

Importance of shade trees (*Grevillea robusta*) in the dispersal of forest tree species in managed tea plantations of southern Western Ghats, India

H. C. Chetana and T. Ganesh¹

Ashoka Trust for Research in Ecology and the Environment (ATREE), Royal Enclave, Srirampura, Jakkur Post, Bangalore -560 064, Karnataka, India
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Abstract: Abandoned plantations of coffee, tea and other commercial crops offer opportunities for understanding ecological processes in modified forest ecosystems. Unlike tree plantations tea is maintained as a shrub with a continuous dense short canopy that precludes large-frugivore activity thereby limiting dispersal of forest species to such areas. In this study we determine how location and density of *Grevillea robusta* a shade tree in tea plantations and proximity of plantations to forests influences seed arrival from forests into the plantations. We also estimate the importance of dispersal modes in the colonization processes. We laid 10 × 10-m plots at three distance intervals from the forest edge in three different plantation types with varying shade tree densities. Within the plots we laid four 1 × 1-m subplots at the corners of the plot. We estimated species richness, abundance and categorized the seeds into dispersal modes in these plots. *Grevillea robusta* increased species richness of seeds by three times and abundance of seeds by 3–30 times compared with plantations without them. Higher density of *G. robusta* increased seed input changed species composition and altered species dominance in the plantations. Distance to forests influenced seed arrival in plantations without *G. robusta* trees and plots 95 m from the forest did not have any seeds in them. No such effect was seen in plantations with *G. robusta* trees. Seeds dispersed by birds or a combination of birds and mammals contribute 30% of the seeds reaching the plantations with *G. robusta* and this was not influenced by distance from the forest. In plantations without *G. robusta* bird dispersal is restricted to 25 m from the forest edge. In general density of shade trees has a strong influence on seed arrival which can negate the forest proximity effect and enhance natural forest colonization.

Key Words: frugivores, seed dispersal, shade tree, tea, Western Ghats

INTRODUCTION

Tropical plantations cover large areas and are often located in biodiversity-rich regions of the globe (Barbosa *et al.* 2009, Chapman & Chapman 1999, Myers *et al.* 2000). Several studies have emphasized that afforestation in degraded land or agricultural land will ameliorate succession by native species (Guariguata *et al.* 1995, Harvey 2000, Raman *et al.* 2009, Teegalapalli *et al.* 2010). However colonization can be complex depending on the type of plantation, the location and the overall richness of the region along with the facilitative role of plantation trees to attract forest seeds through frugivore activity (Hartley 2002, Hunter 1990, Lugo 1997, Norton 1998, Parrotta *et al.* 1997).

Most studies of colonization are restricted to tree plantations and only a few to shrub monocultures like

coffee (Arellano *et al.* 2005, Armbrecht *et al.* 2004, Komar 2006, Pineda *et al.* 2005, Ricketts *et al.* 2001, Williams-Guillén *et al.* 2006). Unlike coffee and cardamom, tea (*Camellia sinensis* (L.) O. Kuntze. (Theaceae)) is a tree maintained as a shrub with a dense continuous short canopy that precludes any large-frugivore activity. It may however facilitate understory frugivores to visit these plantations and help in colonization of some forest species. This again can limit the kind of plant species that are dispersed into the tea.

In some tea plantations, shade trees (*Albizia* spp., *Erythrina* spp., *Grevillea robusta* A. Cunn. ex R.Br.), planted in varying densities for shade, may serve as foci of dispersal for canopy frugivores including bats. However, the importance of distribution and density of such shade trees to colonization by forest species is not clearly understood. Further, the interaction between shade tree dispersion and forest proximity that may be crucial in the eventual colonization of abandoned areas by forest species is also unknown. In this study we determine how

¹ Corresponding author. Email: chetanahc@yahoo.com

managed tea plantations with different density of shade trees and without shade trees facilitate immigration of forest species from surrounding forest to the plantations. More specifically we test the following hypotheses: (1) Seed input, species compositions and dominance vary with density of shade trees; (2) Distance from the forest is inversely related to seed input and seed compositions in the plantations; and (3) Seeds that arrive in the plantations from the forest differ in their dispersal modes across shade tree densities and distance from forest.

METHODS

Study area

The study was carried out from April 2008 to March 2009, within a 350-ha tea plantation (8.55°–8.54° N, 77.35°–77.37° E) located in the Kalakad Mundanthurai Tiger Reserve (KMTR), which is part of the Agasthyamalai range (Ramesh *et al.* 1997). The study area receives both south-west and north-east monsoons. The sampling was timed based on before the south-west monsoon (April–May), after the south-west monsoon (September–October) and after the north-east monsoon (February–March). The mean maximum temperatures ranged from 17 °C to 28 °C, the minimum temperatures ranged from 14 °C to 19 °C and annual rainfall ranges from 800 to 4000 mm (Ganesh & Davidar 1999). The primary rain forests are dominated by *Cullenia exarillata*, *Aglaiia bourdillonii* and *Palaquium ellipticum* (Ganesh *et al.* 1996), while along forest edges early-successional species such as *Elaeocarpus* spp., *Mallotus tetracoccus*, *Macaranga peltata*, *Maesa indica* and *Clerodendrum viscosum* are common (unpubl. data).

Sampling design

Grevillea robusta is the main shade tree used in the tea plantations. These are planted in three density categories across the plantations. We categorized them as continuous shade tree (CST): between 35 to 40 trees ha⁻¹; isolated shade trees (IST): fewer than 3 trees ha⁻¹; and without shade trees (WST): plantations without any shade trees. These plantations (i.e. plantation types) are separated by windbreak corridors that are either linear patches of natural forests or *Eucalyptus* trees (Figure 1a). We estimated forest species richness and seed abundance in the plantation types using 10 × 10-m plots within which four 1 × 1-m subplots were nested in the four corners of the larger plot (Figure 1b, c). The plots were located at 0 m (forest), 25 m, 60 m and 95 m from the forest to the centre of the plot along a transect (Figure 1b).

A total of seven transects were laid in each plantation type separated by a minimum distance of 500 m.

Surface soil was collected within the 1 × 1-m subplots. Large litter including leaves and twigs was removed manually and soil was passed through sieves of different pore sizes (0.5 cm² and 1.0 cm²). Seeds were collected and identified by comparing with reference collections and local flora (Gamble & Fischer 1915–1935). Unidentified seeds were preserved for later identification.

Seeds of each species collected from the surface soil were classified into dispersal modes based on our field observations and literature on seed dispersal modes from the same forest (Ganesh & Davidar 2001). Seeds were classified into six dispersal modes: bird (B), bat (Bt), mammal (excluding bats) (M), bird–mammal (dispersed by both birds and mammals) (BM), bat–other mammals (dispersed by bats and other mammals like civets) (BtM) and passive (wind/gravity dispersed) (P).

Data analysis

Species richness was estimated as the cumulative number of species in the 10 × 10-m plots. Abundance of seeds was pooled from the four subplots within the 10 × 10-m plots. Kruskal–Wallis non-parametric ANOVA was used to test differences in abundance and species richness across the plantation types with distance as a constant factor followed by Wilcoxon test for pairwise comparison whenever the Kruskal–Wallis ANOVA yielded significant result (Zar 1999).

Since seeds were collected from equal numbers of plots at four distance classes within three plantation types, we estimated the mean species richness (± SD) through individual-based Coleman's rarefaction method (Gotelli & Colwell 2001). Further, cumulative species richness was tested by using the rich package (Rossi 2011), to estimate species richness of seeds among distance classes within each plantation type.

Species composition and dominance

Similarities in the community composition across the three plantation types (i.e. CST, IST, WST) within four distance (i.e. 0, 25, 60, 95 m) intervals were examined using single linked clustering (van Tongeren 1987). Similarity distances were expressed as the Bray–Curtis index, where similarity of 0% means nothing is common between the two distance classes and 100% means that all the species are common to the two distance classes.

Two-factor permutational multivariate ANOVA with plantation types and distance intervals as two independent factors was used to test the differences

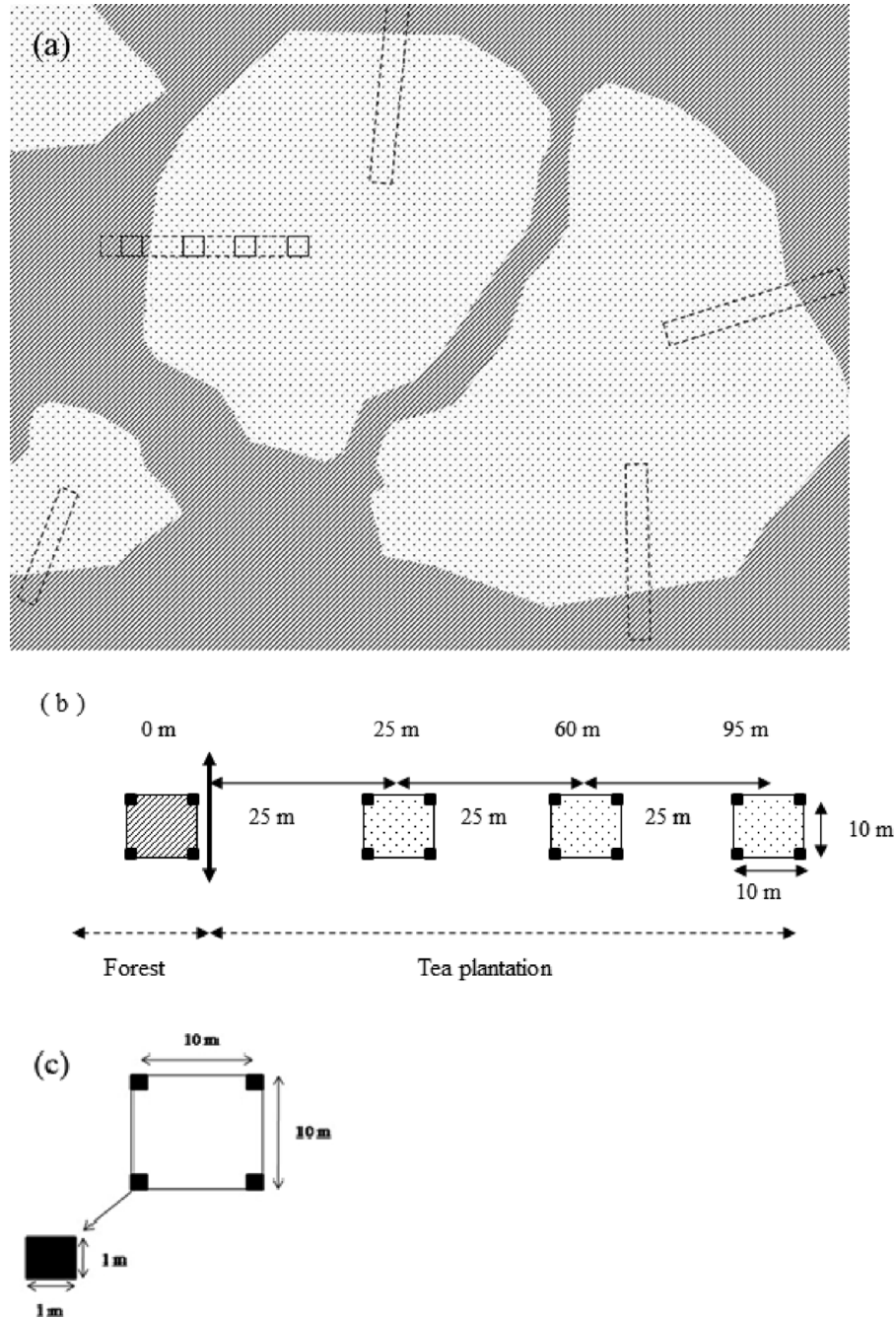


Figure 1. Schematic diagram showing the plantations (dotted) and surrounding forest (hatched) (a); a linear transect with four fixed distance intervals, each represented by a 10 × 10-m plot (b); 1 × 1-m subplot at each corner of the plot (c).

among species composition of seeds. This was done only within plantations and forest was excluded as species composition in plantations is expected to be a subset of forest. This test is ideal in a situation where the data sets represented multiple response variables (species) and multiple objects (transects observations) (Anderson 2001). Moreover, PERMANOVA can handle large multiple species data sets containing more species than replicates with the matrix having numerous zeros

(McArdle & Anderson 2001). For this analysis, the species composition matrix was standardized by row totals, and Bray–Curtis distance measure was used as the basis with 9999 permutations. Pairwise comparisons based on Monte-Carlo (MC) randomization with 4999 permutations were performed to test for differences among the plantation types. The species dominance in forest, each plantation type and across the distance class was done using the rank-abundance curve.

Dispersal modes

The seed abundances in each dispersal mode were compared across four distance classes and in each plantation type, using non parametric Kruskal–Wallis ANOVA. Since bat (Bt), mammal (M) and passive (P) modes were not represented in all the distance intervals, they were excluded from the analysis.

All the analyses were done using free statistical software R 2.12.1 (R Development Core Team) except community composition analysis which was done using PERMANOVA (Anderson 2001).

RESULTS

Species richness and abundance of seeds

A total of 39 species and 7916 seeds were recorded within the 21 transects (84 plots) across the three different plantation types and adjacent forests (Appendix 1). The variation of species richness and abundance across the plantation types are shown in Figure 2. Forest had 3–4 times more species than CST and IST respectively and 6–14 times more than WST (Kruskal–Wallis; $\chi^2 = 8.39$, $df = 2$, $P = 0.01$). Within plantations, species richness in CST was not very different from IST (Wilcoxon test; $W = 9$, $P > 0.05$), but was much higher than in WST ($W = 0$, $P < 0.05$). Similarly seed abundance in forest was 27 times more than in CST, 128 times more than in IST and nearly 500 times more than in WST. CST also had 3–7 times more seeds than in IST and almost 28 times more than in WST. These differences are overall significant (Kruskal–Wallis; $\chi^2 = 10.5$, $df = 2$, $P = 0.005$) in WST vs CST (Wilcoxon test, $W = 0$, $P < 0.01$) and IST vs CST ($W = 1$, $P < 0.05$) but not between IST and WST ($W = 0$, $P > 0.05$).

Cumulative species richness across forest and plantation showed significantly higher number of species in forests compared with in the plantations even at different distances from the forest (Table 1), whereas within the plantations species richness did not vary significantly among the distance intervals (Figure 2a).

Further Coleman's individual-based rarefaction analysis also revealed that species numbers at distances of 60 m and 95 m got saturated with 50–60 seeds in CST, whereas in IST saturation happened in the 95-m distance interval with about 15 seeds. At other distance intervals in CST and IST no saturation was seen. In WST species numbers keeps increasing at 25-m and 60-m intervals (Figure 3).

Species composition

The non-parametric MANOVA indicates that the species composition across plantation types was different ($F =$

Table 1. Comparisons of difference in cumulative species richness between various distance intervals at 95% confidence level using 'rich' (R package). The values indicate differences in species. * $P < 0.001$, NS: not significant, NC: not computable, NA: not applicable.

Distance intervals (m)	CST	IST	WST
0–25	18*	23*	24*
0–60	19*	23*	27*
0–95	20*	26*	NA
25–60	1NS	0 NC	3NS
25–95	2NS	3 NS	NA
60–95	1NS	3 NS	NA

3.02, $df = 2$, $P(\text{MC}) = 0.002$) but not across distance within the plantations ($F = 1.88$, $df = 2$, $P(\text{MC}) = 0.08$). Interaction between plantation type and distances did not show a change in species composition ($F = 0.83$, $df = 4$, $P(\text{MC}) = 0.66$), which is further confirmed by the Bray–Curtis similarity analysis (Figure 4). Further, pairwise comparisons among the plantation types were all significant; CST and IST ($t = 1.51$, $P = 0.04$); CST and WST ($t = 1.98$, $P = 0.005$) and IST and WST ($t = 1.69$, $P = 0.03$). In general forest, CST and IST were distinct while WST was highly dissimilar from the rest.

Species dominance

The species dominance changed from forest to plantation, but was remarkably constant across distance. In forest *Acronychia pedunculata* was the dominant species followed by *Elaeocarpus munronii* while in plantations *E. munronii* and *Elaeocarpus serratus* were the most common species. Within the plantation types, there was variability in the second dominant. In CST, even though *A. pedunculata* and *E. munronii* dominated the forest, it was variable across distance; at 25 m it was *E. munronii* and *E. serratus*, at 60 m it was *E. munronii* and *A. pedunculata*, and at 95 m it was *E. munronii* and *M. tetraococcus* that dominated. In IST even though *A. pedunculata*, *Toddalia asiatica* and *E. munronii* dominated the forest, it was *E. munronii* and *Litsea wightiana* that dominated at 25 m, 60 m and 95 m. In WST, *A. pedunculata*, *E. munronii* and *T. asiatica* were the dominant species in the forest, while *M. peltata* was the dominant species at 25 m and 60 m and no species were recorded at 95 m. In general only *E. munronii* was the dominant species in all the shade-tree plantations but not so in WST plantations.

Dispersal modes

Dispersal modes that occur at all distance intervals from the forest were used in the analysis. Of the three seed

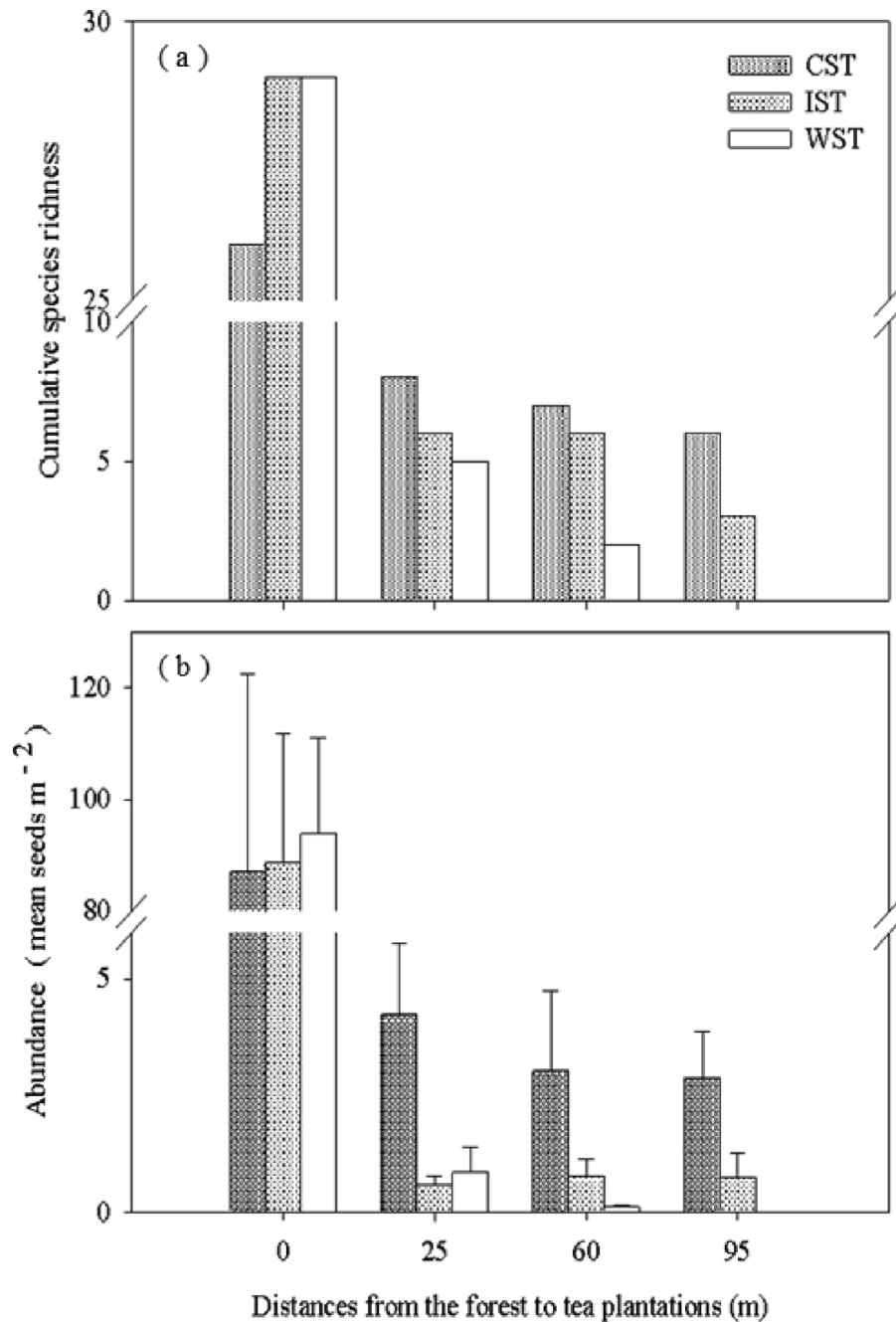


Figure 2. Cumulative species richness (a) and mean seed abundance \pm SE (b) across the three plantation types, where 0 m is forest and the rest are distances from the forest to the interior of tea plantations. * $P < 0.05$, ** $P < 0.001$.

dispersal modes encountered at CST only bird-dispersed seeds varied with distance from the forest but there was no linear decrease with distance (BtM: $\chi^2 = 6.20$, $df = 3$, $P = 0.10$, BM: $\chi^2 = 0.66$, $df = 3$, $P = 0.88$ and B: $\chi^2 = 14.2$, $df = 3$, $P = 0.002$, Figure 5a). Nearly 20% (of that found in the forest) of the BM seeds, 10% of B and less than 5% of BtM seeds reach the plantations at different distances

from the forest. In IST, seed abundances also varied across dispersal modes but no linear trend was noted (B: $\chi^2 = 15.1$, $df = 3$, $P = 0.001$, BM = NS, Figure 4b). In WST, all the dispersal modes declined with distance from the forest and showed a strong negative trend (B: $\chi^2 = 19.9$, $df = 3$, $P = 0.0001$ and BM: $\chi^2 = 18.3$, $df = 3$, $P = 0.0003$, Figure 4c).

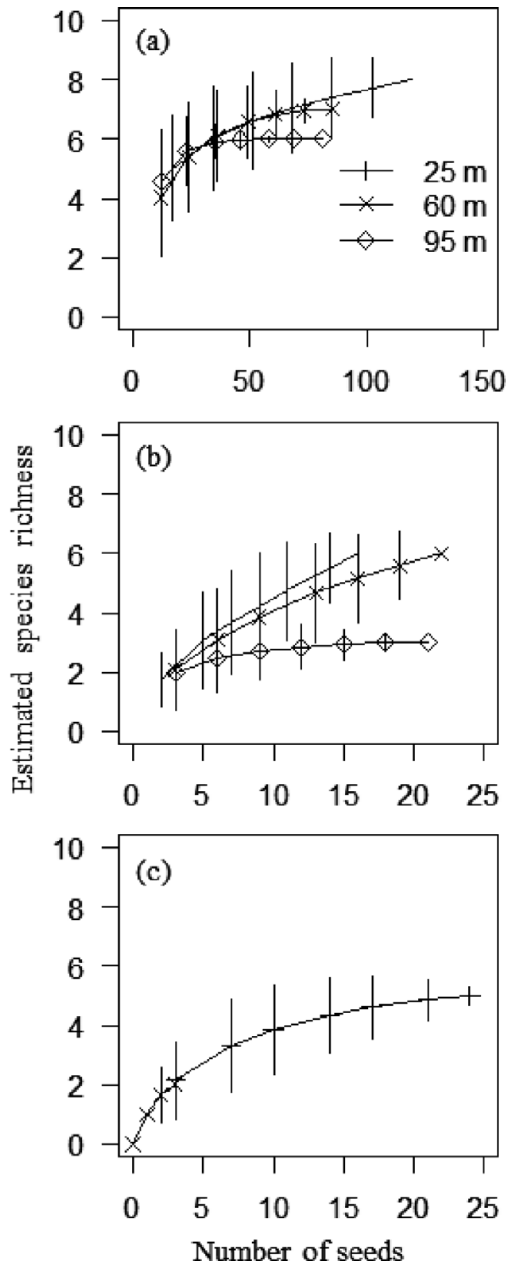


Figure 3. Estimated species richness by Coleman’s individual based rarefaction in different plantation types and within each distance interval. Continuous shade tree (a); isolated shade tree (b); without shade tree plantations (c).

DISCUSSION

Shade trees and dispersal limitation

Several factors could influence seed arrival in plantations. These could include, among others, availability of seeds in the neighbourhood, distance of such seed sources, phenology of trees in the surrounding forests, frugivore activity and availability of suitable habitats such as

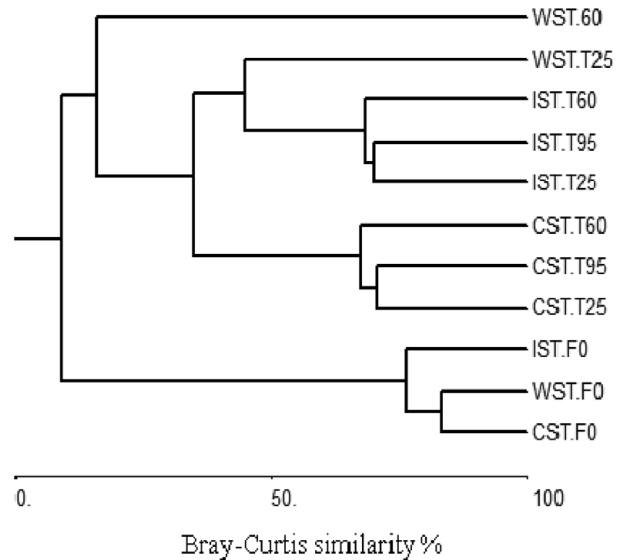


Figure 4. Dendrogram of the three plantations sampled at fixed distances. Cluster distances were calculated with the Bray–Curtis similarity index (single link) for the species composition and abundances; CST: continuous shade tree, IST: isolated shade tree and WST: without shade trees are the plantation types and F0 is forest. Within each plantation type, T25 = 25 m inside the plantation from the forest, T60 = 60 m inside the plantation from the forest and T95 = 95 m inside the plantation from the forest.

perches or remnant trees (Duncan & Chapman 1999, Galindo-González *et al.* 2000, Guevara *et al.* 2004, Holl 1998, 2002; Holl *et al.* 2000, Martinez-Garza *et al.* 2009, Zanini & Ganade 2005). In our study shade trees in the plantations was the primary factor to influence species richness and seed abundance. It increased species richness by more than three times and seed abundances by 3–30 times compared with plantations with no shade trees. In other sites, seed abundance under remnant trees was 150 times greater than in sites without perch trees (McClanahan & Wolfe 1993). In the present site such a large increase is not evident because our sampling was not specific to a shade tree and was spread out in the plantations which only gave an average input of seeds in the plantations. However, even when we compare our sample plots that were directly under shade trees with those away from it, seed input was only 16 times higher clearly indicating that there could be other reasons for low inputs.

The high-elevation wet evergreen forest of southern Western Ghats is limited in the availability of dispersers compared with other wet forest regions (Ganesh & Davidar 2001). Although it is a tropical montane area, the frugivore richness is limited to a total of only six canopy and subcanopy species and two understorey species (Ganesh & Davidar 1997, H. C. Chetana pers. obs., Raman 2006). Moreover the shade trees do not have a dense canopy nor provide edible fruits which can attract

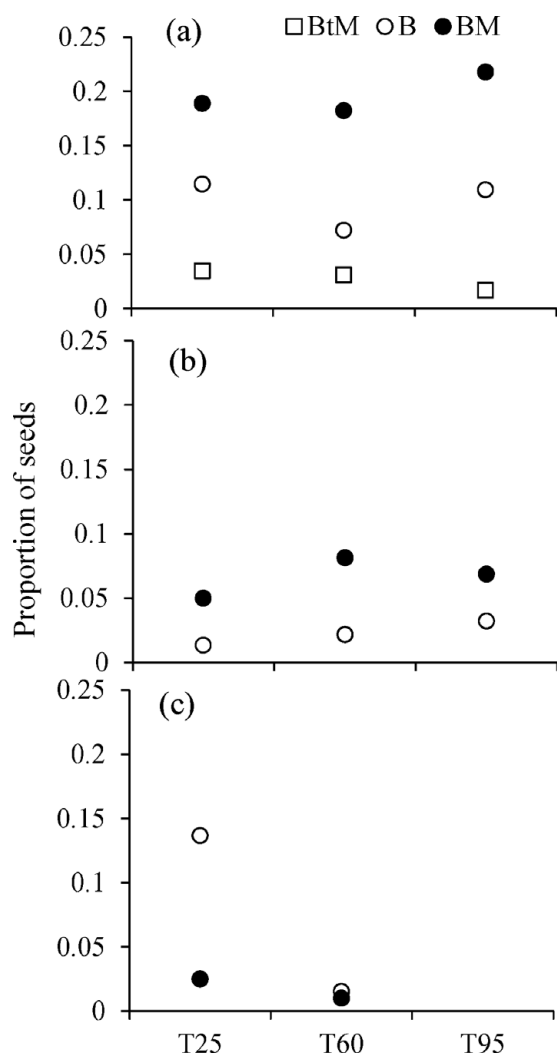


Figure 5. Proportion of seeds from the total available in the forest found in each dispersal mode across plantation types. Continuous shade tree (a); isolated shade trees (b); without shade trees (c). BtM = bat–other mammal, B = birds, BM = bird–mammal, T25 = 25 m inside plantation from the forest, T60 = 60 m inside plantation from the forest and T95 = 95 m inside plantation from the forest.

frugivores directly to the tree (H. C. Chetana pers. obs.). Nevertheless, the facilitative role of shade trees in the tea plantation in attracting canopy frugivores is important in terms of densities of shade trees. Plantations with higher densities of shade trees like CST bring in seven times more seeds than plantations with isolated trees (IST). But isolated trees are also used as stop-overs to richer habitats beyond, with the frugivores thereby dropping seeds leading to comparable species richness in the two plantation types. In contrast the limited dispersal in plantations without shade trees (WST) can be attributed to tea being maintained as a shrub, that attracts only few understorey frugivores such as Eurasian blackbird (*Turdus merula*), which is more an omnivore, and generalist canopy species like the red-whiskered bulbul (*Pycnonotus*

jocosus) that move inside the tea bushes close to the forest edge and also nest in these bushes. In general it appears that even though frugivore richness is low and dispersal limitation exists even in tea with shade trees, the facilitative role of non-native shade trees is critical in catalysing seed arrival in a frugivore-depauperate region.

Forest–tea landscape

The proximity of forests to tea plantations in increasing seed input depends on the plantation type. In WST and IST (Table 1) species richness marginally decreases with distance from forest as observed in abandoned agricultural land elsewhere in the Western Ghats (Teegalapalli *et al.* 2008, 2010) and other (Cubiña & Aide 2001). However, no such effect was seen in terms of abundance either in CST or IST, the two shade-tree plantation types. Distance had a negative effect only in WST. Such differences could be due to differential use of trees by frugivore species. Also the forest patches around the tea are separated by < 1 km and frugivores can see forest across the tea-filled space and species such as black bulbul (*Hypsipetes ganesa*) and pigeon (*Ducula badia*) fly directly over the tea with an occasional halt at the shade trees (isolated) that can be at variable distances from the forest edge. This could be a reason for fairly uniform seed input in isolated shade-tree plantations away from the forests as these are the major seed dispersers in the region (Ganesh & Davidar 1999). Moreover, the rank dominance analysis indicates *Elaeocarpus munronii* seeds to be the dominant species across all distance classes in the shade-tree tea plantations. These are all dispersed by bulbuls (H.C. Chetana, pers. obs.), which carry seeds from the fruiting trees directly to perches away from the forest and therefore can disperse the seeds at variable distances in plantations and negate any distance effect.

Unlike open pastures, tea plantations are made of closely planted tea plants that give it a closed-canopy appearance with minimum light reaching the floor and are ideal for some understorey frugivores. This microhabitat helps the understorey frugivores to move into the tea from the forest, but they do not venture far from the forest edge leading to the observed distance effect in WST with fairly high seed input at 25 m. The facilitative role of shade trees therefore not only enhances seed input into the tea but also distributes the seed rain more uniformly in the plantations.

Even though a number of dispersal modes are represented in the tea plantations, it is the bird-dispersed and bird–mammal-dispersed seeds that dominate in the tea with shade trees. The ability of shade trees to attract frugivores that bring in a select group of seeds into the tea is interesting in several ways. One of the most vagile frugivore groups in the landscape are birds that use

these shade trees and therefore bring in several bird-dispersed species. Moreover, frugivores such as black bulbul (*Hypsipetes ganesa*) and red-whiskered bulbul (*Pycnonotus jocosus*) have a tendency to fly away with seeds from the parental trees to a perch in open tea plantations where they either regurgitate or defecate the seeds. In addition even though many species have dual disperser modes such as 'bird-mammal' and 'bat-other mammal' it is the birds that disperse most of the seeds and a few are dispersed by non-flying mammals such as civets, but they are independent of perch tree availability (pers. obs.). Most of the exclusively bird-dispersed species, like members of the Lauraceae, are large-seeded species and dispersed by pigeons and hornbills (Datta & Rawat 2008, Ganesh & Davidar 2001). These are usually fewer in number in the forest (Ganesh *et al.* 1996), fruit supra-annually (Ganesh & Davidar 2005) and therefore rarely get dispersed in plantations even where shade trees are present. Whereas WST species, like *Macaranga peltata* and *Mallotus tetracocca*, are small-seeded species which are brought in by the Kerala laughing thrush (*Garrulax fairbanki*) and red-whiskered bulbul that move a short distance into WST from adjacent forests. Bats do not seem to use the tea plantations as we never encountered any temporary roosts of bats nor were they seen perching on shade trees in the plantations. Bat-other mammal-dispersed species were brought in by civets and bears which are the other dispersers of the seeds. This may be because the current choice of shade trees do not produce bat-edible fruits nor provide adequate cover for bats to roost which are essential for them to visit and use such spaces (Charles-Dominique 1986, Gorchoff *et al.* 1993, Medina *et al.* 2007, Thomas *et al.* 1988) and therefore the ability of bats to help colonize the tea plantations seems limited. Dispersal by wind is also limited as there are only few wind-dispersed species in the forest and adjoining landscape (Ganesh *et al.* 1996), and only one species was noticed in the WST habitats and one close to the forest.

Establishment of forest trees

Having shade trees within the tea facilitated a 3–30-fold rise in seed deposition from the neighbouring forests compared with places without such trees. The deposition of seeds alone is not enough for successful establishment. The seeds could be predated, the microsite may not be suitable (Dalling & Hubbell 2002), density- and distance-dependent mortality can occur under the shade trees (Janzen 1970), seedling and sapling mortality from pathogens and both vertebrate and invertebrate herbivores can limit seed establishment and survival (Chapman & Chapman 1999, Holl 2002). However, even assuming substantial loss of seeds and seedlings in the tea

to these factors there still remains a chance for some seeds to establish in many of these *Grevillea robusta* shade-tree plantations.

Since this study was conducted in a conventional tea plantation where tea leaves are plucked and the fields maintained free of weeds, very little regeneration of native species was seen. However, in an adjacent plantation which is organic and no weeding is done there is substantial regeneration of many native species recorded in this study such as *Clerodendrum viscosum*, *Maesa indica*, *Mallotus tetracoccus*, *Macaranga peltata*, *Eleaocarpus serratus*, *Litsea* spp., and large numbers of herbs and climbers (unpubl. data). When the current site was abandoned for 2 y in 1998, similar regeneration was seen (T. Ganesh per. obs.). It therefore appears that though post-dispersal factors may constrain regeneration, seedling survival is more likely to be curtailed by management practices. The low seed input into the tea from the forest is limited by dispersal even in tea with shade trees, the ability for native species to colonize the tea may therefore be a slow process initially until some native fruit-yielding species establish.

The plantations usually have *Ficus* spp., on steep rocks or planted for religious reasons, that can be excellent foci for frugivore activity even during non-fruiting periods when they can be used as a place to roost and nest. Once this is done, dispersal can speed up as noticed in an abandoned tea plantation where large numbers of native species have taken over the plantations after 17 y of abandonment with shade trees almost gone now (pers. obs.). Therefore as a strategy to recover abandoned areas, retaining shade trees and *Ficus* spp. found among the rocks and boulders in the area are important for attracting frugivores and facilitating native species colonization. In areas without shade trees we suggest limited bush clearing in the tea and planting pioneer species before the place is abandoned provided other disturbances are curtailed.

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Appendix 1. List of forest species recorded from surface soil in forests and tea plantations. The locations from where the seeds of each species were collected and their dispersal modes are also given. (F: forest; CST: continuous shade tree; IST: isolated shade tree; WST: without shade tree, Bt: bat, BtM: bat–other mammal, B: bird, M: mammal; BM: bird–mammal; P: wind/gravity dispersed).

Species		Dispersal modes	Plantation types
<i>Acronychia pedunculata</i> (L.) Miq.	Rutaceae	BtM	F/CST
<i>Agrostistachys borneensis</i> Becc.	Euphorbiaceae	P	F
<i>Ardisia</i> spp.	Myrsinaceae	BM	F
<i>Beilschmiedia wightii</i> (Nees) Benth. ex Hook.f.	Lauraceae	B	F/CST
<i>Calophyllum austroindicum</i> Kosterm. ex Stevens	Guttiferae	Bt	F
<i>Cinnamomum malabattrum</i> (Burm.f.) Bl.	Lauraceae	B	F
<i>Clerodendrum viscosum</i> Vent.	Verbenaceae	B	F/CST/IST/WST
<i>Cullenia exarillata</i> Robyns	Bombacaceae	P	F
<i>Cyclea peltata</i> (Lam.) Hook.f. & Thoms.	Menispermaceae	B	IST/WST
<i>Diospyros malabarica</i> (Desr.) Kostel.	Ebenaceae	M	F
<i>Elaeagnus</i> spp.	Elaeagnaceae	B	F
<i>Embelia ribes</i> Burm.f.	Myrsinaceae	M	F
<i>Elaeocarpus munronii</i> (Wt.) Mast.	Elaeocarpaceae	BM	F/CST/IST/WST
<i>Epiprinus mallotiformis</i> (Mueller) Croiz.	Euphorbiaceae	P	F
<i>Elaeocarpus serratus</i> L.	Elaeocarpaceae	BtM	F/CST/IST/WST
<i>Elaeocarpus venustus</i> Bedd.	Elaeocarpaceae	Bt	CST
<i>Holigarna nigra</i> Bourd.	Anacardiaceae	M	F
<i>Litsea insignis</i> Gamble	Lauraceae	B	F
<i>Litsea wightiana</i> (Nees) Hook.f.	Lauraceae	B	F/CST/IST
<i>Macaranga peltata</i> (Roxb.) Muell.Arg.	Euphorbiaceae	B	F/CST/IST/WST
<i>Maesa indica</i> (Roxb.) DC.	Myrsinaceae	B	F
<i>Mallotus tetracoccus</i> (Roxb.) Kurz	Euphorbiaceae	B	F/CST/IST/WST
<i>Mastixia arborea</i> (Wight) Bedd.	Cornaceae	B	F
<i>Milium wightiana</i> Hook.f. & Thoms.	Annonaceae	B	F
<i>Myristica beddomei</i> King	Myristicaceae	P	F
<i>Neolitsea cassia</i> (L.) Kosterm.	Lauraceae	B	F
<i>Palaquium ellipticum</i> (Dalz.) Baill.	Sapotaceae	BtM	F
<i>Piper</i> spp.	Piperaceae	B	F
<i>Prunus ceylanica</i> (Wight) Miq.	Rosaceae	B	F
<i>Rapanea wightiana</i> Mez	Myrsinaceae	B	F
<i>Calamus</i> spp.	Arecaceae	M	F
<i>Sarcandra chloranthoides</i> Gard.	Chloranthaceae	B	F
<i>Symplocos cochinchinensis</i> (Lour.) S.Moore.	Symplocaceae	B	F/CST/IST
<i>Syzygium cumini</i> (L.) Skeels	Myrtaceae	BM	F
<i>Syzygium mundagam</i> (Bourd.) Chitra	Myrtaceae	B	F/CST
<i>Toddalia asiatica</i> (L.) Lam.	Rutaceae	M	F
<i>Viburnum punctatum</i> Buch.-Ham. ex D. Don	Caprifoliaceae	BM	F
Unidentified spp.	Loranthaceae	B	F
Unidentified spp.	Unidentified		F/CST

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