The use of artificial fruits to study frugivory and seed dispersal by birds

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ABSTRACT

Birds have excellent vision and use it in foraging for food. Artificial fruits made from modeling clay were used to assess bird fruit preferences and the abundance of avian frugivores. Using this technique, complications arising from the variability of natural fruits could be minimised. In this preliminary study, four comparisons were made: the preference between red and black fruits; between small sized (7 mm in diameter) and large sized (14 mm in diameter) fruits; between artificial fruits displayed among ripe and unripe natural fruits; and between fruits displayed at the forest edge and forest interior. Colour, size and the presence of real ripe fruits had no significant impact on the proportion of artificial fruits with peck marks after 7 days, but fruits in the forest interior received significantly fewer pecks than those on the forest edge. This suggests that habitat has a greater influence than fruit characteristic in determining the frugivory rates. Depending on the shape and size of the peck marks left on the artificial fruits, some frugivores could be identified. Differences between the marks on edge and interior fruits suggested that there was no overlap between the species of birds pecking fruits in these two habitats.

INTRODUCTION

Frugivory is common in the tropics and vertebrates are known to aid in seed dispersal for many woody plants (Corlett, 1998). Birds, in particular, are one of the main primary seed dispersal agents for many plant species (Arruda et al, 2008).

Frugivore colour preference has an effect on the fruits perceived and eaten (Alves-Costa & Lopes, 2001). Other than that, the maximum gape width of the bird also limits the fruits it can eat. The use of artificial fruits is a way to manipulate the fruit traits one by one and in doing so, be able to understand the impact of fruit preferences and habitat on seed dispersal. Oil-based modeling clays were used as they are durable, non-toxic, can be shaped into the desired size with different colours, and provide a record of the birds that peck at them. Red and black are the commonest fruit colours seen to be most eaten by birds.

The main objective of this preliminary study was to assess how artificial fruits can be used in place of real fruits in studying frugivory and seed dispersal in Singapore.

MATERIAL AND METHODS

Study area

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Field work was conducted at the secondary forest along Kent Ridge Road. The periphery of the forest is dominated by a shrub, *Ficus grossularioides*, while the main canopy of the forest interior is dominated by 12-m tall *Adinandra dumosa*, with a sparse understorey of *Adinandra, Caryota mitis, Hevea brasiliensis, Rhodamnia cinerea*, and *Syzygium grandis* saplings.

**Sampling design**

In this experiment, two colours of oil-based, non-toxic and water-proof modeling clay were used — red and black. Thirty *Capsicum frutescens* (chilli) were initially tied to *Melastoma malabathricum* shrubs using green, plastic-coated, twist ties. A total of sixty chilli-shaped artificial fruits were made (thirty of each colour) and hung on the same tree. However, the chillies dried out too quickly and also no pecks were found on the clay models. Bunches of small grapes (*Vitis vinifera*) were also tried with the same results. Similar trials were carried out with the red fruits of *Psychosperma macarthurii*. This time the red fruits were pecked by birds.

To mimic the red fruits of *Psychosperma macarthurii*, the artificial fruits were moulded into a spherical shape, 7 mm in diameter. Ten sites at the periphery of the forest were selected. Each site was at least 200 m away from each other. Thirty red artificial fruits were placed in four of the sites while thirty black artificial fruits were placed in another four. Thirty red spherical fruits with a diameter of 14 mm were placed in the remaining two sites.

To test if the presence of ripe and unripe fruits makes a difference in the rate of frugivory, twelve red artificial fruits were placed on *Psychosperma macarthurii* trees with ripe fruits and the rest with unripe fruits. The frugivory rate at the edge and interior of the forest was tested with sixty red artificial fruits were placed on the understory plants in the interior of the forest.

**Data analysis**

Results were tabulated on the seventh day and the $\chi^2$ test was used to compare the proportions of artificial fruits with pecks in each paired component. The analyses included the different fruit colours, fruit sizes, fruits displayed with ripe and unripe real fruits and fruits displayed on the edge and in the interior of forest. It is important to note that missing artificial fruits were assumed to be eaten by the birds.

**RESULTS**

After 7 days, out of two hundred and forty red and black artificial fruits, 47.5% were pecked, 45.8% had no peck marks and only 6.67% were missing. The mean ($\pm$ 1 SD) of red artificial fruits being eaten at a site is 16 $\pm$ 4 and for the black artificial fruits, it is 16.5 $\pm$ 2.52. Red and black fruits were found to be consumed equally (Red vs. Black artificial fruits, $\chi^2 = 4.039$, df = 3, $P=0.257$).

There was also no significant difference between fruits of different sizes. Fruit diameter of 7 mm or 14 mm were pecked equally (Big vs. Small artificial fruits, $\chi^2 = 1.483$, df = 1, $P=0.223$). The number of pecks on artificial fruits on both ripe and unripe natural fruits did not show any significant difference (Ripe vs. Unripe fruits, $\chi^2 = 1.303$, df = 3, $P=0.728$) as birds visited the artificial fruits even among unripe fruits.

The peck marks were classified into three different categories. First, shallow pecks with obvious beak shape. Second, narrow gape width with serrations. Third, numerous thin pecks with most of the clay pecked off. Most of the fruits found at the periphery of the forest were categories one and two. Category one consist of *Pycnonotus goiavier* (yellow-vented bulbul),
*Eudynamys scolopacea* (Asian koel) and *Treron vernans* (pink-necked green pigeon). *Dicaeum cruentatum* (scarlet-backed flowerpecker) leaves peck marks like category two.

Artificial fruits which were placed in the interior of the forest, with one exception, were category three. The exception might be the doing of a squirrel. There was a significant difference in the number of peck marks found in the interior and the edge of the forest (Interior vs. Periphery of forest, $\chi^2 = 18.07$, df = 1, $P < 0.001$). More peck marks were found at the edge of the forest.

![Figure 3. Types of peck marks found on fruits.](image)

**DISCUSSION**

From the results, we can conclude that avian frugivores view artificial fruits as a type of natural fruit. This is because similar results were recorded in both the actions of artificial and natural fruits. This is probably because birds rely on visual cues while foraging, since the artificial fruits have no scent or taste, most of the mammals would not be attracted to them.

Birds did not show any preference towards red or black-coloured fruits. Bright red fruits stand out among the green foliage to both human and bird vision, while black fruits are much less conspicuous. The fact that birds showed no preference for red over black in this and other similar experiments, suggests that contrast with foliage is not an important factor in fruit choice.

In this study, it was shown that the size of fruits did not have a significant influence on frugivory. However, among the larger fruits, there were more shallow pecks with obvious beak
shape. It is speculated that *Pycnonotus goiavier*, *Eudynamys scolopacea* and *Treron vernans* might be the frugivores for these marks.

It was put forward by Gomes *et al.* (2006) that birds with either high or medium seed dispersal potential were more likely to produce viable seeds. Low seed dispersal potential would be the rest of the birds which consume fruits at a less than occasional rate and destroy high proportion of seeds through feeding or digestion.

Artificial fruits located at the periphery of the forest have a higher rate of consumption as compared to the interior. Galetti *et al.* (2003), proposed that artificial fruits were less conspicuous and there were fewer avian frugivores in the interior of the forest. Consumption of fruits, therefore, depends on the abundance of fruit eating birds.

Using modeling clay allows basic identification of frugivorous birds and can give an assessment of the availability of potential seed dispersal agents in a particular habitat. However, birds probably learn rapidly that the artificial fruits are not edible and will then avoid them. If this is the case, it would mean that the results reflect only the abundance of naive birds and may underestimate the potential for seed dispersal.

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**REFERENCES**


