-4674

Record 118 of 129

Author(s): Iida, S

Title: Quantitative analysis of acorn transportation by rodents using magnetic locator

Source: VEGETATIO, 124 (1): 39-43 MAY 1996

Abstract: Transported distance and mortality of acorns scattered by rodents were investigated with magnets inserted into acorns (40 of *Quercus serrata* and 20 of *Quercus acutissima*) and a magnetic locator in a natural forest stand. All the treated acorns were transported, and 60% of them were discovered again with a magnetic locator from autumn to the next spring. Most transported acorns suffered predation within one month after the start of the experiment. Several acorns were rehoarded at least two or three times. Average transported distance of scattered acorns was 22.1 +/- 8.9 m (max = 38.5 m) and the survival rate was 3.0%. The magnet method is one of the most effective methods for tracking acorns through the winter.

ISSN: 0042-3106

Record 119 of 129

Author(s): LOTT, RH; HARRINGTON, GN; IRVINE, AK; MCINTYRE, S

Title: DENSITY-DEPENDENT SEED PREDATION AND PLANT DISPERSION OF THE TROPICAL PALM NORMANBYA-NORMANBYI

Source: BIOTROPICA, 27 (1): 87-95 MAR 1995

Abstract: We measured the response of seed predators to variation in seed density and distance between seed sources of palms in North Queensland, Australia. Adult palm trees occurred at a density of 20/ha. Their distribution was highly clumped and more than half the immature plants occurred within 3 m of an adult. Adult palms were also arranged in lines down the slope, apparently reflecting patterns of seed carriage by overland water flow. Seed dispersal is also affected by cassowaries, a ratite which ranges over many hundreds of ha and deposits seeds in clusters. Small mammals which range over a few ha may deposit seeds as single entities (singletons). Many seeds remain undispersed beneath the female parent with heavy predation. In this study seeds were placed beneath adult trees at two densities and were dispersed over varying distances as clusters of ten seeds and as singletons. Pigs and earwigs were the principal predators but they did not destroy all the seeds in any treatment. However, the germination percentage of the remaining seeds was greatly depressed indicating that one or both predators were disproportionately selecting potential germinants. Pigs were responsive to both density of seeds beneath a tree and the distance between seed sources; they did not damage dispersed seeds to a great extent. Earwigs also destroyed seeds more heavily beneath adult trees, but they were more efficient than pigs at locating dispersed seeds. Rodent predation was light and not responsive to seed density or dispersal.

ISSN: 0006-3606

Record 120 of 129

Author(s): FORGET, PM

Title: RECRUITMENT PATTERN OF *VOUACAPOUA-AMERICANA* (CAESALPINIACEAE), A RODENT-DISPERSED TREE SPECIES IN FRENCH-GUIANA

Source: BIOTROPICA, 26 (4): 408-419 DEC 1994

Abstract: The recruitment pattern of *Vouacapoua americana* (Caesalpinaceae) and the relationship between growth and survival of recruits were analyzed from 1984 to 1991 on two 2500 m² plots, one with and one without free soil drainage. Most seeds and seedlings below two adult trees in the plots died within 6 to 8 months of establishment. Virtually all seedlings still alive several months after fruiting arose from seeds that were buried by scatterhoarding rodents. Because rodents do not disperse seeds a great distance and *Vouacapoua* seedlings survive well in the shaded understory, offspring recruitment was more dense near adults than further away. A significantly lower proportion of newly established seedlings died on freely drained soil than where drainage was blocked; mortality was due to "damping-off" from fungal attack. First-year survival of seedlings from scatterhoarded seeds and growth rates for understory seedlings from 1984 to 1986 were higher on freely drained soil than on blocked soil. Long-term offspring survival was similar on both plots, while height increment was significantly greater on the freely drained plots than on the poorly drained soil. There was a significant negative relationship between the initial seedling density and proportion of survival on both plots within 6-8 months of establishment. However, there was no evidence of long-term compensatory mortality; the greater the initial density, the greater the final density of recruits surviving through years. The *Vouacapoua* recruitment pattern

appears typical of a partially repelled syndrome with recruits growing both near adults and further away. High Vouacapoua tree density on soil with good drainage, as reported in the literature, is likely to result from better environmental conditions for early seedling survival and long-term growth of recruits.

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Record 121 of 129

Author(s): SANTOS, T; TELLERIA, JL

Title: INFLUENCE OF FOREST FRAGMENTATION ON SEED CONSUMPTION AND DISPERSAL OF SPANISH JUNIPER JUNIPERUS-THURIFERA

Source: BIOLOGICAL CONSERVATION, 70 (2): 129-134 1994

Abstract: We examined the effects of fragmentation on Spanish juniper *Juniperus thurifera* in central Spain by comparing eight small forest fragments (SF, 0.2-16 ha), with two large forests (LF, 150 and 270 ha). Wood mice *Apodemus sylvaticus*, the only rodent seed eaters, were 8.9 times more dense in SF, whereas thrushes *Turdus* spp., the main avian seed dispersers, were 4.6 times more abundant in LF. Finches (seed eaters) were scarce in both forest groups. Mean fruit abundance was significantly higher in LF. Seed consumption was mainly by mice in SF and by finches in LF. Thrush pellets with intact seeds, seedling abundance and the proportion of trees with nearby seedlings, were all higher in LF. This evidence points to a decrease in the dispersal efficiency of Spanish juniper in SF. We suggest that the processes leading to reduced dispersal ability might be inherent to fragmentation and represent a threat for the survival of fruit-bearing plants in patchy environments.

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Record 122 of 129

Author(s): HULME, PE

Title: POSTDISPERSAL SEED PREDATION IN GRASSLAND - ITS MAGNITUDE AND SOURCES OF VARIATION

Source: JOURNAL OF ECOLOGY, 82 (3): 645-652 SEP 1994

Abstract: 1 Post-dispersal seed predation by rodents and invertebrates, was studied in two grassland sites in Berkshire, UK. The influence of season, seed density, seed burial, seed species, as well as within- and between-habitat variation on the removal of nineteen species of herbaceous seeds was investigated using enclosure experiments.

2 Analysis examined two components of seed predation: seed encounter (the probability of at least one seed being removed) and seed exploitation (the proportion of seeds removed once encountered). Seed removal was greatest from treatments to which rodents had access, losses attributable to invertebrates were negligible.

3 Burial reduced rodent encounter at both seed densities used and explained almost 21% of the variation, while having only a limited effect on the proportion of seeds exploited. Burial increased the variation in encounter attributable to the other sources examined and altered the direction of habitat, season and species effects. Interpretation of surface seed predation data to details of plant recruitment for seeds which form buried seed banks should be undertaken with caution.

4 Examination of rodent seed removal patterns revealed that on average 14% of the variation in both seed encounter and exploitation was attributable to small-scale spatial differences within habitats related to the distribution of small mammals.

5 No significant between site variation was found for encounter (< 2%) while seed density effects accounted for approximately 11% of the variation. Single seeds were encountered less than half as frequently as seeds in groups of 10. Density-dependence varied with seed size, with predation of large seeds less influenced by a reduction in seed density.

6 No significant species variation was found for seed encounter (species means ranged from 50 to 60%). In contrast, species effects for seed exploitation were significant and species means ranged from 20 to 95%.

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Record 123 of 129

Author(s): HERRERA, CM; JORDANO, P; LOPEZSORIA, L; AMAT, JA

Title: RECRUITMENT OF A MAST-FRUITING, BIRD-DISPERSED TREE - BRIDGING FRUGIVORE ACTIVITY AND SEEDLING ESTABLISHMENT

Source: ECOLOGICAL MONOGRAPHS, 64 (3): 315-344 AUG 1994

Abstract: The recruitment of *Phillyrea latifolia* L. (Oleaceae), a bird-dispersed tree of Mediterranean forest, is described. Fruit removal by birds, seed rain, post-dispersal seed predation, seed germination, and seedling emergence, survival, and establishment were studied. The main objective was testing whether seed dispersal by birds produced a predictable seedling shadow as a result of coupled patterns of seed rain, seedling emergence, and seedling establishment. *P. latifolia* is a mast-fruiting species and large fruit crops were produced in only 2 (1981 and 1989) out of 15 yr (1978-1992). We report here on the 1989 fruiting event at one scrubland and one forest site.

Ripe fruits were available from mid-September to early June. Extensive removal by birds started after fruit crops of other species were depleted. Seed dispersers were more abundant, and fruit predators more scarce, in scrubland than in forest. *P. latifolia* fruits were a major component in the diet of principal seed dispersers (*Sylvia atricapilla* and *Erithacus rubecula*) that depended almost exclusively on them for food late in the season. Fruit removal levels were higher, crops were depleted earlier, and individual plants dispersed more seeds in scrubland than in forest. Crop size was the best predictor of number of seeds dispersed by individual plants in scrubland, while fruit characteristics were more influential in forest. Seed dispersal was largely a within-

population phenomenon, as no seed fall occurred in traps set beyond the distributional limits of *P. latifolia* in the study region. Frugivores produced a spatially predictable seed rain at the two sites. Seed rain was greatest beneath fleshy fruit-producing species (under female individuals in dioecious species) in scrubland and at forest-gap interfaces in forest. Post-dispersal seed predation was low at the two sites (39 and 54% after 1-yr exposure). In forest, seed survival was lower in gaps than in forest interior or forest edges. In scrubland, seed survival differed widely among microhabitats (defined by overlying plant species), ranging from 19% (open ground) to 61% (beneath *Rosmarinus officinalis*). In forest, density of emerging seedlings was unrelated to location in the habitat mosaic (gap, forest edge, interior). Seedling density did differ among microhabitats in scrubland, where emergence was greatest under fleshy fruit-producing species. Seedling survival was higher in forest than in scrubland, where seedlings incurred greater mortality due to desiccation. In both sites, seedling survival depended significantly on microhabitat and was depressed under adult conspecifics.

The activity of frugivores directly impacted seedling distribution in scrubland, as spatial patterns of seed deposition were not overshadowed by later-acting factors, such as rodent seed predation or variation in germination. In forest, there was spatial discordance between seed rain and seedling distribution, as a consequence of uncoupled seed rain and seedling emergence. Spatial patterns of seed deposition by birds may thus have a lasting impact on the population dynamics of *P. latifolia*, but this will vary among populations depending on the extent of coupling of the different stages in the recruitment process (dispersal-seed rain-germination and seedling establishment).

ISSN: 0012-9615

Record 124 of 129

Author(s): BUSTAMANTE, RO; GREZ, AA; SIMONETTI, JA; VASQUEZ, RA; WALKOWIAK, AM

Title: ANTAGONISTIC EFFECTS OF FRUGIVORES ON SEEDS OF *CRYPTOCARYA-ALBA* (MOL) LOOSER (LAURACEAE) - CONSEQUENCES ON SEEDLING RECRUITMENT

Source: ACTA OECOLOGICA-INTERNATIONAL JOURNAL OF ECOLOGY, 14 (6): 739-745 1993

Abstract: We provide empirical evidence that frugivores affect *Cryptocarya alba* (Lauraceae) seeds both positively and negatively by the simple act of removing the pericarp of the fruits. Germination is both increased and advanced but simultaneously seed mortality by rodent predation is increased as well. Based on fate diagrams we demonstrate that the net effect of frugivores on germination is zero while in terms of seedling recruitment, it is positive. We conclude that the ecological conditions for a mutualistic interaction between frugivores and *Cryptocarya alba* are fulfilled.

ISSN: 1146-609X

Record 125 of 129

Author(s): GIBSON, W

Title: SELECTIVE ADVANTAGES TO HEMI-PARASITIC ANNUALS, GENUS *MELAMPYRUM*, OF A SEED-DISPERSAL MUTUALISM INVOLVING ANTS .2. SEED-PREDATOR AVOIDANCE

Source: OIKOS, 67 (2): 345-350 JUN 1993

Abstract: Field experiments were used to assess the importance of third species antagonists, in this case rodent seed-predators, in driving the evolution of seed dispersal by ants in the genus *Melampyrum*. Daytime and nighttime seed-removal frequencies were determined by placing seeds so that 1) ants and rodents had access, 2) only ants had access, 3) only rodents had access, and 4) neither ants nor rodents had access. Experiments were conducted with *Melampyrum* populations of three different species at four sites, two in the U.S. (*M. lineare* in Maine and Michigan) and two in Switzerland (*M. arvense* and *M. silvaticum*). Morning versus evening fruit dehiscence and the effect of elaiosome removal on seed-attractiveness to ants were also investigated. Though seed predators can have an effect in reducing seed pool numbers (50-70% in ant exclosures), it is suggested that because of the timing of seed release and the thorough nature of dispersal by ants (85-100% in rodent exclosures), third species antagonists are not currently as important as environmental constraints in maintaining this mutualism. Historically, as suggested by the prevalence of morning (versus evening, $p < 0.001$) seed release, the effect of rodents may have been larger. Removal of the elaiosome decreases removal rate by ants ($p < 0.0001$); organisms such as carabid beetles that do so may alter the effectiveness of the mutualism.

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Record 126 of 129

Author(s): VANDERWALL, SB

Title: THE ROLE OF ANIMALS IN DISPERSING A WIND-DISPERSED PINE

Source: ECOLOGY, 73 (2): 614-621 APR 1992

Abstract: Jeffrey pine (*Pinus jeffreyi*) produces winged seeds typical of many wind-dispersed pines. However, seedlings often occur in clumps, suggesting that many seeds are scatter-hoarded by animals. An experiment is described that examines how the initially wind-dispersed seeds end up in animal caches. Two arrays of 1064 Jeffrey pine seeds were arranged around two "source" trees in a pattern predicted from models of wind dispersal. Seeds were labeled with radioactive scandium-46 and numbered 1-12 with indelible ink to represent the 12 1-m wide annuli centered on the source tree where they were deployed. Within 2 d, between 95 and 99% of the seeds had been removed by rodents. Fifty-four and 35% of the seeds were found stored at the two sites, most of these in shallow surface caches. Seed caches were located 1.3-54.2 m and 6.2-62.9 m from the "source"

trees at sites one and two, respectively. Mean distance of the "wind-dispersed" seeds from the source tree was 4.6 m, and rodents moved seeds a mean of 13.0 m farther at site 1 and 24.7 m farther at site 2. Of 375 minimum dispersal measurements, seeds were carried away from the source tree 362 times. Four rodent species may have participated in caching the seeds, but yellow pine chipmunks (*Tamias amoenus*) appeared to be the species that cached most of the seeds. In a second experiment where rodents were excluded, seeds placed on the soil surface in fall rarely became buried during the winter, and if not buried, they would not germinate. Jeffrey pine seeds appear to be dispersed in two phases; seeds are initially scattered by the wind, and subsequently carried farther and cached in soil by animals.

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Record 127 of 129

Author(s): FORGET, PM; MILLERON, T

Title: EVIDENCE FOR SECONDARY SEED DISPERSAL BY RODENTS IN PANAMA

Source: OECOLOGIA, 87 (4): 596-599 1991

Abstract: The data presented show that *Virola nobilis* (Myristicaceae), a bird/mammal-dispersed tree species in Panama, may also be dispersed by a terrestrial rodent, the agouti (*Dasyprocta punctata*). Using a thread-marking method, we observed that agoutis scatterhoarded *V. nobilis* seeds that they found both singly or in clumps. Seed removal and seed burial rates were strongly affected by features of forest habitats, such as *V. nobilis* tree richness (rich vs poor) and/or forest age (old vs young), but not by seed dispersal treatment (scattered vs clumped). Predation (mostly post-dispersal) of unburied seeds by weevils was independent of habitat and dispersal treatment. Seeds artificially buried in a *Virola*-rich area were more likely to escape predation and become established than unburied seeds under natural conditions. The food reward for agoutis is in the germinating seedlings. The seed dispersal syndrome of *V. nobilis* involves long- and short-distance dispersers which both appear important for tree recruitment.

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Record 128 of 129

Author(s): KNIGHT, RS; MACDONALD, IAW

Title: ACACIAS AND KORHAANS - AN ARTIFICIALLY ASSEMBLED SEED DISPERSAL SYSTEM

Source: SOUTH AFRICAN JOURNAL OF BOTANY, 57 (4): 220-225 AUG 1991

Abstract: The seed dispersal of two introduced *Acacia* species by the black korhaan *Eupodotis afra*, a 700-g ground-feeding bird (Otididae), was studied in the southwestern Cape region of South Africa. The seeds of *Acacia cyclops* A. Cunn ex G. Don. possess conspicuous scarlet pseudarils derived from the funicle and were consumed in preference to those of *A. saligna* (Labill.) Wendl. which lack a functional pseudaril. Despite high levels of pre- and post-dispersal seed predation by a hemipteran and rodent species, respectively, the black korhaan dispersed many *A. cyclops* seeds to suitable germination and establishment sites. A successful seed dispersal system has arisen without any coevolution between this plant and this bird.

ISSN: 0254-6299

Record 129 of 129

Author(s): LATOURRE.JE; YOUNG, JA; EVANS, RA

Title: SEED DISPERSAL IN RELATION TO RODENT ACTIVITIES IN SERAL BIG SAGEBRUSH COMMUNITIES

Source: JOURNAL OF RANGE MANAGEMENT, 24 (2): 118-& 1971

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