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

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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

(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-

TABLE 1: State, county, coordinates and host plants.

State	County	Coordinates	Host plants
Alagoas	Miai de Baixo	36°13'59.7"W 10°13'59.7"S	*A. muricata*
Bahia	Juazeiro	40°24'43.6"W 09°23'19.8"S	*A. squamosa; A. muricata* *A. cherimola x A. squamosa*
Ceará	Una	39°03'51.2"W 15°17'13.8"S	*A. muricata*
	Acaraú	40°07'18.5"W 02°52'19.6"S	*A. squamosa*
	Barroquinha	41°08'22.3"W 03°01'14.2"S	*A. muricata*
	Paraipaba	39°13'49.2"W 03°27'49.4"S	*A. muricata*
Maranhão	Junco do Maranhão	46°03'01.7"W 01°44'52.9"S	*A. muricata*
	Viana	44°59'36.1"W 03°12'11.8"S	*A. squamosa*
	Tutóia	42°22'43.0"W 02°47'52.7"S	*A. squamosa*
Pará	Rosário	44°13'09.5"W 02°57'09.6"S	*A. squamosa*
	Capanema	47°12'33.6"W 01°00'23.0"S	*A. squamosa*
	Castanhal	47°56'57.1"W 01°18'03.2"S	*A. muricata*
Pernambuco	Água Preta	35°31'51.0"W 08°42'25"S	*A. squamosa* ; *A. muricata*
	Bonito	35°35'00.0"W 08°40'00"S	*A. squamosa; A. muricata* *A. cherimola x A. squamosa*
	Chã Grande	35°30'59.0"W 08°09'23.0"S	*A. muricata*
	Goiana	34°57'07.6"W 07°38'19.8"S	*A. coriacea* ; *A. muricata*
	Recife	34°56'41.4"W 08°01'07.0"S	*A. coriacea* ; *A. squamosa* *A. muricata*
	Moreno	35°05'32.0"W 08°07'07.0"S	*A. muricata* ; *A. cherimola x A. squamosa*
Paraíba	Pitimbú	34°48'27.3"W 07°28'15.7"S	*A. muricata*
Rio Grande do Norte	João Câmara	35°50'24.1"W 05°31'01"S	*A. squamosa*
	Muriú	35°15'13.5"W 05°35'12.9"S	*A. muricata*
	Touros	35°33'00.6"W 05°14'56.7"S	*A. squamosa*
Sergipe	Santa Cruz dos Abais	37°17'15.1"W 11°19'03.0"S	*A. muricata*
	Neópolis	36°38'28.1"W 10°19'03.0"S	*A. muricata*

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, Phytoseiidade 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

Amblydromalus manihoti (Moraes, 1994)

Amblyseius manihoti Moraes *et al.* 1994: 211.
Typhlodromalus manihoti Gondim Jr. and Moraes 2001: 82; Zacarias and Moraes 2001: 582; Moraes *et al.* 2004: 200.
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)

Amblyseiopsis aerialis Muma 1955: 264; Garman 1958: 75.
Typhlodromus (Amblyseius) aerialis Chant 1959: 88; Muma 1961: 287.
Amblyseius aerialis De Leon 1966: 91; Moraes and Mesa 1988: 71; Denmark and Muma 1989: 15; Kreiter and Moraes 1997: 377; Feres and Moraes 1998: 126.

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 ♀), Água 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 tamatavensis Blommers 1974: 144; Denmark and Muma 1989: 13; Moraes *et al.* 1991: 119.
Amblyseius maai 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 ♂); Água Preta, 10 September 2005 (1 ♀); Ceará, Paraipaba, 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 alatus De Leon 1966: 87; Denmark and Muma 1973: 262; Moraes and McMutry 1983: 137; Feres and Moraes 1998: 127.
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 citrifolius Denmark and Muma 1970: 222; Moraes and McMutry 1983: 138; Moraes *et al*. 1991: 131; Feres and Moraes 1998: 127; Lofego *et al*. 2004: 4; Lofego *et al*. 2009: 43.

Specimens examined — Bahia, Juazeiro, 18 July 2005 (2 ♀) on *Annona muricata*. Bahia, Juazeiro, 18 July 2005 (2 ♀) on *Annona cherimolia* × *Annona squamosa*.

Euseius concordis (Chant, 1959)

Typhlodromus (*Amblyseius*) *concordis* Chant 1959: 69.
Amblyseius (Iphiseius) concordis Muma 1961: 288.
Amblyseius concordis Chant and Baker 1965: 22; Moraes and McMurtry 1983: 138.
Euseius flechtmanni Denmark and Muma 1970: 223; 1973: 261 (synonymy according to Moraes *et al*. 1982: 18).
Euseius concordis Denmark and Muma 1973: 264; Moraes and Oliveira 1982: 317; Moraes and McMutry 1983: 138; Feres and Moraes 1998: 127; Ferla and Moraes 2002a: 870; Lofego *et al*. 2004: 5; 2009: 44.

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)

Amblyseius (*Euseius*) *ho* De Leon 1965a: 125.
Euseius ho Denmark and Muma 1973: 262; Moraes and McMurtry 1983: 139; Moraes *et al*. 1991: 132.

Specimens examined — Perrnambuco, Recife, 8 September 2005 (1 ♂), 16 September 2005 (1 ♂) and 4 September 2005 (1 ♂) on *Annona squamosa*. Pernambuco, Moreno, 5 September 2005 (1 ♂) and 23 November 2005 (1 ♀) on *Annona cherimolia* × *Annona squamosa*. Pernambuco, Recife, 5 October 2005 (1 ♂), 12 December 2005 (1 ♀), 18 January 2006 (1 ♀) on *Annona coriacea*.

Euseius sibelius (De Leon, 1962)

Amblyseius (*Typhlodromalus*) *sibelius* De Leon 1962: 21.
Euseius sibelius Muma *et al*. 1970: 98; Moraes and McMurtry 1983: 140; Moraes *et al*. 1986: 54; 2004: 83; Moraes and Mesa 1988: 81; Feres and Moraes 1998: 128; Chant and McMurtry 2005: 216; 2007: 123; Lofego *et al*. 2004: 6; 2009: 45; Feres *et al*. 2009: 467; Demite *et al*. 2011: 42.
Euseius subalatus De Leon 1965a: 127 (synonymy according to Muma *et al*. 1970).

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

Genus *Iphiseiodes* De Leon

Iphiseiodes zuluagai Denmark and Muma, 1972

Iphiseiodes zuluagai Denmark and Muma 1972: 23; Aponte and McMurtry 1995: 165; Kreiter and Moraes 1997: 377; Feres and Moraes 1998: 127; Lofego *et al.* 2004: 7; 2009: 45.
Amblyseius zuluagai Moraes and Mesa 1988: 79; Moraes *et al*. 1991: 125.

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)

Amblyseiulus cannaensis Muma 1962: 4.
Amblyseius cannaensis Moraes and McMurtry 1983: 132; Moraes and Mesa 1988: 77; Moraes *et al*. 1991: 126; Lofego *et al*. 2009: 53.
Proprioseiopis cannaensis Muma *et al*. 1970: 38; Kreiter and Moraes 1997: 379.

Specimens examined — Maranhão, Junco do Maranhão, 12 September 2005 (1 ♀) on *Annona muricata.*

Subfamily Phytoseiinae Berlese

Genus *Phytoseius* Ribaga

Phytoseius guianensis De Leon 1965

Phytoseius guianensis De Leon 1965b: 18; Denmark 1966: 23; Denmark and Muma 1973: 269; Moraes and McMurtry 1983: 144; Lofego *et al*. 2004: 11.

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

Subfamily Typhlodrominae Scheuten

Genus *Leonseius* Chant and McMutry

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.
Typhlodromus regularis Chant and Yoshida-Shaul 1983: 1034; El-Benhawy 1984: 139.

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)

Kampimodromus transvaalensis Nesbitt 1951: 55.
Neoseiulus transvalensis Muma 1961: 295.
Typhodromus transvaalensis Chant 1955: 498; Ferla and Moraes 2002b: 1020.

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

Genus *Typhlodromus* Scheuten

Typhlodromus (Anthoseius) ornatus
(Denmark and Muma, 1973)

Amblydromella ornata Denmark and Muma 1973: 270.
Typhlodromus (*Anthoseius*) *ornatus* Gondim Jr. and Moraes 2001: 89; Moraes *et al.* 2004: 341; Lofego *et al.* 2004: 13.

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

Genus *Typhlodromina* Muma

Typhlodromina subtropica
Muma and Denmark, 1969

Typhlodromina subtropica Muma and Denmark 1969: 412; Moraes and McMurtry 1983:142.

Specimens examined — Pernambuco, Recife, 4 July 2005 (1 ♀) on *Annona coriacea.*

Family Ascidae Voigts and Oudemans

Genus *Proctolaelaps* Berlese

Proctolaelaps bickleyi (Bram, 1956)

Garmania bickleyi Bram 1956: 292.
Proctolaelaps striata Westerboer 1963: 356. Sinonymy according to Lindquist and Hunter (1965).
Garmania domestica Nesbitt 1951: 44.
Proctolaelaps bickleyi Chant 1963: 269; Lindquist and Hunter 1965: 16; McGraw and Farrier 1969: 72; Karg 1985: 192; 1988: 448; Halliday *et al.* 1998: 31.

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

Atrichoproctus uncinatus Flechtmann 1967: 323; Flechtmann and Baker 1970: 157; Flechtmann and Baker 1975: 116; Feres 2000: 166.

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 (16 ♀; 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* x *Annona squamosa.* Pernambuco, Àgua 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

Tetranychus neocaledonicus André 1933: 302; Pritchard and Baker 1955: 430; Flechtmann and Baker 1970: 162; Flechtmann and Bastos 1972: 86.

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

Tetranychus urticae Koch, 1836

Tetranychus urticae Koch 1836: 10; Boudreux and Dosse 1963: 363; Tuttle and Baker 1968: 129; Flechtmann and Baker 1970: 161; Paschoal 1970a: 49; Flechtmann and Bastos 1972: 86; Flechtmann and Baker 1975: 120.

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

Daidalotarsonemus folisetae Lofego *et al*. 2005: 2.

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

Daidalotarsonemus fossae De Leon, 1956

Daidalotarsonemus fossae De Leon 1956: 165; Suski 1968: 777; Smiley 1972: 91.

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

Daidalotarsonemus tesselatus De Leon, 1956

Daidalotarsonemus tesselatus De Leon 1956: 163; Smiley 1972: 91; Lofego *et al*. 2005: 6.

Specimens examined — Pernambuco, Moreno, 5 September 2005 (1 ♀); Sergipe, Neópolis, 21, July 2005 (2 ♀) on *Annona cherimolia* × *Annona squamosa*. Sergipe, Neópolis, 21 July 2005 (2 ♀) on *Annona muricata.*

Genus *Tarsonemus* Canestrini and Fanzago

Tarsonemus confusus Ewing, 1939

Tarsonemus confusus Ewing 1939: 26; Beer 1954: 1173; Smiley 1969: 221; Kaliszewski 1993: 40; Feres *et al*. 2005: 6; Lofego *et al*. 2005: 24.

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)

Tenuipalpus phoenicis Geijskes 1939: 23.
Brevipalpus phoenicis Sayed 1946: 99; Pritchard and Baker 1958: 233; De Leon 1961: 48; Baker *et al.* 1975: 18; Gonzalez 1975: 82; Meyer 1979: 87; Baker and Tuttle 1987: 98.
Brevipalpus yothersi Baker 1949: 374.
Brevipalpus mcbridei Baker 1949: 374.
Brevipalpus papayensis Baker 1949: 379.

Specimens examined — Pernambuco, Água Preta, 4 September 2005 (8 ♀), 23 December 2005 (1 ♀); Bonito, 14 August 2005 (6 ♀); Ceará, Acarau, 4 September 2005 (1 ♀); Maranhão, Tutóia, 3 September 2005 (1 ♀); Pará, Capanema, 31 July 2005 (1 ♀) on *Annona squamosa.* Pernambuco, Chã Grande, 8 July 2005 (4 ♀); Bonito, 14 August 2005 (9 ♀), 4 September 2005 (2 ♀), 23 October 2005 (2 ♀); Água Preta, 4 September 2005 (1 ♀), 10 September 2005 (1 ♀), 5 December 2005 (1 ♀); Goiana, 8 December 2005 (1 ♀); Sergipe, Neópolis, 21 July 2005 (2 ♀); Alagoas, Miai de Baixo, 22 July 2005 (2 ♀); Ceará, Barroquinha, 4 September 2005 (2 ♀); Rio Grande do Norte, Muriú, 7 September 2005 (1 ♀) on *Annona muricata.* 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 annonae De Leon, 1957

Tenuipalpus annonae De Leon 1957: 91.

Specimens examined — Bahia, Juazeiro, 18 July 2005 (85 ♀); Pernambuco, Moreno, 23 November 2005 (6 ♀) on *Annona cherimolia* × *Annona squamosa*. Maranhão, Rosário, 3 September 2005 (5 ♀); Rio Grande do Norte, João Câmara, 5 September 2005 (2 ♀) on *Annona squamosa*.

Family Tydeidae Kramer
Subfamily Pronematinae André

Genus *Homeopronematus* André

Homeopronematus anconai (Baker, 1943)

Pronematus anconai Baker 1944a: 188.

Specimens examined — Pernambuco, Bonito, 14 August 2005 (4 ♀), 17 August 2005 (1 ♀), 19 September 2005 (1 ♀), 5 October 2005 (1 ♀), 12 December 2005 (2 ♀; 1 ♂); Água Preta, 23 November 2005 (1 ♀); Maranhão, Junco do Maranhão, 12 September 2005 (4 ♀) on *Annona muricata*. Pernambuco, Bonito, 14 August 2005 (3 ♀; 1 ♂); Água Preta, 4 September 2005 (1 ♀), 24 October 2005 (11 ♀; 2 ♂) on *Annona squamosa*. Pernambuco, Recife, 8 August 2005 (23 ♀; 12 ♂), 5 October 2005 (10 ♀; 3 ♂), 12 December 2005 (15 ♀; 2 ♂), 18 January 2006 (15 ♀; 3 ♂) on *Annona coriacea.*

Genus *Parapronematus* Baker

Parapronematus acaciae Baker, 1965

Parapronematus acaciae Baker 1965: 116; Zacarias 2001: 74.

Specimens examined — Pernambuco, Goiana, 5 October 2005 (2 ♀); Água Preta, 24 October 2005 (1 ♂) on *Annona muricata*. Pernambuco, Recife, 8 August 2005 (4 ♀; 2 ♂), 16 September 2005 (1 ♀), 4 October 2005 (1 ♀), 10 November 2005 (2 ♀; 4 ♂), 16 December 2005 (1 ♀); Bonito, 14 August 2005 (14 ♀; 3 ♂) on *Annona squamosa*. Pernambuco, Recife, 8 August 2005 (4 ♀), 5 October 2005 (10 ♀; 5 ♂), 12 December 2005 (5 ♀; 2 ♂) on *Annona coriacea*. Pernambuco, Bonito, 23 October 2005 (1 ♂); Moreno, 23 November 2005 (9 ♀; 7 ♂) on *Annona cherimolia* × *Annona squamosa*.

Genus *Pronematus* Canestrini

Pronematus ubiquitus (McGregor, 1932)

Tydeus ubiquitus McGregor 1932: 62.
Pronematus ubiquitus Thor 1933: 46; Baker 1939: 273; Baker 1946: 255; Meyer and Rodriguez 1965: 19; Baker 1968b: 1093.

Specimens examined — Pernambuco, Goiana, 19 September 2005 (2 ♀; 1 ♂), 5 October 2005 (1 ♀); Sergipe, Neópolis, 21 July 2005 (1 ♀); Bahia,

Juazeiro, 18 July 2005 (9 ♀; 1 ♂) on *Annona muricata*. Pernambuco, Recife, 8 August 2005 (7 ♀), 16 September 2005 (2 ♀), 10 November 2005 (28 ♀; 20 ♂), 16 December 2005 (21 ♀; 6 ♂), 18 January 2006 (34 ♀; 2 ♂); Bonito, 14 August 2005 (2 ♀; 4 ♂); Água Preta, 23 November 2005 (1 ♀); Rio Grande do Norte, Touros, 7 September 2005 (1 ♂); Bahia, Juazeiro, 18 July 2005 (3 ♀) on *Annona squamosa*. Pernambuco, Recife, 8 August 2005 (1 ♀; 1 ♂), 5 October 2005 (2 ♀; 1 ♂), 12 December 2005 (1 ♀) on *Annona coriacea*. Pernambuco, Bonito, 23 October 2005 (10 ♀; 8 ♂) on *Annona cherimolia* × *Annona squamosa*.

Subfamily Tydeinae André

Genus *Lorryia* Oudemans

Lorryia formosa Cooreman, 1958

Lorryia formosa Cooreman 1958: 6; Baker 1968a: 995; Feres *et al*. 2005: 5

Specimens examined — Bahia, Una, 19 July 2005 (1 ♀); Sergipe, Neópolis, 21 July 2005 (6 ♀); Ceará, Paraipaba, 5 September 2005 (4 ♀) on *Annona muricata*. Pernambuco, Recife, 8 August 2005 (12 ♀; 9 ♂), 16 September 2005 (3 ♀; 3 ♂), 4 October 2005 (3 ♂), 10 November 2005 (2 ♂), 16 December 2005 (1 ♀); Bonito, 14 August 2005 (5 ♀) on *Annona squamosa*. Pernambuco, Recife, 4 July 2005 (13 ♀), 8 August 2005 (4 ♀; 5 ♂), 5 October 2005 (1 ♂), 12 December 2005 (2 ♀; 13 ♂), 18 January 2006 (11 ♀; 11 ♂) on *Annona coriacea.*

Lorryia turrialbensis Baker, 1968

Lorryia turrialbensis Baker 1968a: 999; Salviejo 1969: 266; Kazmierski 1998: 298

Specimens examined — Pernambuco, Goiana, 12 December 2005 (1 ♀); Alagoas, Santa Cruz dos Abais, 21 July 2005 (2 ♀) on *Annona muricata*. Pernambuco, Goiana, 17 August 2005 (10 ♀), 17 September 2005 (2 ♀; 1 ♂) on *Annona coriacea*. Pernambuco, Moreno, 23 November 2005 (7 ♂) on *Annona cherimolia* × *Annona squamosa*.

Genus *Neolorryia* André

Neolorryia boycei (Baker, 1944)

Retetydeus boycei Baker 1944b: 78.
Lorryia boycei Baker 1968a: 1004; Feres 2000: 163.
Neolorryia boycei André 1980: 127; Kazmierski 1998: 350.

Specimes 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

Bdella aff. captiosa Atyeo 1963: 170.

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.

Specimens examined — Pernambuco, Água Preta, 14 August 2005 (1 ♀), 23 November 2005 (1 ♀); Goiana, 5 October 2005 (3 ♀; 3 ♂), 12 December 2005 (4 ♀; 1 ♂); Bonito, 23 October 2005 (6 ♀; 6 ♂) on *Annona muricata*. Pernambuco, Bonito, 14 August 2005 (11 ♀; 5 ♂) on *Annona squamosa*. Bahia, Juazeiro, 18 July 2005 (5 ♀) on *Annona cherimolia* × *Annona squamosa.*

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 brazilli* (EL-Benhawy), *E. citrifolius*, *E. concordis*, *E. sibelius*, *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-Banhawy), *Ricoseius loxocheles* (De Leon) and *Typhlodromalus 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. sibelius, 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 tenuipalpid *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 Tenuipalpidae 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 *Xilopia 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. cherimolia*. 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 *Daidalotarsonenus* 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 *Daidalotarsonemus* 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. neocaledonicus* 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.

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