# POTENTIAL DISPERSAL OF *CECROPIA HOLOLEUCA* BY THE COMMON OPOSSUM (*DIDELPHIS AURITA*) IN ATLANTIC FOREST, SOUTHEASTERN BRAZIL

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## RÉSUMÉ

Plusieurs auteurs ont reconnu le rôle des vertébrés comme disperseurs de graines de *Cecropia*. Nous avons comparé sous des traitements différents (lumière et absence de lumière) les taux de germination de graines de *Cecropia hololeuca* provenants des fèces de *Didelphis aurita* à ceux de graines issues de fruits prélevés sur des arbres. En outre, les graines des arbres ont été séparées en trois goupes pour des tests de germination : fruits frais, 15 jours après collecte et 30 jours après collecte. La germination sous lumière a eu plus de succès que sans lumière, pour tous les groupes (fruits frais, 15 jours après collecte et 30 jours après collecte, et fèces). Le taux de germination des graines provenant des fèces ont été plus proches de ceux de 30 jours après collecte que des autres groupes. Ces résultats suggèrent que *D. aurita* se nourrit au sol de fruits de *C. hololeuca.* La possibilité que *D. aurita* disperse les graines dans des zones au-delà des arbres parentaux, jointe au fait que les taux de germination similaires entre graines issues des fèces et graines provenant de fruits récoltés impliquent que *D. aurita* serait un disperseur potentiel de *C. hololeuca.*

## SUMMARY

Several authors have recognized the role of vertebrates as seed disperser of *Cecropia.* Germination rates of *Cecropia hololeuca* from scats of *Didelphis aurita* and from trees were tested in different treatments (light and dark). In addition, seeds from trees were separated in three groups for germination tests: fresh-fruit, 15 days after collection, 30 days after collection. Seed germination under light were more successful than in dark for all groups (fresh-fruit, 15 days after, 30 days after, and from scats). Germination rate of seeds from scats were closer to germination rates of the 30 days after collection group than other groups. These results insinuate that *D. aurita* feeds on fruit of *C. hololeuca* on the ground. The possibility that *D. aurita* disperses seeds to areas beyond parent trees, plus the similar germination rates of seeds from scats with seeds from fruiting trees imply that *D. aurita* is a potential disperser of *C. hololeuca.*

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## INTRODUCTION

Seed dispersal by animals can increase reproductive success of plants either by removing seeds from high-mortality habitat, by dispersing seeds to adequate sites for germination (Fleming & Sosa, 1994; Howe, 1993; Julliot, 1994) and by enhancing seed germination. In the Neotropics, studies on lizards and frogs (Fialho, 1990), marsupials (Medellin, 1994), bats (Fleming & Heithaus, 1981) and primates (e.g. Julliot, 1994; Passos, 1997) suggest that dispersal by zoochory enhances seed survival and germination.

The pioneer *Cecropia* species have a wide distribution in South America (Berg, 1978) and their seeds are animal-dispersed: *C. obtusa* and *C. sciadophylla* are dispersed by birds, marsupials, bats and primates (Charles-Dominique, 1986); *C. obtusifolia* by marsupials, primates and carnivores (Estrada *et al.*, 1984; Medellin, 1994); *C. peltata* by marsupials, bats, primates and rodents (Fleming & Williams, 1990); and *C. concolor* by birds (Silva, 1980). Otherwise, *Cecropia* fruits are frequent items in the diet of frugivorous vertebrates (Estrada *et al.*, 1984; Fleming & Williams, 1990), and can be considered keystone species (Medellin, 1994). However, seed consumption does not necessarily imply seed germination. Studies of seed dispersal rarely determine seed viability after dispersal.

*C. hololeuca* Miq. (Urticales - Cecropiaceae) occurs in States of Bahia, Espírito Santo, Rio de Janeiro, Minas Gerais and São Paulo (Brazil). This species is an evergreen and light-demanding tree, with height of 6-12 m and logs with 20-30 cm of diameter. Each kilogram of seeds counts 900 000 units approximately, and the phenology data indicate that *C. hololeuca* flourishes in more than a time a year, but with larger intensity in the months of October and November (Lorenzi, 1992). We don't know any study about frugivory of this species, neither have observed any animal species consuming the fruits of *C. hololeuca* in the nature. Moreover, we have observed fruits of *C. hololeuca* on the ground, being some whole and other partially eaten.

The common opossum, *Didelphis aurita* Wied-Neuwied, 1826 (Didelphimorphia - Didelphidae), is an endemic widely distributed species in the Atlantic forest (Cerqueira, 1985). This species occurs in primary and secondary forests (Fonseca & Robinson, 1990), feeding on a large range of food types, including many fruits (Grelle 1996; Santori *et al.*, 1995), which makes *D. aurita* a potential disperser.

Here we report the results of seed germination of *C. hololeuca* Miq. (Urticales - Cecropiaceae) collected from scats of *D. aurita,* and from fruiting trees at the same site. Our objective in this study was to determine potential of *D. aurita* as a disperser of *C. hololeuca* seeds. We compared the viability of seeds of *C. hololeuca* collected from scats of *D. aurita* with the viability of seeds collected from trees.

## STUDY AREA

Field research was performed in the Parque Estadual do Rio Doce, State of Minas Gerais, Brazil (19° 48'-19° 29' S, and 42° 38'-28' W). The climate of the park is tropical humid with mean annual temperature of 22 °C. The vegetation of the site is tropical semi-deciduous forest (Stallings, 1989). Additional details about the study site are given in Stallings (1989).

## METHODS

Scats of *D. aurita* were collected between March and October, 1994. Seeds found in faecal samples were washed in tap water, dried, counted and the percentage of damaged seeds determined. Seeds were put to germinate in Petri dishes with paper filter moistened with distilled water (25° ± 2 °C), and separated in two treatments: light or darkness. Four replicates with 25 seeds each were done for the treatments (light and dark). We collected seeds from 20 fruits of two trees as control and put them to germinate in three groups: one group immediately (hereafter fresh-fruit), other group fifteen days after (hereafter 15d), and another group 30 days after (hereafter 30d). In all treatments four replicates with 25 seeds were used, and the observations were carried out for 30 days.

Differences between treatments were tested using Kruskal-Wallis test (Sokal & Rohlf, 1981). This methodology implies some assumptions relative to the collection of seeds from two trees: (1) no phylogenetic effects, (2) no spatial effects due to disease, and (3) no temporal effects due the season.

We used $\chi^2$ test, with Yates' correction for continuity (Sokal & Rohlf, 1981) to compare percentages of germinated seeds among fresh-fruit, 15d, 30d and seeds found in scats. This last test was done to examine which experimental group fits better with germination of seeds from scats.

## RESULTS AND DISCUSSION

From March to October 1994, 968 seeds of *C. hololeuca* were collected from the scats of six individuals of common opossum. Seeds of *C. hololeuca* made up to 53 % of scat weight (Table I). Indices of damaged seeds were generally low (Table I).

TABLE I

*Number of seeds, percentage of damaged seeds, and percentage of seeds weight for sample (pooled by month) of* Cecropia hololeuca *collected in scats of* Didelphis aurita *from Parque Estadual do Rio Doce, Minas Gerais, Brazil in 1994.*

| Month | Number of scats | Number of seeds | Mean (SD) of seeds/scat | % of damaged seeds | % of seeds in total scat weight |
|---|---|---|---|---|---|
| March | 1 | 17 | 17 | 0 | 5.0 |
| July | 2 | 143 | 71.5 (91.3) | 2.6 | 19.1 |
| September | 3 | 501 | 167.0 (174.3) | 14.0 | 24.5 |
| October | 2 | 307 | 153.5 (71.4) | 2.3 | 53.0 |

Seed germination under light was more successful than in dark for the fresh-fruit group ($U = 16.0$, $DF = 3$, $p = 0.02$, Table II), 15d group ($U = 16.0$, $DF = 3$, $p = 0.02$, Table II), 30d group ($U = 16.0$, $DF = 3$, $p = 0.02$, Table II) and for seeds from scats ($U = 16.0$, $DF = 3$, $p = 0.02$, Table II). However, a subtle difference exists among the germination rates submitted to the two treatments (light and dark), if we consider the groups of origin of the seeds (fresh-fruit, 15d, 30d and from scats). All seeds of these groups germinated more under the light, however, the tests with seeds 15 days and 30 days after crop, and those with seeds coming from scats of *D. aurita*, indicated that these seeds germinated practically only under the light (Table II).

TABLE II

*Number of seeds germinated (mean ± SD) of* Cecropia hololeuca *collected in scats of* Didelphis aurita *and from fruiting trees in the Parque Estadual do Rio Doce, Minas Gerais, Brazil in 1994.*

| | Fresh-fruit | | 15 days | | 30 days | | Scats of *D. aurita* | |
|---|---|---|---|---|---|---|---|---|
| Replicates | Light | Dark | Light | Dark | Light | Dark | Light | Dark |
| 1 | 20 | 06 | 20 | 03 | 10 | 0 | 12 | 0 |
| 2 | 18 | 07 | 17 | 02 | 14 | 03 | 11 | 1 |
| 3 | 23 | 07 | 18 | 01 | 12 | 02 | 13 | 1 |
| 4 | 16 | 03 | 22 | 01 | 08 | 01 | 15 | 0 |
| mean ± SD | 19.3 ± 2.9 | 5.7 ± 1.9 | 19.3 ± 2.2 | 1.7 ± 0.9 | 11.0 ± 2.6 | 1.5 ± 1.3 | 12.7 ± 1.7 | 0.5 ± 0.6 |

Although there was no difference in germination rate under light treatments between seeds from scats and seeds from fruiting trees ($\chi^2$ with Yates correction, $p > 0.05$ for all groups), germination rates of seeds from scats were closer to germination rates of the 30d group than to those of other groups (Table III).

TABLE III

*Percentage of seeds germinated of* Cecropia hololeuca *collected in scats of* Didelphis aurita *and from fruiting trees in the Parque Estadual do Rio Doce, Minas Gerais, Brazil in 1994.*

| Fresh-fruit | | 15 days | | 30 days | | Scats of *D. aurita* | |
|---|---|---|---|---|---|---|---|
| Light | Dark | Light | Dark | Light | Dark | Light | Dark |
| 77 | 23 | 77 | 07 | 44 | 06 | 51 | 02 |

Although this is a short-term study, the presence of seeds of *C. hololeuca* in scats from March to October suggests a constant availability of *Cecropia* fruits at the study site. As in other studies (Estrada *et al.*, 1984; Fleming & Williams, 1990; Medellin, 1994), seeds of *Cecropia* represent an abundant food item. Their high rate of consumption by *D. aurita* plus the low rate of seed damage suggest that the common opossum may be an important disperser of this plant species.

According to the Janzen-Connel model (revised in Clark & Clark, 1984) seeds deposited around parent trees have less opportunity for germination than seeds dropped away of the seed-shadow because of density-dependent predation and parasitism. Furthermore, *Cecropia* are known to germinate only under light (Alvarez-Buylla & Garcia-Barrios, 1991). Therefore, seeds of *Cecropia* need to germinate in gaps, away from parent trees. However, fruits of *C. hololeuca* are heavy, with seeds strongly arrested in the pulp, what hinders the split of the seeds soon after the fruit has dropped (Q. Garcia pers. obs.). Our results point out that the seeds of *C. hololeuca* placed to germinate 15d after its crop, practically only germinate under the light. Thus, dispersal appears important to seed survival in this species.

Because the quality of the site to be dispersed appears to be important to *Cecropia* seeds, some features of disperser can increase the success of seed germination. Opossums are habitat generalists, scansorial with high mobility which make them superior relative to other dispersers of *Cecropia* (see Medellin, 1994 for a recent review). In fact, *D. aurita* is nomadic and occurs in a variety of habitats (Cerqueira, 1985; Fonseca & Robinson, 1990; Gentile & Cerqueira, 1995; Grelle, 1996). These characteristics and its potentiality to remove the seeds for sites more suitable for germination, suggest the importance of the didelphids as seed-dispersers (e.g. Medellin, 1994).

As already noticed (e.g. Figueiredo & Longatti, 1997; Lombardi & Motta Junior, 1993), germination rates of seeds from scats are lower than germination rates of seeds collected from fruits. However, seeds of the 30d group germinated as well as those from scats (Table III). Then, it is possible that the time between the collection of the seeds and the germination experiments can influence the germination rates, masking the results of the comparisons among the different germination rates.

Recently, Medellin (1994) discussed the role of *D. marsupialis* as disperser of *C. obtusifolia,* suggesting that the common opossum search for fruits, even climbing fruiting trees. However, the similarity between germination rates of seeds from scats and seeds from 30d group insinuates that *D. aurita* can feed on seeds of *C. hololeuca* on the ground. Two additional informations confirm this interpretation. First, from 52 captures of *D. aurita* only 2 % were in traps above 5 m, confirming the cursorial habit of common opossum in Parque Estadual do Rio Doce (Grelle, 1996). In addition, experiments with digestibility of fruit, meat and shrimp show the high digestive efficiency of *D. aurita* (Santori *et al.*, 1995), indicating that the bulk of food items passed through the gut in 24 hours (R. Santori, pers. comm.).

In conclusion, the similar germination rates of seeds from scats and 30d seeds from fruiting trees, and the possibility of the common opossum disperse seeds to favorable habitats away from parent trees, imply that *D. aurita* is a potential disperser of *C. hololeuca.*

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