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Scientific Note

Surprising diversity of stink bugs (Hemiptera: Pentatomoidea) in a Brazilian ocean beach drift: results of a rapid survey

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Abstract. The insect drift is a natural phenomenon characterized by the passive movement of insects through air or water currents, which influences their dispersal. The phenomenon of insect drift in ocean beaches represents one of the best-known cases. One of the prominent insect group associated with ocean beach drifts is the Heteroptera, commonly known as true bugs, stink bugs, and water bugs. In this brief communication, we present the diversity of stink bugs (Pentatomoidea) obtained from a rapid survey on an insect drift event at Campeche Beach, Florianópolis, Brazil. The survey was conducted on December 02, 2021, along a transect of ~550 meters in the shoreline. A total of 363 individuals were collected. From these, 35 species, 29 genera, and three families were identified. Two species represent undescribed taxa. We found several species that can be considered rare in entomological collections, such as *Copeocoris truncaticornis* (Stål, 1865) (Hemiptera: Pentatomidae), *Capivacius bufo* Distant, 1883 (Hemiptera: Pentatomidae), *Curatia denticornis* Stål, 1864 (Hemiptera: Pentatomidae), and *Tibilis subconspersa* Stål, 1860 (Hemiptera: Pentatomidae), as well as economically important species such as *Diceraeus furcatus* (Fabricius, 1775) (Hemiptera: Pentatomidae), *Thyanta perdidor* (Fabricius, 1794) (Hemiptera: Pentatomidae), and *Piezodorus guildinii* (Westwood, 1837) (Hemiptera: Pentatomidae). Our results underscore the significance of beach drift events, as they provide valuable opportunities to investigate the hidden diversity within particular taxa, bringing new data while unveiling unknown species. Moreover, the presence of two undescribed species reinforces the importance of researching and documenting drift phenomena for taxonomic purposes, shedding light on insect migration and dispersion patterns.

Keywords: Hemiptera, Dispersion, Pentatomoidea, Florianópolis, Atlantic Ocean.

The drift of both aerial and aquatic invertebrates is a common natural phenomenon which has been reported for a long time (Freeman 1945; Waters 1972; Brittain & Eikeland 1988; Lazzari et al. 2008; Campos et al. 2021). This phenomenon is referred to as the passive movement of organisms through air or water currents, enabling the dispersal of many species, including beneficial and pest insects, for instance. The phenomenon of insect drift in lakes and ocean beaches represents one of the best-known cases, as observed by Torre-Bueno (1915), Parshley (1917), and Myers (1926). During these natural events, hundreds, or even million specimens can be found on the sand, typically dead. The distance of the drift can vary from short to long distances. Insects are attracted to the reflecting sunlight on the water's surface, or they can also be carried toward the waterline by strong offshore winds (Parshley 1917; Myers 1926; Lazzari et al. 2008). While not a rare phenomenon, there is a dearth of publications that focus on insect drift over the world, including in Brazil.

Heteroptera, commonly known as true bugs, stink bugs, and water bugs, is usually one of the most abundant insect orders encountered in ocean beach drifts. Torre-Bueno (1915) and Parshley (1917) were pioneers in describing Heteroptera drift on both ocean and lakes in Massachusetts (USA). Torre-Bueno (1915) found 22 species in a lake and 49 species in ocean shores, summing 71 species. Two years later, Parshley (1917) added over 30 new species to the list. Myers (1926) further contributed to the understanding of the insect drift phenomenon by studying the Hemiptera collection from the Massachusetts coast, which expanded the list proposed by Torre-Bueno (1915) and Parshley (1917), demonstrating an interesting diversity of this specific order in drifts events, particularly those of Pentatomidae family.

The insect drift along the Brazilian beaches (coastline) has been poorly documented in scientific literature. The first record of this phenomenon dates back to 2006 (Lazzari et al. 2008), when a one-day event of heteropteran drift was observed on the shores of Praia das Gaivotas in the state of Paraná in January, 2006. On this occasion, millions of dead specimens (16 to 18 million insects) were found on the shoreline, all belonging to a single species, *Mayrinia curvidens* (Mayr, 1864). The reasons for this observed situation was related to meteorological conditions and due to an increase of *M. curvidens* populations along the Atlantic coast of Santa Catarina and Paraná states on their host plants (Lazzari et al. 2008).

In this brief communication, we present the diversity of stink bugs (Pentatomoidea) obtained from a rapid survey on an insect drift event at Campeche Beach, Florianópolis, Brazil. The sampling was conducted on December 02, 2021, along a transect of ~550 meters in the shoreline, near Joaquina Beach (27°38'21.3"S 48°27'31.0"W). The transect was visually inspected, and only Pentatomoidea specimens were manually collected. The samples were preserved in ethanol 70% and then deposited at the Hemiptera Collection of Laboratório de Entomologia Sistemática - Universidade Federal do Rio Grande do Sul (UFRGS) for posterior identification. It is important to note that all insects were freshly dead at the sampling time. Besides pentatomoids, other true bugs were observed in the transect, such as Pyrrhocoridae and Largidae; wasps (Ichneumonidae) and moths (Erebidae) were also frequently observed.

A total of 363 individuals were collected. From these, 35 species, 29 genera, and three families (Cyrtocoridae, Pentatomidae and Scutelleridae) were identified. Two species represent undescribed taxa (*Edessa* sp. and *Tetyra* sp.) (see list below) (Figs. 1-2). As noted

by Parshley (1917), the Pentatomidae was the most abundant family of Heteroptera found in the drift event in Florianópolis. At species level, *Copeocoris truncaticornis* (Stål, 1865) (29.9%) (Fig. 1P), *Mayrinia curvidens* (Mayr, 1864) (16.3%) (Fig. 2A), *Podisus nigrispinus* (Dallas, 1851) (15.5%) (Fig. 1H), *Diceraeus furcatus* (10%), and *Podisus crassimargo* (Stål, 1860) (9.7%) were the most representative.

List of species collected (number of individuals: n; sex: male, female):

Cyrtocoridae

Cyrtocoris egeris Packauskas & Schaefer, 1998 (n=1; 1 female)

Pentatomidae

Asopinae

Alcaeorrhynchus grandis (Dallas, 1851) (n=2; 1 male, 1 female)
Brontocoris tabidus (Signoret, 1863) (n=2; 2 females)
Coryzorhaphis leucocephala Spinola, 1837 (n=3; 2 females, 1 male)
Podisus crassimargo (Stål, 1860) (n=35; 23 females, 12 males)
Podisus fuscescens (Dallas, 1851) (n=5; 1 female, 4 males)
Podisus graziae Brugnera, Roell & Lemaître, 2021 (n=2; 2 males)
Podisus nigrispinus (Dallas, 1851) (n=56; 34 females, 22 males)
Supputius cincticeps (Stål, 1860) (n=1; 1 female)

Discocephalinae

Janeirona stali (Kormilev, 1956) (n=1; 1 female)

Edessinae

Edessa leucogramma (Perty, 1833) (n=2; 1 female, 1 male)
Edessa sp. (undescribed species) (n=1; 1 female)

Pentatominae

Arvelius albopunctatus (De Geer, 1773) (n=1; 1 female)
Capivacius bufo Distant, 1883 (n=1; 1 female)
Chinavia obstinata (Stål, 1860) (n=2; 1 female, 1 male)
Copeocoris truncaticornis (Stål, 1865) (n=108; 57 females, 51 males)
Curatia denticornis Stål, 1864 (n=7; 3 females, 4 males)
Diceraeus furcatus (Fabricius, 1775) (n=36; 20 females, 16 males)
Loxa deducta Walker, 1867 (n=2; 1 females, 1 male)
Grazia tincta (Distant, 1890) (n=1; 1 male)
Mayrinia curvidens (Mayr, 1864) (n=59; 25 females, 34 males)
Oebalus ypsilongriseus (De Geer, 1773) (n=2; 1 female, 1 male)
Oenopiella punctaria (Stål, 1859) (n=1; 1 female)
Serdia concolor Ruckes, 1958 (n=4; 3 females, 1 male)
Serdia apicicornis Stål, 1860 (n=1; 1 female)
Pellaea stictica (Dallas, 1851) (n=1; 1 male)
Piezodorus guildinii (Westwood, 1837) (n=5; 1 female, 4 males)
Proxys albopunctulatus (Palisot de Beauvois, 1805) (n=1; 1 male)
Stichtochilus tripunctatus Bergroth, 1918 (n=2; 1 female, 1 male)
Thyanta (Argosoma) humilis (Stål, 1859) (n=2; 1 female, 1 male)
Thyanta (Thyanta) perditor (Fabricius, 1794) (n=1; 1 female)
Tibilis subconspersa Stål, 1860 (n=12; 3 females, 9 males)
Tibraca limbativentris Stål, 1860 (n=2; 1 female, 1 male)

Scutelleridae

Augocoris illustris (Fabricius, 1781) (n=1; 1 female)
Tetyra sp. (undescribed species) (n=1; 1 male)

Surprisingly, we collected 108 specimens of *Copeocoris truncaticornis* in the transect (~550 m). This species is considered rare in entomological collections, and little is known about its biology apart from an observation recently made in a wheat crop (Panizzi et al. 2021). Previous records indicate that *C. truncaticornis* is distributed in the Atlantic Forest of Brazil (Rio de Janeiro, Santa Catarina, Rio Grande do Sul) and Argentina (Misiones), with its range extending along the south of the pampa grasslands of Brazil (Rio Grande do Sul), Argentina (Buenos Aires), and Uruguay (Cerro Largo) (Barcellos & Grazia 1998; Brugnera et al. 2023). Our findings suggest that *C. copeocoris* can form large populations, and its rarity in entomological collections can be attributed to sampling bias, probably due to its unknown ecological niche.

We collected other species considered rare in entomological collections, such as *C. bufo*, *C. denticornis*, and *T. subconspersa*. These species have been poorly documented in collections and scientific literature, as previoulsy noted by Brailovsky & Rolston (1986) and Barcellos & Grazia (1993; 1998). Additionally, the presence of *O. punctaria* in Florianópolis extends to the north the known distribution of this species, representing the first record to Santa Catarina state (see Fernández-Aldea et al. 2014).

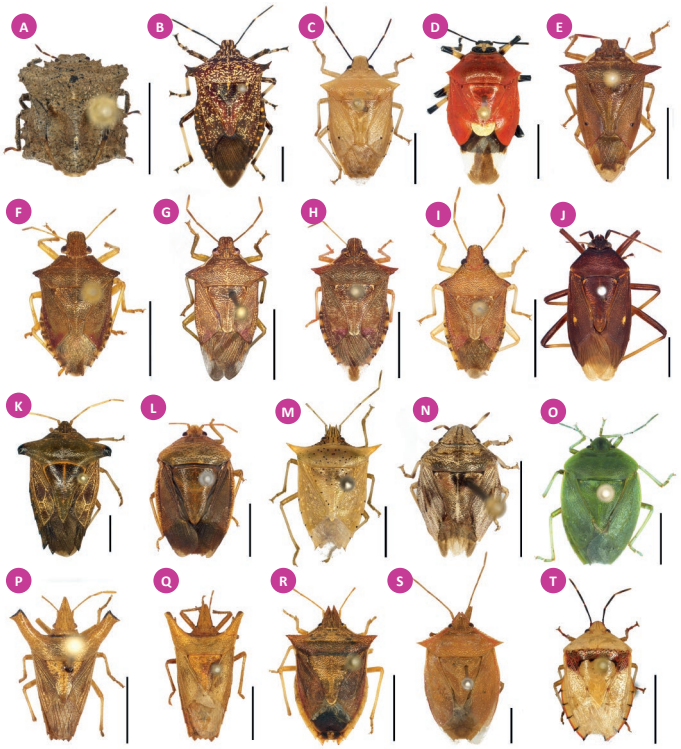

Figure 1. Species of Pentatomoidea collected in Florianópolis (Brazil), part 1. (A) *Cyrtocoris egeris*, (B) *Alcaeorrhynchus grandis*, (C) *Brontocoris tabidus*, (D) *Coryzorhaphis leucocephala*, (E) *Podisus crassimargo*, (F) *Podisus fuscescens*, (G) *Podisus graziae*, (H) *Podisus nigrispinus*, (I) *Supputius cincticeps*, (J) *Janeirona stali*, (K) *Edessa leucogramma*, (L) *Edessa* sp., (M) *Arvelius albopunctatus*, (N) *Capivacius bufo*, (O) *Chinavia obstinata*, (P) *Copeocoris truncaticornis*, (Q) *Curatia denticornis*, (R) *Diceraeus furcatus*, (S) *Loxa deducta*, (T) *Grazia tincta* (scale bars: 4 mm)

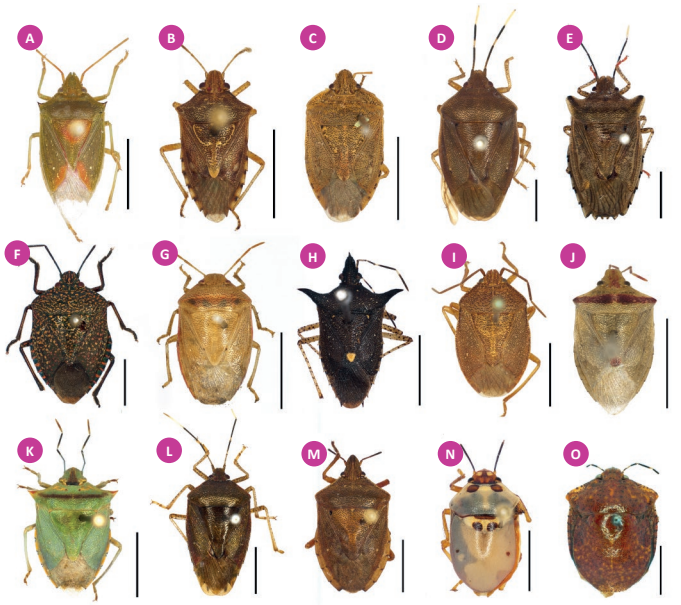

Figure 2. Species of Pentatomoidea collected in Florianópolis (Brazil), part 2. (A) *Mayrinia curvidens*, (B) *Oebalus ypsilongriseus*, (C) *Oenopiella punctaria*, (D) *Serdia concolor*, (E) *Serdia apicicornis*, (F) *Pellaea stictica*, (G) *Piezodorus guildinii*, (H) *Proxys albopunctulatus*, (I) *Stichtochilus tripunctatus*, (J) *Thyanta (Argosoma) humilis*, (K) *Thyanta (Thyanta) perditor*, (L) *Tibilis subconspersa*, (M) *Tibraca limbativentris*, (N) *Augocoris illustris*, (O) *Tetyra* sp. (scale bars: 4 mm)

We highlight the presence of species of economic importance, such as *A. albopunctatus, D. furcatus, M. curvidens*, *T. perdidor*, and *P. guildinii*, considered pest species in crops, such as soybean, wheat,

and maize (see Barros et al. 2021); as well the presence of eight species of predatory stink bugs (Asopinae), including a relevant number of individuals of *P. nigrispinus*, *P. fuscescens*, *B. tabidus* and *S. cincticeps*, largely studied as important tools for biological control, including in South America (De Clercq 2000; Roca-Cusachs et al. 2020; Brugnera et al. 2022; Plata-Rueda et al. 2022).

Our results demonstrate the significance of beach drift events, as they provide an important opportunity to investigate the hidden diversity of a particular taxon. Brues (1926) highlighted that the presence of insect drift along the shorelines of expansive water bodies exemplifies the profusion of numerous insect species, whose population dynamics and numbers often go unnoticed, bringing valuable data and revealing unknown species, than shedding light on the intricacies of ecosystems. Also, the presence of two undescribed species in the Florianópolis event reinforces the importance of investigating and documenting drift phenomena for taxonomic approaches. In addition, drifts can provide information about the migration and dispersion of insects, as the case related by Alves et al. (2019) for *A. grandis* (also collected by us in the present study), found in the Trindade Island, 764 km from the coast of Espírito Santo state, Brazil. *A. grandis* was previously considered an introduced species by Peck et al. (1998) in the Galapagos Islands, which is 1,000 km away from continental South America. The results of Alves et al. (2019) support the hypothesis of natural migration mediated by drift phenomenon regarding the mentioned species.

In conclusion, this rapid survey of an insect drift over a South Atlantic beach revealed a surprising diversity of stink bugs, including some rare species considering their availability in scientific collections. Further research in this area should consider a range of meteorological, biological, and ecological factors to deepen our understanding of these phenomena. Comprehending the mechanisms and variables that influence insect drift is crucial for effective pest management, conservation efforts, and disease control, making it important for agriculture, ecology, and human health. The insect drift holds significant implications for these fields, underscoring the need for a deeper understanding.

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Author's Contributions

GML and RB designed this note. RB collected and identified all specimens to species level. VGS made all the figures presented from acquisition to final art. GML wrote all versions of the manuscript, with contributions from VGS and RB. All authors carefully revised and approved the final version of this Scientific Note.

Conflict of Interest Statement

Authors have no conflict of interest to be declared.

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