Germination and growth rate of exotic plant seeds dispersed by avian communities in the Upper Nilgiris of Tamil Nadu, India.

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Abstract

Study on germination and growth rate between natural seeds and seeds collected from bird droppings was carried out. Such seeds were collected from various sites including selected bird's nests and trees. Totally twenty seeds of each plant species from natural and bird droppings were collected and the same were sown in nursery seed trays and observed for seventy one days. Seeds of five plant species namely *Cesterum aurantiacum, Phytolacca americana, Solanum mauritianum, Rubus nivus* and *R. ellipticus* were selected for this study. Significant difference was observed in germination capacity of two categories of seeds (natural and birds dropping) of *P. americana* (F=6.47 df=5 *P<0.0001774*). Maximum growth was noticed in *P. americana* both in natural and bird droppings, on the contrary, the natural seeds of *C. auranticaum* and *S. mauritianum* showed higher growth rate than the seeds collected from bird droppings. The natural seeds of *R. ellipticus* and *R. nivus* and seeds collected from bird droppings did not show any germination.

Key words: bird dropping, exotic plants, germination, nursery seed tray, seeds dispersal.

INTRODUCTION

Seed germination represents a risky stage of transition which totally dependents on environmental conditions and it is the most vulnerable stage in plant development from seed to seedlings (Harper, 1977). Different environmental factors may determine the seed germination, apart from essential combination of temperature, moisture and light (Mayer and Mayber, 1989; Baskin and Baskin, 1998). In addition, the chemical environment surrounding the seed must be suitable and the presence of allelic chemical inhibitors released by the surrounding vegetation may also determine the germination success (Rice, 1984; Friedman, 1995). Apart from that the seeds of some of the species may undergo dormancy and thus do not form a persistent seed bank. Sometimes the germination is also limited by various climatic hazards.

A large fraction of living plants produce fruits that attract animals. By consuming them, animals can spread the seeds to more or less distant sites from the parent plant, and thus contributing to plant regeneration and colonization of new sites (Willson and Traveset, 2000). Both the pulp and seeds of fruit determine the fruits that are to be selected by the frugivores and gramnivores. Fruit consumers, specifically, may show preferences for fruit traits depending upon their size, shape, colour, chemical composition, etc., and they have specific morphologies and physiologies of the digestive tract that affect the survival probability of the ingested seeds in different ways (Herrera and Pellmyr, 2002). Seed traits are under further selective pressures imposed by a number of biotic (antagonistic fungi, insects and microbes) and abiotic factors (e.g. light, temperature, rainfall, etc.) that influence the dormancy period, germination time and/or future seedling growth, which can ultimately determine germination and seedling success of the plant. Seed treatment in the digestive tract of the animal (which includes pulp separation from seeds and treatment of the seeds) can determine the capacity of seeds to germinate and, thus, is one of the components of disperser's effectiveness that may be crucial for the population dynamics of many fleshy-fruited plant species. The relationship between fruit chemistry, morphology and the type of dispersers are crucial in understanding the co-evolution of plant-frugivore

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interactions (Murray, 1994; Cipollini and Levey, 1997; Wahaj *et al*., 1998; Wenny, 2001; Alcántara and Rey, 2003). Present study deals with a comparative study on germination and growth rate between natural and bird dropping seeds.

METHODOLOGY

Totally two hundred bird droppings were collected from four bird species *viz.* Red-whiskered bulbul (*Pycnonottus jocosus*), Oriental white eye (*Zosterops palpebrosus*), Pied bush chat (*Saxicola caprata*) and Jungle myna (*Acridotheres fuscus*). The droppings were washed with clear water to segregate the undigested seeds to find out the plant species fed by the birds. Fine sieved filters were used to clean the droppings and utmost care was taken during wash to see that no seed was missed. The filtered seeds were dried with blotting paper and segregated species-wise until the nursery experiment was started. To identify the segregated seeds, fruits and berries of plant species in the study area were collected and the plant species were identified using the Flora of the Presidency of Madras (Gamble, 1935). Comparison of the seeds was made between the seeds collected from both droppings and wild. Twenty seeds of each from natural and bird droppings were selected and also representing each plant species (*Cestrum aurantiacum, Phytolacca americana,Solanum mauritianum,Rubus nivus and Rubus ellipticus)* and the same were sown in nursery seed trays. Germination and growth rate were recorded at room temperature and natural daylight conditions. Nursery seed trays were checked daily to record the number of seeds germinated at the initial stage, and later the height of each seedling of natural as well as bird dropping seeds were measured in order to find out the growth rate of natural and bird dropping seeds. The criteria used to consider seed germination was emergence of radicle from each seed. Natural and seeds of bird droppings belonged to each plant species were labeled for regular monitoring. Statistical analyses were done using PAST Statistical software. Analysis of variance (ANOVA) was tested to determine the difference in growth rate of exotic plant species between natural and seeds collected from bird droppings.

RESULTS

Germination and growth rate of natural and seeds collected from bird droppings which belonged to exotic plant species were tested by establishing nursery plot near to the study area. Totally seventy one days of observation was made for this purpose. The seeds collected from bird droppings which belonged to *P. americana* showed considerably higher growth than the natural seeds ($ü^2$*=0.21379 df=1 P=0.99896*) (Fig.1). Similarly, the seeds of the plant species, *S. mauritianum* shows that the seed collected from bird droppings showed sizably higher growth than the natural seeds ($ü^2$*=0.79848 df=1 P=0.93865*) (Fig.2). On the contrary, the germination and growth rate of natural seeds of *C. aurantiacum* were more than the seeds collected from bird dropping ($ü^2$*=0.96498 df=1 P=0.96963*) (Fig.3).

shows significant differences between the germination percentages of two categories of seeds (natural and birds dropping) of *P. americana* (*F=6.47 df=5 P<0.0001*). The maximum growth was noticed in *P. americana* both with natural seeds and the seeds collected from the bird droppings, 7.45cm and 19.21cm, respectively. It was interesting to note that *C. auranticaum* showed that the growth rate was higher in natural seeds that of collected from bird droppings. The seeds of *Solanum mauritianum* collected from bird droppings showed moderate growth increase when compared to natural seeds. The seeds of normal and droppings belonged to *R. nivus* and *R. ellipticus* did not germinate (Table1).

DISCUSSION

Table 1. Comparative status of germination and growth rate of selected plant species between natural seeds and seeds collected from bird droppings

Plant species	Total days	Growth rate of natural Seeds	Growth rate of Dropping seeds (cm)	Mean ± Standard	
				natural Seeds (n=20)	Droppings seeds (n=20)
Cestrum aurantiacum	71	0 – 5.48	0 – 3.865	2.74±1.64	1.58±1.23
Phytolacca americana	71	0 – 7.45	0 – 19.21	3.68±2.27	7.38±5.04

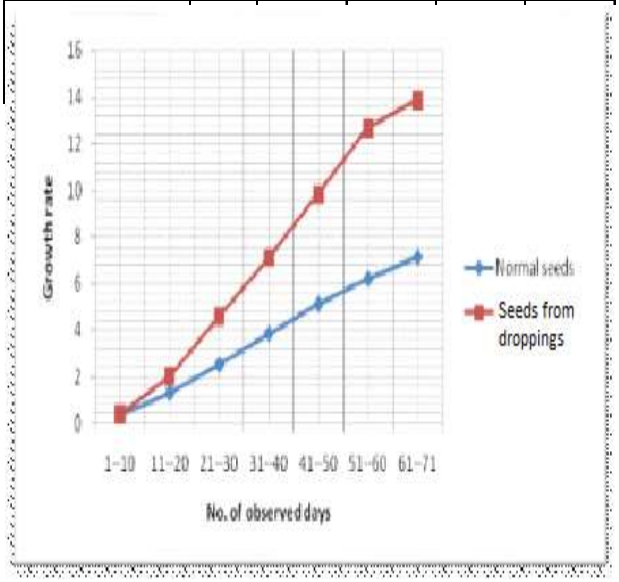

Fig. 1. Germination and Growth Rate of *Phytolacca Americana* between Natural Seeds and Seeds Collected from Bird Dropping

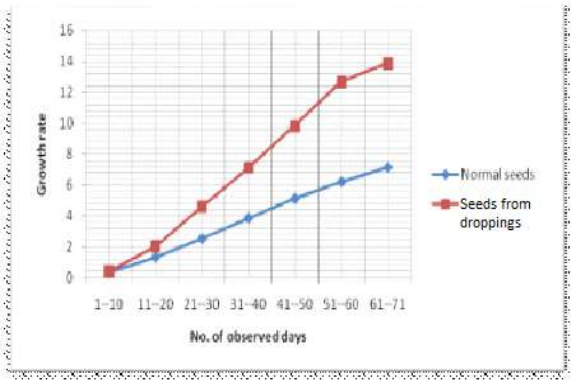

Fig. 2. Germination and growth rate of *Solanum marutianum* between natural seeds and seeds collected from bird droppings

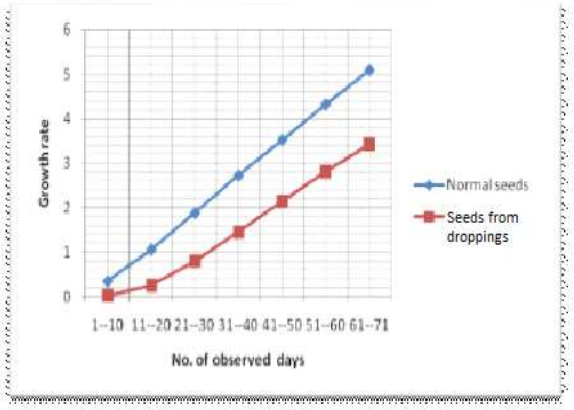

Fig. 3. Germination and growth rate of *Cestrum aurantiacum* between natural seeds and seeds collected from bird droppings

Dispersal of plants by animals (Pijl, 1972; Willson *et al.*,1990) is most important in succession and restoration of the habitats. Frugivorus birds are essentially seed dispersal agents in an ecosystem. When a bird eats a fruit it will pass through the alimentary canal and the seeds get treated. Our study deals with plant and bird interactions, particularly concerning seed dispersal in the disturbed southern montane wet temperate forest patch of the upper Nilgiris, and such studies have not been dealt with so far. Many earlier studies have dealt with the dispersal of native plant species by wild animals (Balasubramanian and Bole, 1993; Balasubramanian, 1995). The data provide first hand information on germination and growth rate of five exotic plant species namely *Cestrum aurantiacum, Phytolacca americana, solanum mauritianum,Rubus nivus and Rubus ellipticus* in degraded shola forest patch. The fruits of these exotic plants are highly preferable food plant species for avian community in the study area.

Among the seeds of five plant species, the seeds of three plant species germinated and grown in the nursery plot. The natural seeds as well as seeds collected from bird droppings of two plant species namely *Rubus elipticus* and *Rubus nivus* did not germinate. This might mainly be because of their dormancy, hard seed coat as well as minute seeds when compared to seeds of other plant species. Generally hard pod coat plays a key role in the seed germination process. This could be the reason for the failure of germination of both these natural seeds and seeds collected from bird droppings in the nursery plots.

Solbrig and Cantino (1975) stated that the seeds are protected by hard resistant coats that might delay germination and prevent them from being destroyed when passing through the digestive tract of animals. Sometimes these seeds may germinate and grow in natural condition and not in the nursery plots due to various edaphic factors. Since no previous studies were attempted on these plant species, our observation throws light on the necessity of future studies on these two species.

It was recorded that the germination and seedling growth were higher in the seeds collected from bird droppings than the natural seeds of *Phytolacca americana* and *Solanum mauritianum*. This could be mainly due to smaller size of the seeds. Seed size is an important factor in determining the dispersal distance and growth, and survival of seedlings (Augspurger, 1983; Foster, 1986). Seed size in fleshy fruits determines the palatability of fruits (Hegde *et al.*, 1991). Smaller seed size or fewer seeds per fruit is associated with more pulp which enhances the palatability and increases the probability of dispersal. In both dispersal modes, smaller size of seeds results in greater dispersal distance. In the present study, the pattern of seed size from the Upper Nilgiris is examined as to how seed size is related to germination and viability.

Germination and growth rate of seeds collected from bird droppings of *Phytolacca americana* were higher than other two plants. This was mainly because of the seed treatment that was happened when the seeds were passed through alimentary canal of some bird species. These studies were found that many of these seeds remained viable, though dormant, after passing through the digestive tract. Further, these seeds showed higher germination rates. Therefore, *Prosopis flexuosa* seeds consumed by cattle showed a pronounced loss of endocarps, reduced viability and increased germination capacity as compared with seeds consumed by other mammals. Most seeds of *Prosopis ruscifolia* that were consumed by horses did not separate from their endocarps, and

germinated rapidly in the cattle dung (Eilberg, 1973). Like this *Phytolacca americana* seeds would be treated more than other two plant seeds when it passes trough alimentary canal of bird species.

In *Cestrum aurantiacum*'natural seeds' germination and growth rates were higher than seeds collected from the bird droppings. This was mainly because of the seeds are getting damaged (sometimes broken) when they passes through the alimentary canal of bird's digestive system. The damaged seeds with hard seed coats may lose seeds viability. However, seeds passing through the rumen quickly may not be scarified and hence have low germination capacity. On the other hand, manually pulp removed natural seeds were sown without any damages. Once scarified in the rumen, additional time in the rumen may be detrimental to seed viability and germination capacity of the seeds (Burton and Andrews, 1948; Yamada and Kawaguchi, 1972; Welch, 1985; Simao Neto *et al*., 1987; Jones and Simao Neto, 1987). Apart from this the size of the *Cestrum aurantiacum* seeds are bigger than all other plants. Sometimes the larger seeds get damaged more than the smaller seeds when they pass through the alimentary canal of the animal tract. Our study concludes that due to large size, the seeds of *Cestrum aurantiacum* were damaged more heavily than that of other smaller seeds. Therefore the germination as well as growth of *Cestrum aurantiacum* were more in the natural seeds than that of bird dispersed seeds.

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