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Mites on Annonaceae species in northeast Brazil and in the state of Para

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and Gilberto José de MORAES3

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ABSTRACT — The family Annonaceae Juss. comprises over 120 genera and 2000 species with origins in the American, Asian and African tropical regions. Many of these species, such as those of the genera Annona, Rollinia, Duguetia, Uvaria and Asimira, are edible. Some pests have been reported in soursop, sugar apple and atemoya, the main annonas grown in Brazil. However, few mites are mentioned as pests of this plant family. This study aimed to identify mite species associated with the Annonaceae in northeastern Brazil and in the state of Pará. A survey was conducted, collecting samples of Annona muricata L. (soursop), Annona squamosa L. (sugar apples), Annona cherimola × A. squamosa (atemoya) and Annona coriacea Mart. (araticum) leaves. Annona coriacea is a wild Annonaceae widely distributed in northeastern Brazil. For each sample, a total of 100 leaves were collected from five individuals of the same species at each site. The samples were taken to the laboratory, where they were processed and the mites were mounted and identified. The mite species found belonged to the families Ascidae, Bdellidae, Phytoseiidae, Stigmaeidae, Tarsonemidae, Tetranychidae, Tenuipalpidae and Tydeidae. Phytoseiidae, Tetranychidae and Tydeidae had the highest diversity. Five of the reported species were found on all four of the studied cultures: Amblyseius aerialis (Muma), Tetranychus mexicanus (McGregor), Parapronematus acaciae Baker, Pronematus ubiquitus (McGregor) and Agistemus floridanus Gonzáles.

KEYWORDS — Acari; diversity; mites; Annona muricata; Annona squamosa

INTRODUCTION

The family Annonaceae Juss. comprises over 120 genera and 2000 species with origins in the American, Asian and African tropical regions. Many of these species are of interest for their edible fruits and are distributed among the genera Annona, Rollinia, Duguetia, Uvaria and Asimira. However, only the first two, especially the Annona, are of economic importance (Mabberley 1997; Nogueira et al. 2005). The genus Annona has approximately 90 species, and its main representatives are Annona reticulata L. (wild sweetsop), Annona muricata L. (soursop), Annona squamosa L. (sugar apples), Annona cherimola Mill. (cherimoya) and the hybrid A. cherimola × A. squamosa (atemoya). Commercial Annonaceae cultivation occurs regionally according to the climatic requirements of each species. The Northeast of Brazil is the main producing region of Annonaceae, especially soursop and sugar apple...
Sousa J.M. de et al. (Leon 1987; Sobrinho et al. 1998; Cardoso and Sousa 2000; Nogueira et al. 2005). Several pests, especially insects, are reported in annonas grown in Brazil. However, few pest mites, such as Oligonychus anonae Paschoal (Tetranychidae) and Aculops flechtmanni Keifer (Eriophyidae), have been found to date; both of these species were described in Southeast Brazil (Flechtmann 1985). This study aimed to describe the existing mite fauna in the main cultivated and native Annonaceae species in Northeast Brazil and the state of Pará.

MATERIALS AND METHODS

The study was conducted at the laboratory of Agricultural Acarology in the Agronomy Department of the Federal Rural University of Pernambuco (Uni-

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<tr>
<th>State</th>
<th>County</th>
<th>Coordinates</th>
<th>Host plants</th>
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<td>A. muricata</td>
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<td>A. squamosa; A. cherimola x A. squamosa</td>
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<td>Neópolis</td>
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<td>A. muricata</td>
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versidade Federal Rural de Pernambuco – UFRPE). The sampling sites are listed in Table 1.

At each sampling site, five plants were chosen. Twenty leaves were sampled from each plant. The samples were taken to the laboratory in plastic bags for further processing. Mites were removed using a stereoscope and a brush, placed in plastic containers containing 70% alcohol and labeled. Subsequently, the mites were mounted in Hoyer’s medium and identified by optical microscopy to at least the genus level.

**RESULTS**

The adult mites identified in this survey belong to eight families, twenty-five genera and thirty-eight species. The families Ascidae, Bdellidae, Phytoseiidae and Stigmaeidae were composed mainly of predator and a few generalist species; the families Tarsonemidae, Tenuipalpidae and Tetranychidae were comprised of phytophagous and one mycophagous species (T. confusus), and Tydeidae included species of polyphagous habits. Among all of the species reported, four (A. aerialis, T. mexicanus, P. acaciae and P. ubiquitus) were found on all the sampled cultures.

A total of 1011 mite specimens were sampled and identified, of which 500 belonged to the Tydeidae family, 162 to Tenuipalpidae, 138 to Tetranychidae, 136 to Phytoseiidae, 47 to Stigmaeidae, 25 to Tarsonemidae, 2 to Bdellidae and 1 to the Ascidae family.

**FAMILY PHYTOSEIIDAE BERLESE**

**SUBFAMILY AMBLYSEINAE MUMA**

**Genus Amblyseius Berlese**

Amblyromalus manihoti (Moraes, 1994)

Amblyseius manihoti Moraes et al. 1994: 211. 
Amblydromalus manihoti Chant and McMurtry 2005: 207.

Specimens examined — Pernambuco, Recife, 16 September 2005 (2 ♀; 2 ♂), 16 December 2005 (1 ♀) and 18 January 2006 (1 ♀) on Anona squamosa.

**Amblyseius aerialis (Muma, 1955)**

Amblyseius aerialis Muma 1955: 264; Garman 1958: 75. 

Specimens examined — Pernambuco, Recife, 8 August 2005 (3 ♀) and 16 September 2005 (1 ♀); Rio Grande do Norte, João Câmara, 6 September 2005 (1 ♀) on Annona squamosa. Pernambuco, Chã Grande, 8 July 2005 (1 ♀), Águia Preta, 4 September 2005 (1 ♀) on Annona muricata. Pernambuco, Moreno, 5 September 2005 (1 ♀) and 23 November 2005 (1 ♀; 2 ♂) on Annona cherimolia x Annona squamosa. Pernambuco, Recife, 12 December 2005 (1 ♀) on Annona coriacea.

**Amblyseius tamatavensis Blommers, 1974**

Amblyseius maaí Tseng 1976: 123 (synonymy according to Denmark and Muma, 1989). 
Amblyseius aegyptiacus Matthysse and Denmark 1981: 343.

Specimens examined — Pernambuco, Bonito, 14 August 2005 (1 ♀), 4 September 2005 (1 ♀; 2 ♂) and 23 October 2005 (6 ♀; 4 ♂); Águia Preta, 10 September 2005 (1 ♀); Ceará, Parapaba, 5 September 2005 (1 ♀) on Annona muricata. Pernambuco, Bonito, 14 August 2005 (13 ♀; 9 ♂) on Annona squamosa.

**Genus Euseius Wainstein**

Euseius alatus De Leon, 1966

Euseius paraguayensis Denmark and Muma 1970:
224 (synonymy according to Moraes and McMurtry 1983: 137)

Specimens examined — Pernambuco, Recife, 4 July 2005 (1 ♀), 12 December 2005 (1 ♀; 1 ♂) and 18 January 2005 (2 ♀; 1 ♂); Goiana, 8 July 2005 (1 ♂) on Annona coriacea. Pernambuco, Recife, 8 August 2005 (1 ♀; 1 ♂), 4 October 2005 (2 ♀) and 10 November 2005 (2 ♂) on Annona squamosa. Pernambuco, Goiana, 17 August 2005 (1 ♂) on Annona muricata.

Euseius citrifolius Denmark and Muma, 1970


Euseius concordis (Chant, 1959)


Specimens examined — Pernambuco, Chã Grande, 8 July 2005 (2 ♀); Bahia, Juazeiro, 18 July 2005 (1 ♀) on Annona muricata. Bahia, Juazeiro, 18 July 2005 (1 ♂); Pernambuco, Recife, 16 December 2005 (1 ♀); Maranhão, Tutóia, 3 September 2005 (1 ♀) on Annona squamosa.

Euseius ho (De Leon, 1965)


Euseius sibelius (De Leon, 1962)


Specimens examined — Bahia, Juazeiro, 18 July 2005 (13 ♀) on Annona cherimola × Annona squamosa.

Genus Iphiseiodes De Leon
Iphiseiodes zuluagai Denmark and Muma, 1972

Specimens examined — Pernambuco, Bonito, 14 August 2005 (1 ♂), Água Preta, 14 September 2005 (1 ♂) and 4 September 2005 (1 ♂) on Annona muricata. Pernambuco, Recife, 4 July 2005 (1 ♂), 5 October 2005 (1 ♂) and 8 August 2005 (1 ♂) on Annona coriacea.

Genus Proprioseiopsis Muma
Proprioseiopsis cannaensis (Muma, 1962)
Specimens examined — Maranhão, Junco do Maranhão, 12 September 2005 (1 ♀) on *Annona muricata*.

**SUBFAMILY PHYTOSEIINAE BERLESE**

**Genus Phytoseius Ribaga**

*Phytoseius guianensis* De Leon 1965


Specimens examined — Bahia, Juazeiro, 18 July 2005 (1 ♀) on *Annona cherimolia × Annona squamosa*.

**SUBFAMILY TYPHLODROMINAE SCHEUTEN**

**Genus Leonseius Chant and McMurtry**

*Leonseius regularis* (De Leon, 1965)

*Typhloseiopsis regularis* De Leon 1965a: 122; Moraes et al. 1991: 136.

*Diadromus regularis* De Leon 1966: 100.

*Chanteius regularis* De Leon 1967: 16.


Specimens examined — Pernambuco, Goiana, 8 July 2005 (4 ♀), 17 August 2005 (4 ♀) and 17 September (3 ♀; 1 ♂); Recife, 8 July 2005 (6 ♀; 1 ♂) on *Annona coriacea*. Pernambuco, Goiana, 5 October 2005 (2 ♀; 1 ♂) on *Annona muricata*.

*Typhlodromus (Anthoseius) transvaalensis* (Nesbitt, 1951)


*Garmania domestica* Nesbitt 1951: 44.


Specimens examined — Pernambuco, Chã Grande, 8 July 2005 (1 ♀) on *Annona muricata*.

**FAMILY ASCIDAE VOIGTS AND OUDEMANS**

**Genus Proctolaelaps Berlese**

*Proctolaelaps bickleyi* (Bram, 1956)


*Garmania domestica* Nesbitt 1951: 44.


Specimens examined — Pernambuco, Chã Grande, 8 July 2005 (1 ♀) on *Annona muricata*.

**FAMILY TETRANYCHIDAE DONNADIEU**

**SUBFAMILY TETRANYCHINAE BERLESE**

**Genus Atrichoproctus Flechtmann**

*Atrichoproctus uncinatus* Flechtmann, 1967

Specimens examined — Pernambuco, Água Preta, 23 February 2005 (4 ♀) on Annona squamosa.

**Genus Oligonychus Berlese**

Oligonychus punicae (Hirst, 1926)

Paratetranychus punicae Hirst 1926: 830.
Oligonychus punicae Pritchard and Baker 1955: 335.

Specimens examined — Pernambuco, Recife, 16 September 2005 (7 ♀; 1 ♂) on Annona squamosa.

Genus Tetranychus Dufour

Tetranychus desertorum Banks, 1900

Tetranychus desertorum Banks 1900: 76; Pritchard and Baker 1955: 403; Tuttle and Baker 1968: 4; Paschoal 1970a: 45.

Specimens examined — Pernambuco, Goiana, 8 July 2005 (1♀; 4♂) on Annona coriacea. Bahia, Juazeiro, 18 July 2005 (1♂) on Annona muricata.

Tetranychus mexicanus (McGregor, 1950)

Septanychus mexicanus McGregor 1950: 323.
Tetranychus mexicanus Pritchard and Baker 1955: 411.

Specimens examined — Pernambuco, Goiana, 19 September 2005 (1♂); Água Preta, 24 October 2005 (1♀), 23 November 2005 (3♀; 4♂) and 5 December 2005 (4♀; 2♂) on Annona muricata. Pernambuco, Moreno, 23 November 2005 (9♀; 5♂) on Annona cherimolia × Annona squamosa. Pernambuco, Âgua Preta, 24 October 2005 (8♀; 2♂) and 23 November 2005 (17♀; 13♂) on Annona squamosa. Pernambuco, Recife 18 January 2006 (4♀; 2♂) on Annona coriacea.

Tetranychus neocaledonicus André, 1933


Specimens examined — Pernambuco, Bonito, 4 September 2005 (19♀; 6♂) on Annona cherimolia × Annona squamosa.

Tetranychus urticae Koch, 1836


Specimens examined — Pernambuco, Goiana, 8 July 2005 (4♀; 1♂) on Annona coriacea.

**Family Tarsonemidae Canestrini and Fanzago**

**Subfamily Tarsoneminae Kramer**

**Genus Daidalotarsonemus De Leon**

Daidalotarsonemus folisetae Lofego et al. 2005


Specimens examined — Sergipe, Neópolis, 21 July 2005 (17♀) on Annona muricata.

Daidalotarsonemus fossae De Leon, 1956


Specimens examined — Pernambuco, Goiana, 8 July 2005 (1♀), 15 July 2005 (1♀) on Annona coriacea.

Daidalotarsonemus tesselatus De Leon, 1956


**Genus Tarsonemus Canestrini and Fanzago**

Tarsonemus confusus Ewing, 1939


Specimens examined — Pernambuco, Água Preta, 14 August 2005 (1♀) on Annona muricata.
FAMILY TENUIPALPIDAE BERLESE

SUBFAMILY BREVIPALPINAE RECK

Genus Brevipalpus Donnadieu

Brevipalpus phoenicis (Geijskes, 1939)


Specimens examined — Pernambuco, Água Preta, 4 September 2005 (8 ♂); Bonito, 14 August 2005 (6 ♂); Ceará, Acaarau, 4 September 2005 (1 ♂); Maranhão, Tutóia, 3 September 2005 (1 ♂); Pará, Bonito, 14 August 2005 (9 ♂); 4 September 2005 (2 ♂), 23 October 2005 (2 ♂); Goiana, 8 December 2005 (1 ♂); Sergipe, Neópolis, 21 July 2005 (2 ♂); Alagoas, Maí de Baixo, 22 July 2005 (2 ♂); Ceará, Barroquinha, 4 September 2005 (2 ♂); Rio Grande do Norte, Muriú, 7 September 2005 (1 ♂) on Annona squamosa. Bahia, Juazeiro, 18 July 2005 (12 ♂); Pernambuco, Bonito, 4 September 2005 (5 ♂), 23 October 2005 (1 ♂) on Annona cherimolia × Annona squamosa.

SUBFAMILY TENUIPALPINAE MITROFANOV

Genus Tenuipalpus Donnadieu

Tenuipalpus annanae De Leon, 1957


FAMILY TYDEIDAE KRAMER

SUBFAMILY PRONEMATINAЕ ANDRÉ

Genus Homeopronematus André

Homeopronematus anconai (Baker, 1943)


Genus Parapronematus Baker

Parapronematus acaciae Baker, 1965


Genus Pronematus Canestrini

Pronematus ubiquitus (McGregor, 1932)


SUBFAMILY TYDEINAE ANDRÉ

Genus Lorryia Oudemans

Lorryia formosa Cooreman, 1958


Lorryia turrialbensis Baker, 1968


Genus Neolorryia André

Neolorryia boycei (Baker, 1944)

Retetydae boycei Baker 1944b: 78.


Specimens examined — Bahia, Juazeiro, 18 July 2005 (5 ♀) on Annona cherimolia × Annona squamosa.

FAMILY BDELLIDAE DUGES

SUBFAMILY BDELLINAE GRANDJEAN

Genus Bdella Latreille

Bdella aff. captiosa Atyeo, 1963


Specimens examined — Alagoas, Miai de Baixo, 22 July 2005 (1 ♀) on Annona muricata. Pernambuco, Recife, 16 December 2005 (1 ♀) on Annona squamosa.

FAMILY STIGMAEIDAE Oudemans

Genus Agistemus Summers

Agistemus floridanus Gonzáles, 1965

Agistemus floridanus Gonzalez 1965: 38; Matioli et al. 2002: 103; Arruda Filho and Moraes 2003: 52.


Genus Zetzellia Oudemans

Zetzellia languida Gonzáles, 1965

Zetzellia languida Gonzalez 1965: 21; Arruda Filho and Moraes 2003: 56

Specimens examined — Pernambuco, Goiana, 5 October 2005 (1 ♂) on Annona muricata.
DISCUSSION

The phytoseiid mites had the highest species diversity. Their presence in these microsystems likely indicates environmental balance because most mites are predators that feed on phytophagous mites and insect eggs, while others feed on pollen and are generalists. Most of the mites in this family are studied for use in biological control. Some Phytoseiidae species are widely used in Europe and North America, and new species are still being researched (Moraes 2002). Ten phytoseiid mite species were sampled on A. muricata, six on A. squamosa, seven on A. cherimola × A. squamosa and six on A. coriacea.

In Brazil, many phytoseiid species were recorded on Annonaceae such as A. aerialis, Amblyseius acalyphus Denmark and Muma, Amblyseius chiapensis De Leon, Amblyseius largoensis (Muma), Amblyseius neochiapensis Lofego, Moraes and McMurtry, E. alatus, Euseius brazilii (EL-Benhawy), E. citrifolius, E. concordis, E. sibielus, Galendromus (Galendromus) annectens De Leon, I. zuluagai, Neoseiulus tunus (De Leon), P. guianensis, Phytoseius kaapre Demite, Lofego and Feres, Phytoseius nahuatlensis De Leon, Proprioseiopsis dominigos (El-Benhawy), Ricoseius loxocheles (De Leon) and Typhlodromus peregrinus (Muma) (Denmark and Muma 1973; Moraes and McMurtry 1983; Ferla and Moraes 2002b; Vasconcelos et al. 2006; Demite et al. 2009; Demite et al. 2011; Rezende & Lofego 2011; Nuvoloni et al. 2011). Among these species, A. aerialis, E. alatus, E. citrifolius, E. concordis, E. sibielus, I. zuluagai and P. guianensis were also recorded in the present study, in addition to another eight species that were also recorded for the first time on annonas.

The tetranychids A. uncinatus and T. mexicanus and the tenui palpidae B. phoenicis were already reported on annonas species in Brazil (Paschoal 1970b; Flechtmann and Baker 1975; Tuttle et al. 1977; Moraes and Flechtmann 1981). The species B. phoenicis was the most commonly found mite in the sampling sites (12). Among the studied species, this species was not recorded only in A. coriacea. Some Tenui palpidae mites had already been reported on annonas. Among these mites, the species B. phoenicis was found in Angola (Africa) on A. cherimola, Annona sp. and Rollinia sp. (Meyer 1979). In Brazil, Flechtmann (1976) observed this species on the same host, and Nuvoloni et al. (2011) found this mite on Xilipia aromatica (Lam.). The species T. annonae was described in Mexico on Annona sp. (De Leon, 1957). In this study, T. annonae was found on A. squamosa and A. squamosa × A. cherimola. In Panamá, Ochoa et al. (1994) observed the species Brevipalpus pseudostriatus Ochoa and Salas on A. cherimola.

A total of six Tydeidae species were reported, five of which were never recorded on annonas in Brazil. Only the species L. formosa was observed on X. aromatica by Nuvoloni et al. (2011). Two of the three species of the Pronematinae (= Iolinidae) subfamily were found on the four studied hosts, while H. anconai was detected on all of the studied plants except atemoya. Among the species belonging to the subfamily Tydeinae, L. formosa occurred on sugar apples, soursop and A. coriacea. Lorryia turrialbensis occurred on all the hosts except for sugar apples, and N. boycei was detected only on atemoya. These mites are not considered plant pests. Some of these mites are mycophagous and may reduce the development of fungi populations, some appear to be alternative prey to Phytoseiidae predator mites, and others are predators. Certain mite species are known for their importance in ecological chains in agroecosystems. Groups of generalist species, such as species of the Tydeidae family, are important in maintaining populations of efficient predator mites and are also alternative food when the preferred prey level is low (Moraes and Flechtmann 2008).

Nuvoloni et al. (2011) found Daidalotarsonemus sp. and Tarsonemus sp. on X. aromatica. In the present study, D. folissetae and T. confusus were recorded on A. muricata, D. fossae was found on A. coriacea, and D. tesselatus was found on atemoya. In the Tarsonemidae family, the genus Tarsonemus is composed of micophagous species, and the genus Daidalotarsonemus is composed by species with food habit not well defined. Lindquist (1986) considered that Daidalotarsonemus are probably algophagous or fungivorous, rather than phytophagous, however, Lofego et al. (2005) observed D. tesselatus feed on leaves of Psidium guajava L. In addition to the mentioned species, three new tarsonemid species of
were also found on the sampled Annonaceae. Two of these species belong to the genus *Daidalotarsone-mus* and one to *Fungitarsonemus*, and both of these groups will soon be described.

The family Tetranychidae is composed of strictly phytophagous organisms. Among the reported species, *T. mexicanus* stood out for occurring on all four of the studied hosts. The species *T. neocalendonicus* was reported on *A. muricata* in Australia by Gutierrez and Schicha (1983). Additionally, *T. mexicanus* and *B. phoenicis* were found on *A. muricata* (i.e., soursop) in Água Preta County. These mites are found on leaves in small populations and without causing damage. However, high populations are found on fruits, causing intense darkening, size reduction and induration of healthy fruits. Moraes and Flechtmann (2008) reported these same species in association with damage to the soursop fruit.

The great mite diversity and apparent species equilibrium in Annonaceae detected in this study may be due to the usage of little or no acaricides in these culture systems and to the essentially cultural management of annonas. There are few studies reporting mite species and the damage caused by them on Annonaceae in Brazil. Usually, these mites are identified through surveys of areas involving various plant species of several families. This study demonstrated the great diversity of mites on the plant species belonging to the family Annonaceae in Northeast Brazil and the state of Pará. However, this fauna seems to be in balance, and high populations were not observed, except for *T. mexicanus* and *B. phoenicis* on soursop fruit.

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