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Yeast communities of the cactus *Pilosocereus arrabidae* as resources for larval and adult stages of *Drosophila serido*

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Abstract

The feeding behavior of *Drosophila serido* on the yeast communities of necrotic stem tissue of *Pilosocereus arrabidae* were studied in a sand dune ecosystem of Rio de Janeiro, Brazil. The prevalence of cactophilic yeasts including *Pichia barkeri*, *Candida sonorensis* and *Geotrichum* sp. in the crops and external surfaces of *D. serido* reflected its association with the cactus habitat. The effective number of yeasts vectored on the surface of flies was higher than that in the crops. Also overlap between the yeasts from stems and from crops was partial suggesting selective feeding by the flies in the substrates visited. The females had a higher effective number of yeast species and a lower similarity than males with the yeast community of *P. arrabidae*. This was probably related to the search for oviposition sites by females. The presence of *Pichia thermotolerans*-like and *Pichia amethionina* var *pachycereana* in the flies, but not in *P. arrabidae* stems, indicated that *D. serido* was not limited to this cactus species. The larvae and adults lived in different patches with the adults feeding in patches with higher yeast species richness. The larvae had a narrower feeding niche and higher overlap with *P. arrabidae*, and preferred *P. barkeri* and *Pichia cactophila* as food. Adult flies fed on patches with the most frequent yeasts except for *P. cactophila*. *Pichia caribaea* was found in higher frequency in the adult crops than in the stems. Our data suggested that there was food selection and diet partitioning between adult and larval stages of *D. serido*.

Introduction

Cactus rots are discrete, ephemeral patches of habitat for yeasts. This requires constant dispersal of yeasts and that is done mainly by *Drosophila* Fallen (Diptera: Drosophilidae)(Ganter 1988). The yeasts provide stimuli and food for both larval and adult stages of the flies by producing volatile cues (Fogleman 1982; Foster & Fogleman 1993; Starmer & Fogleman 1986) and by transforming the substrate into concentrated nutrients (Sang 1978). The community composition of the yeasts associated with the cactus *Pilosocereus arrabidae* (Lem.) Byles and Rowl in the restinga ecosystems of Southeastern Brazil appears to be strongly dependent on insect vectors (Rosa et al. 1994). Yeast communities from *P. arrabidae* necrotic stems differed from those isolated from columnar cacti in other geographic regions mainly in the predominance of *Pichia barkeri* Phaff, Starmer, Tredick-Kline and Aberdeen, and the presence of a new biotype of the *Sporopachydermia cereana* complex and *Pichia caribaea* Phaff, Starmer, Lachance, Aberdeen, and Tredick-Kline. This yeast community also differed from yeasts found in fruits, flowers and the feeding site of the moth *Sigelgaita* (Henrich) sp. (Lepidoptera: Phycitidae) larvae in *P. arrabidae*. *Drosophila serido* Vilela and Sene is the only drosophilid species occurring in necrotic tissues of *P. arrabidae* in this ecosystem, and it was shown to actively vector cactophilic yeasts (Rosa et al. 1994). *Drosophila serido* is a cactophilic species of the *buzzatii* cluster of the *mulleri* complex in the *repleta* group (Ruiz et al. 1982). This species is endemic to South America, has been collected in areas of open vegetation like caatinga, dunes, and chacos, and is always

associated with cacti (Ruiz et al. 1982; Sene et al. 1982; Vilela et al. 1982).

The cactophilic-yeast-*Drosophila* system provides an excellent condition for the study of niche breadth and habitat partitioning by *Drosophila* (Starmer & Fogleman 1986). Cactophilic *Drosophila* species differ in the yeasts that attract adults and also in the suitability of different yeast species for the support of adult and larval growth and development. *Drosophila mojavensis* Patterson larvae did not contain a random sample of yeasts present in their substrate and this could have been due to differential digestion and/or selective feeding in patchy substrates (Fogleman et al. 1981). Larval feeding is relevant to all aspects of insect population biology. Among cactophilic *Drosophila* only larvae from polyphagous species are selective, and ecological specialists tend to be random feeders (Fogleman et al. 1982). This paper describes the yeast community of *Drosophila serido*, defines the feeding behavior of its larval and adult stages in the cactus *P. arrabidae*, and the preferences for different yeasts by adults and larvae of this fly.

Material and methods

Samples of *Pilosocereus arrabidae* were collected between August 1991 and October 1992 from Restinga de Barra de Marica in the state of Rio de Janeiro. Samples were taken by removing several grams of decaying stems from the same individuals of *P. arrabidae* that flies were collected from. Samples of necrotic stems were collected aseptically in sterile plastic bags, transported to the laboratory on ice, and processed within a maximum of 5 hours after collection, as described in Rosa et al. (1994). Colonies of each type of morphology were counted, representatives of each picked from the plates, and pure cultures obtained.

Adult flies were captured from the substrates by aspiration or with sterile plastic bags. Vectored yeasts were isolated from 132 adult flies by allowing them to walk for 8–12 hours on plates containing acidified YMA (0.3% yeast extract, 0.3% malt extract, 0.5% peptone, 1.0% glucose, and 2% agar adjusted to pH 3.7–4.0 with 1.0 N HCl and supplemented with 100 mg/L of chloramphenicol). Yeasts grown on these plates should also include as minor components yeasts regurgitated by the flies and viable yeasts in fecal pellets. These flies were then recovered for identification. Eighty-six more flies were surface sterilized in the field by immersion in 70% ethanol for 1 min and transported to the laboratory within 2 hours on ice in tubes containing sterile distilled water. These flies were identified and crops dissected from them were streaked on YMA. Larvae of *D. serido* were collected directly from necrotic stems in the field with sterile forceps, surface sterilized by immersion in 70% ethanol for 1 min, their intestinal tracts removed, and streaked out on YMA plates. Plates were incubated and yeasts isolated as noted above.

Yeast characterization was done by standard methods as recommended by van der Walt & Yarrow (1984) and Lachance et al. (1988), and the DBB test as described by Hagler & Mendonça-Hagler (1991). Assimilation of ethyl acetate was done as in Rosa et al. (1992). Identifications were done according to the keys of Kreger van Rij (1984), Lachance et al. (1988) and Barnett et al. (1990). Two or more cultures identified as one species from the same sample were considered as a single isolate.

Niche breadth of fly adults and larvae were calculated by the average niche width measure of Hulbert (1978). Niche overlap was obtained by using Morisita's index of similarity (Morisita, 1971). The effective number of species was calculated by the formula $e = (\sum_{i}^{k} \rho_{ik}{}^{2})^{-1}$ extensively used in yeast ecology (Foster & Fogleman 1993; Lachance & Starmer 1982).

Results

Table 1 shows the frequencies of isolation of yeast species vectored by adults, in crops of adults, and intestinal tracts of larvae of *Drosophila serido*, and for the same necrotic stem of *Pilosocereus arrabidae* from which the insects were collected. *Pichia barkeri*, *P. cactophila*, *Candida sonorensis*, *Geotrichum*, *Myxozyma mucilagina* and *Sporopachydermia* sp A were prevalent species representing more than 80% of the total isolates in necrotic stems of *Pilosocereus arrabidae*. The effective number of species in necrotic tissues was 6.9. The effective number of yeast species in necrotic tissues with adult flies was higher (e = 6.3 in 36 samples) than that in stems where only larvae were encountered (e = 2.05 in 8 samples).

The most frequently vectored yeast isolates from adult flies included *P. barkeri*, *C. sonorensis* and *Geotrichum* sp., making up almost 50% of the total of the isolates from both male and female flies. The effective number of yeast species vectored by males