Seed predation and flower visiting by *Epicroesa* sp. (Lepidoptera: Heliodinidae) on a rare Seychelles tree.

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Key words: mutualism, *Pisonia sechellarum*, pollination, seed predation

Abstract:

The interaction between the moth *Epicroesa* sp. and the rare Seychelles tree *Pisonia sechellarum*, is outlined. Seed predation by *Epicroesa* caterpillars is quantified and the incidence of the moth and other insects visiting the *Pisonia* flowers is discussed. This preliminary study suggests an antagonistic mutualism between tree and moth.

Introduction

From July to September 1990, the Oxford University Silhouette Expedition surveyed the unique flora of a small area of mist forest, dominated by the rare tree species *Pisonia sechellarum* Friedmann, 1987 (Nyctagynaceae), on Silhouette Island in the Seychelles (Oxford University Silhouette Expedition 1990). When several *P. sechellarum* trees flowered towards the end of the project, the opportunity was taken to observe insect visitors, and seed predation was quantified. From this work, a close interaction between a microlepidopteran and the tree was found. The moth is an undescribed species of *Epicroesa* (Lepidoptera: Heliodinidae); a small genus made up of five other species from Australia, New Guinea and Japan. The moth is the most frequent visitor at the flowers, and the moth larvae feed on the flowers and seeds of the tree.

Pisonia is a widespread genus of about 35 species (Steenis 1972) *P. sechellarum* was described after its discovery in 1983 between Mont Dauban and Mont Pot a Eau on Silhouette Island (Friedmann 1986). While it may have occurred previously on the island of Mahé at the summit of Morne Blanc (Robertson 1989), the few trees on Silhouette are the only individuals of this species known to exist today. This unique stand of about 200 trees covers an area of 0.48 hectares near the main ridge of the island (a detailed description of the site is given in Oxford University Silhouette Expedition 1990).

Phelsuma 3 (1995): 31-36

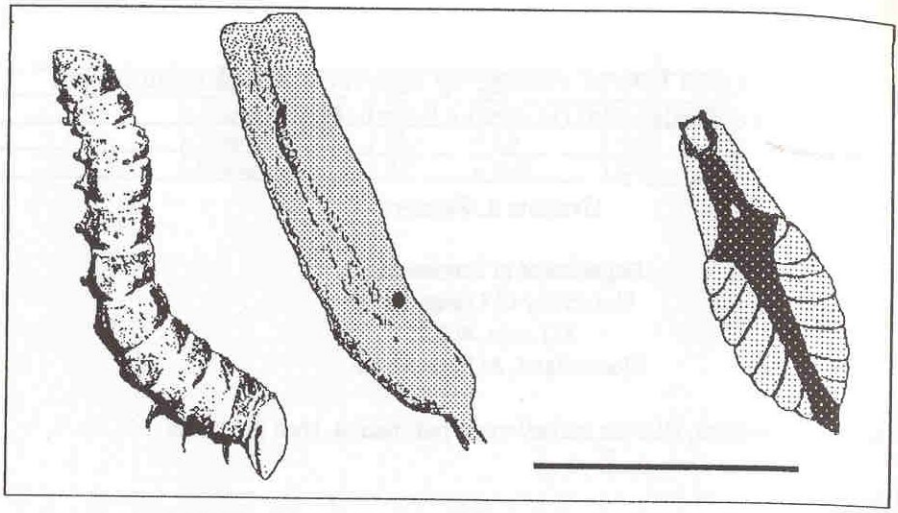

Fig. 1. *Epicroesa* larva, exit hole in *Pisonia sechellarum* fruit and *Epicroesa* pupa. Scale bar: a) = 2mm, b) = 8mm, c) = 2.5mm

The pale yellow flowers, each 4-6 mm long, grow in clusters of 50 to 300, arranged in a panicle at an apical shoot of the tree (Robertson 1989; Gerlach 1994). A single cluster contains either all male or all female flowers, and the tree relies on insects for pollination. At the beginning of September (the end of the expedition) the most mature fruits were green, cylindrical and up to 50mm long. Each fruit contained one seed.

Methods

Four flower clusters, two male and two female, were observed from 1800h (sunset) to 0700h (one hour after sunrise) on the 8th/9th of August 1990. During this time, no insects were observed visiting the flowers. A second night visit between 1900h and 2300h on August 17 also found no nocturnal flower visitors. On September 6, a cluster of female flowers was observed for three hours commencing at 0800h. The species and the time or arrival and departure of each insect to and from the cluster were recorded. From these data, the number of visits and the average time spent by each insect at the cluster were calculated. The inaccessibility of male flowers prevented direct observations of a male cluster. Instead, insects present on three male clusters were collected by surrounding each cluster with a transparent plastic bag and shaking the insects off the flowers. Another 5 clusters of female flowers were also sampled in this way. All 8 clusters were sampled on August 31 and later sorted.

Two hundred fallen fruits were collected from the forest floor, and then cut open using a scalpel. A record was made of the number of fruits containing a larva or showing signs of previous occupancy, as well as the number of intact fruits. All larvae were the distinctive white and black-banded caterpillars of *Epicroesa*, ten of

which were reared through to maturity in Petri dishes. Frass, seed attack and a neat round exit hole through the fruit wall were used as indicators of previous occupancy by *Epicroesa*. A similar record was made for a cluster of 32 fruits, which were still growing on a tree in the area of the fallen fruits (due to the rarity of *P. sechellarum*, no other clusters were sampled). All fruits observed remaining on the trees in this area were of similar maturity. Additionally, the number of female flowers growing in five different flower clusters was recorded, as well as the number of fruits remaining in four fruit clusters.

Results

Regular visitors to the female flowers were *Dichaetomyia fasciculifera* (Stein, 1910) (an endemic muscid fly), *Epicroesa* sp. and several species of *Drosophila*. *Drosophila* were always present in high numbers (7-13 individuals), but remained on the clusters for long periods (generally more than 2 hours). Nevertheless the number of visits to and from the flowers was still relatively high (9 times in 3 hours). *D. fasciculifera* and *Epicroesa* sp. both made a large number of visits (18 and 7 respectively) and stayed on the cluster only 5 to 10 minutes at a time. It should be noted that *Dichaetomyia* is strongly attracted to humans, and it is likely that some individuals alighted on the flowers as a consequence of the observer's presence. A single visit was made by the pyralid moth *Bradina aureolalis* Joannis, 1899. Another unidentified dipteran species also visited the flowers during the 3 hour study.

The number of insects collected from male and female flower clusters was low (Table 1.). *Epicroesa* sp. was the only species present in large numbers on both male and female flowers, representing 77% of flower visitors. *Drosophila* sp. and

Table 1a. Insect visitors on 3 clusters of male flowers

Species	Cluster 1	Cluster 2	Cluster 3	Total
Drosophila spp.	0	0	1	1
Epicroesa sp.	1	5	5	11
B. aureolalis	0	0	1	1
Others	0	1	1	2
ant colonies	1	0	1	2
Epicroesa larvae	0	2	0	2

Table 1b. Insect visitors on 5 clusters of female flowers

Species	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Total
Drosophila spp.	2	2	0	1	0	5
Epicroesa sp.	17	8	0	0	0	25
B. aureolalis	1	0	1	0	0	2
Others	0	0	0	0	0	0
Ant colonies	1	0	0	1	0	2
Epicroesa larvae	16	3	0	1	5	25

B. aureolalis were both found on male and female flowers. though only one individual of each species was found on male flowers. *D. fasculifera* did not occur on any of the flowers sampled. The results suggest that *Epicroesa* sp. is a major pollinator of *P. sechellarum.*

Epicroesa was the only seed predator or frugivore present in the *Pisonia* fruits, and no parasites emerged from *Epicroesa* larvae collected from fruits reared through to adults. Differences between the extent of *Epicroesa* seed predation in fallen fruits and those remaining on the tree were striking. First, those still growing on the tree were significantly larger than the fallen fruits (t=43.54 in a two sample t-test: $p<0.01$) and second, the fruits remaining on the tree were generally intact (5 out of 32 infected). whilst many of the fruits collected from the ground were infected (142 out of 200 infected). A comparison of the proportion of infected fruits on the tree and on the ground gives $\chi^2=34.95$: $p<0.01$. The tree, therefore. seems to abort infected fruits at an early stage of development. Out of 166 caterpillars found in aborted fruits, 45 (or 27%) were dead, probably from starvation.

The results of flower and fruit counts for different trees show that a low proportion of flowers (an estimated 25.3 out of 128, or 20%) develop into viable fruits (table 2). It is evident from the fruit dissections that much of this failure rate is due to attack by *Epicroesa* larvae, with 71% of fallen fruits and 16% of remaining fruits infected. Furthermore, many larvae were found feeding on the flowers themselves, with as many as 16 caterpillars on a single female cluster (Table 1.).

Table 2. Results of flower and fruit counts on different trees (the no. of intact fruits was estimated as 84% of each cluster, being the proportion found in dissected fruits of cluster 8).

Cluster	1	2	3	4	5	6	7	8	9	mean
No. flowers	315	78	84	48	117	-	-	-	-	128
No. fruits	-	-	-	-	-	16	41	32	31	30
Estimated no. of intact fruits	-	-	-	-	-	13.5	34.6	27.0	26.2	25.3

Discussion

The data on flower visits and seed predation, together with additional observations, have been used to construct the following life history of *Epicroesa* sp. The female moth flies from one flower cluster to another, feeding on nectar. Alighting on a female flower, it lays an egg into the ovary (it may feed before or after this act). Although oviposition was not observed at male flowers, caterpillars were present on one male flower cluster. If the female flowers are young, the larva emerges from the ovary and spins a protective tent of silk over a number of flower heads on which it feeds. Caterpillars on the male cluster also spun silk tents. If, however, the flowers are more mature, the fruit develops as normal around the larva. In this case, the larva feeds on the developing seed, and the tree aborts the fruit

before it is fully developed. The larva leaves the fallen fruit via a small exit hole bored through the fruit wall.

Once on the ground (either from the aborted fruit or from dropping on a silk thread from the flower cluster), the caterpillar may crawl a considerable distance to a vertical structure such as a plant stem. The larva then ascends to a pupation site, usually on the surface of a leaf. where it secures itself with a cradle of silk. Details or mating are unknown. This life history has probably evolved from one in which the larva were phytophagous. A similar (perhaps the same) species of *Epicroesa* has been observed feeding on the leaves of *Pisonia grandis* Br., 1810 on Aride Island (Gerlach pers. comm.). As nothing is known of the flowering period of *P. sechellarum, Epicroesa* sp. could also feed on the leaves of this species outside the flowering season.

If *Epicroesa* is pollinating the flowers of *P. sechellarum* (and a further study will be required to confirm this), the moth shares many characteristics of *Greya politella*, a relative of the yucca moths which is a pollinating seed-predator of *Lithophragma* (Pellmyr & Thompson 1992). Like the *G. politella* interaction, the costs of *Epicroesa* sp. to the tree may still outweigh the benefits of pollination if copollinators are involved. In this respect, the interaction differs from obligate mutualisms such as yuccas and yucca moths (Keeley *et al.* 1984; Addicott 1986; Powell 1992) or figs and fig-wasps (Janzen 1979).

The question then arises whether the moth is a threat to the survival of the tree. In this short study, the moth did seem incapable of over-exploiting its food resource, with a number of viable fruits developing, even though many more were destroyed. Due to the nature of the site, any of the remaining viable fruits drop onto bare rock or are eaten by rats. However, while only one *Pisonia* seedling was found in the forest, difficulties of germination may be offset by the longevity of the tree. Side-shoots from fallen trees were common, and in many cases these had developed into mature trees themselves (in one instance, six large trees were found to be offshoots of a single original trunk).

Acknowledgements

I am indebted to the sponsors of the Oxford University Silhouette Expedition and my colleagues on the expedition, all of whom are acknowledged in full elsewhere. I am also very grateful to Dr G. Robinson of the Natural History Museum, London, who identified the moth as *Epicroesa*. Myron Zalucki and David Walter made comments on an earlier draft.

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Pisonia sechellarum forest