

Aleyrodidae in three forest fragments in the state of Rio de Janeiro, Brazil

Aleyrodidae em três fragmentos florestais no estado do Rio de Janeiro

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ABSTRACT: Studies that analyze the occurrence of whiteflies in forest environments are virtually non-existent, which is not justifiable given the ecological and agronomic importance of this insect group. The study aimed to evaluate the occurrence of Aleyrodidae collected from May/2013 to May/2014 in three Atlantic forest fragments in state of Rio de Janeiro, Brazil. Of all, 1,212 puparia were collected, and five genera and seven species of whiteflies occurring in nine hosts were identified. *Aleuropleurocelus cecropiae* was the only aleyrodid registered simultaneously occurring in *Cecropia hololeuca* in the three environments, with lower records in the two fragments considered as less anthropized. For the first time, *Aleurothrixus floccosus* was registered on *Handroanthus ochraceus* and *Mangifera indica*. In addition, it was observed the first register of *Bemisia tabaci* on *Commelina benghalensis* and *Caesalpinia pluviosa*. *Minutaleyrodes minuta* on *Syzygium cumini* was also the register of a new occurrence.

KEYWORDS: conservation; forestry; forest protection.

RESUMO: São praticamente inexistentes os trabalhos que analisam a ocorrência de moscas-brancas em ambientes florestais, o que não é justificável, em vista da importância ecológica e agrônômica desse grupo de insetos. Objetivou-se avaliar a ocorrência de Aleyrodidae em três fragmentos de Mata Atlântica no estado do Rio de Janeiro, no período entre maio/2013 e maio/2014. Propõe-se chave taxonômica para cinco gêneros. Coletaram-se 1.212 pupários e identificaram-se cinco gêneros e sete espécies de moscas-brancas ocorrendo em nove hospedeiros. *Aleuropleurocelus cecropiae* foi o único aleirodídeo registrado simultaneamente, ocorrendo em *Cecropia hololeuca*, nos três ambientes avaliados, com registros inferiores nos dois fragmentos considerados menos antropizados. Ainda, registrou-se pela primeira vez *Aleurothrixus floccosus* em *Handroanthus ochraceus* e em *Mangifera indica*. Também se procedeu ao primeiro registro de *Bemisia tabaci* em *Commelina benghalensis* e *Caesalpinia pluviosa*. *Minutaleyrodes minuta* sobre *Syzygium cumini* é, igualmente, o registro de uma nova ocorrência.

PALAVRAS-CHAVE: conservação; área florestal; proteção florestal.

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INTRODUCTION

The aleyrodids are classified in the suborder Sternorrhyncha and characterized by the existence of an intestinal chamber responsible for facilitating the absorption and concentrating the nutrients to be utilized in the insect's metabolism. The filter chamber captures the excess of sap sucked at the beginning of the digestive tract and directs it to its end. GALLO et al. (2002) report that the surplus of sap is eliminated in the form of droplets, which can be used as a substrate for the development of fungi of the genus *Capnodium* sp. and as food for ants (Hymenoptera).

The aleyrodid reproduction generally occurs in a sexed way with oviparity, but it can be verified the existence of parthenogenesis of the arrhenotokous type, as mentioned by COSTA LIMA (1942), GALLO et al. (2002), GULLAN; CRANSTON (2007). According to BYRNE; BELLOWS JUNIOR (1991), the aleyrodids can get two or six generations per year. Whitefly populations can reproduce continuously with appropriate temperature and photoperiod conditions.

MOUND; HALSEY (1978) consider that the study of aleyrodids, since the early 20th century, presented a large number of changes, such as the redefinitions of subfamily, genus and species, even for synonyms, and even nowadays this situation can be found. In the 20s, BONDAR (1923; 1928) and HEMPEL (1922a; 1922b) described some species that were later characterized by synonymy.

Only from 2011, some studies have shown new hosts and geographic expansion of whiteflies in Brazil (TRINDADE et al., 2011; TRINDADE; LIMA, 2012; TRINDADE et al., 2012). Considering the geographic expansion, these studies included assessments in the Atlantic forest, not before explored as a learning environment for this group of insects.

These studies are relevant as they provide subsidies for the elucidation of the whitefly colonization process in new environments. In this context, REITZ (2007) reports that invasive species, such as aleyrodids, can cause ecological damage, often displacing native or endemic species and promoting modification in environments with their own characteristics. The author also observed that such exotic organisms eventually become established members of these environments and begin spreading into new areas. In addition to the ecological concerns, these studies are particularly important for providing elements to understand the colonization dynamics of aleyrodids in new environments, since among the representative of this group there are relevant agricultural pests.

Thus, forest fragments can be considered as the main new environments to be colonized by the aleyrodids. Given the effects of anthropization, such as the edge effects, the vegetation starts to suffer the consequences of this situation and thus provides conditions for attracting insects, since environments under environmental disturbance are favorable to attracting phytophagous.

Given that, this study aimed to assess and register the occurrence of individuals of the family Aleyrodidae in three Atlantic forest fragments in the state of Rio de Janeiro, Brazil, also proposing a taxonomic key for the genera indicated in this survey.

MATERIALS AND METHODS

For this study, it was collected monthly, from May 2013 to May 2014, aleyrodids in three Atlantic forest fragments in different states of conservation: Mangaratiba, in Sahy district; Nova Friburgo; and Rio de Janeiro (Grajaú Forest Reserve).

The sampled area in each fragment had 1 hectare delimited using the software Google Earth. The information was inserted into a global positioning system (GPS) Garmin, and the area was randomly demarcated in the field with the use of measuring tape and adhesive tapes. In each area, two cecropias were selected for monitoring, being collected randomly five leaves of each tree per month. The presence of whiteflies during the 12 months of the survey was recorded in the other plants that occurred in the defined area. Once the presence of the whitefly was recorded, the host was taxonomically identified, as well as the whitefly that occurred. The total quantification of the insects occurred by the random and monthly collection of five leaves of these plants.

A brief characterization of these environments can be found as follows.

- Mangaratiba's fragment (UTM (23K) 601786.00 m E, 7462842.83 m S; 22°56'21.93" S, 44°00'26.15" W): this area is about 344 m from the sea, with slope over 45°, dense secondary vegetation, and developed without planning or forest maintenance;
- Nova Friburgo's fragment (UTM (23K) 748267.53 m E, 7533884.31 m S; 22°16'58.20" S, 42°35'25.54" W): this area is about 180 m from a road, with slope of 45°, dense vegetation, and developed without planning or forest maintenance. It has tabebuias, tibouchinas, cecropias, angicos, bromeliads, and many shrubs typical of the Atlantic forest. After the fragment demarcation, which had signs of occasional traffic of people, probably hunters and plant collectors, the observations were carried out;
- Rio de Janeiro's fragment (UTM (23K) 677950.64 m E, 7464674.06 m S; 22°54'59.51" S, 43°15'53.35" W): this area is located about 180 m from the Grajaú–Jacarepaguá road, bordering the community Morro do Encontro, which was developed on the Grajaú Forest Reserve. It has slope lower than 45°, vegetation fragment strongly anthropized and numerous exotic species that have been cultivated or not by residents of the nearby community, which uses the space for hiking and hunting of wild animals, especially birds. Throughout the existence of this forest reserve, whose

symbol is a rock known as Pico do Perdido do Grajaú, accidental fires or not have happened in all areas of this urban forest; the studied fragment had the characteristic of being burned almost every year. In the trees and shrubs, with the exception of the cecropias, in which whiteflies were found, it was collected periodically and randomly ten leaves located at the lower part of the canopy; in the underbrush, it was collected randomly ten leaves.

The survey consisted of the inspection and collection of individuals directly on the plants inserted in the fragment. Once detected the presence of aleyrodids, the hosts were marked and monitored monthly by checking the lower part of the canopy. The collected leaves were placed in paper envelopes and sent to the laboratory of the Universidade Federal Rural do Rio de Janeiro (UFRRJ) Technical College for the puparia identification (4th instar nymphs) and, when necessary, sent to the Botany Department of the UFRRJ for later herborization and identification.

When detected whiteflies, the 4th instar nymphs (puparia) were removed from the foliar limb with the use of insect push-pin and, after quantification, fixed between slides and coverslips, using the mounting mediums Hoyer's and/or Canada balsam. The slides were properly labeled with information about the host, place, date and collector, and then taken to an oven at 37°C for a minimum period of 48 hours for removal of air bubbles and drying.

In order to determine the species of whiteflies, it was used stereoscopic microscopes Wild M 5 and Olympus SZ 40 and microscopes Wild M 20 and Olympus BX 41. For the taxonomic identification, the studies of EVANS (2007), HEMPEL (1922a; 1922b), BONDAR (1923; 1928), COSTA LIMA (1928), MARTIN (2004; 2008) and TRINDADE et al. (2012) were consulted.

The terminology used in the description or discussion related to the species considered in this study follows those detailed by RUSSELL (1965), GILL (1990) and MARTIN (2008).

For data analysis, it was generated a table listing the hosts, whitefly species and number of puparia, counted during the collection period.

Additionally, for the whitefly *Aleuropleurocelus cecropiae*, it was elaborated a seasonality graph of the 4th instar nymphs (puparia) in the three fragments. This analysis was performed because *A. cecropiae* has been the only whitefly that met the criteria of having host occurring in the three assessed areas. Due to this characteristic, it was also adopted the analysis of variance of the average number of 4th instar nymphs. For this, the normality of data was conducted by the Lilliefors test, with subsequent use of the Kruskal-Wallis test at 5% of significance. The significant differences between the mean ranks were detected by the Student-Newman-Keuls test (5% of significance) and highlighted the true mean. The data were processed using the software BioStat 5.0.

RESULTS AND DISCUSSION

It was collected 1,212 puparia, of which 105 in Friburgo, 58 in Mangaratiba and 1,049 in Rio de Janeiro. These individuals are from five genera and seven species of whitefly, registered occurring in nine hosts (Table 1). It was only observed the subfamily Aleurodinae, which has the largest number of genera among this group of insects (EVANS, 2008). The genera are: *Aleuropleurocelus* (Drews & Sampson, 1956), *Aleurothrixus* (QUAINTANCE; BAKER, 1914), *Aleurotrachelus* (QUAINTANCE; BAKER, 1914), *Bemisia* (Gennadius, 1889) and *Minutaleyrodes* (Singh, 1931). As a contribution to the identification of these individuals, it is suggested a dichotomous key of these genera.

Regarding to the predation, it was observed *Harmonia axyridis* (Pallas, 1773) (Coleoptera: Coccinellidae) preying on *Bemisia tabaci*, and *Chrysoperla externa* (Hagen, 1861) (Neuroptera: Chrysopidae) preying on nymphs of *B. tabaci* and *Aleurothrixus aepim*.

According to EVANS (2008), aleyrodids at 4th instar nymphs are recognized for not having compound pores (with simple pores usually absent), leg apices showing circular discs, and short lingula not covering the vasiform orifice, with only a pair of setae close of it.

It was registered a wide range of hosts for *Aleurothrixus floccosus*, around six host plant species, as well as a greater amount of 4th instar nymphs collected. In these observations this whitefly on *Handroanthus ochraceus* and *Mangifera indica* was registered for the first time. In its turn, *B. tabaci* has occurred on three hosts and observed for the first time on *Commelina benghalensis* and *Caesalpinia pluviosa*. The aleyrodid *Minutaleyrodes minuta* also had its first register being hosted by *Syzygium cumini* (Table 1).

According to the taxonomic characters, the morphospecies sp. on *Psychotria nuda* is part of the genus *Aleurothrixus*, in accordance to the dichotomous key, and may possibly represent a new species, being considered for this hypothesis the morphological differences in the abdominal segment, vasiform orifice and lingula when compared to the other known species of this genus.

The whitefly *B. tabaci* is one of the world's major insect pests and it is associated with 600 hosts and with the transmission of several viruses (GALLO et al., 2002; REITZ, 2007; LIU et al., 2012). In this work, it was observed great ability of this species to be hosted by underbrush, such as *C. benghalensis* (spiderwort), as well as by the arboreal species *C. pluviosa* (sibipiruna). According to GALLO et al. (2002), *B. tabaci* is widespread in Brazil. RIIS; NACHMAN (2006) consider that the whiteflies *B. tabaci* and *Trialeurodes vaporariorum* (Westwood, 1856) act only on vegetable crops, especially on the families Curcubitaceae, Leguminosae and Solanaceae. However, this study observed the capacity of *B. tabaci* be hosted by hosts with different habits and sizes; the same probably would happen to *T. vaporariorum*. Thus, such non-horticultural hosts may

be a source of spread of whiteflies even in forest fragments if there is no phytosanitary control. This condition may probably be installed in Rio de Janeiro's fragment.

In the Atlantic forest fragments, where samples were taken, small amounts of whitefly species were registered, especially those considered as economically important, except in the Grajaú Forest Reserve. The register of the occurrence of whiteflies was more numerous and diverse at the community Morro do Encontro, which is the most anthropized portion of the Grajaú Forest Reserve.

The factors that could possibly have contributed to the worsening of this condition in the Grajaú Forest Reserve were the reduction of predators and a favoring of microclimate conditions such as increased temperature and decreased humidity, which are related to the spread of whiteflies, in addition to possible successive introductions of exotic plant genetic load, such as fruit trees. In this fragment, located next to the community Morro do Encontro, only a deteriorated wall separates the forest from the residential area and many residents pass freely through the site. Moreover, the area has a history of fires that spread throughout the Reserve, contributing to the modification of the local flora.

Because of the better ecological structure of the forest fragments in Mangaratiba and Friburgo when compared to the Rio de Janeiro's fragment, it was considered that the more preserved the habitat is, the fewer aleyrodid species are registered, which were not considered of economic importance.

Considering that the data analysis, it is suggested that *A. cecropiae* has characteristics that indicate its potential for bioindication. Its occurrence responded consistently to the ecosystem anthropization, being therefore registered a lower average number of individuals in Mangaratiba and Nova Friburgo when compared to Rio de Janeiro, which is the most ecologically disturbed fragment in relation to the others, although the significant difference has been observed only in the comparison conducted with the values registered in Nova Friburgo (Table 2). In addition, the whitefly *A. cecropiae* has as host *Cecropia hololeuca*, a native plant species that occurs in secondary forest environments, facilitating sampling in future monitoring.

Table 2. Mean number (\pm standard deviation) and maximum and minimum room of individuals instar (pupae) of *Aleuropleurocelus cecropiae* collected in *Cecropia hololeuca* occurring sheets in three forest fragments in the state of Rio de Janeiro, Brazil, in May 2013 to May 2014.

Area	Number average	Individuals number	
		Maximum	Minimum
Mangaratiba	4,46 \pm 3,12 a	12	0
Nova Friburgo	1,54 \pm 2,44 b	6	0
Rio de Janeiro	6,69 \pm 3,99 a	14	0

Means followed by different letters in lines, they are statistically different (Student-Newman-Keuls test, 5% of significance).

Table 1. Host, whitefly species and number of pupae collected in three forest fragments located in the cities of Friburgo, Mangaratiba and Rio de Janeiro, Rio de Janeiro, Brazil, from May 2013 to May 2014.

Host	Friburgo		Mangaratiba		Rio de Janeiro	
	Whitefly	n	Whitefly	N.	Whitefly	n
<i>Cecropia hololeuca</i>	<i>Aleuropleurocelus cecropiae</i>	20	<i>A. cecropiae</i>	58	<i>A. cecropiae</i>	87
<i>Handroanthus ochraceus</i>	<i>Aleurothrixus floccosus</i>	64	N.H.R.	---	N.H.R.	---
<i>Psychotria nuda</i>	Morphospecies sp.	21	N.H.R.	---	N.H.R.	---
<i>Syzygium cumini</i>	N.H.R.	---	N.H.R.	---	<i>A. floccosus</i>	136
					<i>Austrogomphus atratus</i>	25
					<i>Minutaleyrodes minuta</i>	31
<i>Mimosa caesalpiniiifolia</i>	N.H.R.	---	N.H.R.	---	<i>A. floccosus</i>	96
					<i>A. atratus</i>	49
<i>Psidium guajava</i>	N.H.R.	---	N.H.R.	---	<i>Bemisia tabaci</i>	34
					<i>Aleurothrixus aepim</i>	190
					<i>A. floccosus</i>	26
<i>Schinus terebinthifolius</i>	N.H.R.	---	N.H.R.	---	<i>A. atratus</i>	74
					<i>A. floccosus</i>	4
<i>Mangifera indica</i>	N.H.R.	---	N.H.R.	---	<i>A. floccosus</i>	4
<i>Commelina benghalensis</i>	N.H.R.	---	N.H.R.	---	<i>B. tabaci</i>	287
<i>Caesalpinia pluviosa</i>	N.H.R.	---	N.H.R.	---	<i>B. tabaci</i>	10
Total		105		58		1,049

N.H.R.: no host register.

Furthermore, *A. cecropiae* in addition to responding to changes in biota, such as the vegetation stress, also has demonstrated its occurrence influenced by abiotic issues. In this sense, it was observed that dry months provided conditions for the increase in population, with population peaks occurring during this period (Fig. 1).

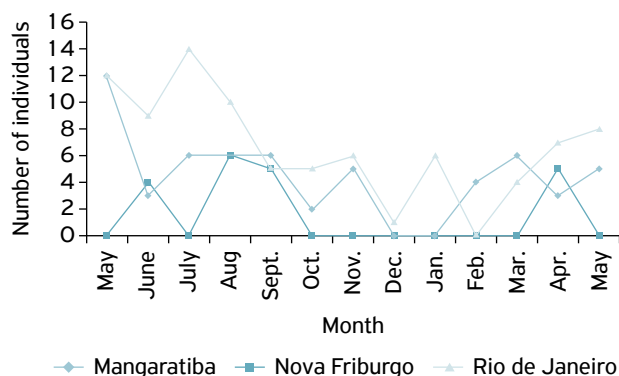


Figure 1. Seasonality room individuals instar (pupae) of *Aleuropleurocelus cecropiae* collected in *Cecropia hololeuca* occurring sheets in three forest fragments in the state of Rio de Janeiro, Brazil, from May 2013 to May 2014.

CONCLUSION

As a hypothesis, this study suggests that whitefly species considered pests will spread increasingly in the Grajaú Forest Reserve, which is a component of the Tijuca Forest, settling on new hosts and thus providing other dispersion points, given the advanced state of anthropization of this forest fragment. For this reason, it is appropriate to research new colonization process environments by the family Aleyrodidae, especially in forest fragments, being possible to provide information for pest control solutions, in addition to ecological knowledge of this insect group.

About these concepts, REITZ (2007) considers that the invasions offer opportunity for ecological experimentation, but unfortunately it can cause enormous environmental and economic costs. This condition was registered in this survey, especially in the Rio de Janeiro's fragment, where the number of hosts is significant and all whitefly species present economic importance, notably *A. floccosus* and *B. tabaci*. This author also observed that the displacement of invasive species could cause the extinction of local species, which are more susceptible to changes in environmental conditions, a fact not observed along the collects since the whiteflies were already present in the areas.

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