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First record of *Drosophila parthenogenetica* and *D. neomorpha, cardini* group, Heed, 1962 (*Drosophila*, *Drosophilidae*), in Brazil.

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The *cardini* group of the Quinaria section of the genus *Drosophila* is composed of 16 Neotropical species. The two focal species of this report, *Drosophila parthenogenetica* and *D. neomorpha*, are included in this group, and are placed in the *cardini* subgroup with seven other species: *D. polymorpha*, *D. cardinoides*, *D. cardini*, *D. neocardini*, *D. acutilabella*, *D. bedicheki* and *D. procardinoides* (Heed and Krishnamurthy, 1959; Heed, 1962; Heed and Russell, 1971; Wilder *et al.*, 2003). The group is characterized by medium-sized flies with a shiny thorax (Vilela *et al.*, 2002). Different species of the group display different abdominal pigmentation patterns (Hollocher *et al.*, 2000a, b), different degrees of divergence and population structure (Wilder *et al.*, 2003; Wilder *et al.*, 2004) as well as different abilities to colonize multiple niches (Rhode and Valente, 1986; Machado *et al.*, 2001). We have been investigating the southern Brazilian Drosophilid communities since the 1990's as a system for understanding the impact of territorial range expansions. In this article, we report the movement of two species of the *cardini* group, *D. parthenogenetica* and *D. neomorpha*, into Brazil and discuss the potential impacts of these range expansions may have on the existing Drosophilid communities.

Drosophilid samples were obtained from collections of adults over fruit and /or vegetable baits in traps in both Atlantic and Amazonian forests in Brazil. The Atlantic sites were within forest in a secondary stage of regeneration at Caldas da Imperatriz (27° 44.480'S; 48° 48.440'W), Joinville (26° 17.150S; 49° 01.00'W), and Campeche Island (27° 41.310' S; 48° 28.880'W), all in the Brazilian State of Santa Catarina. This region is within the transition between subtropical and temperate climatic zones (Moreno, 1961), and, thus, has well-defined seasons with temperatures near 0°C commonly measured during the winter months (June, July, and August) and temperatures reaching 40°C during the summer (December, January and February). The Amazonian sites were at Caxiuana station (S 01° 44.258'; W 51° 27.352') within the northern Brazilian State of Pará, Urucu in the state of Amazonas (S 08° 17.150'; W 35° 0.200') and Alta Floresta in the state of Mato Grosso (S 09° 53.020'; W 56° 14.380'). These central and northern Brazilian regions exist within a tropical climate such that there are not well-defined seasons, with temperatures varying between 25°C and 40°C all year.

At the Atlantic forest site from Caldas da Imperatriz and Campeche Island, we caught three and ten individuals of *D. parthenogenetica*, respectively. This collection brought together *D.*

willistoni, *D. polymorpha*, *D. sturtevanti*, *D. sellata*, *D. malerkotliana*, *D. simulans*, *Zaprionus indianus*, *D. griseolineata*, *D. atrata*, species from *repleta* and *tripunctata* groups, as well as other less frequent species of Drosophilidae. At the Amazonian forest sites we found two, five and four individuals of *D. parthenogenetica* at the sites in Para, Mato Grosso, and Amazonas States, respectively. In Figures 1 and 2 we show, respectively, the external terminalia, and the *aedeagus* (male internal terminalia) of *D. parthenogenetica* (compared with Heed and Russell, 1971).

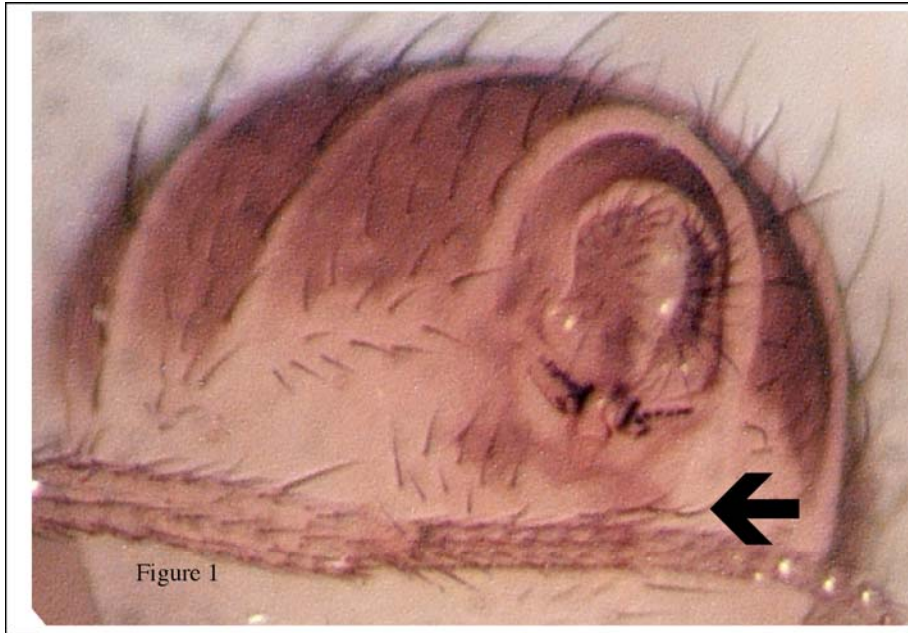


Figure 1. Frontal view of the external terminalia of *D. parthenogenetica*. Notice that the *surstyli* (arrow) are not in a goggle-shape as in *D. polymorpha* (Vilela *et al.*, 2002), but in a hook-shape.



Figure 2. Frontal view of the external terminalia of *D. neomorpha*. Notice the shape of the *surstyli* (arrow). They are composed of two separated rows of teeth, the anterior being the shorter of the two.

Twenty individuals of *D. neomorpha* were detected in the Amazonian rainy season samples (April, 2002) at Para State and five at Mato Grosso. They were caught together with *D. willistoni*, *D.*

paulistorum, *D. tropicalis*, *D. equinoxialis*, *D. sturtevanti*, *D. prosaltans*, *D. sellata*, *D. malerkotliana*, *D. simulans*, *Zaprionus indianus*, as well as *D. parthenogenetica* and other less frequent species of Drosophilidae. *D. neomorpha* was also collected at Santa Catarina State in a Joinville Atlantic Forest sample (May, 2003) together with *D. willistoni* subgroup, *D. simulans*, *D. guarani* subgroup, *D. saltans* subgroup, *D. polymorpha*, *D. neocardini*, as well as other less abundant species of Drosophilidae. In Figures 3 and 4 we show, respectively, the external terminalia and the *aedeagus* of *D. neomorpha* (compared with Heed and Russell, 1971; Vilela *et al.*, 2002).

Figure 3. a: Lateral view of the *aedeagus* of *D. parthenogenetica*, where it is possible to visualize the wide membranous sheath (arrow) in both ventral and dorsal sides; 3b: Lateral view of the *aedeagus* and *aedeagal apodema* of *D. parthenogenetica*; bar = 0.1mm.

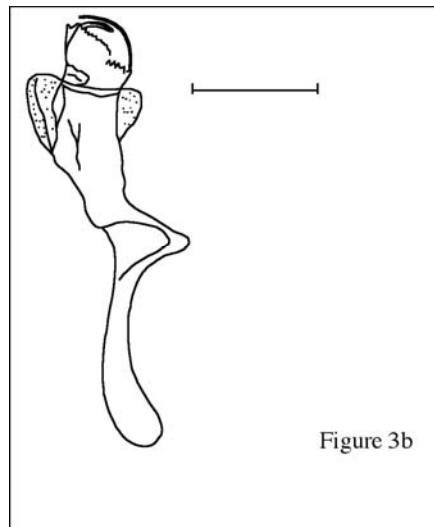


Figure 3b

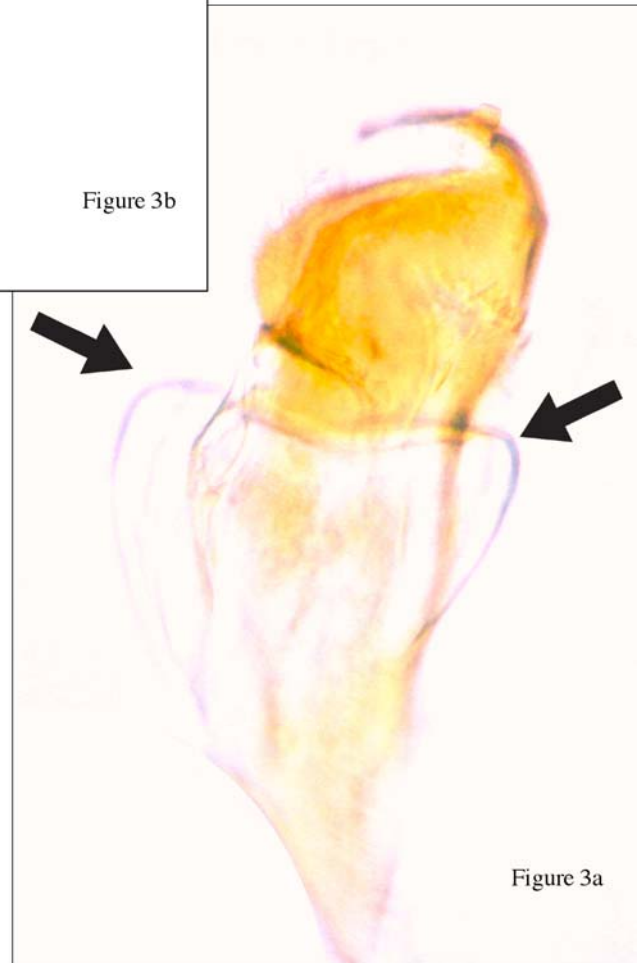


Figure 3a

Previous reports indicated that both of these species were distributed from central Mexico to northern South America (Heed, 1963). Therefore, our collections of *D. parthenogenetica* and *D. neomorpha* from the Amazonian and especially the Atlantic forest sites represent significant range expansions for both species. Our initial detection of these two species was made via sequencing of the mitochondrial *cytochrome B* and adjacent DNA regions (Brisson *et al.*, unpublished data) as well as mitochondrial

16S rRNA and the nuclear gene *yellow* (Penton, *et al.*, unpublished data). In addition, we confirmed their species identifications by male terminalia analysis.

Since *D. parthenogenetica* was initially described as native to Central America and northern South America (Heed, 1963) and now has been found in the state of Santa Catarina in Brazil, we hypothesize that it has expanded its range via northern South America to northern and southern Brazil. We have been making extensive detailed collections in the Atlantic forests of Santa Catarina for the last five years and analyzing the species collected using both internal male terminalia

morphology and chromosomal polymorphism (De Toni *et al.*, 2001b, c). We have not found *D. parthenogenetica* in these collections previously. Therefore, it is likely that this species has arrived in southern Brazil in the last five years or was at a density that was below detection previously. We project that the species will continue southward into the most southern Brazilian state (Rio Grande do

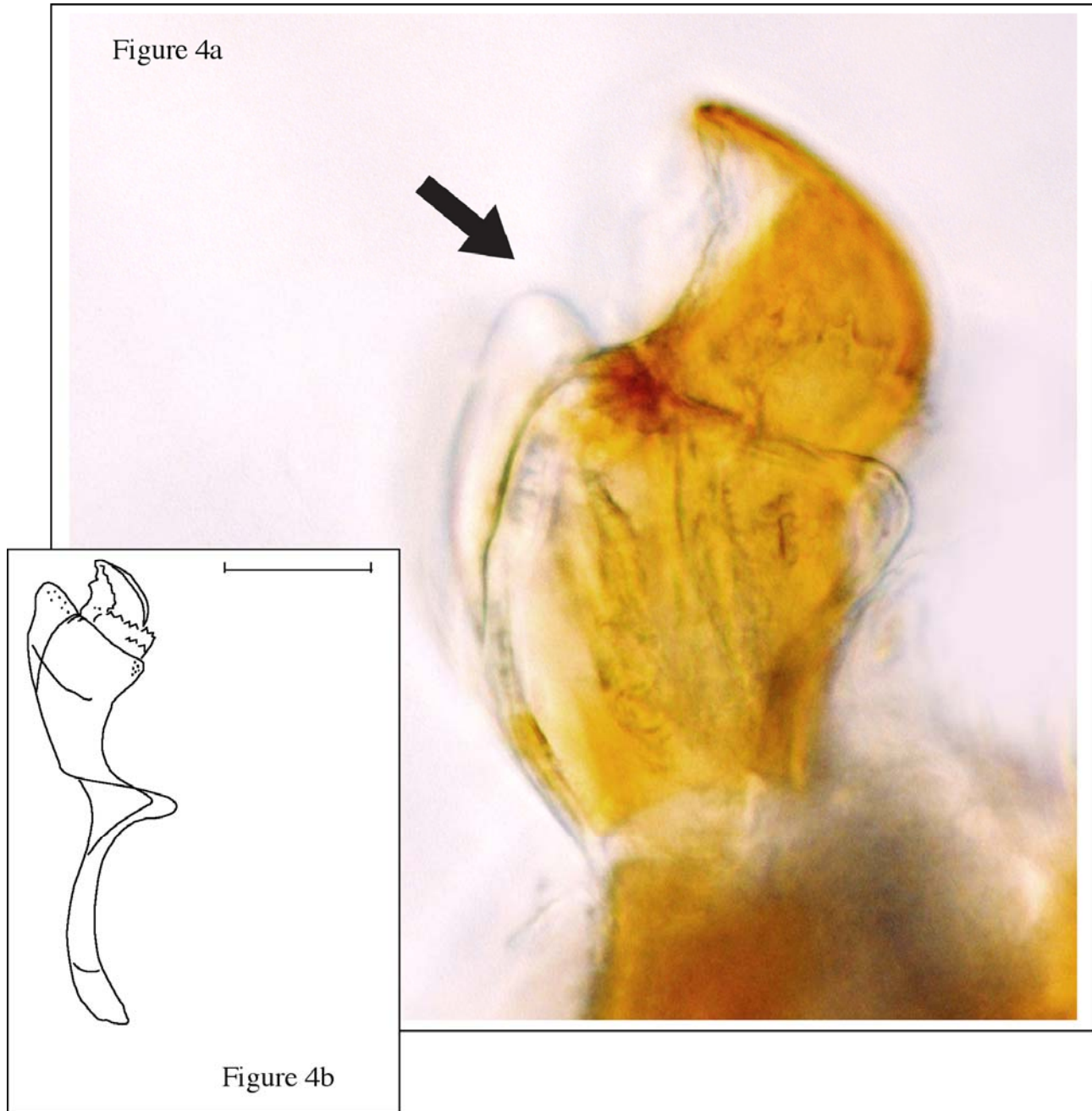


Figure 4. a: Lateral view of the *aedeagus* of *D. neomorpha*. The arrow points to the angle formed between the ventral membranous sheath and the sharp end at the top of the “head” of the *aedeagus*. This angle is smaller than the one observed in *D. polymorpha* (Heed and Russell, 1971) which is almost 180°; 4b: Lateral view of the *aedeagus* and *aedeagal apodema* of *D. neomorpha*; bar = 0.1mm.

Sul), because of the lack of barriers and the continuity of the habitat between these states. Other species of Drosophilidae, such as *D. malerkotliana* (Sene *et al.*, 1980; Martins, 2001) and *Zaprionus indiannus* (De Toni *et al.*, 2001a; Castro and Valente, 2002), have been described first in the Santa Catarina State and after some months were then detected in Rio Grande do Sul.

D. neomorpha is also not reportedly a species native to Brazil (Heed, 1963). We hypothesize that it arrived in the northern Brazilian states recently, and we expect that it already occupies a large portion of the Amazon forest, sharing an ecological niche with *D. polymorpha*, its closest relative. Vilela *et al.* (2002) described the geographical distribution of *Drosophila* of the *cardini* group in morphoclimatic domains of Brazil with very detailed drawings of male terminalia. We believe that the *D. polymorpha aedeagus* of a holotype collected in Bertioga, Sao Paulo State (Southeast region), described in Vilela *et al.* (2002) is actually a *D. neomorpha aedeagus* according to our comparisons made with Heed's drawings (1963). However, interestingly, the *epandrium* and the surstyli are very similar to those of *D. polymorpha*. This combination of morphological characters could be evidence of introgression or it could reflect a wide range of morphological variability in *D. neomorpha* previously undescribed. We favor the latter hypothesis, because multiple molecular markers have consistently placed these morphologically unique individuals into the *D. neomorpha* species categories (Penton, *et al.*, unpublished data). Given this result, it is important that the specimens of *D. polymorpha* collected earlier in various regions of Brazil should be re-examined to determine if any are in fact *D. neomorpha*.

Throughout the years, populations of the four species of the *cardini* group (*D. polymorpha*, *D. cardinoides*, *D. cardini* and *D. neocardini*) that are commonly distributed throughout Brazil have been studied to elucidate the characteristics that allow them to exploit various habitats, such as chromosomal inversions (De Toni *et al.*, 2001b, c) and abdominal pigmentation (Da Cunha, 1949; Heed, 1963; Rhode and Valente, 1986; Valente and Araújo, 1991; Machado *et al.*, 2001; Brisson *et al.*, 2004). It appears that *D. parthenogenetica* and *D. neomorpha* are now sympatric with these four species that have traditionally been found throughout Brazil. *D. parthenogenetica* and *D. neomorpha* occupy very similar, if not identical, ecological niches that overlap with *D. polymorpha* and *D. neocardini*, and both exhibit similar abdominal pigmentation adaptations to temperature and humidity (Penton *et al.*, unpublished data). This raises questions regarding how and when this territory expansion occurred and what route it took. Of special concern is whether their presence represents significant new competitive interactions with their previously resident close relatives.

Interestingly, the recent expansion of *D. parthenogenetica* and *D. neomorpha* into Brazil is part of a greater influx of new arrivals into the south Brazilian Atlantic forest *Drosophila* community over the last few decades. This trend includes the invasion and expansion of *D. malerkotliana* with the subsequent displacement of the *D. willistoni* group species in certain parts of their ranges (Sene and Val, 1977; Martins, 2001) and the first register of six new species from the *Sophophora* subgenus (Doge *et al.*, 2004). It is evident that the equilibrium of these *Drosophila* guilds has been recently disrupted, yet the long-term impact this will have is yet to be revealed. Further studies of the dynamics of these Drosophilid communities will be important to understand what new interactions may be occurring between the different species and the evolutionary and ecological factors that may be critically important in shaping diversity in these Amazonian and Atlantic forests.

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Mortality patterns in *Drosophila buzzatii* lines selected for wing length and developmental time.

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Introduction

Intrinsic mortality patterns become evident when the external mortality factors are removed as in laboratory rearing conditions. Mortality can be affected directly or indirectly by selection regimes (e.g., Foley and Luckinbill, 2001). Besides, genetic correlations among traits are a central feature in quantitative genetics and also provide a parameter to measure indirect responses to selection in other traits, sharing genes with the true target of selection (Roff, 1996). This approach is fruitful in experiments aimed to address indirect effects of artificial selection.

In the present study, we investigated the intrinsic mortality patterns in *Drosophila buzzatii* lines selected for wing length (WL) and developmental time (DT) (Cortese *et al.*, 2002). These lines were previously selected for body size and developmental time, two traits involved in a trade off. Three sets of lines were selected for reduced developmental time, the first was also selected for shortened wing length (S lines), *i.e.*, in the same direction of the trade off, the second was selected for increased wing length, *i.e.*, in the opposite direction of the trade off (L lines), and finally F lines were not selected for wing length. In response to selection, the lines have dramatically diverged for both traits (Cortese *et al.*, 2002), with S lines showing the strongest response. However, no response was observed for developmental time in L lines, whereas wing length in F lines, did not diverge from the control. These results are consistent with the hypothesis that both traits are related in a trade-off (Cortese *et al.*, 2002) and now we evaluate the indirect effect of artificial selection on mortality. All selection lines were compared for age-specific mortality rate at 25°C in order to test whether or not they responded to selection on either body size or developmental time.