Ácaros Plantícolas (Acari) da “Estação Ecológica de Paulo de Faria”, Estado de São Paulo, Brasil[1]

Renato Buosi[2], Reinaldo José Fazzio Feres[3], Anibal Ramadan Oliveira[4], Antonio Carlos Lofego[5] &
Fábio Akashi Hernandes[2]

Biota Neotropica v6 (n1) – http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn02006012006

Recebido em 29/09/2005
Versão revisada recebida em 13/01/2006.
Publicado em 10/02/2006

[1]Parte do Programa BIOTA/FAPESP - O Instituto Virtual da Biodiversidade, http://www.biota.org.br
[2]Programa de Pós-Graduação em Biologia Animal, UNESP - Universidade Estadual Paulista,
Campus de São José do Rio Preto, SP / Bolsistas FAPESP e CNPq.
[3]Depto. de Zoologia e Botânica, UNESP - Universidade Estadual Paulista, Campus de São José do Rio Preto, SP.
Rua Cristóvão Colombo, 2265, 15054-000 São José do Rio Preto, São Paulo.
[4]Setor de Zoologia Agrícola, Escola Superior de Agricultura “Luiz de Queiroz”, USP - Universidade de São Paulo,
13418-900 Piracicaba, São Paulo.
[5]Centro Universitário do Norte Paulista, UNORP – Rua Ipiranga, 3460, Jardim Alto Rio Preto, 15020-040
São José do Rio Preto, São Paulo.
Autor para correspondência: e-mail: reinaldo@ibilce.unesp.br

Abstract

Buosi, R. , Feres, R.J.F., Oliveira, A.R., Lofego, A.C. and Hernandes, F.A. **Plant inhabiting mites (Acari) of the “Estação Ecológica de Paulo de Faria”, State of São Paulo, Brazil.** *Biota Neotrop*. Jan/Abr 2006 vol. 6, no. 1, http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn02006012006. ISSN 1676-0603

This study was conducted in the “Estação Ecológica de Paulo de Faria”, northern region of the State of São Paulo, Brazil, to determine the biodiversity of plant inhabiting mites in patches of native semideciduous forest. One hundred twenty three species of the suborders Gamasida, Actinedida, Acaridida and Oribatida (35 nominally identified), belonging to 78 genera in 25 families, were collected on 18 plant species. The most frequent species were *Euseius concordis* (Chant) and *Iphiseiodes zuluagai* Denmark & Muma, found on eight and six plant species, respectively. The largest richness was observed in *Psicotria cartagenensis* (eight species), *Cecropia pachystachya* (seven species), *Guarea kunthiana* and *Jacaratia spinosa* (six species).

Key words: *biodiversity, distribution, mites, Neotropics, taxonomy*

Resumo

Buosi, R. , Feres, R.J.F., Oliveira, A.R., Lofego, A.C. and Hernandes, F.A. **Ácaros Plantícolas (Acari) da “Estação Ecológica de Paulo de Faria”, Estado de São Paulo, Brasil.** *Biota Neotrop*. Jan/Abr 2006 vol. 6, no. 1, http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn02006012006. ISSN 1676-0603

O presente estudo foi realizado na “Estação Ecológica de Paulo de Faria”, região norte do estado de São Paulo, Brasil, visando conhecer a biodiversidade de ácaros associados a plantas em fragmentos de mata estacional semidecidual nativa. Cento e vinte e três espécies das subordens Gamasida, Actinedida, Acaridida e Oribatida (35 identificadas nominalmente), pertencentes a 78 gêneros de 25 famílias, foram coletadas sobre 18 espécies vegetais. As espécies mais freqüentes foram *Euseius concordis* (Chant) e *Iphiseiodes zuluagai* Denmark & Muma (Phytoseiidae), encontradas sobre oito e seis espécies vegetais, respectivamente. A maior riqueza de espécies foi observada em *Psicotria cartagenensis* (oito espécies), *Cecropia pachystachya* (sete espécies), *Guarea kunthiana* e *Jacaratia spinosa* (seis espécies).

Palavras-chave: *ácaros, biodiversidade, distribuição, região neotropical, taxonomia*

Introdução

Estudos sobre biodiversidade são importantes pois, devido ao crescimento explosivo das populações humanas, o ambiente está sendo desgastado de forma muito acelerada e grande parte da diversidade está se perdendo irreversivelmente através da extinção causada pela destruição de hábitats naturais (Wilson 1997). Devido à crescente devastação das matas é possível que muitas espécies de ácaros estejam sendo extintas, antes mesmo de serem catalogadas.

O conhecimento da acarofauna associada a plantas nativas é básico para futuros estudos de manejo de agroecossistemas, pois essas plantas podem servir como reservatórios para ácaros fitófagos, além de abrigarem espécies ainda desconhecidas de inimigos naturais que poderiam se tornar disponíveis como agentes de controle biológico de pragas agrícolas. Feres *et al.* (2005) investigaram a diversidade de ácaros em plantas de ecossistemas naturais que compõem a "Estação Ecológica do Noroeste Paulista", São José do Rio Preto e Mirassol, SP, registrando 83 espécies (36 nominais) de 48 gêneros em 20 famílias.

A Estação Ecológica de Paulo de Faria (19°55'-19°58'S, 49°31'- 49°32'W), localizada no município de Paulo de Faria, SP, abrange uma área de floresta estacional semidecidual, um dos últimos remanescentes da floresta original que recobria a região norte do estado de São Paulo (Kronka *et al.* 1993). Essa Estação Ecológica possui área de 435,73 ha e está situada na margem esquerda do Rio Grande (represa de Água Vermelha), divisa com o estado de Minas Gerais. O clima da região caracteriza-se por apresentar duas estações climáticas bem definidas: uma seca, de abril a setembro, com média pluviométrica de 167 mm e uma chuvosa, de outubro a março, com média de 978 mm (Barcha & Arid 1971). Stranghetti & Ranga (1998) identificaram 201 espécies vegetais vasculares nessa reserva, sendo que Euphorbiaceae foi uma das famílias com maior número de espécies.

Este trabalho teve como objetivo estudar a biodiversidade de ácaros associados a plantas desse fragmento de mata estacional semidecidual.

Material e Métodos

Foram realizadas 12 coletas mensais, no período de maio de 2003 a abril de 2004, dos ácaros associados a três espécies de euforbiáceas nativas: *Actnostemon communis* (Müll. Arg.) e *Acalypha diversifolia* Jacq, ambas arbustivas e mais abundantes dentre as euforbiáceas da Estação Ecológica de Paulo de Faria, e *Alchornea glandulosa* Poepp. & Endl, arbórea, com exemplares localizados na margem da estrada que circunda a Estação Ecológica. Além disso, foram feitas três coletas esporádicas (maio e novembro de 2003; abril de 2004) dos ácaros associados a outras 15 plantas de nove famílias, incluindo outras espécies de Euphorbiaceae. De 10 a 20 folhas foram coletadas ao redor da copa de cada um dos exemplares das plantas estudadas, considerando-se o tamanho relativo de suas folhas, que foram acondicionadas em sacos de papel protegidos por sacos de polietileno, no interior de caixas isotérmicas de poliestireno com Gelo-X® em seu interior. No laboratório, os ácaros presentes nas folhas foram coletados sob estereomicroscópio, com o uso de um pincel umedecido. Para posterior identificação e contagem, todos os Gamasida, Actinedida e Acaridida foram montados em lâminas de microscopia com meio de Hoyer (Flechtmann 1975, Jeppson *et al.* 1975). Os Oribatida foram fixados em álcool etílico (70%) e posteriormente clarificados em ácido lático para observação em lâmina escavada (Travé *et al.* 1996).

A nomenclatura adotada para as categorias superiores foi a proposta por Woolley (1988). Devido às poucas informações taxonômicas sobre Oribatida imaturos, apenas espécimes adultos foram identificados, principalmente através dos livros de Balogh & Balogh (1988, 1990, 1992). A distribuição mundial das espécies de Tetranychidae e Phytoseiidae foi baseada em Bolland *et al.* (1998) e Moraes *et al.* (2004), respectivamente, e conforme indicado no texto para as espécies dos demais grupos. Na apresentação dos resultados, após o nome da espécie vegetal coletada no item "material examinado", os algarismos romanos e arábicos indicam o mês e ano da coleta, respectivamente, e os algarismos entre parênteses o número de exemplares examinados. Exemplares-testemunho estão depositados na coleção de Acari (DZSJRP) – http://splink.cria.org.br/, do Departamento de Zoologia e Botânica, Universidade Estadual Paulista (UNESP), São José do Rio Preto, São Paulo.

Resultados e Discussão

O estudo taxonômico dos exemplares revelou a ocorrência de 123 espécies de ácaros (35 nominais) pertencentes a 78 gêneros de 25 famílias. Nas coletas mensais registrou-se 84 espécies pertencentes a 62 gêneros de 18 famílias e nas coletas esporádicas, 42 espécies pertencentes a 31 gêneros de 12 famílias, sendo 30 delas comuns às registradas nas coletas mensais.

Gamasida

Ascidae Voigts & Oudemans, 1905

***Asca* sp.**

Material examinado. *Acalypha diversifolia* Jacq. V-03 (45), VI-03 (26), VII-03 (27), X-03 (13), XI-03 (8), XII-03 (18), I-04 (28), II-04 (19), III-04 (45), IV-04 (41); *Actnostemon communis* (Müll. Arg.) Pax, V-03 (5), VI-03 (10), VII-03 (4), X-03 (2), XII-03 (3), I-04 (10), II-04 (1), III-04 (8), IV-04 (5); *Alchornea glandulosa* Poepp. & Endl. V-03 (4), VI-03 (1), VII-03 (3), VIII-03 (1), X-03 (4), XI-03 (3), XII-03 (3), I-04 (1), II-04 (9), III-04 (8), IV-04 (5).

Lasioseius sp.

Material examinado. *A. diversifolia.* XI-03 (1).

Zercoseius sp.

Material examinado. *A. diversifolia.* XI-03 (1).

Observações. Algumas espécies da família Ascidae são predadoras de ácaros fitófagos na parte baixa da vegetação, enquanto outras são eficientes predadoras de ovos e larvas de ácaros, traças e carunchos que atacam os cereais armazenados (Flechtmann 1975).

Phytoseiidae Berlese, 1913

Amblyseius aerialis (Muma, 1955)

Amblyseiopsis aerialis Muma, 1955: 264; Garman, 1958: 75.

Typhlodromus (*Amblyseius*) *aerialis*; Chant, 1959: 88.

Amblyseius aerialis; Athias-Henriot, 1957: 338; De Leon, 1966: 91; Moraes *et al.*, 1986: 6, 1991: 117, 2004: 13; Moraes & Mesa, 1988: 71; Denmark & Muma, 1989: 15; Kreiter & Moraes, 1997: 377; Feres & Moraes, 1998: 126; Moraes *et al.*, 1999 (2000): 238; Gondim Jr. & Moraes, 2001: 67; Feres *et al.*, 2005: 3.

Amblyseius (*Amblyseius*) *aerialis*; Muma, 1961: 287.

Material examinado. *A. diversifolia* VI-03 (1), XI-03 (51), XII-03 (9), I-04 (5), II-04 (1), III-04 (1); *A. communis* V-03 (1), VI-03 (2), XI-03 (2), XII-03 (6), I-04 (2), II-04 (1), III-04 (2), IV-04 (1); *A. glandulosa* XI-03 (1), XII-03 (1), I-04 (1), II-04 (2), III-04 (1); *Manihot langsdorffi* Müell. Arg. IV-04 (1).

Distribuição. Argélia; Bermudas; Brasil- Bahia, Pernambuco, São Paulo; Colômbia; Cuba; EUA; Galápagos; Guadalupe; Guiana; Honduras; Índia; Jamaica; Martinica; México; Venezuela.

Observações. Espécie freqüentemente associada com infestações de *Brevipalpus* spp.; exemplares foram observados alimentando-se de *Panonychus citri* (McGregor) (Muma 1964 *apud* Muma 1971).

Amblyseius chiapensis De Leon, 1961

Amblyseius chiapensis De Leon, 1961a: 85; 1962a: 175; McMurtry, 1983: 250; Moraes & Mesa, 1988: 72; Moraes *et al.*, 1986: 10, 1991: 118, 2004: 19; Denmark & Muma, 1989: 94; McMurtry & Moraes, 1989: 185; Gondim Jr. & Moraes, 2001: 67; Ferla & Moraes, 2002a: 1.013; Lofego *et al.*, 2004: 3; Feres *et al.*, 2005: 3.

Amblyseius triplaris; De Leon, 1967: 25 (sinônimo júnior, de acordo com Denmark & Muma, 1989: 94).

Material examinado. *A. diversifolia* V-03 (9), VI-03 (11), VII-03 (13), VIII-03 (23), IX-03 (11), XI-03 (1), XII-03 (1), II-04 (1), III-04 (6), IV-04 (11); *A. communis* VI-03 (3), VII-03 (1), VIII-03 (1), IX-03 (3); *A. glandulosa* V-03 (34), VI-03 (36), VII-03 (55), VIII-03 (52), IX-03 (15), XI-03 (1), XII-03 (1), II-04 (3), III-04 (25), IV-04 (33); *Cecropia pachystachya* Trec. IV-04 (7); *Psychotria carthagenensis* Jacq. XI-03 (1).

Distribuição. Brasil- Bahia, Ceará; Maranhão, Pernambuco, Rio Grande do Sul, Santa Catarina, São Paulo; Colômbia; El Salvador; Guatemala; Honduras; México; Porto Rico; Venezuela.

Amblyseius herbicolus (Chant, 1959)

Typhlodromus (*Amblyseius*) *herbicolus* Chant, 1959: 84.

Amblyseius herbicolus; Daneshvar & Denmark, 1982: 5; McMurtry & Moraes, 1984: 34; Denmark & Muma, 1989: 59; Moraes *et al.* 1986: 14, 1991: 118, 2004: 27; Gondim Jr. & Moraes, 2001: 70; Zacarias & Moraes, 2001: 580; Ferla & Moraes, 2002a: 1013.

Amblyseius (*Ambliseius*) *herbicolus*; Muma, 1961: 287.

Amblyseius deleoni; Muma & Denmark, 1970: 68 in Muma *et al.*, 1970: 68 (sinonímia de acordo com Daneshvar & Denmark, 1982: 5).

Amblyseius impactus; Chaudhri, 1968: 553 (sinonímia de acordo com Daneshvar & Denmark, 1982: 5).

Material examinado. *A. diversifolia* V-03 (3), VI-03 (1), VII-03 (7), VIII-03 (7), IX-03 (2), I-04 (1), IV-04 (9); *A. communis* V-03 (4), VI-03 (12), VII-03 (17), VIII-03 (21), XII-03 (1), III-04 (1), IV-04 (2); *A. glandulosa* V-03 (36), VI-03 (17), VII-03 (49), VIII-03 (7), IX-03 (1), I-04 (2), II-04 (1); *M. langsdorffi* IV-04 (1).

Distribuição. Brasil- Minas Gerais, Paraná, Rio Grande do Sul, São Paulo.

Amblyseius aff. *igarassuensis*

Material examinado. *A. diversifolia* V-03 (91), VI-03 (103), VII-03 (88), VIII-03 (8), IX-03 (1), X-03 (20), XI-03 (13), XII-03 (10), I-04 (17), II-04 (45), III-04 (24), IV-04 (45); *A. communis* V-03 (24), VI-03 (38), VII-03 (26), VIII-03 (8), X-03 (4), XI-03 (4), XII-03 (8), I-04 (5), II-04 (22), III-04 (9), IV-04 (6); *A. glandulosa* V-03 (3), VI-03, VII-03 (7), IX-03 (1), I-04 (1), III-04 (1), IV-04 (4); *Jacaratia spinosa* (Aubl.) DC. IV-04 (5); *Trichilia claussenii* C. DC. IX-03 (2).

Euseius alatus De Leon, 1966

Euseius alatus De Leon, 1966: 87; Denmark & Muma, 1973: 262; Moraes & McMurtry, 1983: 137; Moraes *et al.* 1986: 36, 1991: 131, 2004: 60; Feres & Moraes, 1998: 127; Gondim Jr. & Moraes, 2001: 73; Zacarias & Moraes, 2001: 581; Ferla & Moraes, 2002a: 1015.

Euseius paraguayensis; Denmark & Muma, 1970: 224 (sinonímia de acordo com Moraes & McMurtry, 1983: 137).

Material examinado. *A. diversifolia* VI-03 (1), VII-03 (1), VIII-03 (2); *A. glandulosa* VI-03 (1), VII-03 (3), XII-03 (2), III-04 (1).

Distribuição. Brasil- Bahia, Ceará, Maranhão, Minas Gerais, Paraíba, Pernambuco, Rio Grande do Sul, São Paulo, Sergipe; Colômbia; Martinica; Peru; Venezuela.

Euseius citrifolius Denmark & Muma, 1970

Euseius citrifolius Denmark & Muma, 1970: 222; Moraes & McMurtry, 1983: 138; Moraes *et al.*, 1986: 38, 1991: 131, 2004: 64; Feres & Moraes, 1998: 127; Feres, 2000: 161; Feres & Nunes, 2001: 1254; Feres *et al.*, 2002: 139, 2003: 375; Gondim Jr. & Moraes, 2001: 74; Zacarias & Moraes, 2001: 581; Ferla & Moraes, 2002a: 1.016; Lofego *et al.*, 2004: 4.

Material examinado. *A. diversifolia* V-03 (1), VI-03 (1), VIII-03 (3), IX-03 (2), XI-03 (1); *A. communis* VIII-03 (4), IX-03 (2); *A. glandulosa* VII-03 (1), VIII-03 (2), X-03 (4), XII-03 (2), I-04 (1), II-04 (2); *Terminalia argentea* Mart. et Zucc. XI-03 (2).

Distribuição. Brasil- Bahia, Ceará, Maranhão, Minas Gerais, Paraíba, Pernambuco, Piauí, Rio Grande do Sul, São Paulo; Colômbia; Nicarágua; Peru.

Observações. Esta espécie ocorre sobre diversas espécies de plantas. Na região noroeste do estado de São Paulo é a mais freqüente e abundante (Feres & Moraes 1998). Segundo Gravena *et al.* (1994), essa espécie é predadora de *Brevipalpus phoenicis*. Foi mantida em criações de laboratório com pólen de *Typha angustifolia* L. (Furtado & Moraes 1998) e de *Mabea fistulifera* Mart. (Daud & Feres 2004).

Euseius concordis (Chant, 1959)

Typhlodromus (*Amblyseius*) *concordis* Chant, 1959: 69.

Amblyseius (*Iphiseius*) *concordis*; Muma, 1961: 288.

Amblyseius concordis; Chant & Baker, 1965: 22.

Euseius concordis; Denmark & Muma, 1973: 264; Moraes & Oliveira, 1982: 317; Moraes & McMurtry, 1983: 138; Moraes *et al.*, 1986: 39, 2004: 64; Feres & Moraes, 1998: 127; Feres, 2000: 161; Feres & Nunes, 2001: 1255; Feres *et al.*, 2002: 140, 2005: 3; Gondim Jr. & Moraes, 2001: 74; Ferla & Moraes, 2002a: 1016; Lofego *et al.*, 2004: 5.

Euseius flechtmanni; Denmark & Muma, 1970: 223, 1973: 261 (sinônimo júnior, de acordo com Moraes *et al.*, 1982: 18).

Material examinado. *A. diversifolia* V-03 (13), VI-03 (7), VII-03 (25), VIII-03 (80), IX-03, X-03 (35), XI-03 (14), XII-03 (7), I-04 (32), II-04 (25), III-04 (3), IV-04 (2); *A. communis* VI-03 (3), VII-03 (4), VIII-03 (13), IX-03 (25), X-03 (11), XI-03 (18), XII-03 (14), I-04 (3), II-04 (1), III-04 (2); *A. glandulosa* V-03 (18), VI-03 (36), VII-03 (63), VIII-03 (110), IX-03 (101), X-03 (71), XI-03 (109), XII-03 (83), I-04 (65), II-04 (31), III-04 (23), IV-04 (16); *Guarea kunthiana* A. Juss. XI-03 (2); *M. langsdorffi* IV-04 (1); *P. carthagenensis* XI-03 (1); *T. claussenii* XI-03 (1); *Unonopsis lindmanii* Fries. XI-03 (3).

Distribuição. Argentina; Brasil - Bahia, Ceará, Minas Gerais, Paraíba, Pernambuco, Piauí, Rio Grande do Sul, São Paulo; Colômbia; Costa Rica; El Salvador; Guatemala; Honduras; Monte Negro; Nicarágua; Paraguai; Portugal; Trinidad e Tobago; Venezuela.

Observações. Predador de *Aculops lycopersici* segundo Moraes & Lima (1983). Predador de *Brevipalpus phoenicis* segundo Komatsu & Nakano (1988). Fitoseídeo mais abundante em seringueiras no Mato Grosso (Ferla & Moraes 2002b), também registrado em seringueiras do estado de São Paulo (Feres *et al.* 2002).

Euseius sibelius (De Leon, 1962)

Amblyseius (*Typhlodromalus*) *sibelius* De Leon, 1962b: 21.

Euseius sibelius; Muma *et al.*, 1970: 98; Moraes & McMurtry, 1983: 140; Moraes & Mesa, 1988: 81; Moraes *et al.*, 1986: 54, 2004: 83; Feres & Moraes, 1998: 128; Feres *et al.*, 2003: 375; Ferla & Moraes, 2002a: 1017; Lofego *et al.*, 2004: 6.

Euseius subalatus; De Leon, 1965: 127 (sinonímia de acordo com Muma *et al.*, 1970: 35).

Material examinado. *A. glandulosa* X-03 (2), XI-03 (1), I-04 (1).

Distribuição. Brasil- Bahia, Paraíba, Pernambuco, Piauí, Rio Grande do Sul, São Paulo; Colômbia; El Salvador; Guadalupe; Honduras; Jamaica; Porto Rico.

Galendromus (*Galendromus*) *annectens* (De Leon, 1958)

Typhlodromus annectens De Leon, 1958: 75; Chant & Yoshida-Saul, 1984: 1868; Moraes & McMurtry, 1983: 142; Moraes & Mesa, 1988: 82; Moraes *et al.*, 1991: 134; Feres & Moraes, 1998: 128; Feres, 2000: 161; Feres & Nunes, 2001: 1256; Zacarias & Moraes, 2001: 583.

Galendromus annectens; Muma, 1961: 298, 1963: 20; Muma *et al.*, 1970: 135; Denmark & Muma, 1973: 274; Farias *et al.*, 1981: 21; Denmark, 1982: 142; Moraes *et al.*, 1982: 21, 1986: 186; Gondim Jr. & Moraes, 2001: 88; Ferla & Moraes, 2002a: 1019; Feres *et al.* 2003: 375.

Galendromus (*Galendromus*) *annectens*; Moraes *et al.*, 2004: 265; Lofego *et al.*, 2004: 12; Feres *et al.*, 2005: 4.

Material examinado. *A. diversifolia* VIII-03 (8), IX-03 (14), X-03 (1), XI-03 (1); *A. communis* VIII-03 (1); *A. glandulosa* VI-03 (1), X-03 (1), XI-03 (1), XII-03 (1), I-04 (3), II-04 (1), III-04 (1), IV-04 (1).

Distribuição. Brasil- Bahia, Ceará, Minas Gerais, Pernambuco, Rio Grande do Sul, São Paulo; Canadá; Colômbia; Costa Rica; Cuba; El Salvador; E.U.A.; Galápagos; Honduras; Jamaica; México; Porto Rico; Venezuela.

Iphiseiodes zuluagai Denmark & Muma, 1972

Iphiseiodes zuluagai Denmark & Muma, 1972: 23, 1973: 251, 1975: 287; Moraes *et al.*, 1982: 18, 1986: 61, 2004: 91; Aponte & McMurtry, 1995: 176; Kreiter & Moraes, 1997: 377; Feres & Moraes, 1998: 127; Feres & Nunes, 2001: 1255; Feres *et al.*, 2002: 140; Moraes *et al.*, 1999 (2000): 245; Gondim Jr. & Moraes, 2001: 76; Zacarias & Moraes, 2001: 581; Ferla & Moraes, 2002a: 1013; Lofego *et al.*, 2004: 7; Feres *et al.*, 2005: 3.

Amblyseius zuluagai; Moraes & Mesa, 1988: 79; Moraes *et al.*, 1991: 125.

Material examinado. *A. diversifolia* V-03 (9), VI-03 (8), VII-03 (44), VIII-03 (24), IX-03 (16), X-03 (1), XII-03 (1), I-04 (13), III-04 (5), IV-04 (6); *A. communis* VI-03 (2), VIII-03 (2); *A. glandulosa* V-03 (45), VI-03 (78), VII-03 (57), VIII-03 (104), IX-03 (46), XI-03 (1), XII-03 (2), I-04 (4), II-04 (2), III-04 (9), IV-04 (49); *C. pachystachya* IV-04 (11); *M. langsdorffi* IV-04 (3); *P. carthagenensis* XI-03 (1).

Distribuição. Brasil- Bahia, Maranhão, Minas Gerais, Pernambuco, Rio Grande do Sul, São Paulo; Colômbia; Cuba; Guadalupe; Marie Galante; Martinica; Panamá; Porto Rico; Venezuela.

Observações. Espécie mais abundante em pomares cítricos de Presidente Prudente, SP (Sato *et al.* 1994). Predador de *Brevipalpus phoenicis* segundo Yamamoto & Gravena (2001).

Metaseiulus (Metaseiulus) adjacentis (De Leon, 1959)

Typhlodromus adjacentis De Leon, 1959: 124; Chant & Baker, 1965: 7; Chant & Yoshida-Shaul, 1983: 1052; Moraes *et al.*, 1991: 136.

Metaseiulus (*Metaseiulus*) *adjacentis*; Moraes *et al.* 2004: 276.

Typhlodromina adjacentis; Muma, 1961: 297; De Leon, 1965: 121, 1967: 16; Denmark & Muma, 1975: 298, Moraes *et al.*, 1986: 235.

Paraseiulella adjacentis; Denmark, 1994: 18.

Material examinado. *A. diversifolia* V-03 (4), VI-03 (7), VII-03 (5); *A. glandulosa* VI-03 (1), VII-03 (1).

Distribuição. Colômbia; Jamaica; Nicarágua; Peru; Puerto Rico; Trinidad.

Observações. Primeiro registro no Brasil.

Neoseiulus tunus (De Leon, 1967)

Typhlodromips tunus De Leon, 1967: 29; Denmark & Muma, 1973: 253; Moraes *et al.*, 1986: 151; Feres & Moraes, 1998: 126.

Amblyseius tunus; McMurtry & Moraes, 1989: 181.

Neoseiulus tunus; Ferla & Moraes, 2002a: 1018; Moraes *et al.*, 2004: 148; Lofego *et al.*, 2004: 8; Feres *et al.*, 2005: 3.

Material examinado. *A. diversifolia* V-03 (2), VI-03 (4), VII-03 (10), VIII-03 (4), XI-03 (2), XII-03 (3), I-04 (8), II-04 (37), III-04 (9), IV-04 (28); *A. communis* VII-03 (3), VIII-03 (2), X-03 (1), XII-03 (1), I-04 (2), IV-04 (1); *A. glandulosa* V-03 (1), VI-03 (3), VII-03 (1), VIII-03 (1), XI-03 (4), XII-04 (1), I-04 (7), II-04 (6), III-04 (4), IV-04 (6); *C. pachystachya* IV-04 (1); *T. argentea* XI-03 (1).

Distribuição. Brasil- Rio Grande do Sul, São Paulo; Guadalupe; Jamaica; Martinica; Peru; Trinidad e Tobago.

Paraphytoseius multidentatus Swirski & Shechter, 1961

Paraphytoseius multidentatus Swirski & Shechter, 1961: 114; McMurtry & Moraes, 1984: 27; Moraes *et al.*, 1986: 104, 2004: 162; Zacarias & Moraes, 2001: 581.

Sinônimo sênior de *Paraphytoseius cracentis*, Matthysse & Denmark, 1981; *P. bhadrakaliensis*, *P. horrifer*, *P. hyalinus*, *P. narayanani*, *P. nicobarensis*, *P. orientalis*, *Paraphytoseius parabilis* (Chaudhri), *P. santurcensis*, *Paraphytoseius subtropicus* (Tseng) e *Paraphytoseius urumanus* (Ehara). Sinonímias de acordo com Denmark *et al.* (1999) e Matthysse & Denmark (1981).

Material examinado. *A. glandulosa* V-03 (1), VI-03 (1).

Distribuição. Brasil- Espírito Santo, Mato Grosso, São Paulo; China; Colômbia; Costa Rica; Guadalupe; Hong Kong; Índia; Japão; Kenia; Madagascar; Malásia; Martinica; Nigéria; Pakistão; Filipinas; Taiwan; Venezuela; Zaire.

Phytoseius cf. *plumifer*

Material examinado. *A. diversifolia* VI-03 (2), VIII-03 (1), IX-03 (1), XI-03 (1); *A. glandulosa* I-04 (1).

Proprioseiopsis dominigos (El-Banhawy, 1984)

Amblyseius dominigos El-Banhawy, 1984: 130; McMurtry & Moraes, 1989: 185; Moraes *et al.*, 1991: 126; Feres & Moraes, 1998: 126.

Proprioseiopsis dominigos; Moraes *et al.*, 1986: 114, 2004: 175; Gondim Jr. & Moraes, 2001: 81; Zacarias & Moraes, 2001: 582.

Material examinado. *A. diversifolia* VII-03 (1); *A. glandulosa* I-04 (1); *C. pachystachya* I-04 (1).

Distribuição. Brasil- Santa Catarina, São Paulo; Colômbia; Peru.

Proprioseiopsis neotropicus (Ehara, 1966)

Amblyseius neotropicus Ehara, 1966: 133; Moraes & Mesa, 1988: 79; Moraes *et al.*, 1991: 126.

Proprioseiopsis neotropicus; Moraes *et al.*, 1986: 119, 2004: 183; Gondim Jr. & Moraes, 2001: 81; Zacarias & Moraes, 2001: 582; Ferla & Moraes, 2002a: 1019; Lofego *et al.*, 2004: 9; Feres *et al.*, 2005: 4.

Material examinado. *A. diversifolia* VI-03 (1), VII-03 (2), X-03 (1), XI-03 (1), IV-04 (1); *A. communis* VII-03 (1); *A. glandulosa* V-03 (1), VI-03 (1), II-04 (2), IV-04 (4); *P. carthagenensis* XI-03 (1).

Distribuição. Brasil- Pernambuco, Rio Grande do Sul, São Paulo; Colômbia; Equador.

***Proprioseiopsis ovatus* (Garman, 1958)**

Amblyseiopsis ovatus Garman, 1958: 78.

Amblyseiulus ovatus; Muma, 1961; Moraes & McMurtry, 1983: 133; Moraes *et al.*, 1991: 127.

Typhlodromus (*Amblyseius*) *ovatus*; Chant, 1959: 90.

Proprioseiopsis ovatus; Denmark & Muma, 1973: 237; Moraes *et al.*, 1986: 121, 2004: 184; Gondim Jr. & Moraes, 2001: 82.

Material examinado. *A. diversifolia* X-03 (1), XI-03 (2).

Distribuição. Brasil- São Paulo; Costa Rica; Cuba; Equador; Egito; Hawai; Honduras; Filipinas; Porto Rico; Taiwan.

Silvaseius* cf. *barretoae

Material examinado. *A. diversifolia* X-03 (1).

Observações. Gênero monoespecífico descrito com base em uma única fêmea coletada de planta não identificada, em Monteverde, Costa Rica. Primeiro registro do gênero após a descrição original.

Transeius bellottii (Moraes & Mesa, 1988)

Amblyseius bellottii Moraes & Mesa, 1988: 75.

Neoseiulus bellottii; Moraes *et al.*, 2004: 108; Lofego *et al.*, 2004: 7; Feres *et al.*, 2005: 3.

Transeius bellottii; Chant & Mcmurtry, 2004: 187.

Material examinado. *A. diversifolia* V-03 (2), VI-03 (1), III-04 (7), IV-04 (1).

Distribuição. Brasil- Bahia, São Paulo (Lofego *et al.* 2004); Colômbia.

***Typhlodromalus aripo* De Leon, 1967**

Typhlodromalus aripo De Leon, 1967: 21; Denmark & Muma, 1973: 257; Moraes *et al.*, 1986: 128, 1999 (2000): 252, 2004: 195; Feres & Nunes, 2001: 1255; Lofego *et al.*, 2004: 10; Feres *et al.* 2005: 4.

Amblyseius aripo; Moraes & McMurtry, 1983: 132; Moraes & Mesa, 1988: 73; Feres & Moraes, 1998: 126.

Material examinado. *A. diversifolia* IX-03 (1), III-04 (1), IV-04 (1); *A. glandulosa* VII-03 (2), I-04 (2), II-04 (8), IV-04 (1).

Distribuição. Brasil- Bahia, Ceará, Maranhão, Pernambuco, Piauí, Rio Grande do Sul, São Paulo; Colômbia; Costa Rica; El Salvador; Guadalupe; Guiana; Jamaica; Paraguai; Trinidad e Tobago.

***Typhlodromalus manihoti* (Moraes, 1994)**

Amblyseius manihoti Moraes *et al.*, 1994: 211.

Typhlodromalus manihoti; Gondim Jr. & Moraes, 2001: 82; Zacarias & Moraes, 2001: 582; Moraes *et al.* 2004: 200.

Material examinado. *A. glandulosa* VI-03 (9), VII-03 (3), VIII-03 (2); *Margaritaria nobilis* Lf. V-03 (4).

Distribuição. Bolívia; Brasil- Bahia, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, São Paulo, Sergipe; Colômbia; Cuba; Equador; Guatemala; Nicarágua; Paraguai; Peru; Suriname; Trinidad; Venezuela.

***Typhlodromalus peregrinus* (Muma, 1955)**

Typhlodromus peregrinus Muma, 1955: 270.

Typhlodromalus peregrinus; Muma *et al.*, 1970: 88; Moraes *et al.*, 1986: 132, 2004: 202; Zacarias & Moraes, 2001: 582.

Typhlodromus (*Amblyseius*) *peregrinus*; Chant, 1959: 97.

Amblyseius peregrinus; McMurtry, 1983: 255; Moraes *et al.*, 1991: 130.

Typhlodromus (*Amblyseius*) *robineae*; Chant, 1959: 98; *Typhlodromus* (*Amblyseius*) *evansi* Chant, 1959: 99; *Typhlodromus* (*Amblyseius*) *primulae*, Chant, 1959: 99. Sinonímias de acordo com Muma (1964a).

Material examinado. *A. diversifolia* VIII-03 (1); *A. glandulosa* V-03 (1).

Distribuição. Brasil- Pernambuco, São Paulo; Colômbia; Costa Rica; Cuba; Equador; Guiana; Hawai; Honduras; México; Peru; Suriname; EUA; Venezuela.

***Typhlodromalus* sp.**

Material examinado. *A. glandulosa* IV-04 (2).

Actinedida

Bdellidae Dugès, 1834

Hexabdella* cf. *singula

Material examinado. *A. diversifolia* II-04 (1); *A. glandulosa* IX-03 (1).

***Cyta* sp.**

Material examinado. *A. diversifolia* IV-04 (1); *A. communis* XII-03 (1), IV-04 (1).

Camerobiidae Southcott, 1957

***Neophyllobius* sp.**

Material examinado. *A. communis* IV-04 (1).

Cheyletidae Leach, 1815

***Cheletogenes ornatus* (Canestrini & Fanzago, 1876)**

Cheyletus ornatus Canestrini & Fanzago, 1876: 106.

Cheletia ornatus; Oudemans, 1904: 154.

Cheletogenes ornatus; Oudemans, 1905: 208; Baker, 1949a: 305; Arruda *et al*., 1969: 36; Vila & Flechtmann, 1970: 101.

Material examinado. *A. glandulosa* X-03 (1), XII-03 (1).

Distribuição. Brasil- Ceará, Pernambuco (Arruda *et al*. 1969), São Paulo (Vila & Flechtmann 1970); Antilhas; Austrália; China; E.U.A.; Hawai; Itália (Baker 1949a).

***Cheletomimus* (*Hemicheyletia*) *wellsi* (Baker, 1949)**

Cheyletia wellsi Baker, 1949a: 300-301.

Paracheyletia wellsi; Volgin, 1955: 152; Muma, 1964b: 245-246.

Dendrocheyla wellsi; Volgin, 1969: 211.

Hemicheyletia wellsi; Summers & Price, 1970: 18; Feres & Flechtmann, 1995: 535; Feres, 2000: 162.

Cheletomimus (*Hemicheyletia*) *wellsi*; Fain *et al*., 2002: 45; Feres *et al*. 2005: 4.

Material examinado. *A. diversifolia* V-03 (2), IX-03 (1), X-03 (4), II-04 (1); *A. communis* VII-03 (1), I-04 (1), II-04 (1), IV-04 (1); *A. glandulosa* IX-03 (1), X-03 (1), I-04 (10), III-04 (1).

Distribuição. África (Rodrigues 1968); Brasil- São Paulo (Feres & Flechtmann 1995); E.U.A. (Muma 1964b).

Observações. Tem sido registrada em folhas e frutos de citros atacados por *Phyllocoptruta oleivora* (Ashmead) (Eriophyidae), o ácaro da falsa ferrugem dos citros (Chiavegato 1980). Já registrada em seringais do estado de São Paulo (Feres 2000, Feres *et al*. 2002).

***Chiapacheylus* sp.**

Material examinado. *A. diversifolia* XI-03 (1), II-04 (1), III-04 (1); *A. communis* XII-03 (2), I-04 (2), II-04 (1).

Observações. A maioria das espécies da família Cheyletidae são predadoras de grande variedade de pequenos artrópodes, como ácaros e colêmbolos. Algumas espécies ocorrem sobre a folhagem das plantas, onde se alimentam de ácaros fitófagos e cochonilhas (Flechtmann 1975).

Cunaxidae Thor, 1902

***Armascirus* sp.**

Material examinado. *A. diversifolia* XI-03 (2), I-04 (1); *A. communis* XII-03 (1); *A. glandulosa* XII-03 (3), II-04 (1), III-04 (1); *P. carthagenensis* XI-03 (1).

***Cunaxoides* sp.**

Material examinado. *A. diversifolia* V-03 (1), VI-03 (1), XI-03 (2), XII-03 (1), I-04 (3), II-04 (2), III-04 (1), IV-04 (2); *A. communis* IV-04 (1); *A. glandulosa* VI-03 (1), I-04 (1), II-04 (4), III-04 (7), IV-04 (4).

***Scirula* sp.**

Material examinado. *A. diversifolia* XI-03 (2), I-04 (1), IV-04 (4); *A. glandulosa* X-03 (10), XI-03 (2), XII-03 (1), I-04 (1), II-04 (3), III-04 (3), IV-04 (2); *C. pachystachya* IV-04 (1).

Observações. Ácaros da família Cunaxidae são predadores de cochonilhas e outros pequenos artrópodes (Smiley 1975).

Eupalopsellidae Willman, 1952

Aff. *Eupalopsis* sp.

Material examinado. *A. diversifolia* VI-03 (1).

***Exothorhis* sp.**

Material examinado. *A. glandulosa* II-04 (2), IV-04 (2).

Eupodidae Koch, 1842

***Eupodes* sp.**

Material examinado. *A. diversifolia* V-03 (1), VI-03 (4), VII-03 (2), X-03; *A. communis* VII-03 (1), I-04 (1); *T. claussenii* XI-03 (1).

Stigmaeidae Oudemans, 1931

Agistemus* aff. *floridanus

Material examinado. *A. diversifolia* VI-03 (1), VII-03 (3), VIII-03 (6), IX-03 (25), X-03 (27), XI-03 (47), XII-03 (14), I-04 (11), II-04 (16), III-04 (1); *A. communis* VI-03 (1), VIII-03 (1), X-03 (4), XI-03 (1), XII-03 (3), II-04 (1); *A. glandulosa* VI-03 (6), VII-03 (2), VIII-03 (3), IX-03 (1), X-03 (2), XI-03 (1), XII-03 (2), I-04 (3), II-04 (1), III-04 (9), IV-04 (1); *C. pachystachya* IV-04 (1); *G. kunthiana* XI-03 (3); *J. spinosa* IV-04 (1); *M. nobilis* IV-04 (1); *T. argentea* XI-03 (1).

Observações. Foram realizadas medições do corpo e setas dorsais de 42 individuos (30 fêmeas e 12 machos), encontrando-se grande amplitude de variação. Os valores encontrados, tanto para o comprimento como para proporção entre comprimento e distância entre setas, abrangem aqueles relatados por Matioli *et al.* (2002) para *A. brasiliensis* Matioli *et al.* (2002) e *A. floridanus* Gonzalez (1965), não sendo possível separá-las a partir desses valores. Espécies de *Agistemus* são geralmente conhecidas como predadoras de ovos de tetraniquídeos (McMurtry *et al.* 1970, Oomen 1982 e Inoue & Tanaka 1983 *apud* Ehara 1993), ocorrendo sobre grande número de plantas.

Zetzellia quasagistemas **Hernandes & Feres, 2005**

Zetzellia quasagistemas Hernandes & Feres, 2005: 37.

Material examinado. *A. glandulosa* VIII-03 (1), II-04 (1), III-04 (1).

Distribuição. Brasil- Mato Grosso, São Paulo (Hernandes & Feres, 2005).

Observações. Apesar de descrita recentemente, essa espécie foi registrada em seringueira nos estados de São Paulo e Mato Grosso, como *Zetzellia* sp. e *Z.* aff. *yusti* (Feres 2000, Ferla & Moraes 2002, Bellini *et al.* 2005). Foi registrada associada a *Lorryia formosa* Cooremann e *Tenuipalpus heveae* Baker (Hernandes & Feres 2006, no prelo) sendo possivel que se alimente dessas espécies. É conhecido o hábito alimentar de *Zetzellia mali* (Ewing), que se alimenta de várias espécies de ácaros tetraniquídeos na América do Norte, Europa e Israel (Jeppson *et al.* 1975).

Tarsonemidae Canestrini & Fanzago, 1877

Daidalotarsonemus tesselatus **De Leon, 1956**

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

Material examinado. *A. diversifolia* II-04 (1), III-04 (1), IV-04 (4); *A. communis* I-04 (1), II-04 (1); *A. glandulosa* V-03 (7), VI-03 (2), I-04 (12), II-04 (25), III-04 (19), IV-04 (31).

Distribuição. E.U.A., Japão (Lin & Zhang 2002); Brasil (Feres *et al.* 2005, Lofego *et al.* 2005).

Observações. Esta espécie tem hábitos alimentares não muito bem definidos, mas é provavelmente fitófaga, podendo se alimentar também de algas e fungos (Lofego *et al.* 2005).

Daidalotarsonemus **sp.**

Material examinado. *A. glandulosa* VIII-03 (1), I-04 (1).

Fungitarsonemus **sp.1**

Material examinado. *A. diversifolia* VIII-03 (1), IX-03 (2), X-03 (10), XI-03 (12), XII-03 (1), I-04 (12), II-04 (7), IV-04 (1); *A. communis* V-03 (1), VI-03 (2), VII-03 (1), VIII-03 (5), IX-03 (11), X-03 (18), XI-03 (9), XII-03 (14), I-04 (28), II-04 (39), III-04 (3), IV-04 (2); *A. glandulosa* VIII-03 (3), XII-03 (2), I-04 (46), II-04 (52), III-04 (6); *Inga marginata* Willd XI-03 (1).

Fungitarsonemus **sp.2**

Material examinado. *A. diversifolia* VIII-03 (1), I-04 (1); *A. glandulosa* VII-03 (1), VIII-03 (1), II-04 (3); *Sapium glandulatum* (Vell.) Pax. IV-04 (1).

Metatarsonemus megasolenidii **Lofego & Ochoa, 2005**

Metatarsonemus megasolenidii Lofego & Ochoa, 2005 *In* Lofego *et al.*, 2005: 7.

Material examinado. *A. diversifolia* VI-03 (1), VII-03 (1), II-04 (5), III-04 (7), IV-04 (16); *A. communis* VII-03 (3), XII-03 (1), I-04 (1), II-04 (4), III-04 (2), IV-04 (16); *A. glandulosa* V-03 (28), VI-03 (1), VII-03 (1), VIII-03 (7), IX-03 (20), X-03 (1), I-04 (2), II-04 (12), III-04 (4), V-04 (23).

Distribuição. Brasil (Lofego *et al.* 2005).

Observações. Não há estudos sobre os hábitos alimentares de ácaros deste gênero. No entanto, a coloração do conteúdo intestinal, verde clara nas larvas e verde escura nos adultos, é um forte indicativo de que sejam fitófagos (Feres *et al.* 2005, Lofego *et al.* 2005).

Metatarsonemus **sp.**

Material examinado. *A. communis* II-04 (1); *S. glandulatum* V-03 (2).

Tarsonemus **(*Floridotarsonemus*) sp.**

Material examinado. *A. communis* II-04 (4), IV-04 (1); *S. glandulatum* V-03 (2).

Tarsonemus **(*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.

Material examinado. *A. diversifolia* VII-03 (1), VIII-03 (1), IX-03 (1), XII-03 (1), II-04 (2), III-04 (3), IV-04 (1); *A. communis* II-04 (1), III-04 (2), IV-04 (1); *A. glandulosa* V-03 (2), XI-03 (3), II-04 (1).

Distribuição. Alemanha, Bielorussia, China, Coreia, Holanda, Irlanda, Itália, Japão, Polônia, Turquia; Ucrânia (Lin & Zhang 2002); Brasil (Feres *et al.* 2005; Lofego *et al.* 2005).

Observações. Espécies do gênero *Tarsonemus* são primariamente micófagas (Lindquist 1986).

Tarsonemus (*Tarsonemus*) sp.1

Material examinado. *A. diversifolia* IV-04 (1).

Tarsonemus (*Tarsonemus*) sp.2

Material examinado. *A. communis* II-04 (1).

Tarsonemus (*Tarsonemus*) sp.3

Material examinado. *A. communis* VI-03 (1), XI-03 (1), II-04 (3), III-04 (1), IV-04 (4); *A. glandulosa* II-04 (3), III-04 (1).

Tarsonemus (*Tarsonemus*) sp.4

Material examinado. *A. diversifolia* X-03 (1).

Tarsonemus (*Tarsonemus*) sp.5

Material examinado. *A. glandulosa* X-03 (1).

Tarsonemus (*Tarsonemus*) sp.6

Material examinado. *A. glandulosa* V-03 (1).

Xenotarsonemus sp.1

Material examinado. *A. diversifolia* II-04 (1), III-04 (3), IV-04 (8); *A. communis* XII-03 (1), III-04 (1), IV-04 (2); *A. glandulosa* II-04 (1), IV-04 (1).

Distribuição. Espécies do gênero ocorrem em regiões temperadas e tropicais, com ampla distribuição geográfica (Lindquist 1986).

Observações. Hábito alimentar não definido (Lindquist 1986).

Xenotarsonemus sp.2

Material examinado. *A. communis* IV-04 (3); *A. glandulosa* II-04 (1), IV-04 (1).

Xenotarsonemus sp.3

Material examinado. *A. diversifolia* IV-04 (2).

Xenotarsonemus sp.4

Material examinado. *A. communis* III-04 (2), IV-04 (1).

Tenuipalpidae Berlese, 1913

Brevipalpus phoenicis (Geijskes, 1939)

Tenuipalpus phoenicis Geijskes, 1939: 23.

Brevipalpus phoenicis; Sayed, 1946: 99; Pritchard & Baker, 1958: 233; De Leon, 1961b: 48; Gonzalez, 1975: 82; Baker *et al.*, 1975: 18; Meyer, 1979: 87; Baker & Tuttle, 1987: 98-99.

Brevipalpus yothersi; Baker, 1949b: 374.

Brevipalpus mcbridei; Baker, 1949b: 374.

Brevipalpus papayensis; Baker, 1949b: 379.

Material examinado. *A. communis* X-03 (1), XI-03 (1), I-04 (1); *A. diversifolia* VII-03 (1), X-03 (1); *A. glandulosa* VIII-03 (3), IX-03 (10), X-03 (14), XI-03 (17), XII-03 (5), I-04 (2), III-04 (2); *g. kunthiana* XI-03 (1).

Distribuição. Espécie de ampla distribuição geográfica, ocorrendo sobre grande número de espécies de plantas hospedeiras. África- África do Sul, Moçambique, Egito, Rodésia, Malaui, Angola, Nigéria, Maurício, Sudão, Uganda, Quênia, Tanzânia (Meyer & Rodrigues 1965, Rodrigues 1968, Meyer 1979); Brasil- Alagoas, Bahia, Ceará, Minas Gerais, Paraná, Pernambuco, Rio de Janeiro, São Paulo (Flechtmann 1976); Colômbia (Zuluaga & Saldarriaga 1970); E.U.A. (Baker & Tuttle 1987); Porto Rico (Cromroy 1958).

Observações. Referido como “ácaro da leprose dos citros”, pois é o vetor da virose que causa essa patogenia nos citros (Chiavegato 1980). Espécie registrada em seringueiras de Itabuna, BA e Rio Claro, SP (Flechtmann & Arleu 1984) e em seringueiras do noroeste paulista (Feres 2000, Feres *et al.* 2002).

Brevipalpus sp.

Material examinado. *C. pachystachya* IV-04 (1).

Tenuipalpus aff. *heteropyxis*

Material examinado. *A. glandulosa*. V-03 (22), VI-03 (22), VII-03 (7), VIII-03 (21), IX-03 (9), X-03 (48), XI-03 (58), XII-03 (51), I-04 (132), II-04 (107), III-04 (172), IV-04 (141).

Tenuipalpus aff. *zhizhilashviliae*

Material examinado. *Sebastiania brasiliensis* Spreng IV-04 (5).

Tenuipalpus aff. *oxalis*

Material examinado. *Trichilia cassaretti* C. DC. XI-03 (22).

Tenuipalpus aff. *anoplomexus*

Material examinado. *A. diversifolia* III-04 (1), IV-04 (1).

Tenuipalpus aff. *zanthus*

Material examinado. *A. diversifolia* IV-04 (1).

Tenuipalpus aff. *unimerus*

Material examinado. *A. diversifolia* II-04 (1).

Tenuipalpus aff. *lunatus*

Material examinado. *S. glandulatum* IV-04 (19).

Tetranychidae Donnadieu, 1875

Aponychus* cf. *schultzi

Material examinado. *A. diversifolia* V-03 (17), VI-03 (53), VII-03 (114), VIII-03 (44), IX-03 (13), X-03 (30), XI-03 (10), XII-03 (41), I-04 (43), II-04 (49), III-04 (46), IV-04 (43); *A. glandulosa* V-03 (1); *M. langsdorfii* IV-04 (1).

***Atrichoproctus uncinatus* Flechtmann, 1967**

Atrichoproctus uncinatus Flechtmann, 1967: 39 *apud* Flechtmann & Baker, 1970: 157; Flechtmann & Baker, 1975: 116; Feres, 2000: 166; Feres *et al*. 2005: 7.

Material examinado. *A. glandulosa* III-04 (2).

Distribuição. Brasil; Colômbia; Cuba.

Observações. Ocorre preponderantemente na face superior das folhas; registrado em seringueira de Itiquira, Mato Grosso (Feres 2000).

***Eotetranychus* sp.**

Material examinado. *A. diversifolia* XII-03 (1).

Neotetranychus asper Feres & Flechtmann, 2000

Neotetranychus asper Feres & Flechtmann, 2000: 224; Flechtmann, 2004:10; Feres *et al*. 2005: 8.

Material examinado. *A. diversifolia* VII-03 (1), XI-03 (1).

Distribuição. Brasil (Feres & Flechtmann 2000).

Observações. Primeiro registro da espécie em *Acalypha diversifolia*.

***Oligonychus gossypii* (Zacher, 1921)**

Paratetranychus gossypii Zacher, 1921: 183.

Oligonychus gossypii; Pritchard & Baker, 1955: 359; Baker & Pritchard, 1960: 508; Meyer, 1974: 263; 1987: 152; Feres, 2000: 166; Feres *et al*. 2005: 8.

Material examinado. *A. communis* XI-03 (1).

Distribuição. Angola; Benin; Brasil; Camarões; República da África Central; Colômbia; Congo; Costa Rica; Equador; Etiópia; Honduras; Madagascar; Nigéria; Quênia; São Tomé; Senegal; Serra Leoa; Tanzânia; Togo; Uganda; Venezuela; Zaire.

Observações. Registrada em várias espécies de plantas. Habitam a superfície inferior das folhas, onde produzem teia. Relatada causando danos em seringueira (Flechtmann 1989).

***Oligonychus yothersi* (McGregor, 1914)**

Tetranychus yothersi McGregor, 1914: 355.

Oligonychus yothersi; Pritchard & Baker, 1955: 330; Baker & Pritchard, 1962: 322; Flechtmann & Baker, 1970: 156; Feres *et al*. 2005: 8.

Material examinado. *Guarea guidonia* (L.) Sleumer XI-03 (18).

Distribuição. Argentina; Brasil; Chile; China; Colômbia; Costa Rica; Cuba; Equador; E.U.A.; Havaí; México; Nicarágua; Paraguai; Peru.

***Oligonychus* sp.**

Material examinado. *U. lindmanii* XI-03 (3).

***Tetranychus mexicanus* (McGregor, 1950)**

Septanychus mexicanus McGregor, 1950: 323.

Tetranychus mexicanus; Pritchard & Baker, 1955: 411; Flechtmann & Baker, 1970: 162; Feres *et al*. 2005: 9.

Material examinado. *A. diversifolia* V-03 (2), VI-03 (1), VII-03 (2), VIII-03 (20), IX-03 (36), X-03 (19), XI-03 (4), II-04 (1), III-04 (1); *A. glandulosa* V-03 (7), VI-03 (1), VIII-03 (3), IX-03 (1), X-03 (7), XII-03 (1), II-04 (3), III-04 (2), IV-04 (3).

Distribuição. Argentina; Brasil; Colômbia; Costa Rica; Cuba; El Salvador; E.U.A.; Honduras; México; Nicarágua; Paraguai; Peru; Uruguai.

Observações. As fêmeas dessa espécie apresentam coloração variável do verde ao vermelho; machos geralmente verde-amarelados ao vermelho. Ocorrem na face inferior das folhas, onde produzem apreciável quantidade de teias (Feres 2000).

***Tetranychus riopretensis* Feres & Flechtmann, 1996**

Tetranychus riopretensis Feres & Flechtmann, 1996: 299.

Material examinado. *A. communis* V-03 (8), VI-03 (16), VII-03 (2), VIII-03 (5), IX-03 (18), X-03 (32), XI-03 (23), XII-03 (20), I-04 (24), II-04 (3), III-04 (5).

Observação. Primeiro registro da espécie após a descrição original. Habitam a superfície inferior das folhas, onde produzem pouca teia (Feres & Flechtmann 1996).

***Tetranychus* sp.**

Material examinado. *T. cassaretti* XI-03 (3).

Tydeidae Kramer, 1877

***Homeopronematus* sp.**

Material examinado. *A. diversifolia* VII-03 (2), VIII-03 (1), IX-03 (8), X-03 (54), XI-03 (37), XII-03 (2), I-04 (2), II-04 (1), IV-04 (6); *A. communis* V-03 (3), VI-03 (3), VII-03 (8), VIII-

03 (1), IX-03 (17), X-03 (12), XI-03 (43), XII-03 (29), I-04 (24), II-04 (26), III-04 (17), IV-04 (13); *A. glandulosa* IX-03 (9), X-03 (65), XI-03 (73), XII-03 (9), I-04 (7), II-04 (17), III-04 (4), IV-04 (4); *G. kunthiana* XI-03 (6); *P. carthagenensis* XI-03 (3); *T. cassaretti* XI-03 (7); *U. lindmanii* XI-03 (4).

Observações. Ácaros diminutos e de movimentos rápidos. São translúcidos e apresentam coloração de branco à laranja, quando vivos. A espécie *Homeopronematus anconai* (Baker, 1943) é referida como predadora de *Aculops lycopersici* (Masse, 1937), considerado praga de tomateiros (Hessein & Perring 1986 *apud* Gerson *et al*. 2003).

Lorryia formosa Cooreman, 1958

Lorryia formosa Cooreman, 1958: 6-10; Baker, 1968: 995-996; Feres *et al*. 2005: 5.

Material examinado. *A. diversifolia* V-03 (1), VIII-03 (1), IX-03 (3), X-03 (3), XI-03 (5), XII-03 (2), I-04 (2), II-04 (1); *A. communis* IX-03 (1), XI-03 (1), I-04 (4); *A. glandulosa* IX-03 (1), X-03 (1), XI-03 (4), XII-03 (8), I-04 (7), II-04 (2); *G. kunthiana* XI-03 (1).

Distribuição. Argentina; Brasil; Equador; Espanha; França; Marrocos; México; Uruguai (Baker 1968); Paraguai (Aranda & Flechtmann 1969, Flechtmann 1973).

Observações. Ácaros de coloração verde-amarelada; registrada em seringais do estado de São Paulo (Feres 2000, Feres *et al*. 2002). Ocorrem praticamente ao longo de todo o ano, sobre um grande número de plantas, sem causar dano aparente às folhas.

Lorryia sp.1

Material examinado. *A. diversifolia* V-03 (2), VII-03 (2), VIII-03 (7), IX-03 (9), X-03 (8), XI-03 (3), XII-03 (1), I-04 (1), II-04 (7), III-04 (3), IV-04 (2); *A. communis* VI-03 (3), VII-03 (4), VIII-03 (13), IX-03 (27), X-03 (5), XI-03 (12), XII-03 (14), I-04 (54), II-04 (40), III-04 (21), IV-04 (2); *A. glandulosa* VIII-03 (2), IX-03 (7), X-03 (4), XI-03 (7), XII-03 (12), I-04 (92), II-04 (76), III-04 (3), IV-04 (1); *J. spinosa* IV-04 (4); *T. argentea* XI-03 (2).

Lorryia sp.2

Material examinado. *A. communis* VI-03 (1), I-04 (1).

Lorryia sp.3

Material examinado. *A. diversifolia* VIII-03 (1), X-03 (1), II-04 (1); *A. communis* IV-04 (1); *A. glandulosa* I-04 (4), II-04 (5), IV-04 (1); *I. marginata* XI-03 (1); *J. spinosa* IV-04 (2).

Lorryia *sp.4*

Material examinado. *A. diversifolia* IV-04 (1).

Metatriophtydeus sp.

Material examinado. *A. diversifolia* VI-03 (1), VIII-03 (2), IX-03 (1), X-03 (4), XI-03 (2), XII-03 (1), I-04 (1), IV-04 (2); *A. communis* VI-03 (4), VII-03 (6), VIII-03 (1), IX-03 (3), XI-03 (3), XII-03 (1), I-04 (17), II-04 (9), III-04 (5), IV-04 (7); *A. glandulosa* VIII-03 (2), IX-03 (1), X-03 (4), XI-03 (2), I-04 (2), II-04 (2), III-04 (1), IV-04 (2); *G. guidonia* XI-03 (1); *G. kunthiana* XI-03 (2); *P. Carthagenensis* XI-03 (1).

Neolorryia boycei (Baker, 1944)

Retetydeus boycei Baker, 1944: 78.

Lorryia boycei; Baker, 1968: 1004; Feres, 2000: 163.

Neolorryia boycei; André, 1980: 127.

Material examinado. *A. diversifolia* VIII-03 (1), IX-03 (1), X-03 (1), III-04 (1); *A. communis* I-04 (1), II-04 (3), III-04 (7), IV-04 (1); *A. glandulosa* XII-03 (1), II-04 (2), III-04 (1).

Distribuição. Brasil- São Paulo (Feres 2000); EUA, México (Baker 1968).

Observação. Espécie registrada por Baker (1968) sobre musgo e sob o súber de camélia. Foi registrada em seringueira de Reginópolis, São Paulo (Feres 2000).

Pronematus sp.

Material examinado. *A. diversifolia* VIII-03 (1), IX-03 (3), X-03 (26), XI-03 (17), II-04 (1), IV-04 (1); *A. communis* VI-03 (3), VIII-03 (2), IX-03 (1), X-03 (2), XI-03 (24), XII-03 (10), I-04 (1), II-04 (6); *A. glandulosa* IX-03 (4), X-03 (24), XI-03 (40), XII-03 (4), I-04 (1), II-04 (3), III-04 (3), IV-04 (2); *Aspidospermon cylindrocarpon* M.Arg. XI-03 (1); *I. marginata* XI-03 (1); *M. nobilis* XI-03 (1); *T. argentea* XI-03 (1).

Observações. São diminutos, translúcidos e levemente brancacentos e de movimentos rápidos. *Pronematus ubiquitus* (McGregor) é comum em figueira, onde alimenta-se do ácaro do figo *Aceria fícus* (Cotte) (Baker & Wharton 1952).

Paralorryia sp.

Material examinado. *A. diversifolia* VII-03 (1).

Parapronematus sp.

Material examinado. *A. diversifolia* VII-03 (2), VIII-03 (3), X-03 (2), XI-03 (1), II-04 (4), III-04 (2); *A. communis* VII-03 (2), VIII-03 (3), IX-03 (4), XI-03 (2), I-04 (1), II-04 (31), III-04 (15), IV-04 (3); *A. glandulosa* V-03 (1), VIII-03 (1), IX-03 (1), XI-03 (1), XII-03 (1), I-04 (8), II-04 (16), III-04 (3), IV-04 (5); *A. cylindrocarpon* XI-03 (1); *I. marginata* XI-03 (1); *J. spinosa* IV-04 (5) ; *P. carthagenensis* XI-03 (3); *S. brasiliensis* IV-04 (1); *T. cassaretti* XI-03 (1).

Observações. Semelhantes a *Pronematus* sp. na forma e coloração, diferem entretanto por apresentarem setas bífidas sobre os fêmures III e IV (Feres 2000).

Pausia sp.

Material examinado. *A. communis* II-04 (1).

Pretydeus sp.

Material examinado. *A. glandulosa* VIII-03 (1), IV-04 (1).

Pseudolorryia sp.

Material examinado. *A. diversifolia* X-03 (2); *A. communis* VIII-03 (1); *T. claussenii* XI-03 (2); *U. lindmanii* XI-03 (1).

Tydeus sp.

Material examinado. *A. diversifolia* VI-03 (1).

Observação. Pouco se conhece a respeito da biologia das espécies pertencentes a este gênero. Podem ser encontrados em grande número, sobre folhas de plantas diversas, no húmus, fragmentos vegetais e sobre produtos alimentícios armazenados (Baker 1970).

Meyerellinae

Gênero não identificado

Material examinado. *A. diversifolia* X-03 (2), XII-03 (1); *A. communis* VI-03 (1), VIII-03 (3), IX-03 (2), X-03 (1), XII-03 (2); *A. glandulosa* V-03 (1), VIII-03 (1), IX-03 (2).

Diptilomiopidae Keifer, 1944

Diptilomiopus sp.

Material examinado. *A. glandulosa* VII-03 (35), VIII-03 (6), IX-03 (9), X-03 (268), XI-03 (58), XII-03 (21), I-04 (26), II-04 (13), III-04 (4), IV-04 (2).

Aff. _Vimola_ sp.

Material examinado. *G. guidonia* XI-03 (49).

Eriophyidae Nalepa, 1898

Aceria sp.

Material examinado. *A. diversifolia* VII-03 (15).

Aff. _Monotrymacus_ sp.

Material examinado. *A. cylindrocarpon* XI-03 (18)

Phyllocoptes sp.

Material examinado. *A. glandulosa* V-03 (1), X-03 (39), XI-03 (104), XII-03 (11), I-04 (1.051), II-04 (441), III-04 (25), IV-04 (51).

Phyllocoptruta sp.

Material examinado. *S. glandulatum* V-03 (20).

Procalacarus sp.

Material examinado. *A. glandulosa* X-03 (2), XI-03 (1), I-04 (1), II-04 (14), III-04 (1), IV-04 (4).

Tegonotus sp.

Material examinado. *A. glandulosa* XI-03 (1).

Aff. _Tetraspinus_ sp.

Material examinado. *A. glandulosa* V-03 (8), X-03 (71), XI-03 (158), XII-03 (23), I-04 (445), II-04 (84), III-04 (20), IV-04 (13).

Anthocoptini

Gênero não identificado

Material examinado. *M. nobilis* V-03 (14).

Phyllocoptini

Gênero não identificado

Material examinado. *S. brasiliensis* IV-04 (2).

Acaridida

Acaridae Ewing & Nesbitt, 1954

Caloglyphus sp.

Material examinado. *A. diversifolia* VI-03 (1), VII-03 (2), VIII-03 (24), IX-03 (2), II-04 (10), III-04 (55), IV-04 (9); *A. communis* VII-03 (1), III-04 (17), IV-04 (1); *A. glandulosa* VI-03 (2), VII-03 (35), VIII-03 (131), IX-03 (2), IV-04 (3).

Tyrophagus putrescentiae (Schrank, 1781)

Acarus putrescentiae Schrank, 1781: 521.

Tyrophagus putrescentiae; Oudemans, 1924: 250.

Material examinado. *A. diversifolia* IV-04 (1).

Observações. Espécie registrada como praga de meios de cultura e dietas de insetos em laboratórios e produtos alimentícios armazenados (Flechtmann 1986).

Winterschmidtiidae Oudemans, 1923

Czenspinskia sp.

Material examinado. *A. diversifolia* V-03 (4), VII-03 (5), VIII-03 (18), IX-03 (37), X-03 (5), XI-03 (20), XII-03 (6), I-04 (12), II-04 (13), III-04 (3), IV-04 (3); *A. communis* XI-03 (2), XII-03 (9), I-04 (5), II-04 (15), III-04 (7), IV-04 (2); *A. glandulosa* V-03 (47), VI-03 (6), VII-03 (1), IX-03 (2), X-03 (1), XII-03 (32), I-04 (149), II-04 (34), III-04 (20), IV-04 (9).

Observações. São ácaros translúcidos, de movimentos lentos e apresentam coloração creme em vida. Provavelmente são micófagos (Baker & Wharton 1952, Krantz 1978).

***Oulenzia* sp.**

Material examinado. *A. diversifolia* VII-03 (5), VIII-03 (3), II-04 (4), III-04 (1); *A. glandulosa* II-04 (1), IV-04 (6); *J. spinosa* IV-04 (1).

Observações. Ácaros de coloração brancacenta brilhante. *Oulenzia arboricola* (Oudemans) foi descrita sobre folhas de *Hevea* em Sumatra; espécimes também foram coletados sobre juta, na Índia. Relatados como sendo de hábito herbívoro (Baker & Wharton 1952).

Oribatida

Ceratozetidae Jacot, 1925

Ceratozetes* cf. *catarinensis

Material examinado. *A. diversifolia* V-03 (5), VI-03 (4), VII-03 (5), VIII-03 (1), IX-03 (4), X-03 (26), XI-03 (1), XII-03 (6), I-04 (2), II-04 (7), III-04 (3), IV-04 (6); *A. communis* XII-03 (3), I-04 (1), II-04 (1); *A. glandulosa* V-03 (5), VI-03 (11), VII-03 (12), VIII-03 (4), IX-03 (8), X-03 (12), XI-03 (5), XII-03 (3), I-04 (9), II-04 (21), III-04 (9), IV-04 (12); *C. pachystachya* IV-04 (1), IV-04 (11); *G. kunthiana* XI-03 (14); *J. spinosa* IV-04 (14); *P. carthagenensis* XI-03 (1); *T. cassaretti* XI-03 (1).

Observações. Espécies da família Ceratozetidae são freqüentemente encontradas em hábitats plantícolas, às vezes constituindo grandes populações (Behan-Pelletier 2000). A única espécie de *Ceratozetes* conhecida do Brasil, *C. catarinensis*, foi descrita por Pérez-Iñigo & Pérez-Iñigo Jr. (1993) com espécimes coletados sobre ramos de *Araucaria angustifolia* em Santa Catarina. A possível afiliação da espécie coletada no presente estudo à espécie descrita por Pérez-Iñigo & Pérez-Iñigo Jr. (1993) está sendo investigada.

Cymbaeremaeidae Sellnick, 1928

***Scapheremaeus* sp.1**

Material examinado. *A. diversifolia* IX-03 (1); *A. communis* II-04 (1), IV-04 (1).

***Scapheremaeus* sp.2**

Material examinado. *A. diversifolia*. II-04 (1), III-04 (1); *A. communis* III-04 (2).

Observações. Representantes dos Cymbaeremaeidae são primaria ou exclusivamente plantícolas e constituem uma das mais características famílias de oribatídeos habitantes de folhas (Norton 1983, Walter & Behan-Pelletier 1999, Walter & Proctor 1999). Embora não existam espécies da família formalmente registradas no Brasil, exemplares do gênero *Scapheremaeus* estão entre os Oribatida mais comumente encontrados em hábitats plantícolas do estado de São Paulo, com grande número de espécies morfologicamente distintas representadas.

Galumnidae Jacot, 1925

***Galumna* sp.1**

Material examinado. *A. diversifolia* V-03 (2), X-03 (1), XI-03 (1), XII-03 (2), I-04 (1), II-04 (1), III-04 (1); *A. communis* VI-03 (2), VII-03 (1), X-03 (1), II-04 (1); *A. glandulosa* XI-03 (1), III-04 (1).

***Galumna* sp.2**

Material examinado. *A. diversifolia* X-03 (1); *A. communis* VIII-03 (1).

Observações. Com cerca de 40 gêneros e 450 espécies distribuídas mundialmente, os Galumnidae são ácaros principalmente edáficos, com hábitos alimentares diversificados (Gerson *et al.* 2003). Várias espécies morfologicamente distintas de *Galumna* têm sido freqüentemente encontradas em hábitats plantícolas no estado de São Paulo, embora poucas espécies tenham sido identificadas sobre plantas no Brasil.

Mochlozetidae Grandjean, 1960

Dynatozetes* cf. *amplus

Material examinado. *A. glandulosa* III-04 (3); *C. pachystachya* IV-04 (1).

Observações. Espécies de Mochlozetidae são primaria ou exclusivamente plantícolas mas, aparentemente, não exibem muita especificidade às plantas hospedeiras. Uma razão é que as plantas em si mesmas não parecem servir de alimento a estes ácaros (Norton 1983). Embora *Dynatozetes obesus* Grandjean e *Terrazetes mauritius* (Jacot) ingiram materiais originados de vegetais superiores (Grandjean 1960), a maioria dos Mochlozetidae parece se alimentar primariamente de esporos e hifas de fungos (Norton 1983). A possível afiliação da espécie coletada no presente estudo a *Dynatozetes amplus*, descrita por

Grandjean (1960) do Panamá, está sendo investigada. Apenas uma espécie do gênero, *D. obesus*, foi registrada no Brasil (Pérez-Iñigo & Baggio 1994).

Oripodidae Jacot, 1925

***Oripoda* sp.1**

Material examinado. *A. diversifolia* X-03 (1), XI-03 (2); *A. communis* VI-03 (1), VIII-03 (2); *A. glandulosa* X-03 (1), I-04 (2), III-04 (1).

***Oripoda* sp.2**

Material examinado. *A. diversifolia* IX-03 (3), X-03 (2); *A. communis* VII-03 (1), X-03 (1), XI-03 (1), IV-04 (1).

Observações. Representantes dos Oripodidae são primaria ou exclusivamente plantícolas (Norton 1983, Walter & Behan-Pelletier 1999). Exemplares dos gêneros *Pirnodus* e, principalmente, *Oripoda***,** estão entre os oribatídeos mais comumente encontrados em hábitats plantícolas do estado de São Paulo, com grande número de espécies morfologicamente distintas representadas. Apenas três espécies de *Oripoda* são conhedidas do Brasil: uma plantícola, *O. araucariae*, descrita por Pérez-Iñigo & Pérez-Iñigo Jr. (1993) de ramos de *Araucaria angustifolia* de Santa Catarina, e duas edáficas, *O. brasiliensis* e *O. lenkoi*, descritas por Pérez-Iñigo & Baggio (1980) e Balogh & Mahunka (1978), respectivamente, do estado de São Paulo.

Pheroliodidae Paschoal, 1987

***Pheroliodes* sp.1**

Material examinado. *A. diversifolia* XI-03 (1).

***Pheroliodes* sp.2**

Material examinado. *A. communis* I-04 (1).

Observações. Espécies da família Pheroliodidae, embora sejam predominantes em ambientes edáficos, são freqüentemente encontradas em hábitats plantícolas. Várias espécies morfologicamente distintas de *Pheroliodes* têm sido comumente encontradas em sobre plantas no estado de São Paulo, embora poucas espécies plantícolas tenham sido identificadas no Brasil.

Scheloribatidae Grandjean, 1933

Hemileius* cf. *initialis

Material examinado. *A. diversifolia* VI-03 (1), IX-03 (1).

***Scheloribates* sp.1**

Material examinado. *A. diversifolia* VII-03 (1), VIII-03 (1); *A. glandulosa* VIII-03 (1), XI-03 (1).

***Scheloribates* sp.2**

Material examinado. *A. diversifolia* X-03 (1).

***Scheloribates* sp.3**

Material examinado. *A. diversifolia* X-03 (2), XI-03 (1); *A. communis* VIII-03 (1), II-04 (2).

Observações. Membros da família Scheloribatidae podem ingerir partes vegetais moles, fungos, algas, liquens, musgos e, ainda, danificar plantas vivas (Lan *et al.* 1986 e Stamou & Asikidis 1992 *apud* Gerson *et al.* 2003). Seus imaturos freqüentemente escavam tecidos moles. Uma espécie, *Dometorina praedatoria* Lan, Xin & Aoki, foi registrada se alimentando de eriofiídeos formadores de galhas afetando citros na China (Lan *et al.* 1986 *apud* Gerson *et al.* 2003). Essa observação sugere que outros membros da família também possam ser predadores. Embora a maioria das espécies conhecidas de Scheloribatidae seja edáfica, espécies dos gêneros *Hemileius* e, principalmente, *Scheloribates*, são freqüentemente encontradas em hábitats platícolas do estado de São Paulo, com grande número de espécies morfologicamente distintas representadas.

Scutoverticidae Grandjean, 1954

Arthrovertex* cf. *hauseri

Material examinado. *A. diversifolia* XI-03 (1).

Observações. Com apenas dois gêneros, *Arthrovertex* e *Scutovertex*, representados na Região Neotropical (Balogh & Balogh 1990), os Scutoverticidae constituem uma família muito heterogênea, formada por oribatídeos morfologicamente relacionados a *Scutovertex* (Pérez-Iñigo 1993). A possível afiliação da espécie coletada no presente estudo a *Arthrovertex hauseri*, descrita por Mahunka (1985) de troncos em decomposição de Guadalupe (Antilhas), está sendo investigada.

Dentre as 123 espécies determinadas, foram identificadas 35 espécies nominais. Dos gêneros (sete) e espécies (88) não identificadas, pelo menos cinco gêneros e 52 espécies são novas para a ciência. A grande maioria dos trabalhos taxonômicos contendo registros de Oribatida no Brasil se restringiu aos oribatídeos edáficos. As espécies plantícolas desse grupo, embora comuns e abundantes, raramente podem ser identificadas com segurança, sendo a maioria das registradas nesse trabalho (11 das 15 determinadas), provavelmente, novas para a ciência.

Das plantas amostradas nas coletas esporádicas, *Psicotria cartagenensis*, *Cecropia pachystachya*, *Guarea kunthiana* e *Jacaratia spinosa*, apresentaram as maiores riquezas (oito, sete e seis espécies, respectivamente). Das três euforbiáceas amostradas mensalmente, *Acalypha diversifolia* e *Alchornea glandulosa* apresentaram maior riqueza, registrando-se 63 espécies em *A. diversifolia* e 58 em *A. glandulosa*. A família Phytoseiidae, a mais importante de ácaros predadores em plantas, foi a que apresentou o maior número de espécies (23). As mais comuns foram *Euseius concordis* e *Iphiseiodes zuluagai*, encontradas sobre oito e seis espécies vegetais, respectivamente.

Metaseiulus (*Metaseiulus*) *adjacentis* (De Leon) e os gêneros *Chiapacheilus* (Cheyletidae) e *Silvaseius* (Phytoseiidae) são registrados pela primeira vez no Brasil. *Neotetranychus asper* Feres & Flechtmann é registrada sobre *Acalypha diversifolia*, nova planta hospedeira, e *Tetranychus riopretensis* Feres & Flechtmann é registrada pela primeira vez após a descrição original, sendo coletada em *Actnostemon communis*, provavelmente a mesma espécie de euforbiácea de onde foram coletados os espécimes-tipo (R.J.F. Feres, obs. pess.).

Referências Bibliográficas

ANDRÉ, H.M. 1980. A generic revision of the family Tydeidae (Acari: Actinedida). IV. Generic descriptions, keys and conclusions. Bull. Ann. Soc. R. Entomol. Belg. 116:103-167.

APONTE, O. & McMURTRY, J.A. 1995. Revision of genus *Iphiseiodes* De Leon (Acari: Phytoseiidae). Int. J. Acarol. 21:165-183.

ARANDA C., B.R. & FLECHTMANN, C.H.W. 1969. Ácaros do gênero *Lorryia* no Brasil e Paraguay. An. II Reun. Soc. Brasil. Entomol., Recife, p.41-42.

ARRUDA, G.P. de, OLIVEIRA, A.A. de & FLECHTMANN, C.H.W. 1969. Ácaros associados a plantas no Nordeste do Brasil. An. II Reun. Soc. Brasil. Entomol., Recife, 35-36.

ATHIAS-HENRIOT, C. 1957. Phytoseiidae et Aceosejidae (Acarina, Gamasina) d'Algerie. I Genres *Blattisocius* Keegan, *Iphiseius* Berlese, *Amblyseius* Berlese, *Phytoseius* Ribaga, *Phytoseiulus* Evans. Bull. Soc. Hist. Nat. Afr. Nord 48:319-352.

BAKER, E.W. 1944. Tideideos mexicanos (Acari, Tydeidae). Rev. Soc. Mex. Hist. Natur. 5(1-2):73-81.

BAKER, E.W. 1949a. A review of the mites of the family Cheyletidae in the United States National Museum. Proc. U.S. Natl. Mus. 99:267-320.

BAKER, E.W. 1949b. The genus *Brevipalpus* (Acarina: Pseudoleptidae). Am. Midl. Nat. 42:350-402.

BAKER, E.W. 1968. The genus *Lorryia.* Ann. Entomol. Soc. Am. 61:986-1008.

BAKER, E.W. 1970. The genus *Tydeus*: Subgenera and species groups with descriptions of new species (Acarina: Tydeidae). Ann. Entomol. Soc. Am. 63:163-177.

BAKER, E.W. & PRITCHARD, E.A. 1960. The tetranychoid mites of Africa. Hilgardia 29:455-574.

BAKER, E.W. & PRITCHARD, E.A. 1962. Arañas rojas de America Central. Rev. Soc. Mex. Hist. Nat. 23:309-340.

BAKER, E.W. & TUTTLE, D.M. 1987. The false spider mites of Mexico (Tenuipalpidae: Acari). Tech. Bull. / U.S. Dep. Agric. n° 1706, p.1-237.

BAKER, E.W. & WHARTON, G.W. 1952. An introduction to Acarology. MacMillan CO., New York.

BAKER, E.W., TUTTLE, D.M. & ABBATIELLO, M.J. 1975. The false spider mites of northwestern and north central Mexico (Acarina: Tenuipalpidae). Smithson. Contrib. Zool.194:1-23.

BALOGH, J. & BALOGH, P. 1988. Oribatid mites of the Neotropical Region I. Elsevier, Amsterdam.

BALOGH, J. & BALOGH, P. 1990. Oribatid mites of the Neotropical Region II. Elsevier, Amsterdam.

BALOGH, J. & BALOGH, P. 1992. The oribatid mites genera of the world. Hungarian Natural History Museum, Budapest.

BALOGH, J. & MAHUNKA, S. 1978. New data to the knowledge of the oribatid fauna of the Neogea (Acari). III. Acta Zool. Hung. 24:269-299.

BARCHA, S.F. & ARID, F.M. 1971. Estudo da evapotranspiração na região Norte Ocidental do Estado de São Paulo. Revista Científica da Faculdade de Ciências e Letras de Votuporanga 1:97-122.

BEER, R.E. 1954. A revision of the Tarsonemidae of the Western Hemisphere (Ordem Acarina). Kansas Univ. Sci. Bull. 36, Pt. 2, (16):1091-1387.

BEHAN-PELLETIER, V.M. 2000. Ceratozetidae (Acari: Oribatida) of arboreal habitats. Can. Entomol. 132:153-182.

BELLINI, M. R., MORAES, G. J. de & FERES, R. J. F. 2005. Ácaros (Acari) de dois sistemas de cultivo da seringueira no noroeste do estado de São Paulo. Neotrop. Entomol. 34:475-484.

BOLLAND, H.R., GUTIERREZ, J. & FLECHTMANN, C.H.W. 1998. World catalogue of the spider mite family (Acari: Tetranychidae). Brill, Leiden.

CANESTRINI, G. & FANZAGO, F. 1876. Nuovi Acari Italiani. Atti Soc. Veneto-Trentina Sci. Nat. 5:99-111.

CHANT, D.A. 1959. Phytoseiid mites (Acarina: Phytoseiidae). Part I. Bionomics of seven species in southeastern England. Part II. A taxonomic review of the family Phytoseiidae, with descriptions of thirty-eight new species. Can. Entomol. 91 (Suppl. 12):1-166.

CHANT, D.A. & BAKER, E.W. 1965. The Phytoseiidae (Acarina) of Central America. Mem. Entomol. Soc. Can. 41:1-56.

CHANT, D.A. & McMURTRY, J.A. 2004. A review of the subfamily Amblyseinae Muma (Acari: Phytoseiidae): Part III. The tribe Ambliseiini Wainstein. Int. J. Acarol. 30:171-228.

CHANT, D.A. & YOSHIDA-SHAUL, E. 1983. A world review of five similar species groups in the genus *Typhlodromus* Scheuten. Part II. The *conspicuus* and *cornus* groups (Acarina: Phytoseiidae). Can. J. Zool. 61:1041-1057.

CHANT, D.A. & YOSHIDA-SHAUL, E. 1984. A world review of the *occidentalis* species group in the genus *Typhlodromus* Scheuten (Acarina: Phytoseiidae). Can. J. Zool. 62:1860-1871.

CHAUDHRI, W.M. 1968. Six new species of mites of the genus *Amblyseius* (Phytoseiidae) from Pakistan. Acarologia 10:550-562.

CHIAVEGATO, L.G. 1980. Ácaros da cultura dos citros. In Citricultura brasileira (O. Rodriguez & F.C.P. Viégas, coord.). Fundação Cargill, Campinas, p.469-501.

CROMROY, H.L. 1958. A preliminary survey of the plant mites of Puerto Rico. J. Agric. Univ. P. R. 42:39-144.

COOREMAN, J. 1958. Notes et observations sur les Acariens. VII- *Photia graeca* n.sp. (Acaridia, Canestriniidae) et *Lorryia formosa* n.sp. (Stomatostigmata, Tydeidae). Bull. Inst. R. Sci. Nat. Belg. Sci. Entomol. 34:1-10.

DANESHVAR, H. & DENMARK, H.A. 1982. Phytoseiids of Iran (Acarina: Phytoseiidae). Int. J. Acarol. 8:3-14.

DAUD, R.D. & FERES, R.J.F. 2004. O valor de *Mabea fistulifera* Mart. (Euphorbiaceae), planta nativa do Brasil, como reservatório para o predador *Euseius citrifolius* Denmark & Muma (Acari, Phytoseiidae). Rev. Bras. Zool. 21:453-458.

DE LEON, D. 1956. Some mites from lychee. Description of two genera and five new species of Tarsonemidae. Fla. Entomol. 39:163-174.

DE LEON, D. 1958. Four new *Typhlodromus* from southern Florida (Acarina: Phytoseiidae). Fla. Entomol. 41:73-76.

DE LEON, D. 1959. The genus *Typhlodromus* in Mexico (Acarina: Phytoseiidae). Fla. Entomol. 42:123-129.

DE LEON, D. 1961a. Eigth new *Amblyseius* from Mexico with collection notes on two other species (Acarina: Phytoseiidae). Fla Entomol. 44:85-91.

DE LEON, D. 1961b. The genus *Brevipalpus* in Mexico. Part II (Acarina:Tenuipalpidae). Fla Entomol. 44:41-52.

DE LEON, D. 1962a. The cervices of some phytoseiid type specimens (Acarina: Phytoseiidae). Acarologia 4:174-176.

DE LEON, D. 1962b. Twenty-three new Phytoseiidae, mostly from Southeastern United States (Acaria: Phytoseiidae). Fla Entomol. 45:11-27.

DE LEON, D. 1965. Phytoseiid mites from Puerto Rico with descriptions of new species (Acarina: Mesostigmata). Fla Entomol. 48:121-131.

DE LEON, D. 1966. Phytoseiidae of British Guyana with keys to species (Acarina: Mesostigmata). In Studies on the Fauna of Suriname and other Guyanas (D.C. Geijskes & P.W. Hummelinck, eds.), v.8, p.81-102.

DE LEON, D. 1967. Some mites of the Caribbean Area. Part I. Acarina on plants in Trinidad, West Indies. Allen Press Inc., Lawrence.

DENMARK, H.A. 1982. Revision of *Galendromus* Muma, 1961 (Acarina: Phytoseiidae). Int. J. Acarol. 8:133-167.

DENMARK, H.A. 1994. Revision of the genus *Paraseiulella* Muma (Acari: Phytoseiidae). Int. J. Acarol. 20:11-24.

DENMARK, H.A. & MUMA, M.H. 1970. Some phytoseiid mites of Paraguay (Phytoseiidae: Acarina). Fla Entomol. 53:219-227.

DENMARK, H.A. & MUMA, M.H. 1972. Some Phytoseiidae of the Colombia (Acarina : Phytoseiidae). Fla Entomol. 55:19-29.

DENMARK, H.A. & MUMA, M.H. 1973. Phytoseiid mites of Brazil (Acarina: Phytoseiidae). Rev. Bras. Biol. 33:235-276.

DENMARK, H.A. & MUMA, M.H. 1975. The Phytoseiidae (Acari: Mesostigmata) of Puerto Rico. J. Agric. Univ. P. R. 59:279-304.

DENMARK, H.A. & MUMA, M.H. 1989. A revision of the genus *Amblyseius* Berlese, 1914 (Acari: Phytoseiidae). Occ. Pap. Florida St. Coll. Arthropods 4:1-149.

DENMARK, H.A., EVANS, G.A., AGUILAR, H., VARGAS, C. & OCHOA, R. 1999. Phytoseiidae of Central America (Acari: Mesostigmata). Indira Publishing House, West Bloomfield.

EHARA, S. 1966. Some mites associated with plants on the State of São Paulo, Brazil, with a list of plant mites of South America. Jpn. Jour. Zool. 15:129-149.

EHARA, S. 1993. Two new species of the genus *Agistemus* Summers from Malaysia (Acari, Stigmaeidae). Jour. Acarol. Soc. Jpn. 2:79-82.

EL-BANHAWY, E.M. 1984. Description of some phytoseiidae mites from Brazil (Acarina: Phytoseiidae). Acarologia 25:125-144.

EWING, H.E. 1939. A revision of the mites of the subfamily Tarsoneminae of North America, the West Indies and Hawaiian Islands. Tech. Bull. / U.S. Dep. Agric. 653:1-63.

FAIN, A., BOCHKOV, A.V. & CORPUZ-RARUS, L.A. 2002. A revision of the *Hemicheyletia* generic group (Acari: Cheyletidae). Bull. Inst. Roy. Sci. Nat. 72:27-66.

FARIAS, A.R., FLECHTMANN, C.H.W., MORAES, G.J. de & McMURTRY, J.A. 1981. Predadores do ácaro verde da mandioca no Nordeste do Brasil. Pesq. Agropec. Brasil. 16:313-317.

FERES, R.J.F. 2000. Levantamento e observações naturalísticas da acarofauna (Acari, Arachnida) de seringueiras cultivadas (*Hevea* spp., Euphorbiaceae) no Brasil. Rev. Bras. Zool. 17:157-173.

FERES, R.J.F. & FLECHTMANN, C.H.W. 1995. Mites (Acari) associated with bamboo (*Bambusa* sp., Poaceae) in a wood area from northwestern São Paulo State, Brazil. Rev. Bras. Zool. 12:533-546.

FERES, R.J.F. & FLECHTMANN, C.H.W. 1996. A new *Tetranychus* (Acari, Tetranychidae) from São Paulo State, Brazil. Rev. Bras. Entomol. 40:299-300.

FERES, R.J.F. & FLECHTMANN, C.H.W. 2000. Four new *Neotetranychus* Trägardh (Acari, Tetranychidae) from São Paulo State, Brazil. Acarologia 41:215-226.

FERES, R.J.F. & MORAES, G.J. de. 1998. Phytoseiid mites (Acari: Phytoseiidae) from wood areas in the State of São Paulo, Brazil. Syst. Appl. Acarol. 3:125-132.

FERES, R.J.F. & NUNES, M.A. 2001. Ácaros (Acari, Arachnida) associados a euforbiáceas nativas em áreas de cultivo de seringueiras (*Hevea brasiliensis* Muell. Arg., Euphorbiaceae) na região noroeste do estado de São Paulo, Brasil. Rev. Bras. Zool. 18:1253-1264.

FERES, R.J.F., ROSSA-FERES, D. de C., DAUD, R.D. & SANTOS, R.S. 2002. Diversidade de ácaros (Acari, Arachnida) em seringueiras (*Hevea brasiliensis* Muell. Arg., Euphorbiaceae) na região noroeste do estado de São Paulo, Brasil. Rev. Bras. Zool. 19:137-144.

FERES, R.J.F., BELLINI, M.R. & ROSSA-FERES, D. de C. 2003. Ocorrência e diversidade de ácaros (Acari, Arachnida) associados a *Tabebuia roseo-alba* (Ridl.) Sand (Bignoniaceae), no município de São José do Rio Preto, São Paulo, Brasil. Rev. Bras. Zool. 20:373-378.

FERES, R.J.F., LOFEGO, A.C. & OLIVEIRA, A.R. 2005. Ácaros plantícolas (Acari) da "Estação Ecológica do Noroeste Paulista", estado de São Paulo, Brasil. Biota Neotropica 5(1):1-14. http://www.biotaneotropica.org.br/v5n1/pt/abstract?article+BN00405012005 (último acesso em 20/02/2006)

FERLA, N.J. & MORAES, G.J. de. 2002a. Ácaros predadores (Acari) em plantas nativas e cultivadas do estado do Rio Grande do Sul, Brasil. Rev. Bras. Zool. 19:1011-1031.

FERLA, N.J. & MORAES, G.J. de. 2002b. Ácaros (Arachnida, Acari) da seringueira (*Hevea brasiliensis* Muell. Arg.) no estado do Mato Grosso, Brasil. Rev. Bras. Zool. 19:867-888.

FLECHTMANN, C.H.W. 1973. *Lorryia formosa* Cooremann, 1958 - Um ácaro dos citros pouco conhecido no Brasil. Cienc. Cult. 25:1179-1181.

FLECHTMANN, C.H.W. 1975. Elementos de Acarologia. Livraria Nobel S.A., São Paulo.

FLECHTMANN, C.H.W. 1976. Preliminary report on the false spider mites (Acari: Tenuipalpidae) from Brazil and Paraguai. Proc. Entomol. Soc. Wash. 78:58-64.

FLECHTMANN, C.H.W. 1986. Ácaros em produtos armazenados e na poeira domiciliar. Fundação de Estudos Agrários "Luiz de Queiroz", Piracicaba.

FLECHTMANN, C.H.W. 1989. Seringueira (*Hevea* sp.), um novo hospedeiro para *Oligonychus gossypii* (Zacher, 1920) (Acari: Tetranychidae). Bol. Mus. Para. Emílio Goeldi, Zool. 5:127-128.

FLECHTMANN, C.H.W. 2004. Two new plant feeding mites from *Brachiaria ruziziensis* in citrus groves in São Paulo, Brazil and new distribution records of other plant mites in Brazil. Zootaxa 708:1-11.

FLECHTMANN, C.H.W. & ARLEU, R.J. 1984. *Oligonychus coffeae* (Nietner, 1861), um ácaro tetraniquídeo da seringueira (*Hevea brasiliensis*) novo para o Brasil e observações sobre outros ácaros desta planta. Ecossistema 9:123-125.

FLECHTMANN, C.H.W. & BAKER, E.W. 1970. A preliminary report on the Tetranychidae (Acarina) of Brazil. Ann. Entomol. Soc. Am. 63:156-163.

FLECHTMANN, C.H.W. & BAKER, E.W. 1975. A report on the Tetranychidae (Acari) of Brazil. Rev. Bras. Ent. 19:111-122.

FURTADO, I.P. & MORAES, G.J. de. 1998. Biology of *Euseius citrifolius*, a candidate for the biological control of *Mononychellus tanajoa* (Acari: Phytoseiidae: Tetranychidae). Syst. Appl. Acarol. 3:43-48.

GARMAN, P. 1958. New species belonging to the genera *Amblyseius* and *Amblyseiopsis* with keys to *Amblyseius*, *Amblyseiopsis* and *Phytoseiulus*. Ann. Entomol. Soc. Am. 51:69-79.

GEIJSKES, D.C. 1939. Beitraege zur Kenntnis der europeaischen Spinnmilben (Acari, Tetranychidae), mit besonderer Beruecksichtigung der niederlaendischen Arten. Meded. Landbouwhoogesch. Wagening. 42:1-68.

GERSON, U., SMILEY, R.L. & OCHOA, R. 2003. Mites (Acari) for biological control. Blackwell Science, Oxford.

GONDIM Jr., M.G.C. & MORAES, G.J. de. 2001. Phytoseiid mites (Acari: Phytoseiidae) associated with palm trees (Arecaceae) in Brazil. Syst. Appl. Acarol. 6:65-94.

GONZALEZ, R.H. 1975. Revision of the *Brevipalpus phoenicis* "complex", with descriptions of new species from Chile and Thailand (Acarina, Tenuipalpidae). Acarologia 17:82-91.

GRANDJEAN, F. 1960. Les Mochlozetidae n. fam. (Oribates). Acarologia 2:101-148.

GRAVENA, S., BENETOLI, I., MOREIRA, P.H.R. & YAMAMOTO, P.T. 1994. *Euseius citrifolius* Denmark & Muma predation on citrus leprosies mite *Brevipalpus phoenicis* (Geijskes) (Acari: Phytoseiidae: Tenuipalpidae). An. Soc. Entomol. Brasil. 23:209-218.

HERNANDES, F.A. & FERES, R.J.F. 2005. Two new species of *Zetzellia* Oudemans (Acari: Stigmaeidae) that threaten the concept of genera: disgeneric marriage? Zootaxa 1048:27-44.

HERNANDES, F.A. & FERES, R.J.F. 2006. Diversidade e sazonalidade de ácaros (Acari) em seringal (*Hevea brasiliensis*, Muell. Arg.) no município de Cedral, SP. Neotrop. Entomol. 35:(no prelo).

JEPPSON, L.R., KEIFER, H.H. & BAKER, E.W. 1975. Mites injurious to economic plants. University of California Press, Berkeley.

KALISZEWSKI, M. 1993. Key to Palearctic species of the genus *Tarsonemus* (Acari, Tarsonemidae). Wydawnictwo Naukowe Uniwersytet Im. Adama Mickiewica w Poznaniu, Seria Zoologia, v.14, p.1-204.

KOMATSU, S.S. & NAKANO, O. 1988. Estudos visando o manejo do ácaro da leprose do citros através do ácaro predador *Euseius concordis* (Acari: Phytoseiidae). Rev. Téc. Cient. Citricultura. 9:124-146.

KRANTZ, G.W. 1978. A manual of Acarology. Oregon State University Book Stores, Corvallis.

KREITER, S. & MORAES, G.J. de. 1997. Phytoseiid mites (Acari: Phytoseiidae) from Guadeloupe and Martinique. Fla Entomol. 80:376-382.

KRONKA, F.J.N., MATSUKUMA, C.K., NALON, M.A., DELCALI, I.H., ROSSI, M., MATTOS, I.F.A., SHIN-IKE, M.S. & PONTINHAS, A.A.S. 1993. Inventário florestal do estado de São Paulo. Instituto Florestal, São Paulo.

LIN, J.Z. & ZHANG, Z.Q. 2002. Tarsonemidae of the World (Acari: Prostigmata): Key to Genera, Geographical Distribution, Systematic Catalogue and Annotated Bibliography. Systematic and Applied Acarology Society, London.

LINDQUIST, E.E. 1986. The world genera of Tarsonemidae (Acari: Heterostigmata): a morphological, phylogenetic and systematic revision, with a reclassification of family-group taxa in the Heterostigmata. Mem. Entomol. Soc. Can. 136:1-516.

LOFEGO, A.C., MORAES, G.J. de & CASTRO, L.A.S. 2004. Phytoseiid mites (Acari: Phytoseiidae) on Myrtaceae in the State of São Paulo, Brazil. Zootaxa. 516:1-18.

LOFEGO, A.C., OCHOA, R. & MORAES, G.J. de. 2005. Some tarsonemid mites (Acari: Tarsonemidae) from the Brazilian “Cerrado” vegetation, with descriptions of three new species. Zootaxa. 823:1-27.

MATIOLI, A.L., UECKERMANN, E.A. & OLIVEIRA, C.A.L. 2002. Some stigmeid and eupalopsellid mites from citrus orchards in Brazil. Int. J. Acarol. 28:99-120.

MATTHYSSE, J.G. & DENMARK, H.A. 1981. Some phytoseiids of Nigéria (Acarina: Mesostigmata). Fla. Entomol. 64:340-357.

MAHUNKA, S. 1985. Neue und interessante Milben aus dem Genfer Museum LVII. Oribatida Americana 9: Antilles I (Acari). Rev. Suisse Zool. 92:119-144.

McGREGOR, E.A. 1914. Four new tetranychids. Ann. Entomol. Soc. Am. 7:354-364.

McGREGOR, E.A. 1950. Mites of the family Tetranychidae. Am. Midl. Nat. 44:257-420.

McMURTRY, J.A. 1983. Phytoseiidae mites from Guatemala, with descriptions of two new species and redefinitions of the genera *Euseius*, *Typhloseiopsis* and *Typhlodromus occidentalis* species group (Acari: Mesostigmata). Int. J. Entomol. 25:249-272.

McMURTRY, J.A. & MORAES, G.J. de. 1984. Some phytoseiid mites from the South Pacific, with descriptions of new species and a definition of the *Amblyseius largoensis* species group. Int. J. Acarol. 10:27-37.

McMURTRY, J.A. & MORAES, G.J. de. 1989. Some phytoseiid mites from Peru with descriptions of four new species (Acari: Phytoseiidae). Int. J. Acarol. 15:179-188.

MEYER, M.K.P.S. 1974. A revision of the Tetranychidae of Africa (Acari) with a key to the genera of the world. Entomol. Mem. Dept. Agric. Tech. Serv. Repub. S. Afr. 36:1-291.

MEYER, M.K.P.S. 1979. The Tenuipalpidae (Acari) of Africa with keys to the world fauna. Entomol. Mem. Dept. Agric. Tech. Serv. Repub. S. Afr. 50:1-135.

MEYER, M.K.P.S. 1987. African Tetranychidae (Acari: Prostigmata), with reference to the world genera. Entomol. Mem. Dep. Agric. Wat. Supply Repub. S. Afr. 69:1-175.

MEYER, M.K.P.S. & RODRIGUES, M. da C. 1965. Acari associated with cotton in Southern Africa (with reference to other plants). Garcia de Orta 13:195-226.

MORAES, G.J. de & LIMA, H.C. 1983. Biology of *Euseius concordis* (Chant) (Acarina: Phytoseiidae), a predator of the tomato russet mite. Acarologia 24:251-255.

MORAES, G.J. de & McMURTRY, J.A. 1983. Phytoseiid mites (Acarina) of northeastern Brazil with descriptions of four new species. Int. J. Acarol. 9:131-148.

MORAES, G.J. de, & MESA, N.C. 1988. Mites of the family Phytoseiidae (Acari) in Colombia, with descriptions of three new species. Int. J. Acarol. 14:71-88.

MORAES, G.J. de & OLIVEIRA, J.V. de. 1982. Phytoseiid mites of coastal Pernambuco in northeastern Brazil. Acarologia. 23:315-318.

MORAES, G.J. de, DENMARK, H.A. & GUERRERO, J.M. 1982. Phytoseiid mites of Colombia (Acarina: Phytoseiidae). Int. J. Acarol. 8:15-22.

MORAES, G.J. de, MCMURTRY, J.A., & DENMARK, H.A. 1986. A catalog of the mite family Phytoseiidade. References to taxonomy, synonymy, distribution and habitat. Empresa Brasileira de Pesquisa Agropecuária, Departamento de Difusão e Tecnologia, Brasília.

MORAES, G.J. de, MESA, N.C. & BRAUN, A. 1991. Some phytoseiid mites of Latin America (Acari: Phytoseiidae). Int. J. Acarol. 17:117-139.

MORAES, G.J. de, MESA, N.C., BRAUN, A. & MELO, E.L. 1994. Definition of the *Amblyseius limonicus* species group (Acari: Phytoseiidae), with description of two new species and new records. Int. J. Acarol. 20:209-217.

MORAES, G.J. de, KREITER, S. & LOFEGO, A.C. 1999 (2000). Plant mites (Acari) of the French Antilles. 3. Phytoseiidae (Gamasida). Acarologia 40:237-264.

MORAES, G.J. de, McMURTRY, J.A., DENMARK, H.A. & CAMPOS, C.B. 2004. A revised catalog of the mite family Phytoseiidade. Zootaxa. 434:1-494.

MUMA, M.H. 1955. Phytoseiidae (Acarina) associated with citrus in Florida. Ann. Entomol. Soc. Am. 48:262-272.

MUMA, M.H. 1961. Subfamilies, genera, and species of Phytoseiidae (Acarina: Mesostigmata). Bull. Florida St. Mus. Biol. Sci. 5:267-302.

MUMA, M.H. 1963. The genus Galendromus Muma, 1961 (Acarina: Phytoseiidae). Fla. Entomol. Suppl. 1:15-41.

MUMA, M.H. 1964a. Annotated list and keys to Phytoseiidae (Acarina: Mesostigmata) associated with Florida citrus. Univ. Fla. Agr. Expt. Sta. Bull. 685:1-42.

MUMA, M.H. 1964b. Cheyletidae (Acarina:Trombidiformes) associated with citrus in Florida. Fla. Entomol. 47:239-253.

MUMA, M.H. 1971. Food habits of Phytoseiidae (Acarina: Mesostigmata) including common species on Florida citrus. Fla. Entomol. 54:21-34.

MUMA, M.H., DENMARK, H.A. & DE LEON, D. 1970. Phytoseiidade of the Florida. Arthropods of Florida and neighboring land areas, 6. Florida Department of Agriculture and Consume Services, Division of Plant Industry, Gainesville.

NORTON, R.A. 1983. Redefinition of *Mochloribatula* (Acari: Mochlozetidae), with new species, recombinations, and notes on plant associations. Acarologia 24:449-464.

OUDEMANS, A.C. 1904. Acarologische Aanteekeningen. XI. Ent. Ber. Nederl. Ent. 1:153-155.

OUDEMANS, A.C. 1905. Acarologische Aanteekeningen. XV. Ent. Ber. Nederl. Ent. 1:207-210.

OUDEMANS, A.C. 1924. Acarologische Aanteekeningen. LXXIV. Entomol. Ber. Amst. 6:249-260.

PÉREZ-IÑIGO, C. 1993. Acari, Oribatei, Poronota. Museo Nacional de Ciencias Naturales, Consejo Superior de Investigaciones Científicas, Madrid.

PÉREZ-IÑIGO, C. & BAGGIO, D. 1980. Oribátidos edáficos do Brasil. I. Bolm. Zool., Univ. S. Paulo 5:111-147.

PÉREZ-IÑIGO, C. & BAGGIO, D. 1994. Oribates édaphiques du Brésil (VIII). Oribates de l'État de São Paulo (Cinquieme Partie). Acarologia 35:181-198.

PÉREZ-IÑIGO, C. & PÉREZ-IÑIGO Jr., C. 1993. Oribates (Acari, Oribatei) trouvés sur branches d'*Araucaria angustifolia* au Brésil. Acarologia 34:167-176.

PRITCHARD, A.E. & BAKER, E.W. 1955. A revision of the spider mite family Tetranychidae. Pacific Coast Entomological Society, San Francisco, Memoirs Series v.2, p.1-472.

PRITCHARD, A.E. & BAKER, E.W. 1958. The false spider mites (Acarina: Tenuipalpidae). Univ. Calif. Publ. Entomol. 14:175-274.

RODRIGUES, M. da C. 1968. Acarina de Moçambique - Catálogo das espécies relacionadas com a agricultura. Agron. Mocamb. 2:215-256.

SATO, M.E., RAGA, A., CERAVOLO, L.C., ROSSI, A.C. & POTENZA, M.R. 1994. Ácaros predadores em pomar cítrico de Presidente Prudente, estado de São Paulo. An. Soc. Entomol. Bras. 23:435-441.

SAYED, M.T. 1946. Description of *Tenuipalpus granati* nov. spec. and *Brevipalpus pyri* nov. spec. Bull. Soc. Fouad Ler Entomol. 30:99-104.

SCHRANK, F. von de P. 1781. "Enumeratio Insectorum Austriae Indiginorum, Austae Vindelicorum" p.507-524.

SMILEY, R.L. 1969. Further studies on the Tarsonemidae, II (Acarina). Proc. Entomol. Soc. Wash. 71:218-229.

SMILEY, R.L. 1972. A review of the genus *Daidalotarsonemus* De Leon (Acarina: Tarsonemidae). Proc. Entomol. Soc. Wash. 74:89-94.

SMILEY, R.L. 1975. A generic revision of the mites of the family Cunaxidae (Acarina). Ann. Entomol. Soc. Am. 68:227-244.

STRANGHETTI, V. & RANGA, N.T. 1998. Levantamento florístico das espécies vasculares da floresta estacional mesófila semidecídua da Estação Ecológica de Paulo de Faria - SP. Rev. Bras. Bot. 21:289-298.

SUMMERS, F.M. & PRICE, D.W. 1970. Revision of the family Cheyletidae. Univ. Calif. Publ. Entomol. 61:1-153.

SWIRSKI, E. & SHECHTER, R. 1961. Some phytoseiid mites (Acarina: Phytoseiidae) of Hong-Kong, with a description of a new genus and seven new species. Israel J. Agr. Res. 11:97-117.

TRAVÉ, J., ANDRÉ, H.M., TABERLY, G. & BERNINI, F. 1996. Les Acariens Oribates. AGAR/SIALF, Wavre.

VILA, W.M. & FLECHTMANN, C.H.W. 1970. Ácaros em essências florestais. Silv. S. Paulo 7:99-102

VOLGIN, V.I. 1955. In Acarina of Rodents of the USSR Fauna (E.N. Paulovskii, ed). Akad. Nauk SSSR, Zool. Inst., Opredelitelipo faune SSSR 59:1-459.

VOLGIN, V.I. 1969. Acarina of the family Cheyletidae of the World. Akad. Nauk. SSSR, Zool. Inst., Opredelitelipo faune SSSR 59:1-495.

WALTER, D.E. & BEHAN-PELLETIER, V. 1999. Mites in forest canopies: filling the size distribution shortfall? Annu. Rev. Entomol. 44:1-19.

WALTER, D.E. & PROCTOR, H.C. 1999. Mites: ecology, evolution and behavior. CABI Publishing, Wallingford.

WILSON, E.O. 1997. A situação atual da diversidade biológica. In Biodiversidade (E.O. Wilson, org.). Editora Nova Fronteira, Rio de Janeiro, p. 3-24.

WOOD, T.G. 1967. New Zealand mites of the family Stigmaeidae (Acari, Prostigmata). Trans. Roy. Soc. N.Z., Zool. 9:93-139.

WOOLLEY, T.A. 1988. Acarology: Mites and Human Welfare. Wiley, New York.

YAMAMOTO, P.T. & GRAVENA, S. 2001. Influência da dieta na oviposição de *Iphiseiodes zuluagai* Denmark & Muma (Acari: Phytoseiidae). Rev. Bras. Frutic. 23:82-86.

ZACARIAS, M.S. & MORAES, G.J. de. 2001. Phytoseiid mites (Acari) associated with rubber trees and other euphorbiaceous plants in southeastern Brazil. Neotrop. Entomol. 30:579-586.

ZACHER, F. 1921. Neue und wenig bekannte Spinnmilben. Z. Angew. Entomol. 7:181-187.

ZULUAGA C., I. & SALDARRIAGA V., A. 1970. Reconocimiento, identificacion y algunas observaciones sobre dinamica de poblaciones de acaros, en citricos del Valle del Cauca, Colombia. Acta Agron. 20:114-141.

Título: Ácaros Plantícolas (Acari) da “Estação Ecológica de Paulo de Faria”, Estado de São Paulo, Brasil[1]

Autores: Renato Buosi, Reinaldo José Fazzio Feres, Anibal Ramadan Oliveira, Antonio Carlos Lofego & Fábio Akashi Hernandes

Biota Neotropica, Vol. 6 (número 1): 2006
http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn02006012006

Recebido em 29/09/2005 - Revisado em 13/01/2006.
Publicado em 10/02/2006

ISSN 1676-0603

Estimativa da variabilidade genética intra-específica da dourada - *Brachyplatystoma rousseauxii* Castelnau 1855 (Pimelodidae – Siluriformes) no sistema Estuário-Amazonas-Solimões

Jacqueline da Silva Batista

Resumo

A dourada (*Brachyplatystoma rousseauxii)* é uma das duas espécies de bagres mais importantes para a pesca da região Norte, sendo capturada comercial e artesanalmente desde Iquitos, no Peru, até a região do estuário do rio Amazonas, em Belém. Trabalhos de vários autores sugerem que esta espécie possui áreas diferenciadas de alimentação/crescimento e reprodução e que, na Amazônia, a espécie é composta por uma única população que sazonalmente migra desde as áreas de alimentação e crescimento para as áreas de reprodução. Este trabalho teve como objetivos principais: estimar a variabilidade genética entre indivíduos de *B. rousseauxii*, coletados em três pontos ao longo do eixo Estuário-Amazonas-Solimões (EAS), e verificar se esta variabilidade estava correlacionada com a distribuição geográfica. Foram seqüenciados 1037 pb da região controle do DNA mitocondrial de 45 indivíduos de *B. rousseauxii*, coletados em Belém, Manaus e Letícia. As seqüências nucleotídicas foram utilizadas em quatro análises: filogenéticas (parcimônia, máxima verossimilhança e distância genética), polimorfismo de DNA, AMOVA e de clados inseridos. Foram identificados 31 haplotipos e nestes 27 *singletons* entre os 45 indivíduos de *B. rousseauxii* seqüenciados. A maior variabilidade genética foi encontrada em Belém e a menor em Letícia, mas não houve correlação da variabilidade genética com distribuição geográfica, sugerindo que *B. rousseauxii* englobe uma única população migradora no eixo EAS. No entanto, como explanação para a maior variabilidade genética encontrada em Belém, não se pode descartar a hipótese de que várias sub-populações de *B. rousseauxii* segreguem-se geográfica e geneticamente nos diferentes afluentes do sistema EAS em função da migração reprodutiva.

Palavras-chave: *Brachyplatystoma rousseauxii*, região controle, seqüenciamento de DNA, filogeografia

FICHA CATALOGRÁFICA

Batista, Jacqueline da Silva

Estimativa da variabilidade genética intra-específica da dourada - *Brachyplatystoma rousseauxii* Castelnau 1855 (Pimelodidae – Siluriformes) no Sistema Estuário-Amazonas-Solimões.

Manaus: INPA, 2001.

XVIII + 97 p.

Dissertação de Mestrado

1. Peixe 2. Siluriformes 3. Pimelodidae 4. Dourada 5. Dna Mitocondrial

6. Região controle 7. Filogeografia

Detectability of capybaras in forested habitats

Gustavo Romeiro Mainardes Pinto[1], Kátia Maria Paschoaletto Micchi de Barros Ferraz[2,4],
Hilton Thadeu Zarate do Couto[2] & Luciano Martins Verdade[3]

Biota Neotropica v6 (n1) – http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn01906012006

Date Received 08/08/2005
Revised 10/15/2005
Accepted 01/26/2006

[1]Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, Gerência Executiva de Santa Catarina,
Av. Mauro Ramos 1113, 88020-3003 Florianópolis, Santa Catarina, Brasil.
[2]Laboratório de Métodos Quantitativos, Departamento de Ciências Florestais, ESALQ, Universidade de São Paulo,
Cx. P. 09, 13418-900 Piracicaba, São Paulo, Brasil.
[3]Laboratório de Ecologia Animal, Departamento de Ciências Biológicas, ESALQ, Universidade de São Paulo, Cx. P. 09,
13418-900 Piracicaba, São Paulo, Brasil.
[4]Autor para correspondência: kferraz@esalq.usp.br

Abstract

Pinto, G.R.M.; Ferraz, K.M.P.M.B.; Couto, H.T.Z. and Verdade, L.M. **Detectability of Capybaras in forested habitats**. *Biota Neotrop*. Jan/Abr 2006, vol. 6, no. 1 http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn01906012006. ISSN 1676-0611

Direct count has been commonly used as an abundance index to estimate wildlife population size. However, systematic errors in sample-based estimators are common in sampling animal populations. At this study we aimed to estimate capybara’s observability, through a detectability index in forested habitats. Sampling surveys of capybaras population was obtained by direct count (abundance index) and also by complete count (census). The average detectability index of capybaras in forested habitats was 0.63 ± 0.32 for a single observer. The variability in the detectability index among habitats was due to the presence of more or less dense vegetation. This information might be useful for management purposes of the species in the agroecosystems of southeastern Brazil where species is widespread and overabundant.

Key words: *Hydrochoerus hydrochaeris, capybara, abundance index, direct count, detectability index*

Resumo

Pinto, G.R.M.; Ferraz, K.M.P.M.B.; Couto, H.T.Z. and Verdade, L.M. **Detectabilidade de capivaras em habitats florestais**. *Biota Neotrop*. Jan/Abr 2006, vol. 6, no. 1 http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn01906012006. ISSN 1676-0611

O método de contagem direta de animais tem sido freqüentemente utilizado como índice de abundância para estimar o tamanho de populações silvestres. Entretanto, erros sistemáticos de parâmetros baseados em amostras são comuns em amostragens de populações de animais silvestres. Neste estudo, nós estimamos a observabilidade de capivaras, através de um índice de detectabilidade em habitats florestais. As amostragens da população foram realizadas através da contagem direta (índice de abundância) e da contagem total (censo). O índice médio de detectabilidade de capivaras do observador em habitats florestais foi de 0,63 ± 0,32. A variabilidade no índice de detectabilidade entre os habitats ocorreu devido à vegetação ser mais ou menos densa. Esses resultados deverão ser úteis para o manejo da espécie em agroecossistemas do sudeste brasileiro onde a espécie é amplamente distribuída e abundante.

Palavras-chave: *Hydrochoerus hydrochaeris, capivara, contagem direta, índice de abundância, índice de detectabilidade*

Introduction

Direct count has been commonly used as an abundance index to estimate wildlife population size (Lancia et al. 1996, Thompson et al. 1998, Williams et al. 2002). Although, systematic errors in sample-based estimators are common in sampling animal populations, good estimates of population size are essential for wildlife management and conservation, as well as control (Williams et al. 2001). Unfortunately, as Williams et al. (2002) have pointed out, the issue of variable detection rate has received insufficient emphasis in both observational and experimental studies in ecology. Karanth et al. (2003) provided a critical review about the census-based paradigm. They emphasize the importance of proposing alternative approaches concerning the problems of spatial sampling and observability. Bayliss (1987) related some of the variables that may affect the consistent detection of animals on a survey as observer experience, distance to animal, noise, animal behavior, weather and cover habitat.

Observability refers to the typical inability to detect and count all animals from the surveyed population, making observers to estimate the underlying detection probabilities from sample counts (Lancia et al. 1996, Thompson et al. 1998, Williams et al. 2002, Karanth et al. 2003). As Karanth et al. (2003) have pointed out, it has been generally assumed that the estimated proportion of the total area actually by survey (a) and the estimated proportion of counted animals in the surveyed area (p) is equal to 1, or that all animals are detected on the sampled area, assuming that a true animal census is carried out.

Capybaras (*Hydrochoerus hydrochaeris*), the largest grazing herbivore widely distributed in South America (Ojasti 1973, Azcárate 1980, Nowak & Paradiso 1991, Eisenberg & Redford 1999), have been considered as a potential plague in east central region of the State of São Paulo, Brazil, due to their higher population density in anthropogenic habitats (Verdade & Ferraz 2006) usually associated with crop damage (Ferraz et al. 2003), and the spread of Brazilian Spotted Fever (Labruna et al. 2004). Their high reproductive capacity, generalist food habits, and low habitat requirements are some aspects of the species biology that could contribute for their success in anthropogenic landscapes. In addition, the Brazilian hunting prohibition (Federal Law No. 5.197 from January 1967), the great food availability provided by the growth of cultivated lands, and the predators decline due to habitat loss (Costa et al. 2005) are the possible causes of the species population booming in these areas (Verdade & Ferraz 2006).

Capybaras are usually surveyed or monitored in many open flat habitats during their foraging activity by terrestrial (Ojasti 1973, Azcárate 1980, Cordero & Ojasti 1981, Macdonald 1981, Schaller & Crawshaw 1981, Herrera 1986, Jorgenson 1986, Alho et al. 1989, Herrera & Macdonald 1989, Verdade & Ferraz 2006) and aerial direct counts (Mourão et al. 1994; Mourão & Campos 1995, Mourão & Magnusson 1997). Correction procedures (as formerly suggested by Caughley 1977) are recommended in circumstances where the total population is unknown and its estimate is either needed or desired. However, it is likely that capybaras are less detectable in forest than in open areas. This problem could be more relevant in areas with high hunting pressure where capybaras forage at night time (Ojasti 1973, Verdade 1996).

This study aims to estimate capybara’s detectability by an abundance index in forested habitats. This information might be useful for management purposes of the species for development correction factor in the counts of capybaras.

Material and Methods

Four study sites located in Campinas, east central region of the State of São Paulo, Brazil, were selected for this study (Figure 1). The study sites were carefully selected in order to provide accurate estimates of the true population size. This was only possible because all of them were fenced areas (i.e., no immigration) and the number of adults was previously known by the local offices. The observer only needed to check the births and deaths occurred in each survey. Habitats description is listed in Table 1.

Sampling surveys of capybara population was obtained by direct count (abundance index) and also by complete count (census) in 26 days on a weekly basis from March to September 2002. First, the observer just counted visible animals (direct count) while walking around the main water body in the study sites. Afterwards, he counted all animals he could find in the area (complete count). So the observer could have both estimates at the same time: the number of animals counted and the number of animals present in the area (true population size).

Detectability index (β), also called detection probability and observability, was estimated according to Lancia et al. (1996), Thompson et al. (1998) and Williams et al. (2002) as follows: $E(C_i) = \beta_i N_i$, where expected value of count C in time *i* is equal to the detectability (β) in time *i* multiplied by the true population size N in time *i*. The probability of seeing or catching an animal (β) will generally be less than 1. As the detectability index is the chance of confirming the occurrence of an animal within some defined space and time (Thompson et al. 1998), this index could be used as observer error estimative in the estimates of animal population size.

Results and Discussion

The average detectability index of capybaras in forested habitats was 0.63 ± 0.32 (ranging from 0.31 to 0.95) for a single observer (Table 1). This means that the observer could be able to detect from 31% to 95% of the true capybara population in such conditions.

Thompson et al. (1998) pointed out that to be unbiased detectability index ought to assume that there is no influence of any factors such as weather, individual behavior, age and so on. As the observer and also the methodology of capybaras counting were the same during the whole study period we assume that the variability in the detectability index among habitats was due to the presence of more or less dense vegetation. The study sites Taquaral and Unicamp2 were habitats with no dense vegetation and large open areas where animals could be easily detected by the observer. Also, they were areas intensively used by people for leisure activities which means that animals could be more used to human presence. This could explain the higher detectability index by the observer in watching capybaras in these habitats.

Only 31.6% of the total population could be explained by the direct count considering all the study sites ($p<0.001$), described by the following equation: Total population survey = 6.992 + 0.7635(sampling population survey). In Taquaral, 35.3% of the capybara total population could be explained by the direct count ($p < 0.001$), described by the following equation: Total population survey= 7.150 + 0.6541(sampling population survey). The others sites had no significant relationship in the regression models between total and sampling population surveys. The weak relationship between total and sampling population surveys could be explained by the low variability of the total population numbers and the high variability of the abundance index in all study sites.

Despite the fact that our results are still preliminary they emphasize the importance and necessity of estimating observer error in animal counts for population size estimative, not only in forested habitats, but in open habitats too (Mourão et al. 1994). Verdade & Ferraz (2006) verified that distance between observers and capybaras can result in counting bias even in open habitats. When knowing observer error in counting animals it is possible to estimate population size in similar habitats. In addition, Bayliss (1987) recommend rigidly standardized survey procedures for minimizing sampling error.

In management programs, a harvest can be controlled either by placing a quota on offtake or by controlling harvesting effort (Caughley & Sinclair 1994). The control of harvest by quotas could not work properly with populations that fluctuate along time or those whose estimate is imprecise like capybaras in forested habitats. For those, controlling harvesting effort (as suggested by Caughley & Sinclair 1994) could be more effective.

Acknowledgements

The present study has been supported by Fundação de Estudos Agrários Luiz de Queiroz (FEALQ) and Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP).

References

ALHO, C.J.R., CAMPOS, Z.M. & GONÇALVES, H.C. 1989. Ecology, social behavior and management of the capybara in the Pantanal of Brazil. In Advances in Neotropical Mammalogy (K.H. Redford & J.F. Eisenberg, eds). Sandhill Crane, Gainesville, p.163-194.

AZCÁRATE, T. de. 1980. Sociobiologia y manejo del capibara (*Hydrochoerus hydrochaeris*). Donana Acta Vert. 7(6):1-228.

BAYLISS, P. 1987. Survey methods and monitoring within crocodile management programmes. In Wildlife Management: Crocodiles and Alligators (G.J.W. Webb, S.C. Manolis & P.J. Whitehead, eds). Surrey Beatty & Sons, Chippping Norton, NSW, Australia. p.157-175.

CAUGHLEY, G. 1977. Analysis of vertebrate populations. John Wiley, London.

CAUGHLEY, G. & SINCLAIR, A.R.E. 1994. Wildlife ecology and management. Blackwell Science Publications, Boston.

CORDERO, R.G.A. & OJASTI, J. 1981. Comparison of capybara populations of open and forested habitats. J. Wild. Mngt. 45(1):267-271.

COSTA, L.P., LEITE, Y.L.R., MENDES, S.L. & DITCHFIELD, A.D. 2005. Mammal conservation in Brazil. Conserv. Biol. 19(3):672-679.

EISENBERG, J.F. & REDFORD, K.H. 1999. Mammals of the Neotropics: The Central Neotropics. v.2.University of Chicago, Chicago.

FERRAZ, K.M.P.M.B., LECHEVALIER, M., COUTO, H.T.Z. & VERDADE, L.M. 2003. Damage caused by capybaras in a corn field, São Paulo, Brasil. Sc. Agric. 60(1):191-194.

HERRERA, E.A. 1986. The behavioural ecology of capybara, *Hydrochoerus hydrochaeris*. Ph.D. dissertation, University of Oxford, Oxford.

HERRERA, E.A. & MACDONALD, D.W. 1989. Resource utilization and territoriality group-living Capybaras (*Hydrochoerus hydrochaeris*). J. Anim. Ecol. 58:667-679.

JORGENSON, J.P. 1986. Notes on the ecology and behavior of capybaras in northeastern Colômbia. Vida Silv. Neotr. 1(1):31-40.

KARANTH, K.U., NICHOLS, J.D., SEIDENSTICKER, J., DINERSTEIN, E., SMITH, J.L.D., MCDOUGAL, C., JOHNSINGH, A.J.T., CHUNDAWAT, R.S. & THAPAR, V. 2003. Science deficiency in conservation practice: the monitoring of tiger populations in India. Anim. Cons. 6:141-146.

LANCIA, R.A., NICHOLS, J.D. & POLLOCK, K.H. 1996. Estimating the numbers of animals in wildlife populations. In Research and management techniques for wildlife and habitats. (T.A. Bookhout, ed.). 5 ed. The Wildlife Society, Bethesda, p.215-253.

MACDONALD, D.W. 1981. Dwindling resources and the social behaviour of capybara, (*Hydrochoerus hydrochaeris*) (Mammalia). J. Zool. Lond. 194:371-391.

MOURÃO, G., BAYLISS, P., COUTINHO, M., ABERCROMBIE, C.L. & ARRUDA, A. 1994. Test of an aerial survey for caiman and other wildlife in the Pantanal, Brazil. Wild. Soc. Bull. 22:50-56.

MOURÃO, G.M. & CAMPOS, Z. 1995. Survey of broad-snouted caiman (*Caiman latirostris*), marsh deer (*Blastocerus dichotomus*) and capybara (*Hydrochaeris hydrochaeris*) in the area to be inundated by Porto Primavera dam, Brazil. Biol. Conserv. 73:27-31.

MOURÃO, G.M. & MAGNUSSON, W. 1997. Uso de levantamentos aéreos para o manejo de populações silvestres. In Manejo e Conservação de Vida Silvestre no Brasil (C. Valladares-Padua & R.E. Bodmer, eds). Sociedade Civil Mamirauá, p.23-33.

NOWAK, R.M. & PARADISO, J.L. 1991. Walker's Mammals of the World. 5. ed. Johns Hopkins, London.

OJASTI, J. 1973. Estudio Biológico del Chigüire o Capibara. Fondo Nacional de Investigaciones Agropecuarias, Caracas.

SCHALLER, G.S. 1983. Mammals and their biomass on a Brazilian ranch. Arq. Zool. 31(1):1-36.

VERDADE, L.M. 1996. The influence of hunting pressure on the social behavior of vertebrates. Brazilian J. Biol. 56(1):1-13.

VERDADE, L.M. & FERRAZ, K.M.P.M.B. 2006. Capybaras on an anthropogenic habitat in Southeastern Brazil. Braz. J. Biol. 66(1b): 371 - 378.

THOMPSON, W.L., WHITE, G.C. & GOWAN, C. 1998. Monitoring Vertebrate Populations. Academic Press, São Diego.

WILLIAMS, B.K., NICHOLS, J.D. & CONROY, M.J. 2002. Analysis of Management o Animal Populations. Academic Press, San Diego.

Title: Detectability of capybaras in forested habitats

Authors: Gustavo Romeiro Mainardes Pinto, Kátia Maria Paschoaletto Micchi de Barros Ferraz[4], Hilton Thadeu Zarate do Couto & Luciano Martins Verdade

Biota Neotropica, Vol. 6 (number 1): 2006
http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn01906012006

Date Received 08/08/2005 - Revised 10/15/2005
Accepted 01/26/2006

ISSN 1676-0611

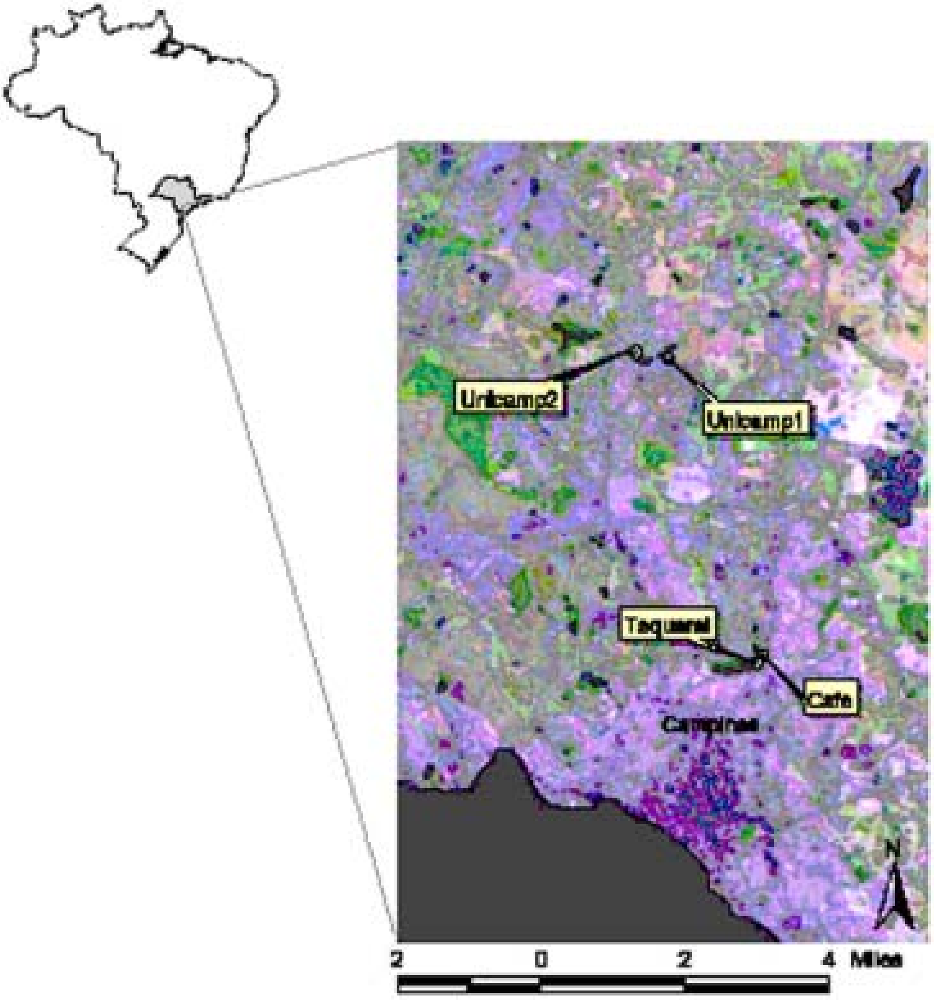


Figure 1. Location of the study sites, Campinas, east central region of the State of São Paulo, Brazil.

Table 1. Habitat description and detectability index (β) (mean ± standard deviation) of an observer of counting capybaras in forested habitats.

Study sites	**Habitat description**	**Detectability Index (β) (mean ± standard deviation)**
Café	Three artificial ponds (3 ha) surrounded by dense vegetation and open areas (pasture), not intensive used by people for leisure activities	0.54 ± 0.30
Taquaral	Artificial pond (14 ha) surrounded by scarce vegetation and open areas intensively used by people for leisure activities	0.69 ± 0.23
Unicamp1	Artificial pond (4 ha) surrounded by dense vegetation, not used by people for leisure activities	0.61 ± 0.39
Unicamp2	Artificial pond (7 ha) surrounded by vegetation and open areas intensively used by people for leisure activities	0.69 ± 0.34

Chalcidoid parasitoids (Hymenoptera) of *Actinote parapheles* Jordan, 1913 (Lepidoptera: Nymphalidae)

***Hélcio R. Gil-Santana*[1] *& Marcelo Teixeira Tavares*[2]**

Biota Neotropica v6 (n1) – http://www.biotaneotropica.org.br/v6n1/pt/abstract?short-communication+bn01006012006

Date Received 08/04/2005
Revised 11/11/2005
Accepted 01/01/2006

[1]Laboratório de Diptera, Instituto Oswaldo Cruz, Av. Brasil, 4365, Manguinhos, 21045-900
Rio de Janeiro, Rio de Janeiro, Brasil. E-mail: helciogil@uol.com.br
[2]Departamento de Ciências Biológicas, Universidade Federal do Espírito Santo, UFES,
Avenida Marechal Campos, 1468, 29040-090 Vitória, Espírito Santo, Brasil. E-mail: mtavares@npd.ufes.br

Abstract

Gil-Santana, H.R. and & Tavares, M.T. **Chalcidoid parasitoids (Hymenoptera) of *Actinote parapheles* Jordan, 1913 (Lepidoptera: Nymphalidae).** *Biota Neotrop*. Jan/Abr 2006, vol. 6, no. 1 http://www.biotaneotropica.org.br/v6n1/pt/abstract?short-communication+bn01006012006. ISSN 1676-0611

Three parasitoids of *Actinote parapheles* Jordan 1913 (Lepidoptera: Nymphalidae), in the Superfamily Chalcidoidea (Hymenoptera) are recorded: *Brachymeria mnestor* (Walker 1841) (Chalcididae), *Palmistichus elaiesis* Delvare & LaSalle 1993 and *Tetrastichus* sp. (Eulophidae).

Key words: *Tetrastichinae, Nova Friburgo, Brachymerinii.*

Resumo

Gil-Santana, H.R. and & Tavares, M.T. **Parasitóides Chalcidóideos (Hymenoptera) de *Actinote parapheles* Jordan, 1913 (Lepidoptera: Nymphalidae).** *Biota Neotrop*. Jan/Abr 2006, vol. 6, no. 1 http://www.biotaneotropica.org.br/v6n1/pt/abstract?short-communication+bn01006012006. ISSN 1676-0611

Três parasitóides de *Actinote parapheles* Jordan 1913 (Lepidoptera: Nymphalidae), pertencentes à Superfamília Chalcidoidea (Hymenoptera), são registrados: *Brachymeria mnestor* (Walker 1841) (Chalcididae), *Palmistichus elaiesis* Delvare & LaSalle 1993 e *Tetrastichus* sp. (Eulophidae).

Palavras-chave: *Tetrastichinae, Nova Friburgo, Brachymerinii.*

Introduction

Neotropical Acraeini butterflies (Nymphalidae: Heliconiinae) include many species common at medium to high altitudes, especially in the genus *Actinote* Hübner, [1819] (Lamas 2004). The American Acraeini butterflies often ingest large amounts of dehydropyrrolizidine alkaloids (PAs) from their Asteraceae hostplants in both larval and adult stages, but do not normally store these compounds for defence, instead biosynthesizing large amounts of cyanogenic glucoside linamarin in all stages (Brown Jr. & Francini 1990). Cyanogenesis is considered a common, non-specific and moderate defense mechanism in insects and was verified as being present in several species of *Actinote* including *A. parapheles* (Brown Jr. & Francini 1990). *Actinote parapheles* Jordan 1913 is a common butterfly in Southern Brazil whose larvae feed on leaves of *Mikania* spp. (Asteraceae: Eupatorieae) (D'Abrera 1987, Brown Jr. 1992).

Material and Methods

Pupae of *Actinote parapheles* were collected by the first author in the field at the "Bela Vista" farm (22°17'61" S - 42°29'34" W; 1090 m a.s.l.) in Nova Friburgo city, Rio de Janeiro State, Brazil in June 2004 (seven pupae) and May 2005 (three pupae).

The lepidopteran species was identified based on D'Abrera (1987) and Brown Jr. (1992) and is deposited at "Coleção Entomológica do Museu Nacional da Universidade Federal do Rio de Janeiro (MNRJ)".

The hymenopterous species were identified based on study of type material (*B. mnestor*, Lectotype in Natural History Museum, London, type Hym # 5460), Delvare & LaSalle (1993) and Schauff et al (1997) (*Tetrastichus*). The chalcidoid voucher specimens are deposited in the "Coleção Entomológica do Departamento de Ciências Biológicas da Universidade Federal do Espírito Santo (UFES)".

Results and Discussion

From the material collected in June 2004, two pupae were parasitized, and gave origin to six females of *Tetrastichus* sp., a male and a female of *Palmistichus elaiesis* Delvare & LaSalle 1993 (Eulophidae) in one pupa, and five males and four females of *P. elaiesis* in the second pupa (Figure 1). From May 2005 one pupa was parasitized and a single female of *Brachymeria mnestor* (Walker 1841) (Chalcididae) emerged (Figures 2, 3). This is the first record of chalcidoid parasitoids associated with *Actinote*.

Brachymeria mnestor is frequently reared from many species of lepidopteran pupae in the families Ctenuchidae, Hesperiidae, Noctuidae, Papilionidae, Pieridae and Pyralidae (Noyes 2003). It is one of the most common *Brachymeria* species in Brazil. *P. elaiesis* has been recorded as parasitoid from moth pupae belonging to ten different families (Arctiidae, Limacodidae, Lycaenidae and others) and from pupae of a chrysomelid beetle (Noyes 2003).

Godfray (1994) compiled published data about effects of secondary plant compounds on the performance of juvenile parasitoids and reinforced that all of them support the hypothesis that specific secondary compounds will have less effect on parasitoids that specialize on hosts feeding on plants containing the chemical and more effect on generalist parasitoids. *B. mnestor* and *P elaiesis* are generalist parasitoids and emerged from pupae of *A. parapheles*, however it was not possible to confirm if there was any effect of host plant secondary compounds in the latter on the development of the parasitoids.

In the other hand, considering the vast amount of papers confirming the chemical defenses of several Lepidoptera groups (see Brown Jr. & Francini 1990), future studies could be done to understand how the hymenopteran parasitoids manage to complete all their own larval phases in the immature forms of these chemically protected butterflies.

Acknowledgements

The authors thank the entomologists Carlos G. C. Mielke and Eurides Furtado for the confirmation of the identification of *Actinote parapheles*, and André Victor Lucci Freitas, Olaf H. H. Mielke and Francini Osses for helping with important bibliography information and comments in the last version of the manuscript.

References

BROWN JR., K.S. 1992. Borboletas da Serra do Japi: diversidade, hábitos, recursos alimentares e variação temporal. In História Natural da Serra do Japi, ecologia e preservação de uma área florestal no Sudeste do Brasil (L.P.C. Morellato, Org.). Universidade Estadual de Campinas/FAPESP, Campinas, p.142-187.

BROWN JR., K.S. & FRANCINI, R.B. 1990. Evolutionary strategies of chemical defense in aposematic butterflies: cyanogenesis in Asteraceae-feeding American Acraeinae. Chemoecology 1:52-56.

D'ABRERA, B. 1987. Butterflies of the Neotropical Region. Part III Brassolidae, Acraeidae, Nymphalidae (*partim*). Victoria, Hill House, 140p.

DELVARE, G. & LASALLE, J. 1993. A new genus of Tetrastichinae (Hymenoptera: Eulophidae) from the Neotropical region, with the description of a new species parasitic on key pests of oil palm. J. Nat. Hist. 27:435-444.

GODFRAY, H.C.L. 1994. Parasitoids: behavioral and evolutionary ecology. Princeton University Press, Princeton.

LAMAS, G. (ed.). 2004. Checklist: Part 4A. Hesperioidea-Papilionoidea. Atlas of Neotropical Lepidoptera. Association for Tropical Lepidoptera/Scientific Publishers, xxxvi+439p.

NOYES, J.S. 2003. Universal Chalcidoidea Database. Avaible at: http://www.nhm.ac.uk/research-curation/projects/chalcidoids/index.html. Access in: 07 june 2005.

SCHAUFF, M. E.; LASALLE, J. L. & COOTE, L. D. 1997. Eulophidae. In Annotated key to genera of Neartic Chalcidoidea (Hymenoptera) (G. A. P. Gibson, J. T. Huber & J. B. Wooley, eds.). NCR Research Press, Ottawa, p.327-429.

Title: Chalcidoid parasitoids (Hymenoptera) of *Actinote parapheles* Jordan, 1913 (Lepidoptera: Nymphalidae)

Authors: Hélcio R. Gil-Santana & Marcelo Teixeira Tavares

Biota Neotropica, Vol. 6 (number 1): 2006
http://www.biotaneotropica.org.br/v6n1/pt/abstract?short-communication+bn01006012006

Date Received 08/04/2005 - Revised 11/11/2005
Accepted 01/01/2006

ISSN 1676-0611

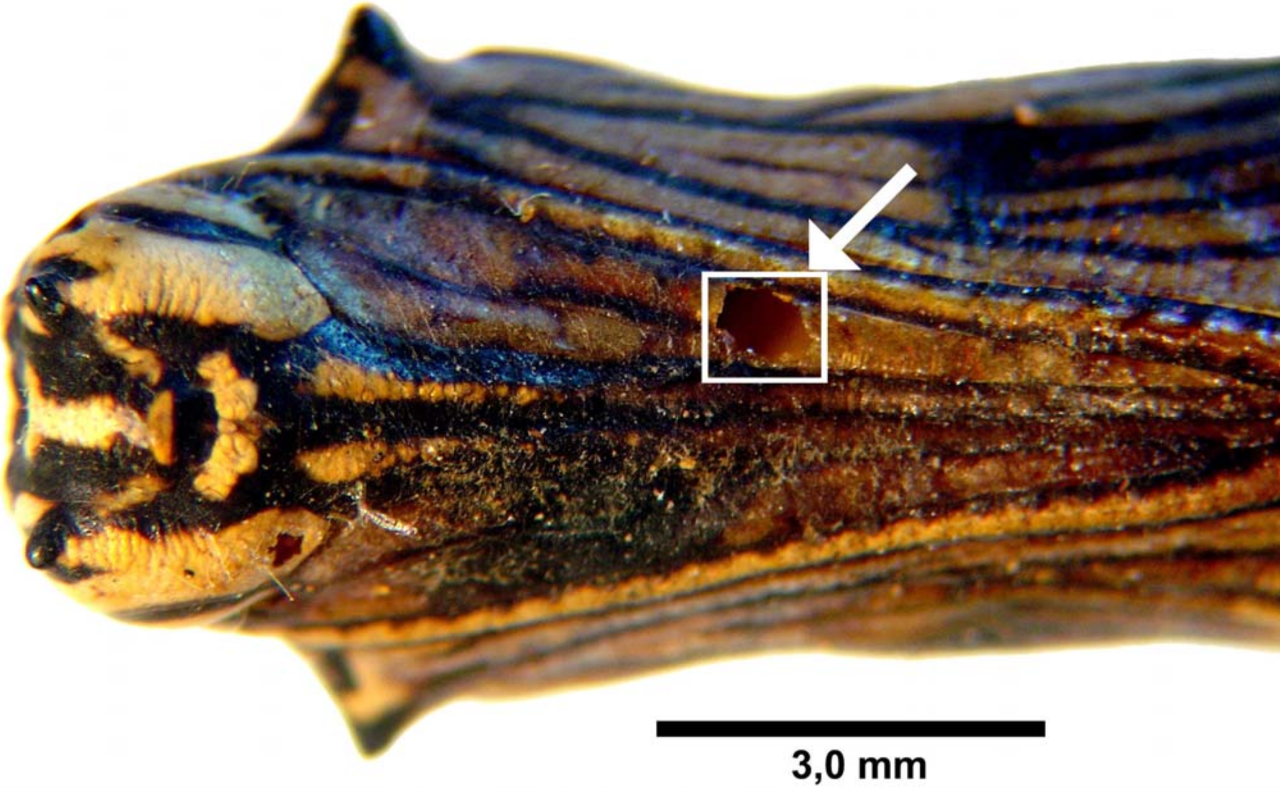


Figure 1. Pupa of *<u>Actinote parapheles</u>* *showing the orifice of emergence of the Eulophidae adults (arrow), ventral view.*

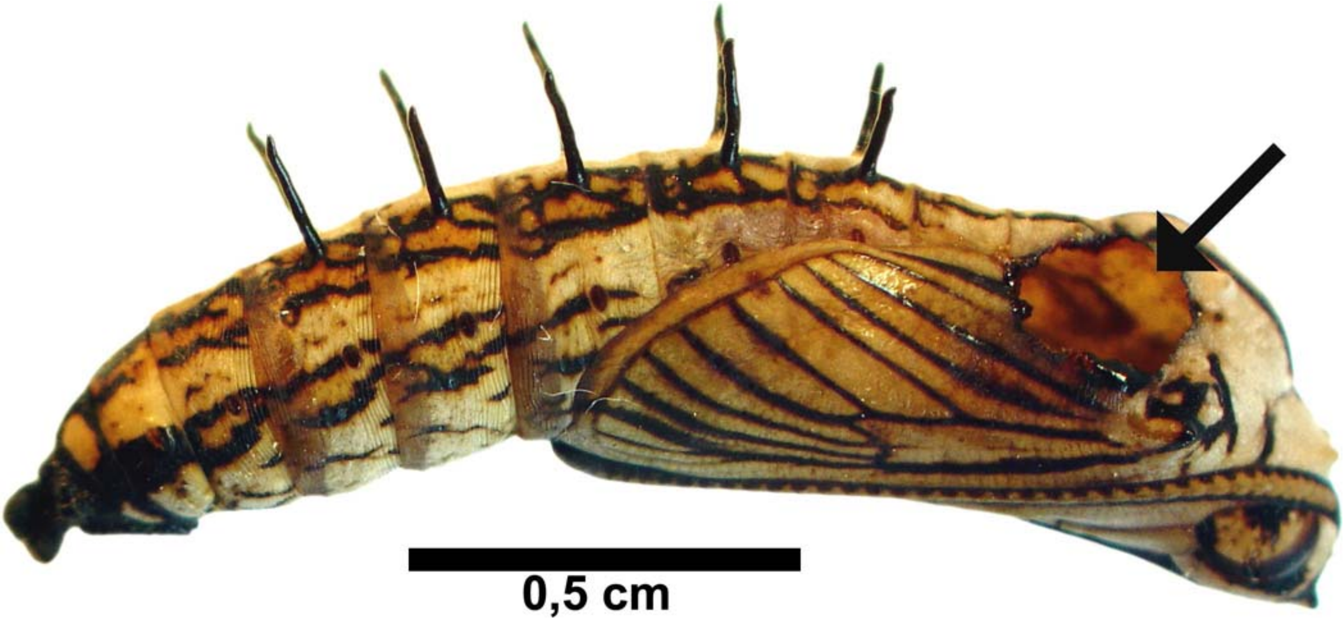


Figure 2. Pupa of Actinote parapheles after emergence of the *<u>Brachymeria mnestor</u>* *adult, with the orifice indicated by the arrow, lateral view.*

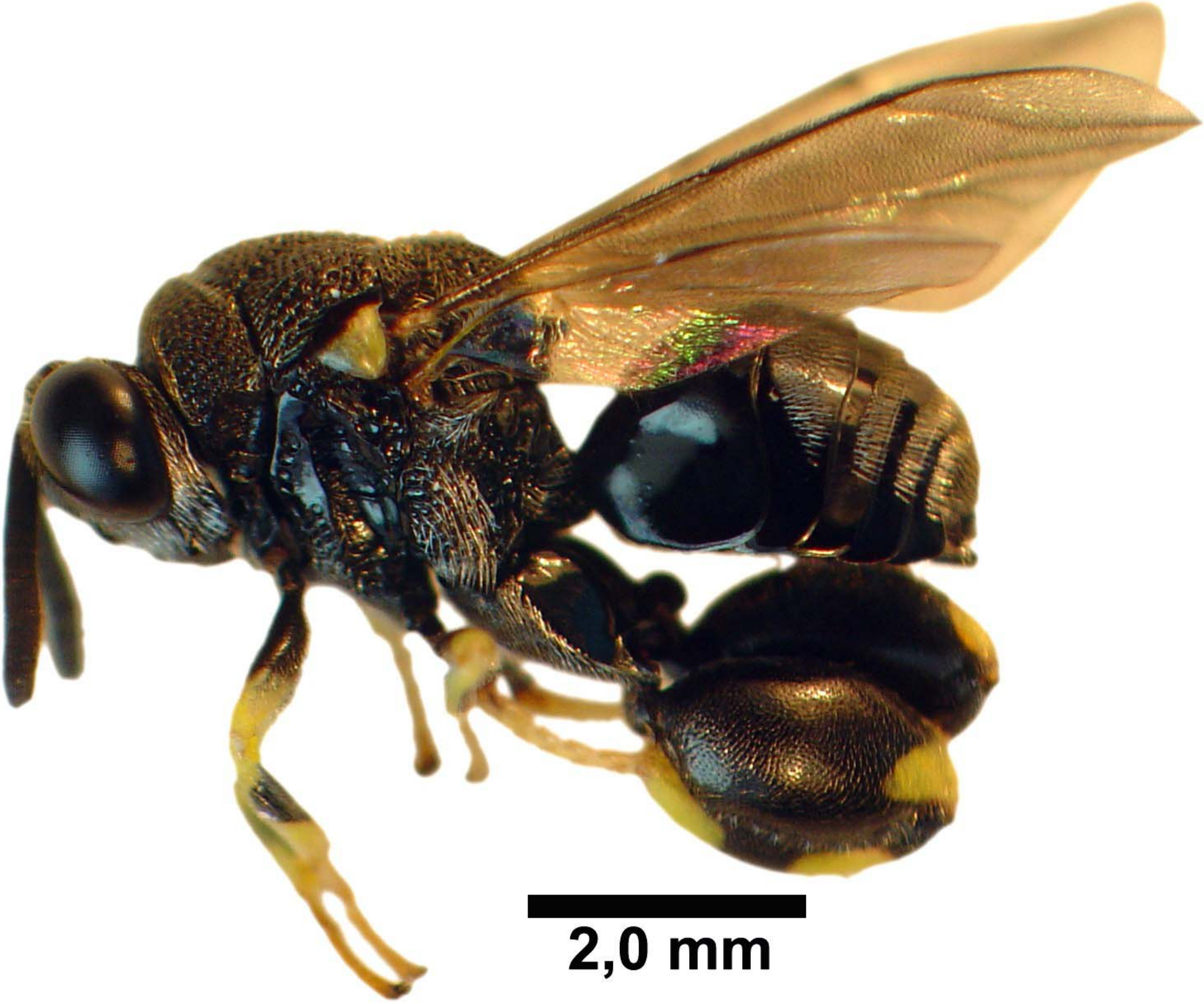


Figure 3. Adult of Brachymeria mnestor (Walker, 1841), lateral view.

Occurrence of sea turtles during seismic surveys in Northeastern Brazil

Cristiano Leite Parente[1]*, Juliana Doyle Lontra*[1] *& Maria Elisabeth de Araújo*[1]

Biota Neotropica v6(n1) – http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn00306012006

Date Received 07/08/2005
Revised 10/18/2005
Accepted 01/01/2006

[1]Federal University of Pernambuco, Pos-Graduation Program in Oceanography, Department of Oceanography
[2]Correspondence address: Av. Prof. Moraes Rego, 1235, Cidade Universitária, 50670-901 Recife, Pernambuco, Brasil
(cristiano.parente@uol.com.br).

Abstract

Parente, C.L.; Lontra. J.D. and Araújo, M.E. **Ocurrence of sea turtles during seismic surveys in northeastern Brazil.** *Biota Neotrop*. Jan/Abr 2006, vol. 6, no. 1 http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn00306012006. ISSN 1676-0611

There are seven species of sea turtles around the world. Among these, five visit the northeast coast of Brazil to reproduce and feed. These sea turtles are impacted by human activity and need conservation measures. The seismic survey is one of these activities due to its high intensity and low frequency sound emissions in the marine environment. Records of sea turtles during seismic surveys in shallow waters of the northeast of Brazil between 2002 and 2003 are presented in this study with some discussion about the effectiveness of the monitoring procedures. Three species of sea turtle were recorded within the seismic survey areas. The *Chelonia mydas* species was the most commonly sighted turtle. There was only one record of *Caretta caretta* and *Lepidochelys olivacea*. The presence of sea turtles in Sergipe state was linked to the reproductive period while this pattern was not observed in Ceará state. The absence of information about distribution and abundance of sea turtles in the surveyed areas previous to and after the seismic surveys, as well as numerous incomplete data make it hard to identify the effect of seismic surveys on those factors and also sea turtle behaviors.

Key words: *sea turtles, seismic survey, sea-life surveys, South America, Northeastern Brazil*

Resumo

Parente, C.L.; Lontra. J.D. and Araújo, M.E. **Ocorrência de tartarugas marinhas durante prospecções sísmicas no nordeste do Brasil..** *Biota Neotrop*. Jan/Abr 2006, vol. 6, no. 1 http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn00306012006. ISSN 1676-0611

Existem atualmente sete espécies de tartarugas marinhas distribuídas no mundo. Dessas, cinco ocorrem no nordeste do Brasil, utilizando a área para reprodução e alimentação. As populações sofrem os efeitos das atividades humanas, necessitando de medidas para a conservação. Dentre as atividades de risco, destaca-se a prospecção sísmica, a qual emite sons de alta intensidade e baixa freqüência no ambiente marinho podendo causar efeitos negativos nos diversos animais. As observações de tartarugas marinhas realizadas durante as prospecções sísmicas ocorridas em águas rasas do nordeste brasileiro entre 2002 e 2003 são apresentadas em conjunto com uma discussão sobre a efetividade das observações. Foi registrada a presença de três espécies de tartarugas marinhas na área dos estudos sísmicos no nordeste do Brasil. A tartaruga *Chelonia mydas* foi a espécie mais observada nos monitoramentos, com apenas um registro das outras duas espécies identificadas, *Caretta caretta* e *Lepidochelys olivacea*. A presença de tartarugas em Sergipe esteve relacionada com o período reprodutivo, enquanto que no Ceará, a ocorrência foi maior fora da temporada reprodutiva. A ausência de dados pretéritos e posteriores à análise e a grande quantidade de dados incompletos dificultaram a identificação dos efeitos da atividade sísmica na abundância, na distribuição e no comportamento das tartarugas marinhas.

Palavras-chave: *tartaruga marinha, prospecção sísmica, monitoramento de animais marinhos, América do Sul, Nordeste do Brasil*

Introduction

Sea turtles have existed for 200 millions of years and currently there are seven living species around the world (Márquez 1990). Five of these species come to the coast of Brazil to feed and reproduce (Marcovaldi & Marcovaldi 1999). According to The World Conservation Union (IUCN) all species of sea turtle occurring along the Brazilian coast are threatened. The green-sea-turtle (*Chelonia mydas*), the loggerhead-turtle (*Caretta caratta*), and the olive-ridley-turtle (*Lepidochelys olivacea*) are classified as endangered species, while the hawksbill-sea-turtle (*Eretmochelys imbricata*) and the leatherback-turtle (*Dermochelys coriacea*) are classified as critically endangered (IUCN 2004). The five species are also listed in the official list of endangered species from Brazil (MMA 2003).

Many human activities were responsible for the present conservation status of sea turtles but capture was the main among them. Nowadays, some other factors have contributed to continuation of the endangered status, a few that stand out are the beaches' disordered occupation (by hotels, houses, and crowding) fisheries bycatch and sea pollution (Márquez 1990).

One important subject recently studied is the effect of anthropogenic noise in sea turtles. For many years sound sources have been used by seismic surveys to search the presence of oil and gas within the sea bottom (Jones 1999). In the past, chemical explosives were used that caused serious damage to the sea environment and its marine life. After the demands of conservationists and researchers, less aggressive methods to the environment were developed, such as use of airguns to do seismic surveys. Despite the reduction of environmental damage, the use of airguns continues representing danger to marine life with the risk of changing the distribution and behavior of some species (Turnpenny & Nedwell 1994).

The impact of seismic surveys on marine life depends on the environmental characteristics, such as depth and bottom type, and on the noise characteristics, such as intensity, frequency, time duration and distance from the animal to the sound source (Dobbs 2001). The airgun arrays commonly used in seismic surveys produce noise pulses with high intensity in the frequency bands between 10 Hz to 500 Hz. However, the noise pulses can reach 500 Hz to 1000 Hz during high-resolutions surveys (IBAMA 2003a). There is an overlap of those frequencies and the audible frequency range of sea turtles which perceive sounds from 60 Hz to 1000 Hz (Ridgway et al. 1969).

Some studies have been done about the effect of airguns on fishes, turtles and marine mammals (e.g. Lenhardt 1994, Sverdrup et al. 1994, Harris et al. 2001, Stone 2000, 2003, McCauley et al. 2003). Nevertheless, changes in behavior are the focus of those studies, since physiological damages are very hard to observe in live animals (Cummings & Brandom 2004). Behavior responses to airguns were observed in sea turtles. Studies carried out by Lenhardt (1994) showed that sea turtles increase their movements after airgun shots and do not return to the depth where they usually rest. McCauley et al. (2000) did observations of sea turtles in cages and concluded that noises from airguns louder than 166 dB re 1μPa rms increased their swimming activity, and louder than 175 dB re 1μ Pa rms caused erratic behavior. They also estimated an alert behavior at a distance of 2 km from the noise source and escape behavior at a distance of 1 km.

Despite those studies, the knowledge concerning the effects of seismic surveys on sea turtles is very restricted (National Research Council 1990). Seismic surveys are conducted mainly in shallow waters and in the northeast of Brazil. Sea turtles were observed during subaquatic explosions next to the Archipelago of "Fernando de Noronha" but researchers did not observe any effect on the specimens (Sanches & Bellini 1998).

Therefore, considering all sea turtle species occurring on northeast of Brazil are threatened (MMA 2003, IUCN 2004), the Brazilian Institute of Environment and Natural Renewable Resources (IBAMA) started to require sightings and observations during seismic surveys to expand the knowledge about the sea turtle's life cycle and to try to avoid effects of the activity (IBAMA 2003a). The information from these sightings is essential to establish efficient measures to the management of sea turtles.

This study describes the occurrence and distribution of sea turtles during seismic surveys in northeastern Brazil between June 2002 and August 2003. The species diversity and weather effects recorded were analyzed to support a discussion about the effectiveness of those observations.

Material and Methods

This sightings of sea turtle during seismic surveys were done in the following states of northeast Brazil: Sergipe (10°S - 37° W), Rio Grande do Norte (05°S - 35° W) and Ceará (03°S - 38°W), between July, 2002 and August, 2003 (Table 1 and Figure 1). The characteristics of seismic surveys and observations of sea turtles are described as following:

Characteristics of seismic surveys

The Ocean-Bottom-Cable (OBC) seismic survey method used four or six boats to Lay-out (6 m). These boats were responsible for spreading and pulling out cables with hydrophones along the sea bottom. The cables were then connected to a Record Boat. After that, the Gunboat (35 m) crosses the area dragging air-guns that emit sound pulses in low-frequency. The generation system of sound pulses used by the Gunboat was four to eight Generator-Injector (GI) airguns with an operation capacity of 1410 psi each, supplied by a compressor operating at 2000 psi, standardized for all projects.

Characteristics of biota monitoring

The methodology was designed to observe marine mammals but sea turtle observations were included as another goal of the projects. The sightings were done by a single observer aboard the Gunboat during the Caioba-Camurim project. It began with sunrise and was concluded at the end of Gunboat activities that continued throughout the night as a whole. Night vision glasses of the type Gen 1 Pathfinder® was used to aid observations during the night period.

During RNS-144, Guaricema-Dourado, and AXEC projects the sightings were done by three observers who would change between the Gunboat and the Monitoring boat (16 m), which was used exclusively for observing animals. During the night, only the Gunboat had an observer aboard so that this period of observation would be the same as the Caioba-Camurim project.

In the project CES-134, five observers were aboard the Cable Lay-Out boats besides those aboard the Gunboat and Monitoring boat. This procedure was applied to increase the efficacy of monitoring due to large presence of Antillean manatees (*Trichechus manatus*) in that area. Seismic surveys were not done at night in this project resulting in no monitoring effort during this period.

The information on dates and times of sightings, name of boat, boat's geographical coordinates, distance of animal or group in relation to the observation point, and depth at the point of observation was recorded on a specific form. All boats were equipped with satellite navigation systems (DGPS) to help with the recording of the sighting positions.

Data analysis

The sighting databank was analyzed in relation to the diversity, distribution, distance between sightings and land, and distance between sea turtles and boats, and behavioral responses of sea turtle to the seismic surveys were determined. The sea turtles distribution was plotted on maps of the seismic areas. These maps were developed with georeferenced images software.

The effort was analyzed according to days and hours and a sighting index was created by dividing the number of sea turtles by the effort in hours for each seismic survey (turtle/hour). This index was used to reduce bias during comparison of sea turtle abundance among seismic projects.

The time of sighting was grouped into two hours intervals to verify the effect of luminosity on observations of sea turtles. The statistical test Kruskal-Wallis was applied to evaluate differences among intervals.

The sea turtle observations were associated with depth and distance from land for each project. The distances from land were calculated in kilometers by the distance between coordinates of each sighting and the closest point in line to the coast.

Besides that, the effect of sea and weather conditions in sightings of sea turtle were verified. To do this, analysis indexes were grouped according to sea and weather conditions presented in the forms (calm, moderate, and storm) and then the Kruskal-Wallis statistical test was applied to verify significant differences among them.

The influence of airguns on sea turtles was analyzed by comparing the index of sightings (turtle/hour) according to airgun state (switched on or switched off) for each seismic project. Likewise, the behaviors were analyzed according to airgun state. The Wilcoxon statistical test was applied in both analyses to verify significant differences between indexes. All statistical analyses used the significant level of $p<0.05$.

Results

The seismic surveys in northeast Brazil totaled 320 days and 2028 hours of biota sightings. Three sea turtles species were identified as follows: The green-sea-turtle (*Chelonia mydas*), the loggerhead-turtle (*Caretta caretta*), and the olive-ridley-turtle (*Lepidochelys olivacea*). There was a large variation in the index of sea turtles among seismic surveys (Figure 2).

All sightings of sea turtle occurred between 04:00 h and 18:00 h and there were no sightings during the dark period. The highest index of sightings occurred between 08:00h and 10:00h, while the lowest index occurred between 0400h and 0600h (Figure 3). Although data have suggested a direct relation between lighter time and higher indexes, the Kruskal-Wallis test was not significant (H=7.3835; p=0.2868).

Distribution and diversity of species

Forty-six sea turtles were observed during the monitoring of biota in the seismic surveys. The green-sea-turtle (*Chelonia mydas*) was the highest species sighted (0.087 turtle/hour). The two other species (*Lepidochelys olivacea* and *Caretta caretta*) were only seen once. The index of unidentified species (0.100 turtle/hour) was higher than the index of identified species (0.090 turtle/hour) and correlated with 57% of records. The distribution of sea turtle by seismic survey area is presented in Figure 4.

The green-sea-turtle (*Chelonia mydas*) was sighted in all projects except in the Caioba-Camurim project, which was carried out in Sergipe state. In fact, there was only one record of sea turtle at this project but was not possible to identify it. RNS-144, which was carried out in the Rio Grande do Norte state, also had low sightings of sea turtles. In this project all sightings were related to green-sea-turtle with an index of 0.012 turtle/hour.

The third area of lowest abundance was the Guaricema-Dourado area with 0.014 turtle/hour. It was possible to identify species (*Chelonia mydas*) in only one opportunity in this project with the unidentified species corresponding to 81.8% of the observations of the project and 34.6% of unidentified species in all projects.

The Ceará state had the highest abundance with 77.8% of the sightings as a whole. The area of most abundance was the project CES-134 with 0.147 turtle/hour followed by the project AXEC with 0.016 turtle/hour.

Sea turtles were observed between 1.6 km and 41.1 km away from the coast. The loggerhead-turtle and olive-ridley-turtle, both recorded only once, were as far as 41.1 km from coastline in the Ceará state and 15.9 km from coastline in Sergipe state, respectively.

The green-sea-turtle was also widely distributed and was sighted between 1.6 and 39.3 km from the coastline. But its highest abundance was approximately 10 km away from the coastline with 56.3% of the total sightings for the species. The index of sea turtle was 16.7% at a distance of over 30 km from the coastline.

Only 22 records had information regarding depth of sea turtles with a total of 0.124 turtle/hour. The index of sea turtles up to depths of 10 m was 93.3% (0.116 turtle/hour) and all of these were green-sea-turtles. The loggerhead-turtle was sighted in area of 40 m depth and no information about depth was collected for the olive-ridley-turtle.

Effect of sea and weather conditions and of airguns on sightings of sea turtles

The sightings of sea turtles seem to have varied with the sea and weather conditions, but only 19 records had this information. Among these, the highest index of sightings occurred when sea and weather conditions were classified as calm (0.039 turtle/hour; 46.6%), followed by moderate (0.033 turtle/hour; 38.9%) and storm (0.012 turtle/hour; 14.5%). However, the Kruskal-Wallis test did not considered those differences significant (H= 3.4209; p=0.1808).

The information about airgun state (switched on or switched off) was presented in 32 records. The index of sightings with airguns on was 0.054 turtle/hour and during airguns off was 0.075 turtle/hour. In the project Caioba-Camurim (Sergipe state), the single sea turtle was sighted during airguns on, while in the project RNS-144 (Rio Grande do Norte State) all of them occurred during airguns off. The Wilcoxon test did not consider the differences significant between airguns states (Z=-1.75; p=0.0896). The loggerhead-turtle and olive-ridley-turtle were sighted during airguns on and the first species was dead at 10 m from the boat, while the second was live at 30 m from the boat and dove immediately.

The IBAMA has defined a minimum distance of 500 m between sea turtle and Gunboat as requirement to switch off airguns temporarily (IBAMA 2003b). But only 26 sightings recorded this distance and only 17 records had information about airguns state as a whole.

The sightings of sea turtles occurred between 3 and 2000 m, although only one occurred 500 m from the boat. Most of the animals (17 sightings) were until 50m from boat, but only 61.5% (13 sightings) gave information about airguns state. In eight sightings, the sea turtles were 30 m from the Gunboat during airguns on and they were immediately switched off. In these cases, the activity was restarted after the observer did not sight the sea turtle again.

The following behaviors were observed for the sea turtles, the highest index was for swimming (0.093 turtle/hour) followed by still (0.006 turtle/hour), playing (0.004 turtle/hour), and floating (0.003 turtle/hour). Some other behaviors were not identified (0.004 turtle/hour) and there were an index of dead animals (0.011 turtle/hour). The Wilcoxon test (Z=-1.57; p=0.1159) did not result in significant difference between indexes of behavior according airgun state (Figure 5).

Discussion

The sea turtles are a highly migratory species, moving among continents oceanwide to reproduce, feed and rest (Meylan 1982). The sea turtles distribution in Brazil is well known and the main areas used for reproduction, feeding and resting are defined as a whole. Northeastern Brazil is very important region to sea turtles and five species are recorded in that area (Marcovaldi & Marcovaldi 1999, Sanches, 1999). Although there is this general knowledge about sea turtles in northeast Brazil, there are no information correlating its occurrence with seismic surveys. This lack in knowledge is evident concerning the effects of seismic surveys on sea turtle distribution and behavior.

The sea turtles observed in this study for instance, use northeast Brazil mainly to reproduce (Sanches 1999, Silva et al. 2001). However, the hawksbill-sea-turtle (*Eretmochelys imbricata*) was not observed in this study despite the fact that this species has the largest number of nests along the coast of Rio Grande do Norte state (Sanches 1999) where the project RNS-144 was carried out. The absence of this species can be explained by the fact that its reproductive period in that region occurs between November and April, and is very close to shore (Claudio Bellini, personal communication), while the project RNS-144 was carried out between August and October. Another species previously described to occur along northeastern Brazil is the leatherback-turtle (*Dermochelys coriacea*), but its presence in this area is considered rare, being more common in the southeast and south of Brazil (Sanches 1999). Aside from that, the species *Chelonia mydas*, *Caretta caretta* and *Lepidochelys olivacea* did occur during seismic surveys in shallow waters of northeastern Brazil between 2002 and 2003. For this reason their occurrence and distribution will be discussed separately.

The green-sea-turtle, Chelonia mydas

The green-sea-turtle is an abundant species along the Brazilian coast (Sanches 1999). It uses mainly oceanic islands to nest and it is usually not found along the northeastern coast during the turtle's reproductive period, which is between September and March and in some cases in April (Marcovaldi & Marcovaldi 1999). Nevertheless, it was the most common species in this study, being present in all prospected areas.

Even though the species uses mainly oceanic islands to nest, there are records of nesting along the coast of the Sergipe and Rio Grande do Norte states (Sanches 1999), where the Caioba-Camurim, Guaricema-Dourado, and RNS-144 projects occurred. The absence of species during observations in the Caioba-Camurim project can be explained by the development period of that project (June to August) which occurred while the species is typically not near Sergipe, but in feeding areas (Hendrickson 1980). This hypothesis is reinforced by presence of the species during the Guaricema-Dourado project that also was carried out in Sergipe state during reproductive period of green-sea-turtle.

The low index of green-sea-turtle in the Rio Grande do Norte state during the project RNS-144 also can also be explained by the reproductive period of the species in that state. As the state is located north of Sergipe state, the reproductive period of that species begins later, about November (Claudio Bellini, personal communication), and few specimens had arrived in the area during the time period of the seismic survey. Nevertheless, this hypothesis could not be confirmed by this study due to absence of previous sightings in the area of seismic survey.

The state of Ceará has a feeding area for green-sea-turtles located along the west coast, called Almofala (Marcovaldi et al. 1998, Sanches 1999; Lima 2001, Marcovaldi 2001). The sea turtles use that coastline mainly between January and July (Lima et al. 1997, Projeto TAMAR 2005) when specimens come from Suriname (Pritchard 1973) and Ascension's Island (Carr 1975, Mortimer & Carr 1987) after nesting.

This species is found most frequently along coastline of Ceará state (Sanches 1999) and it is found near shore due to the large presence of algae and sea grass forage (Hendrickson 1980, Bjorndal 1997). The sea grass banks are abundant in areas of depths upto 10m, being most common between 2 and 3m (Laborer-Deguen 1963, Eskinazi-Leça et al. 2004). Therefore, since the project AXEC was carried out along the west coast of the Ceará state, during the feeding time period of sea turtles, the low abundance of species during that project can be related with the depth of the area which varied from 25 to 58 m.

The depth could also explain the high abundance of green-sea-turtles during the CES-134 project, carried out along the east coastline of the Ceará state in area between 2 and 10 m depth. The index of sightings of sea turtles in that project was extremely high compared to the four other projects.

According to Lima et al. (1997) the sea turtles leave feeding areas from the Ceará state in July and return to nesting areas. However, the turtles that nest in Suriname may stay longer in the area around Ceará. This is likely because the reproductive period in Suiname occurs mainly between March and May and there are records of sea turtles marked in Suriname and captured in the Ceará between April and September (Pritchard 1973).

Pendoley (1997) reported that seismic surveys carried out in feeding areas of sea turtles can represent risk to all classes of population, be it male or female, juveniles or adults. But like in the states of Sergipe and Rio Grande do Norte, it was not possible to infer about effect of seismic surveys in the distribution of green-sea-turtles in the state of Ceará due to absence of previous observations.

The olive-ridley-turtle, Lepidochelys olivacea

The olive-ridley-turtle is an essentially pelagic species comes nearshore during its reproductive period (Hendrickson 1980) and it is the main species along the coastline of Sergipe between September and March (Marcovaldi & Marcovaldi 1999, Sanches 1999, Silva et al. 2001). The north coastline of that state has a very important nesting area to sea turtles called Biological Reserve of Santa Isabel. For this reason, it is possible during the Caioba-Camurim project that species was feeding in pelagic areas, which would explain its absence in that area. The species was sighted during the Guaricema-Dourado, which was carried out during the nesting period, even though this was a single observation. It is also possible that the high number of unidentified sea turtles recorded during the Guaricema-Dourado corresponds to the olive-ridley-turtle and they were not identified due their feeding behavior on benthic organisms (Hendrickson 1980), which makes it difficult to see the turtles as they are spending longer periods underwater. Its occurrence from Bahia to Sergipe is sporadic (Márquez 1990) and it has been previously recorded in the state of Ceará with a nest in Almofala (Lima et al. 2003), the absence of species in other seismic surveys areas could be result of the problem with identify them at sea, since animals were only observed from boats in few times.

The loggerhead-turtle, Caretta caretta

The loggerhead-turtle is widely distributed along coastal tropical and subtropical areas around the world (Márquez 1990) and has been found in neritic waters feeding benthic organisms (Hendrickson 1980). There are records of its accidental capture in water between 638 m and 4000 m (Barata et al. 1998) even though the deepest dive recorded is 233 m (Lutcavage & Lutz 1997).

The species has been previously recorded in Brazil with nests in states of Maranhão and Ceará with an annual production of over a thousand nests, and from Sergipe and Bahia (Márquez 1990). These previous records justify its presence during the project AXEC carried out in west coast of Ceará and it was the animal recorded in the greatest water depth and furthest from coastline of all of the seismic surveys.

In studies done by Lenhardt (1994) with loggerhead-turtles in captive, they use the sea bed to rest and emerge to breathe about every 10 minutes before acoustic stimulus from seismic surveys. After beginning stimulus sea turtles started to swim without any one returning back to the bottom or stopping swimming. The loggerhead-turtles stayed slightly submerged in the interface water-air to reduce the effects of noise. If the same behavior had occurred during the seismic surveys of northeast Brazil, the index of sightings for species would have been higher.

Considerations about sighting effectiveness to identify seismic surveys effects

The most information concerning effects of seismic surveys in marine life is related to cetaceans and pinnipeds (e.g. Evans et al. 1993, Richardson et al. 1995, Harris et al. 2001, Stone 2003, Parente 2005). The study that gives the best information about the behavior response of sea turtles during the use of airguns was done by McCauley et al. (2000) in Australian waters.

The behavior in Testudomorpha is more complicated to evaluate than in mammals due to unreliable identification of behavior responses to external stimulus (Bartol et al. 1999). In the present study, behaviors described are very superficial and hard to analysis when associated with airgun states. This occurred because the forms were developed with the main objective to describe marine mammals' behavior, despite being very superficial.

McCauley et al. (2000) studied sea turtles exposed to airgun shots, and observed an increase in its swimming activity with agitation and presented erratic movements in consequence of increased noise levels. The increase of turtles' swimming speed and diving behavior were also observed with 500 Hz at 113 dB and with 30 Hz at 164 dB, respectively (Lenhardt 2002). Different from the research developed by McCauley et al. (2000) and Lenhardt (2002), this study only characterized the behavior without consider velocity and direction of sea turtles according to airguns shots. Without this information the record of "swimming" behavior does not explain anything about behavior response of specimens to the seismic surveys because it is not possible to define changes on turtles' swimming patterns.

The "swimming" behavior could be an indicative of seismic survey impacts if considered information presented by Lenhardt (1994). Stone (2003) recorded similar behavior to cetaceans adding an increase of surface exposures. Despite predominance of "swimming" behavior in the present study and presence of "floating" behavior, there is no information that supports the hypothesis of Lenhardt (1994).

An evident error in behavior categories presented in forms to sea turtles is the "playing" behavior. This is a largely studied behavior in marine mammals and it is related to learning and handling ability of some cetacean species but there is no information concerning this behavior to sea turtles. The record of this behavior to sea turtle figures little knowledge of observers about this subject and generates doubt about the effectiveness of sightings.

The sea and weather conditions directly influenced observation of marine life, mainly when this observation is done by floating, flying or fixed superficies. Previous studies have shown direct correlation between good weather conditions and luminosity with highest indexes of sightings around oceans (e.g. DeMaster et al. 2001, Harris et al. 2001, Stone 2003, Parente 2005). The data from this study suggests the same effects of these subjects in indexes of sighting, but statistical analyses did not shown it significantly. It is possible that the sample size was too small and this should be increased for this analysis in the next studies.

According to IBAMA (2003b) all sea turtles sighted upto 500m away from the Gunboat shall be recoded and airguns shots stopped as to not disturb the animals. The results from this research show that it is very hard to sight a sea turtle at long distances and most of the sightings occurred with the specimens being 50m away from the boat. Although airguns have been turned off in all these cases, this result demonstrates that the methodology used did not circumvent close contact of sea turtles with the highest intensities of noise pulses.

Likewise, anterior studies indicate that marine life stay far away from airguns when they are turned on and approach when they are switched off (Stone 2000, Harris et al. 2001, Almeida et al. 2004, Carmo et al. 2004). The same was not observed in this study suggesting at first that the activity did not affect the specimens. But the absence of data concerning direction of swimming of sea turtles in relation to the Gunboat makes it not possible to draw any conclusions about this particular behavior.

According to Pendoley (1997), the period between nesting in a reproductive station is biologically critic to females of sea turtles because eggs are being formed. Therefore, the seismic surveys during reproductive stations of sea turtles could impact the species and egg formation and should be avoided in areas and periods classified as important to species conservation. Long term studies to identify effects of seismic surveys in sea turtles populations should be continued in Brazil and around the world to generate precise information concerning this subject.

Conclusions

The information about occurrence and distribution of sea turtle species in northeast Brazil acquired during seismic surveys in shallow water contributed to the knowledge of species. Nevertheless, they were unable to give information about the effects of the activity on the distribution and behavior of sea turtles being which would have allowed for necessary corrections and adjustments in methodology to improve this information. Other factor that influenced low effectiveness of sighting was the absence of previous information concerning sea turtles occurrence and distribution in the areas.

The most common species present in northeast of Brazil, during seismic surveys, was the green-see-turtle (*Chelonia mydas*) and its highest index of sightings was in the state of Ceará. Its distribution in that state was strongly influenced by low depth and proximity of coastline suggesting that areas as an important foraging area for the species. The presence of sea turtles in state of Sergipe was related to reproductive period.

Finally, the high number of specimens unidentified and the low quality of information suggest it is necessary to training observers and use other techniques to monitoring sea turtles during seismic surveys. As this study only explores data from seismic surveys occurring in shallow waters during two years using ocean-bottom-cable techniques, it is recommended to extend this analysis to other years and techniques.

Aknowledegments

The authors thank Grant Geophysical from Brazil Ltd. to make available the results of sightings of sea turtles, in special to Darci Matos, Douglas Silva Araújo and Gisele Soares, as well as the observers team: Antonio Albuquerque, Francisco Ávila, Guilherme Amado, Leo Bruno, Rommel Feitosa, Rose Emília de Queiroz and Tito Tsuji. Thanks also to Tamar Project/IBAMA for bibliographies and valuables suggestions of Claudio Belline. This study was supported by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES-MEC).

References

ALMEIDA, A.N.F., ABREU, M.D., CASTROVIEJO, C., COSTA, L.D.S., DENRTL, J.R., MIRANDA, C.M., OLIVEIRA, J.L.M., PEREIRA, E., SOUZA, S.A.C. & ULLER, G.A. 2004. Avistagens de cetáceos na costa do Brasil durante levantamentos sísmicos marítimos. In I Congresso Brasileiro de Oceanografia (UNIVALI, ed), Itajaí, p. 364.

BARATA, P.C.R., GALLO, B.M.G., SANTOS, S., AZEVEDO, V.G. & KOTAS, J.E. 1998. Captura acidental da tartaruga marinha *Caretta caretta* (Linnaeus, 1758) na pesca de espinhel de superfície na ZEE brasileira e em águas internacionais. <www.projetotamar.com.br>. Accessed in 15 March 2005.

BARTOL, S.M., MUSICK, J.A. & LENHARDT, M.L. 1999. Auditory evoked potencials of the loggerhead sea turtle (*Caretta caretta*). Copeia, 3:836-840.

BJORNDAL, K.A. 1997. Foraging and nutrition of sea turtles. In: LUTZ, P.L. & MUSICK, J.A.. The biology of sea turtles. Boca Raton: CRC, 1997, 199-231.

CARMO, V.B., MORA, F.G., RINALDI, G.C. & PERUZZOLO, C.F. 2004. Avaliação das avistagens de cetáceos e tartarugas marinhas em relação aos disparos de fontes sísmicas, a bordo no navio sísmico SR/V Veritas Vantage, no Golfo do México, EUA. In I Congresso Brasileiro de Oceanografia (UNIVALI, ed.) Itajaí, p. 369.

CARR, A. 1975. The Ascension Island Green Turtle Colony. Copeia, 3:547-555.

CUMMINGS, J. & BRANDOM, N. 2004. Sonic impact: a precautionary assessment of noise pollution from ocean seismic surveys. Greenpeace Report. <www.greenpeace.org>. Accessed in 30 March 2005.

DOBBS, K. 2001. Gereneral Impacts of Human Activity on Marine Turtles. In Marine turtles in the Great Barrier Reef world heritage area: a compendium of information and basis for the development of policies and strategies for the conservation of marine turtles. Great Barrier Reef Marine Park Authority, Townsville, Australia.

ESKINAZI-LEÇA, E., NEUMMAN-LEITÃO, S. & COSTA, M.F. (Compilers) 2004. Oceanografia: um cenário tropical. Bagaço, Recife.

EVANS, P.G.H., LEWIS, E.J. & FISHER, P. 1993. A study of the possible effects of seismic testing upon cetaceans in the Irish Sea. Rep. from Sea Watch Foundation. Marathon Oil UK Ltd., Oxford.

HARRIS, R.E., MILLER, G.W. & RICHARDSON, W.J. 2001. Seal responses to airgun sounds during summer seismic surveys in the Alaskan Beaufort Sea. Mar. Mamm. Sci.. 17(4):795-812.

HENDRICKSON, J.R. 1980. The ecological strategies of sea turtles. American Zool., 20:597-608.

KOTAS, J.E., SANTOS, S., AZEVEDO, V.G., GALLO, B.M.G. & BARATA, P.C.R. 2004. Incidental capture of loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea*) sea turtles by the pelagic longline fishery off Southern Brazil. Fish. Bull., 102:393-399.

IBAMA 2003a. Impactos Ambientais da Atividade de Prospecção Sísmica Marítima. Informação ELPN/IBAMA n° 012/03.

IBAMA 2003b. Termo de referência para a elaboração do estudo ambiental para a atividade de aquisição de dados sísmicos marítimos 3D. Termo de Referência ELPN/ IBAMA s/n°.

IUCN 2004. 2004 IUCN Red list of threatened species. <www.redlist.org>. Accessed in 18 November 2004.

JONES, E.J.W. 1999. Marine geophysics. John Wiley and Sons Ltd., West Sussex.

LABOREL-DEGUEN, F. 1963. Notas preliminares sobre a ecologia das pradarias de fanerógamas marinhas nas costas dos estados de Pernambuco e da Paraíba. Trabalhos do Instituto Oceanográfico, 3(1):39-50.

LENHARDT, M.L. 1994. Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (*Caretta caretta*). In Proceedings of the fourteenth annual symposium on sea turtle biology and conservation (K.A. Bjorndal, A.B. Bolten, D.A. Johnson & P.J. Eliazar, eds.) NOAA Technical Memorandum, NMFS-SEFC-351, National Technical Information Service, Springfield, Virginia, 238-241.

LENHARDT, M. 2002. Sea turtle auditory behavior. J. Acoust. Soc. Am., 112(5):2314-2319.

LIMA, E.H.S.M., CAVALCANTE, N.C. & EVANGELISTA, L.E.V. 1997. Dados de ocorrências de tartarugas marinhas em Almofala, Ceará/Brasil. In Encontro de Zoologia do Nordeste (Universidade Federal do Ceará, ed.) Fortaleza, p. 55.

LIMA, E.H.S.M. 2001. Registros de tartarugas marinhas mortas em Fortaleza - Ceará e áreas circunvizinhas. In XIV Semana Nacional de Oceanografia (Centro Acadêmico Livre de Oceanografia, ed.) Rio Grande, p. 044.

LIMA, E.H.S.M., MELO, M.T.D. & BARATA, P.C.R. 2003. First record of olive ridley sea turtle (*Lepidochelys olivacea*) nesting in the state of Ceará, Brazil. Marine Turtle Newsletter, 99:20.

LUTCAVAGE, M.E. & LUTZ, P.L. 1997. Diving physiology. In The biology of sea turtles (P.L. Lutz & J.A. Musick, eds) CRC Press, Boca Raton, Florida - USA, 277-296.

MARCOVALDI, M.A., BAPTISTOTTE, C., CASTILHOS, J.C., GALLO, B.M., LIMA, E.H.S.M., SANCHES, T.M. & VIEITAS, C.F. 1998. Activities by Project TAMAR in Brazilian sea turtle feeding grounds. Marine Turtle Newsletter, 80:5-7.

MARCOVALDI, M.A. & MARCOVALDI, G.G.D. 1999. Marine turtles of Brazil: the history and structure of Projeto TAMAR-IBAMA. Biol. Conserv., 91:35-41.

MARCOVALDI, M.A. 2001. A new initiative to protect green turtles at an important foraging ground in Ceara, Brazil. Marine Turtle Newsletter, 63:13-14.

MÁRQUEZ, M.R. 1990. Sea turtles of the world. an annotated and illustrated catalogue of sea turtles species known to date. FAO Fisheries Synopsis, Rome, FAO.

McCAULEY, R.D., FEWTRELL, J. DUNCAN, A.J., JENNER, C., JENNER, M.-N., PENROSE, J.D., PRINCE, R.I.T., ADHITYA, A., MURDOCH, J. & McCABE, K. 2000. Marine seismic surveys: a study of environmental implications. APPEA Journal, 40:692-708.

McCAULEY, R.D., FEWTRELL, J. & POPPER, A.N. 2003. High intensity anthropogenic sound damages fish ears. J. Acoust. Soc. Am., 113 (1):638-642.

MEYLAN, A. 1982. Sea turtle migration - evidence from tag returns. In Biology and conservation of sea turtles (K. A. Bjorndal, ed.) Smithsonian Institution Press, Washington, D.C., 91-100.

MEYLAN, A.B. & MEYLAN, P.A. 1999. Introduction to the evolution, life history, and biology of sea turtles. In: ECKERT, K.L., BJORNDAL, K.A., ABREU-GROBOIS, F.A. & DONNELLY, M. Research and management techniques for the conservation of sea turtles. IUCN/SSC Marine Turtle Specialist Group Publication, 4:3-5.

MMA 2003. Lista de Espécies da Fauna Brasileira Ameaçadas de Extinção. <www.ibama.gov.br/fauna/extincao.htm> Acessed in 19 June 2004.

MORTIMER, J.A. & CARR, A. 1987. Reproduction and migrations of the Ascension Island green turtle (*Chelonia mydas*). Copeia, 1:103-113.

NATIONAL RESEARCH COUNCIL 1990. Decline of the sea turtles: causes and prevention. Committee on Sea Turtle Conservation, National Academy Press, Washington.

PARENTE, C.L. 2005. Monitoramento de mamíferos marinhos durante estudos sísmicos no nordeste do Brasil. Dissertação de Mestrado, Universidade Federal de Pernambuco, Recife.

PENDOLEY, K. 1997. Sea turtles and management of marine seismic programs in Western Australia. PESA Journal, 25:8-16.

PRITCHARD, P. 1973. International Migrations of South American Sea Turtles (Cheloniidae and Dermochelidae). Animal Behav., 21:18-27.

PROJETO TAMAR, 2005. <www.tamar.org.br> Acessed in 10 March 2005.

RICHARDSON, W.J., GREENE-JR, C.R., MALME, C.I. & THOMSON, D.H. 1995. Marine Mammals and Noise. Academic Press. San Diego, California.

RIDGWAY, S.H., WEVER, E.G., McCORMICK, J.G., PALIN, J. & ANDERSON, J.H. 1969. Hearing in the giant sea turtle, *Chelonia mydas*. Proc. Natl. Acad. Scien., 64:884-890.

SANCHES, T.M. & BELLINI, C. 1998. Impactos sobre Tartarugas Marinhas Causados por Explosões: um Estudo Preliminar em Fernando de Noronha, PE, Brasil. In Congresso Brasileiro de Zoologia (Universidade Federal de Pernambuco, ed.), Recife, p. 288.

SANCHES, T.M. 1999. Projeto de Conservação e Utilização Sustentável da Diversidade Biológica Brasileira - PROBIO – Tartarugas Marinhas. Programa Nacional de Biodiversidade – PRONABIO, Termo de Referência n° 155/98.

SILVA, A.C.C.D., CASTILHOS, J.C., WEBER, M.I., OLIVEIRA, F.L.C., MACHADO, I.F. & BARBIERI, M.B. 2001. Taxas de Eclosão em Ninhos de *Lepidochelys olivacea* Submetidos a Diferentes Técnicas de Manejo na Reserva Biológica de Santa Isabel, Sergipe, Brasil, Temporada 2000/2001. XIV Semana Nacional de Oceanografia, Rio Grande, RS.

STONE, C.J. 2000. Cetacean Observations During Seismic Surveys. JNCC Report, 301:62.

STONE, C.J. 2003. The Effects of Seismic Activity on Marine Mammals in UK Waters, 1998-2000. JNCC Report no. 323. January 2003. JNCC, Peterborough.

SVERDRUP, A., KJELLSBY, P.G, KRÜGER, P.G., FLOYSAND, R., KNUDSEN, F.R., ENGER, P.S., SERCK-HANSSEN, G. & HELLE, K.B. 1994. Effects of Experimental Seismic Shock on Vasoactivity of Arteries, Integrity of the Vascular Endothelium and on Primary Stress Hormones of the Atlantic Salmon. Fish Biol., 45:973-995.

TURNPENNY, A.W.H. & NEDWELL, J.R. 1994. The Effects on Marine Fish, Diving Mammals and Birds of Underwater Sound Generated by Seismic Surveys. Fawley Aquatic Research Laboratories Ltd, Consultancy Report FCR 089/94. London.

Title: Occurrence of sea turtles during seismic surveys in Northeastern Brazil

Authors: Cristiano Leite Parente, Juliana Doyle Lontra & Maria Elisabeth de Araújo

Biota Neotropica, Vol. 6 (number 1): 2006
http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn00306012006

Date Received 07/08/2005 - Revised 10/18/2005
Accepted 01/01/2006

ISSN 1676-0611

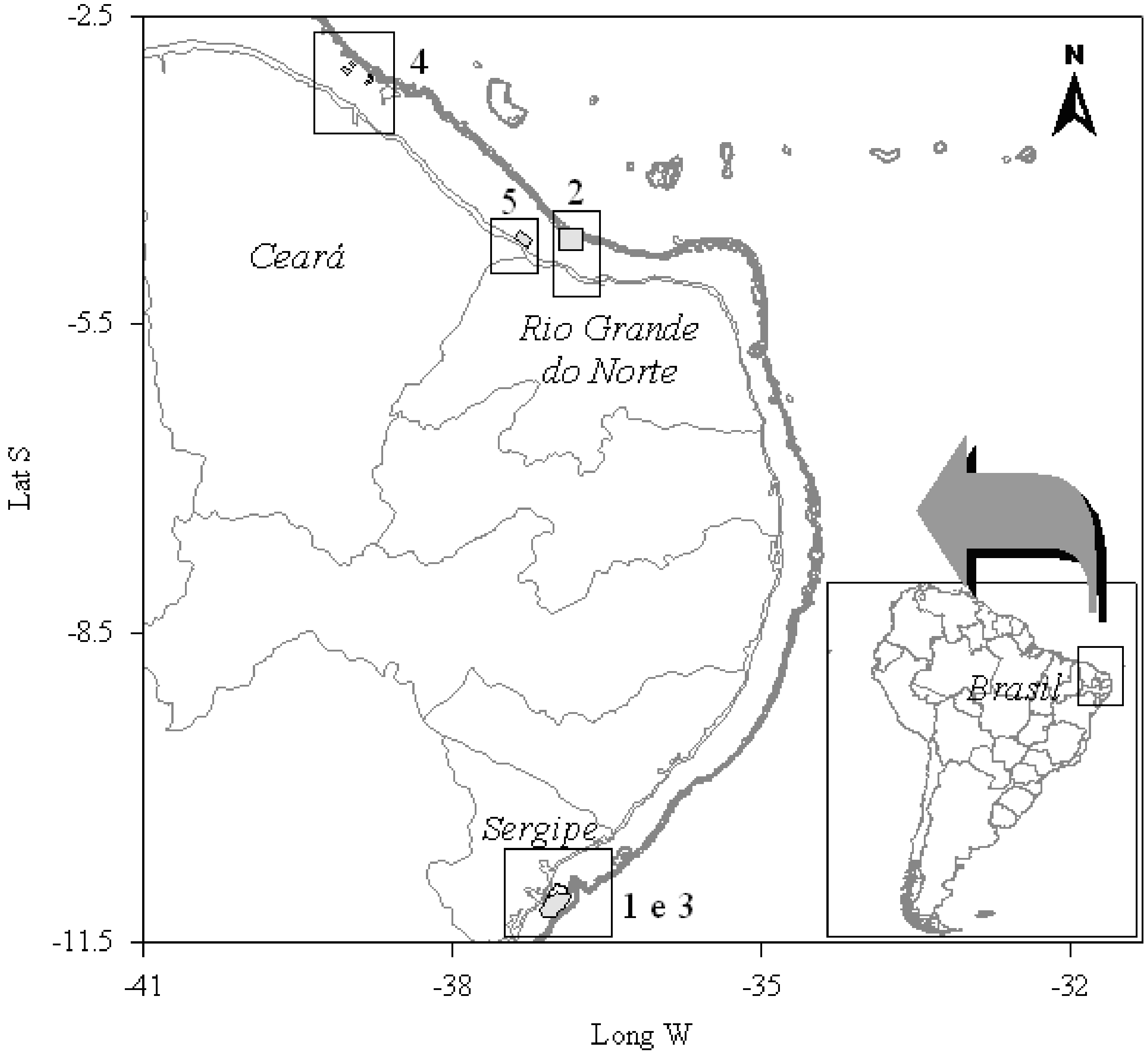


Figure 1 – Map of northeastern Brazil focusing on the ocean-bottom-cable seismic surveys done between 2002 and 2003. (1 – Caioba-Camurim; 2 – RNS-144; 3 – Guaricema-Dourado; 4 – Atum-Xaréu-Espada-Curimã; 5 – CES-134)

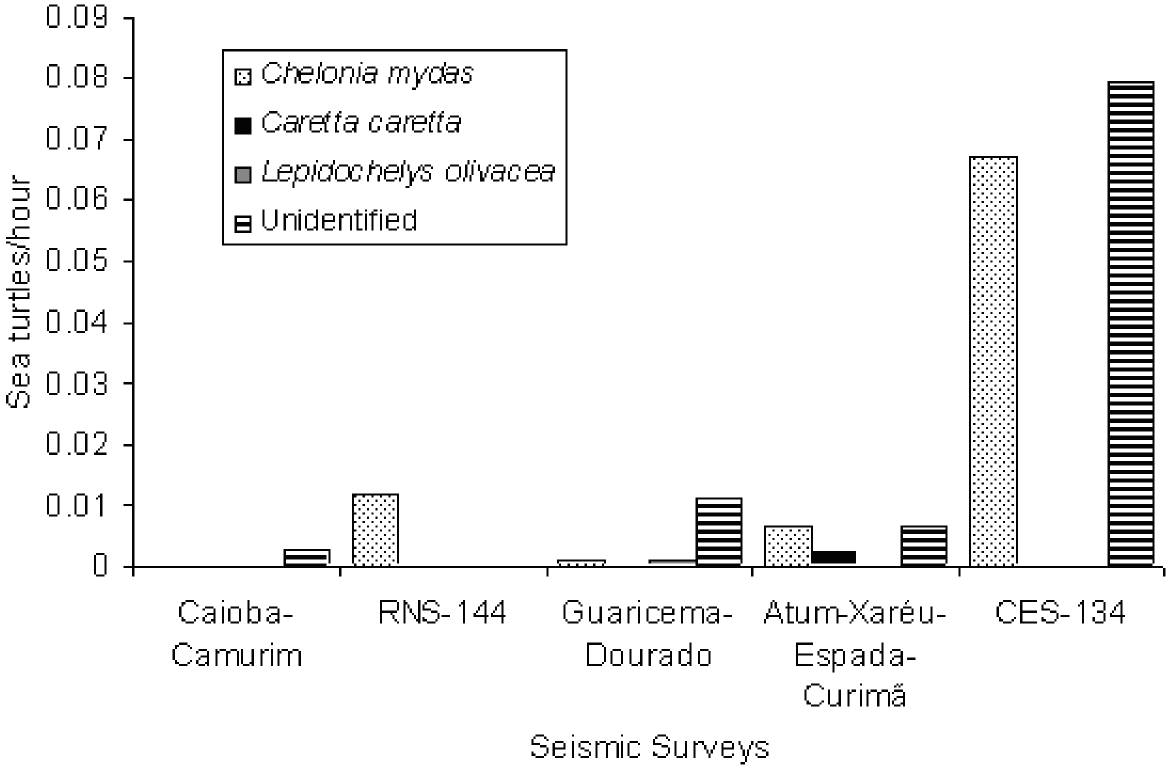


Figure 2 – Index of sea turtle sightings by seismic survey done in the northeastern Brazil between 2002 and 2003

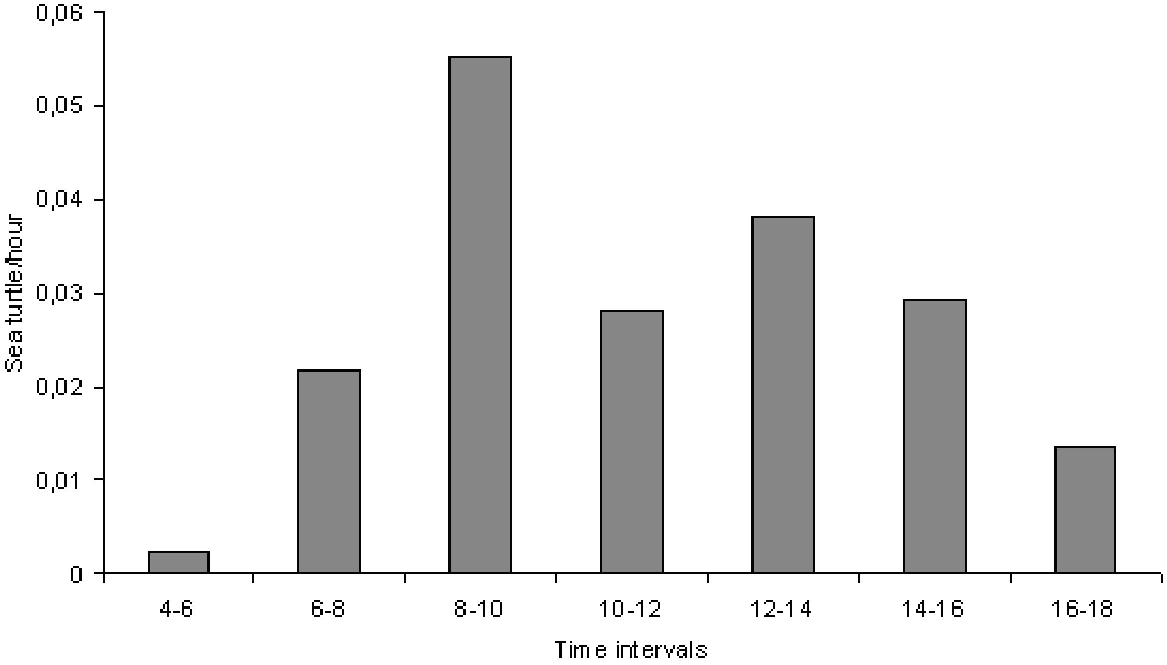


Figure 3 – Indexes of sea turtle sightings during the seismic surveys that occurred in northeastern Brazil between 2002 and 2003 according to the time of day.

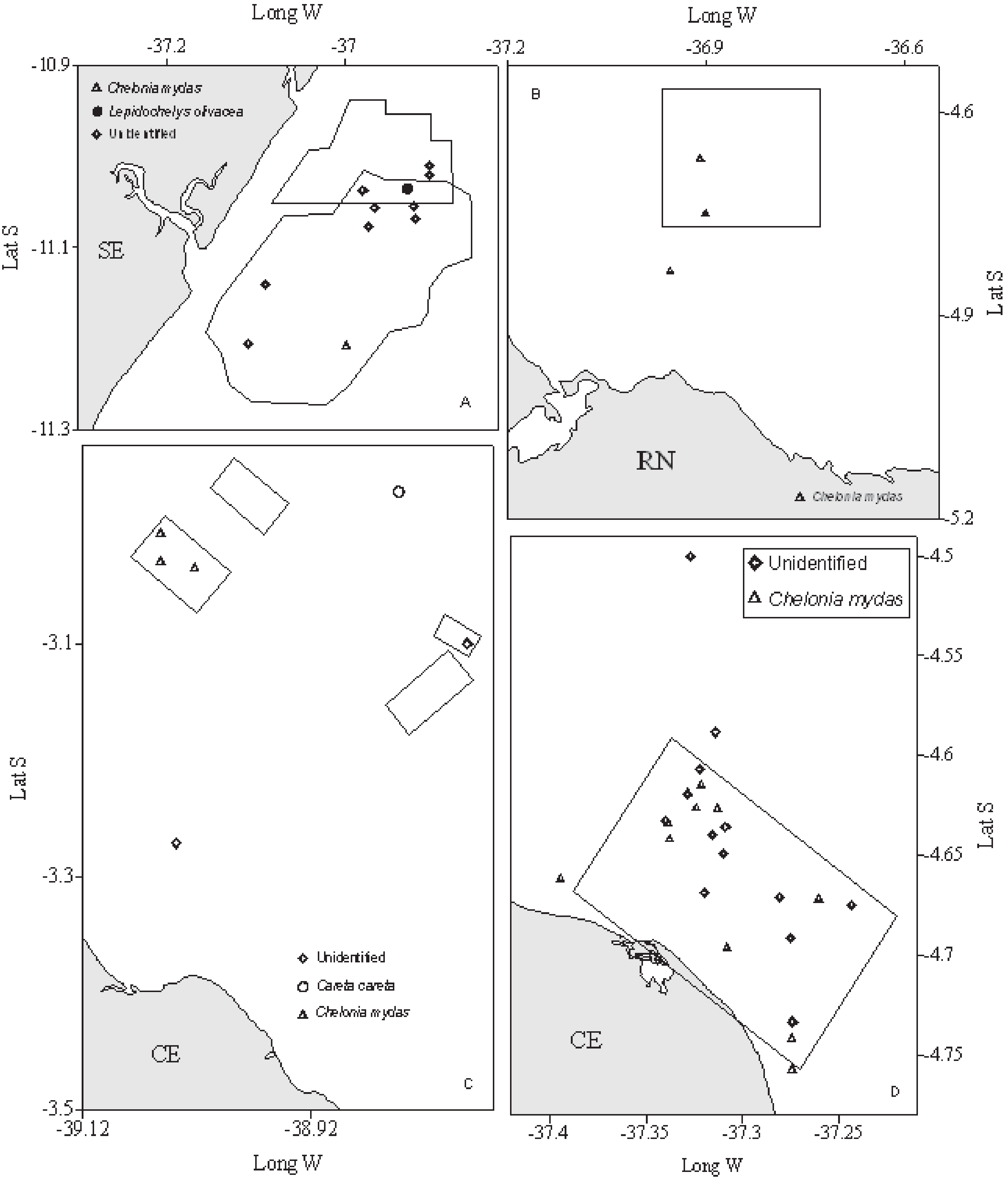


Figure 4 – Sea turtles distribution during the seismic surveys that occurred in northeastern Brazil between 2002 and 2003 (A – Caioba-Camurim and Guaricema-Dourado; B – RNS-144; C – Atum-Xaréu-Espada-Curimã; D – CES-134). Outlined areas indicate area of survey

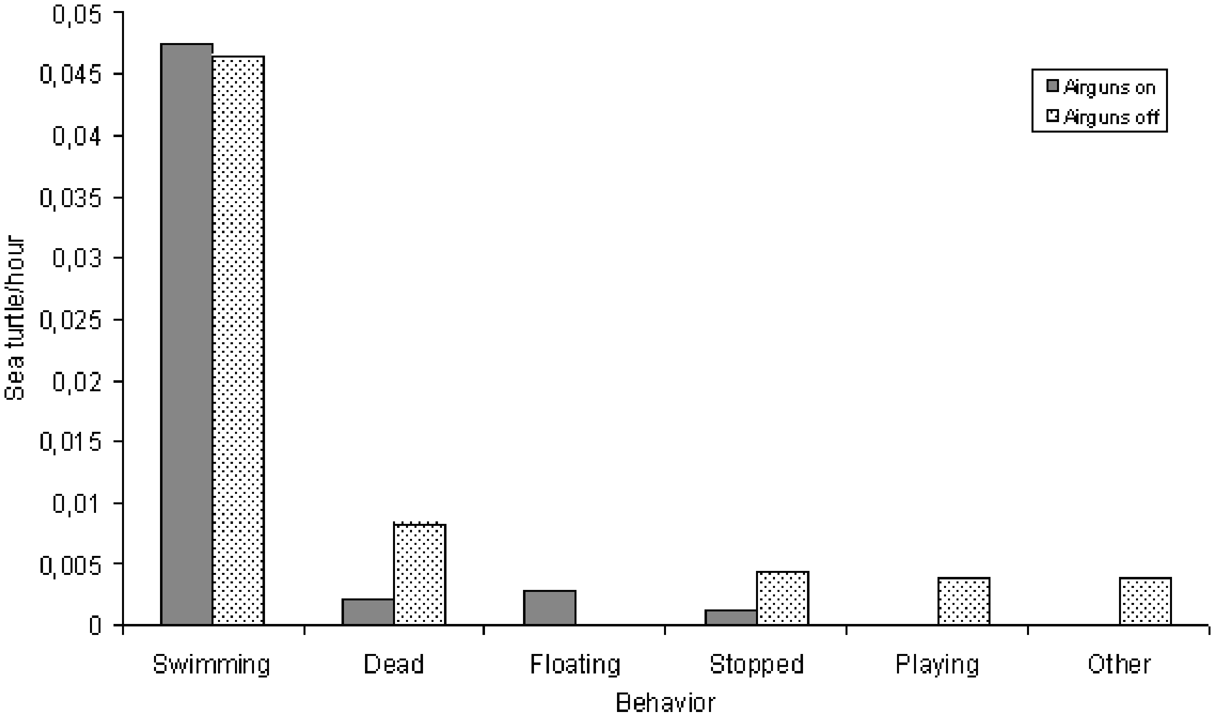


Figure 5 – Index of sea turtles behaviors observed during the seismic surveys occurring in northeastern Brazil between 2002 and 2003 according to the airgun state

Characterization and taxonomic key for tadpoles (Amphibia: Anura) from the northwestern region of São Paulo State, Brazil[1]

Denise de Cerqueira Rossa-Feres[2] & Fausto Nomura[3,4]

Biota Neotropica v6 (n1) – http://www.biotaneotropica.org.br/v6n1/pt/abstract?identification-key+bn00706012006

Date Received 05/15/2005
Revised 10/10/2005
Accepted 01/01/2006

[1] This work was supported by the state of São Paulo Research Foundation (FAPESP), within the BIOTA/FAPESP – The Biodiversity Virtual Institute Program (http://www.biota.org.br; grant 01/13341-3)

[2] Departamento de Zoologia e Botânica. Universidade Estadual Paulista-UNESP, R. Cristóvão Colombo, nº 2265, Jd Nazareth, 15054-000 São José do Rio Preto, São Paulo State, Brazil.
e-mail: denise@ibilce.unesp.br (corresponding author)
[3] Laboratório de Ecologia Animal. Universidade Estadual Paulista-UNESP/São José do Rio Preto, São Paulo State, Brazil.
e-mail: fausto_nomura@yahoo.com.br
[4] Programa de Pós-Graduação em Zoologia. Universidade Estadual Paulista-UNESP/Rio Claro, São Paulo State, Brazil.

Abstract

Rossa-Feres, D.C and Nomura,F. **Characterization and taxonomic key for tadpoles (Amphibia: Anura) from the northwestern region of São Paulo State, Brazil**. *Biota Neotrop*. Jul/Dez 2005, vol. 5, no. 2 http://www.biotaneotropica.org.br/v6n1/pt/abstract?identification-key+bn00706012006. ISSN 1676-0611

Difficulties in species identification and the absence of taxonomic keys are several of the obstacles in elaborating adequate conservation, management and habitat recovery programs. This study provides a taxonomic key, morphological characterization, and drawings for the 22 known anuran tadpoles from the northwestern region of São Paulo state, southeastern Brazil. Specimens of all species analyzed are deposited in the scientific amphibian collection of Universidade Estadual Paulista (DZSJRP), São José do Rio Preto, SP.

Key words: *Cerrado, Neotropical region, biodiversity, morphological variation, taxonomy.*

Resumo

Rossa-Feres, D.C and Nomura,F. **Caracterização e chave taxonômica para girinos (Amphibia: Anura) da região noroeste do estado de São Paulo, Brasil.** *Biota Neotrop*. Jul/Dez 2005, vol. 5, no. 2 http://www.biotaneotropica.org.br/v6n1/pt/abstract?identification-key+bn00706012006. ISSN 1676-0611

Dificuldades na identificação de espécies e a ausência de chaves taxonômicas são alguns dos maiores obstáculos na elaboração de programas de conservação, manejo e recuperação de hábitats. Este estudo apresenta uma chave taxonômica, caracterização morfológica e desenhos para as 22 espécies de larvas de anuros conhecidas para a região noroeste do Estado de São Paulo, sudeste do Brasil. Espécimes de todos os girinos analisados estão depositados na coleção científica da Universidade Estadual Paulista, São José do Rio Preto, SP (DZSJRP).

Palavras-chave: *Cerrado, região neotropical, biodiversidade, variação morfológica, taxonomia.*

Introduction

For the majority of anuran species, tadpoles are the easiest developmental stage to encounter and to collect, remaining in ponds for longer periods of time than adults (Lips & Savage 1996, Altig & McDiarmid 1999a). However, difficulties in tadpole identification are a major obstacle in anuran surveys, and in the development of conservation and biodiversity management programs. As a consequence, identification keys are valuable tools, especially where the anurofauna is poorly known, as is the case for the Brazilian inland regions (Haddad & Sazima 1992, Brandão & Araújo 1998, Haddad 1998). Despite the intensive use of land for agriculture and pasture activities (PROBIO 1998), 29 species of anurans have been registered in the Northwestern region of São Paulo State (Vizotto 1967, Cais 1992, Bernarde & Kokubum 1999, Rossa-Feres & Jim 2001). The climate of this region is AW type, with a rainy season (October to March) and a pronounced dry season (April to September) that receive only 15% of the total annual precipitation, which ranges from 1100 to 1500 mm (Barcha & Arid 1971). The climate and human activities have restricted the environment available for the development of tadpoles mostly to temporary ponds, with annual variations in the hydroperiod (Rossa-Feres & Jim 2001). In this report, we provide a morphological characterization and taxonomic key for tadpoles of 22 species for which the larval stages are known

Material and Methods

For the elaboration of the taxonomic key we examined tadpoles between stages 34 and 40 (sensu Gosner 1960) deposited in the scientific amphibian collection (DZJSRP) of Universidade Estadual Paulista, UNESP, São José do Rio Preto campus, SP. The characters are described according to Altig & McDiarmid (1999b), with coloration analysis based on preserved specimens, and the classification according Frost (2004), Faivovich et al. (2005) and Nascimento et al. (2005). In the item Characteristics, total length of each tadpole is given with mean ± standard deviation (range). Drawings were made under a camera lucida adapted to a Zeiss stereomicroscope and images were captured with a Cannon Power Shot S40 digital camera adapted to a Leica MZ-6 stereomicroscope.

Results and Discussion

Morphological characterization and comparisons

Bufonidae Gray, 1825

Bufo schneideri Werner, 1894 (Figures 1A, 9A)

Specimens examined. 11 tadpoles, stage 36 to 38, lot 91 (Nova Itapirema: 21º04'40'' S, 49º32'23'' W).

Characteristics. Total length 24.31 ± 1.26 mm (22.95 – 26.78 mm). Body depressed, oval in dorsal view and globular/depressed in lateral view. Snout rounded in dorsal view and sloped in lateral view. Eyes small, dorsal and laterally directed. Nares large, oval, dorsally positioned with opening dorsolaterally directed, with a very small projection on the marginal rim. Spiracle sinistral, long and wide, opening on the posterior third of the body, laterally directed, centripetal wall totally fused to the body wall and longer than the external wall. Vent tube short, medial, fused with the ventral fin, with medial opening and ventral and dorsal walls of the same length. Oral disc anteroventral, emarginate laterally; row of marginal papillae uniseriate, with dorsal and ventral gaps; marginal papillae small, triangular, with three submarginal papillae laterally in the oral disc, forming a row on the inner side of the lateral emargination. Tooth row formula 2(2)/3; A-1 and A-2 of the same length, P-3 a little shorter than P-2. Jaw sheaths narrow, with triangular serration; upper jaw sheath "arc" shaped and lower jaw sheath "U" shaped, upper jaw sheath and lower jaw sheath of the same width. Dorsal fin low with convex margin, originating in the anterior third of the tail at a high slope; ventral fin low with margin parallel to the longitudinal axis of the tail. Dark coloration with translucent non-pigmented fins.

Comments. The tadpoles (treated as *B. paracnemis*) described by Rosa (1965) from Jaboticabal and by Vizotto (1967) from northwestern region, São Paulo State, Brazil, and by Cei (1980) from Argentinean populations differ from those described herein only by having an interrupted P-1 tooth row and by the absence of a submarginal papillae row. However, Rosa (1965) suggests that this interruption can be caused by damage during manipulation of the tadpoles.

Hylidae Rafinesque, 1815

Dendropsophus minutus (Peters, 1872) (Figures 1B, 9B)

Specimens examined. 10 tadpoles, stage 37 to 40, lots: 15.3, 518 (Nova Itapirema: 21º04'40'' S, 49º32'23'' W), 459 (Macaúbas: 49º30'00'' W, 20º34'59" S).

Characteristics. Total length 37.52 ± 2.96 mm (32.4 – 41.7 mm). Body compressed, oval in dorsal view and triangular in lateral view. Snout rounded in dorsal view and sloped in lateral view. Eyes large, lateral, laterally directed. Nares large, circular, laterally positioned with opening posterodorsally directed, without projections on marginal rim. Spiracle sinistral, lateroventral, short and narrow, opening at the middle third of body, posterodorsally directed, centripetal wall fused to the body wall and longer than the external wall. Vent tube short, dextral, fused to the ventral fin, with medial opening and ventral wall shorter than dorsal wall. Oral disc anteroventral, not emarginate and with marginal papillae row uniseriate ventrally and biseriate laterally, with dorsal gap; marginal papillae triangular, long, with dorsal papillae shorter than ventral; submarginal papillae absent. Tooth row formula varies from 0/0 to 0/1 and 1/2, with the last being more common; P-1 and P-2 of same length. Upper jaw sheath "arc" shaped and lower jaw sheath "U" shaped; upper jaw sheath narrower than the lower one. Dorsal fin low, with convex margin, emerging on the posterior third of the body at a high slope; ventral fin high, with convex margin; tail with flagellum. Coloration brown, with light stripes and blotches in body dorsum, opaque in the gular region and translucent in the belly region.

Comments. Three morphological characters vary among populations from different regions: total length, number of rows of marginal papillae and tooth row formula. The tadpoles here described are longer than those from Campo Grande, Mato Grosso State, Brazil (mean 30 mm, probably stage 39, Fig. 20, pag. 472; Bokermann 1963), but smaller than those studied by Kenny (1969) from Trinidad (40 mm, stage 31 to 39) and by Duellman (1978) from Ecuador (41,7 mm, stage 41). The tadpoles from Trinidad and Venezuela present a row of uniseriate marginal papillae (Kenny 1969, Duellman 1997), while those from Campo Grande have the oral disc with a row of marginal papillae biseriate ventrally, although the figure shows the row biseriate also laterally (Fig. 21, pag. 472; Bokermann 1963), and those from Ecuador present a marginal papilla row biseriate ventrally and laterally (Duellman 1978). In the population studied here the row of marginal papillae is biseriate only laterally. The tooth row formula varies from 0/1 (Bokermann 1963, Duellman 1997) to 0/2 (Duellman 1978) and 1/2 (Vizotto 1967, Kenny 1969, Cei 1980). These differences in the larvae from widely separated sites suggest the possibility of *D. minutus* being a species-complex, as noted by Duellman (1997), but the tooth row formula could vary even in the same population, as in the presently studied population. Vizotto (1967) reports that, during development, *D. minutus* tadpoles gradually lose labial tooth rows, first P-2, followed by A-1, whereas the P-1 row is more persistent. However, this sequence was not observed in the tadpoles described by Duellman (1978), that at the end of the larval stage (sensu Gosner 1960) have a tooth row formula of 0/2, nor in the present study, where tadpoles at stages 36 and 40 presented a tooth row formula of 1/2.

Dendropsophus nanus (Boulenger, 1889) (Figures 1C, 9C)

Specimens examined. 13 tadpoles, stage 37, lots: 21.2, 121.2 (Nova Itapirema: 21º04'40'' S, 49º32'23'' W).

Characteristics. Total length 27.32 ± 1.36 mm (25.37 – 29.76 mm). Body compressed, oval in dorsal view and triangular/depressed in lateral view. Snout pointed in dorsal view and sloped in lateral view. Eyes large, lateral, laterally directed. Nares small, oval, laterally positioned with opening anterolaterally directed, without projections on marginal rim. Spiracle sinistral, lateroventral, long and narrow, opening on the middle third of the body, posterodorsally directed, centripetal wall fused with the body wall and the same length as the external wall. Vent tube short, dextral opening, positioned at the origin of the ventral fin, concealed by hind limbs. Oral disc anteroventral, modified to a protractile tube, without rows of marginal papillae or labial teeth. Jaw sheaths narrow, with triangular serration; upper jaw sheath "arc" shaped and lower jaw sheath "V" shaped. Dorsal fin high with convex margin, emerging on the posterior third of the body at a high slope; ventral fin low, with convex margin; tail with flagellum. Coloration reddish-brown, with light stripes between the eye and the snout, translucent fins, lightly pigmented, with non-pigmented areas forming light blotches.

Comments. These tadpoles are similar to those described by Bokermann (1963) from Campo Grande, São Paulo State, which differ from those described herein by the smaller total length and by the oral disc similar to a kind of "U" shaped sucker. Lavilla (1990), on the basis of the geographical range of *Dendropsophus nanus* and *Dendropsophus sanborni*, considered that the tadpoles described by Bokermann (1963) belong to *D. sanborni*, and described the tadpole of *D. nana* from the Chaco region, Argentina, distinguishing them from *D. sanborni* tadpoles by the "violin" body shape, dorsal fin emerging at the middle of the body, and by the absence of a protractile tube in the former. The analysis of tadpoles used by Bokermann (1963) in his description (Lot: WCAB 13287) reveals that the oral disc presents a protractile tube and that the "U" shaped structure described by the author is the anterior margin of the tube when it is retracted. These results indicate that the geographical distribution and the morphological characterization of *Dendropsophus nanus* and *D. sanborni* need to be better studied.

Hypsiboas albopunctatus (Spix, 1824) (Figures 2A, 9D)

Specimens examined. 35 tadpoles, stage 37 to 40, lots: 170, 180, 478, 503, 520 (Nova Itapirema: 21º04'40'' S, 49º32'23'' W), 545, 546 (Engenheiro Schmidt: 20º52'06'' S, 49º16'40'' W), 482 (Vitória Brasil: 20º11'24" S, 50º28'48" W).

Characteristics. Total length 45.44 ± 5.39 mm (39.5 – 58.2 mm). Body depressed, oval in dorsal view and globular/depressed in lateral view. Snout oval in dorsal view and rounded in lateral view. Eyes large, dorsal, laterally directed. Nares large, oval, dorsally positioned, with opening dorsolaterally directed, with a large projection on marginal rim. Spiracle sinistral, long and narrow, opening on the posterior third of the body, posteriorly directed, centripetal wall not fused to body wall and the same length of the external wall. Vent tube long, medial, fused to the ventral fin, with dextral opening and ventral wall longer than dorsal wall. Oral disc ventral, roughly triangular, emarginate ventrally; row of marginal papillae uniseriate with a narrow dorsal gap, submarginal papillae absent; marginal papillae long and triangular. Tooth row formula 2(1,2)/3(1), P-1 with a narrow interruption, less than three labial teeth; anterior tooth rows of the same length; P-3 half the length of P-2. Jaw sheaths narrow, with serration conical and long; upper jaw sheath "arc" shaped and lower jaw sheath "V" shaped; upper jaw sheath narrower than lower jaw sheath. Dorsal fin low and slightly convex, originating at the body-tail junction at a small slope; ventral fin low and parallel to the longitudinal tail axis. Coloration yellowish-brown, sometimes with black dots scattered throughout the dorsum, ventral region translucent in the belly region and opaque in the gular region, and irregularly pigmented with dark brown blotches; tail with a medium-lateral dark brown stripe on the anterior third of the tail muscle; translucent fins, with dark brown pigmentation accumulated in the posterior third of the fins.

Comments. The tadpoles described by de Sá (1995) differ from those studied herein by having a rounded snout, oval nares, eye positioned dorsolaterally, submarginal papillae and tooth row formula 2(2)/3(1). The tadpoles described by Heyer et al. (1990) from Boracéia, São Paulo State, differ from those studied herein by having a rounded snout. There are some variations in the tail muscle width among tadpole populations of this species. Tadpoles of *H. albopunctatus* are found generally in streams among the marginal vegetation, but some specimens were found in lentic (e.g. artificial pond) pools. In tadpoles found in streams, the width of the tail muscle is considerably larger than in those living in lentic ponds (tail muscle width/body width - stream dwelling tadpoles: 0.52 ± 0.08, n = 9; lentic dwelling tadpoles: 0.42 ± 0.06, n = 10; t = -3.22; p < 0.01).

Hypsiboas lundii (Burmeister, 1856) (Figures 2B, 9E)

Specimens examined. 5 tadpoles stage 35 to 39, lot 521 (Mirassol: 49º31'15" W, 20º49'09" S).

Characteristics. Total length 45.78 ± 4.52 mm (40.1 – 52.4 mm). Body depressed, ovoid in dorsal view and globular in lateral view. Snout oval in dorsal view and rounded in lateral view. Eyes small, dorsally positioned and dorsolaterally directed. Nares large, oval, dorsally positioned with opening dorsally directed, with a large projection on marginal rim. Spiracle sinistral, lateroventral, long and wide, opening on the posterior third of the body, posterodorsally directed, centripetal wall not fused to the body wall and longer than external wall. Vent tube long, dextral, fused to the ventral fin, with dextral opening and ventral wall longer than dorsal wall. Oral disc ventral, row of marginal papillae biseriate, with dorsal and ventral gaps; marginal papillae conical, long, with dorsal papillae shorter than ventral; few submarginal papillae laterally, with conical shape. Tooth row formula 2(2)/4(1). Jaw sheaths narrow, with triangular serration; upper jaw sheath "arc" shaped and lower jaw sheath "V" shaped. Dorsal fin low with convex margin and emerging at the body-tail junction at a low slope; ventral fin low, with margin parallel to the longitudinal tail axis. Brown coloration, with small black dots scattered throughout the dorsum, fins translucent, lightly pigmented.

Comments. The tadpoles described by Bokermann & Sazima (1973) (treated as *Hyla biobeba*) from Serra do Cipó, Minas Gerais State, Brazil, differ from those studied herein by having a longer total length (66 mm, stage 37), an oral disc not emarginate ventrally, and by having three rows of posterior labial tooth, although the figure shows four rows (Fig. 5, pg. 331; *op. cit.*).

Hypsiboas raniceps (Cope, 1862) (Figures 2C, 9F)

Specimens examined. 5 tadpoles, stages 34 to 37, lots: 22, 126(P1), 139, 142, 555 (Nova Itapirema: 21º04'40" S, 49º32'23" W).

Characteristics. Total length 57.58 ± 8.07 mm (52.6 – 66.9 mm). Body globular, ovoid in dorsal view and globular/depressed in lateral view. Snout oval in dorsal view and rounded in lateral view. Eyes small, dorsal, dorsally directed. Nares large, oval, dorsally positioned with opening dorsally directed, with a large projection on marginal rim. Spiracle sinistral, long and narrow, opening on the posterior third of the body, posteriorly directed, with centripetal wall not fused with the body wall and of the same length as the external wall. Vent tube long, medial, fused with the ventral fin, with dextral opening and ventral and dorsal wall of the same length. Oral disc ventral, emarginate ventrally; row of marginal papillae uniseriate, with narrow dorsal gap; marginal papillae small, triangular, with one or two submarginal papillae laterally. Tooth row formula 2(1,2)/3(1); anterior labial tooth rows of the same length, P-2 longer than P-1 and P-3. Jaw sheaths wide, with triangular serration; upper jaw sheath "arc" shaped and lower jaw sheath "V" shaped; upper and lower jaw sheath of the same width. Dorsal fin high, with triangular margin, emerging on the posterior third of the body at a high slope; ventral fin low, about half the height of the tail muscle. Coloration reddish-brown, with small black dots scattered throughout the body dorsum and dark brown rectangular blotches in the dorsal region of the tail muscle along the longitudinal tail axis.

Comments. These tadpoles are similar to those described by Vizotto (1967), from Ibirá, São Paulo State, Brazil. The tadpoles characterized by Cei (1980) from Argentinean populations, differ from the population here studied by having a dextral vent tube, narrower upper jaw sheath and a tooth row formula 2/3(1).

Pseudis paradoxa (Linnaeus, 1758) (Figures 3A, 9G)

Specimens examined. 11 tadpoles, stage 37, lots: 553, 554 (Ribeirão Preto: 47º48'37" W, 21º10'39" S).

Characteristics. Total length 185.55 ± 15.30 mm (169.1

– 208.23 mm). Body compressed, oval in dorsal view and globular/triangular in lateral view. Snout truncate in dorsal view and sloped in lateral view. Eyes small, lateral, laterally directed. Nares small, oval, dorsally positioned with opening laterally directed, with a small projection on the marginal rim. Spiracle sinistral, short and narrow, opening on the middle third of the body, posteriorly directed, centripetal wall not fused with the body wall and longer than the external wall. Vent tube long, medial, fused to the ventral fin, with ventral and dorsal wall of the same length, medial opening. Oral disc ventral, emarginate ventrally; row of marginal papillae biseriate, with a narrow dorsal gap; marginal papillae long, conical, with five to six submarginal papillae scattered laterally and ventrally. Tooth row formula 2(2)/3(1); A-1 and A-2 of the same length, P-2 longer than P-3. Jaw sheaths narrow, with very short and conical serration; upper jaw sheath “arc” shaped and lower jaw sheath “V” shaped; upper jaw sheath wider than the lower one. Dorsal fin high, with convex margin, emerging on the anterior third of the body at a small slope; ventral fin high, with a convex margin. Coloration grayish-brown, with dark spots and non-pigmented areas scattered throughout the body and tail.

Comments. These tadpoles are larger than those described by Vizotto (1967) from Icém, São Paulo State (168 mm, stage 38), and larger than those from Cáceres, Minas Gerais State, Brazil, described by Miranda-Ribeiro (1926; 105 mm, probably stage 38). Vizotto (1967) considered these tadpoles to have large eyes compared to the interocular distance. In the present study, we used body length as reference to qualify the eyes as small. The tooth row formula of the Cáceres specimen (2/3; Miranda-Ribeiro 1926) differs from other descriptions (Vizotto 1967, Cei 1980) and from the present one [2/3(1)]. Vizotto (1967) suggests that this difference may be due the poor preservation of the Cáceres specimen.

Scinax fuscomarginatus (A. Lutz, 1925) (Figures 3B, 9H)

Specimens examined. 6 tadpoles, stage 37, lots: 25, 31.4, 106.3, 105.2, 128.3 (Nova Itapirema: 21º04’40’’ S, 49º32’23’’ W).

Characteristics. Total length 27.11 ± 0.83 mm (26.30 – 28.05 mm). Body compressed, oval in dorsal view and triangular/depressed in lateral view. Snout rounded in dorsal and lateral view. Eyes large, lateral, laterally directed. Nares large, circular, dorsolaterally positioned with opening dorsolaterally directed, without projection on marginal papillae. Spiracle sinistral, short and narrow, opening on the middle third of the body, posterodorsally directed, centripetal wall fused to the body wall and longer than the external wall. Vent tube short, dextral, fused to the ventral fin, with ventral opening and ventral and dorsal wall as the same length. Oral disc anteroventral, emarginate ventrally; row of uniseriate marginal papillae, with dorsal gap; marginal papillae long, conical; submarginal papillae aggregate laterally in the oral disc. Tooth row formula 2(2)/3(1); A-1 and A-2 of the same length and P-2 longer than P-1 and P-3. Jaw sheaths narrow with triangular serration; upper jaw sheath “arc” shaped and lower jaw sheath “U” shaped; upper and lower jaw sheaths of the same width. Dorsal fin high with a convex margin, emerging on the anterior third of the body at a high slope; ventral fin high with a convex margin; tail with flagellum; dorsal tail muscle highly developed concealing the limit between the end of the body and the beginning of the tail. Coloration light brown with a dark stripe between the snout and the eyes and melanophores grouped at the spiracle base, a mediolateral stripe on the anterior third of the tail muscle, fins translucent, lightly pigmented, with marginal dark blotches on the posterior third of the tail.

Comments. These tadpoles are similar to those described by Vizotto (1967) (treated as *Hyla parkeri*), from Nova Itapirema, São Paulo State, Brazil, which differ from those described herein by the row of marginal papillae biseriate laterally and by the medial vent tube. The author reports the tooth row formula 2(2)/3, but denotes a tendency for bipartition of P-1.

Scinax fuscovarius (A. Lutz, 1925) (Figures 4A, 10A)

Specimens examined. 10 tadpoles, stage 37 to 39, lots: 74.5, 117.6 (Nova Itapirema: 21º04’40’’ S, 49º32’23’’ W).

Characteristics. Total length 38.50 ± 1.65 mm (36.70 – 41.57 mm). Body compressed, oval in dorsal view and triangular in lateral view. Snout rounded in dorsal view and sloped in lateral view. Eyes large, lateral, laterally directed. Nares large, oval, dorsolaterally positioned with opening laterally directed, without projection on the marginal rim. Spiracle sinistral, long and narrow, opening on the posterior third of the body, posteriorly directed, centripetal wall fused to the body wall and longer than the external wall. Vent tube long, dextral, fused to the ventral fin, with a ventral opening, ventral and dorsal wall of the same length. Oral disc anteroventral, emarginate ventrally; row of marginal papillae uniseriate, with dorsal gap; marginal papillae long, conical; submarginal papillae smaller than the marginal ones, forming rows laterally in the oral disc. Tooth row formula 2(2)/3(1); A-1 and A-2 of the same length, P-3 slightly smaller than P-2. Jaw sheaths wide, with conical serration; upper jaw sheath “M” shaped and lower jaw sheath “V” shaped; upper jaw sheath narrower than lower jaw sheath. Dorsal fin high, with a convex margin, emerging on the middle third of the body at a high slope; ventral fin high, with a convex margin; tail with flagellum. Coloration silver-grayish, with small dark spots scattered all over the body; fins translucent without pigments.

Comments. These tadpoles are similar to those described by Vizotto (1967) from northwestern region of São

Paulo State, Brazil, and by Cei (1980), from Argentinean populations. The tadpoles described herein differ from the former descriptions by the absence of 4 to 6 rows of submarginal papillae in the lateral region of the oral disc.

Scinax similis (Cochran, 1952) (Figures 4B, 10B)

Specimens examined. 10 tadpoles, stage 37 and 38, lot 21.6 (Nova Itapirema: 21º04'40'' S, 49º32'23'' W).

Characteristics. Total length 28.47 ± 1.63 mm (25.68 – 30.39 mm). Body compressed, oval in dorsal view and triangular in lateral view. Snout rounded in dorsal view and sloped in lateral view. Eyes large, lateral, laterally directed. Nares large, rounded/circular, dorsolaterally positioned with opening directed dorsolaterally, without projection on the marginal rim. Spiracle sinistral, long and narrow, opening on the posterior third of the body, posterodorsally directed, centripetal wall fused with the body wall and longer than the external wall. Vent tube short, dextral, fused to the ventral fin, with ventral opening and ventral and dorsal wall of the same length. Oral disc anteroventral, emarginate ventrally; row of marginal papillae uniseriate, with dorsal gap; marginal papillae long and conical; submarginal papillae shorter than the marginal ones, laterally aggregate in the oral disc. Tooth row formula 2(2)/3(1); A-1 and A-2 of the same length, P-3 slightly shorter than P-2. Jaw sheaths wide, with triangular serration; upper jaw sheath "M" shaped and lower jaw sheath "V" shaped, upper and lower jaw sheath of the same width. Dorsal fin high, with convex margin, emerging on the middle third of the body at a high slope; ventral fin high, with convex margin; tail with flagellum. Coloration light brown, tail muscle with mediolateral and mediodorsal dark stripes, fins lightly pigmented, marginally mottled.

Comments. The tadpoles described by Alves & Carvalho-e-Silva (1999), from Rio de Janeiro State, Brazil, differ from those studied herein by a longer total length (31 mm at stage 37), globular body, oval nares, spiracle opening posterodorsally directed and submarginal papilla distribution, with some papillae forming an irregular row and others distributed in a disorganized way.

Trachycephalus venulosus (Laurenti, 1768) (Figures 4C, 10C)

Specimens examined. 10 tadpoles, stage 37 and 38, lot 113.4 (Nova Itapirema: 21º04'40'' S, 49º32'23'' W).

Characteristics. Total length 43.85 ± 1.03 mm (42.47 – 45.05 mm). Body globular, oval in dorsal view and triangular/depressed in lateral view. Snout rounded in dorsal view and sloped in lateral view. Eyes small, lateral, laterally directed. Nares small, oval, dorsolaterally positioned with opening anterolaterally directed, without projection on the marginal rim. Spiracle sinistral, lateroventral, long and narrow, opening on the middle third of the body, posterodorsally directed, centripetal wall fused with body wall and the same length as the external wall. Vent tube short, medial, fused to the ventral fin, with medial opening and ventral and dorsal wall of the same length. Oral disc anteroventral, emarginate ventrally; row of marginal papillae biseriate, with dorsal gap; marginal papillae short, triangular; submarginal papillae conical, of the same length as the marginal papillae, distributed laterally, forming rows. Tooth row formula 4(1,2,4)/6(1,6); A-1 and A-2 fragmented and A-3 shorter than A-4, P-6 fragmented. Jaw sheaths narrow, with triangular serration; upper jaw sheath "arc" shaped and lower jaw sheath "V" shaped; upper jaw sheath wider than lower jaw sheath. Dorsal fin low, with convex margin, emerging on the middle third of the body at a median slope; ventral fin low, with convex margin; tail with flagellum. Coloration brown, translucent fins lightly pigmented, with non-pigmented areas forming light blotches.

Comments. These tadpoles are similar to those analyzed by Duellman (1970), from Panamá and México populations (treated as *Phrynohyas venulosa*), from which those studied herein differ only by presenting a ventral fin lower than the dorsal fin.

Leptodactylidae Werner, 1896

Eupemphix nattereri Steindachner, 1863 (Figures 5A, 10D)

Specimens examined. 10 tadpoles, stage 35 to 39, lots: 113.6, 117.4 (Nova Itapirema: 21º04'40'' S, 49º32'23'' W).

Characteristics. Total length 32.64 ± 1.02 mm (30.37 – 33.93 mm). Body globular, ovoid in dorsal view and globular in lateral view. Snout pointed in dorsal view and sloped in lateral view. Eye small, dorsal, dorsolaterally directed. Nares small, circular, dorsally positioned with opening dorsally directed, without projection on the marginal rim. Spiracle sinistral, long and wide, opening on the middle third of the body, posterodorsally directed, centripetal wall totally fused to the body wall and the same length as the external wall. Vent tube short, dextral, fused to the ventral fin, dextrally directed, with ventral and dorsal membrane of the same length. Oral disc ventral, emarginate laterally; row of marginal papillae uniseriate, with dorsal gap; marginal papillae long, conical; submarginal papillae absent. Tooth row formula 2(2)/3(1); A-1 shorter than A-2, P-2 slightly longer than P-1 and P-3. Jaw sheaths narrow, with triangular serration; upper jaw sheath "arc" shaped and lower jaw sheath "V" shaped; upper and lower jaw sheath of the same width. Dorsal fin low, with convex margin, emerging on the posterior third of the body at a median slope; ventral fin low, with margin parallel to the longitudinal axis of the tail muscle. Coloration brown, with tail muscle pigmented and fins translucent and slightly pigmented.

Comments. The tadpoles described by Vizotto (1967) from the northwestern region of the São Paulo State, Brazil, differ from those studied herein by having a medial vent tube. The tadpoles described by Cei (1980) from Argentinean populations, differ from those studied herein by the presence of submarginal papillae and wider jaw sheath.

Leptodactylus fuscus (Schneider, 1799) (Figures 5B, 10E)

Specimens examined. 10 tadpoles, stage 37, lot 117.1 (Nova Itapirema: 21º04'40'' S, 49º32'23'' W).

Characteristics. Total length 27.76 ± 2.30 mm (24.35 – 31.28 mm). Body depressed, oval in dorsal view and globular/depressed in lateral view. Snout oval in dorsal view and sloped in lateral view. Eyes small, dorsal, laterally directed. Nares small, oval, dorsally positioned with opening laterally directed, without projection on the marginal rim. Spiracle sinistral, short and narrow, posterodorsally directed, opening on the middle third of the body, centripetal wall totally fused with the body wall and the same length as the external wall. Vent tube long, medial, fused to the ventral fin, with medial opening and ventral membrane longer than the dorsal one. Oral disc anteroventral, not emarginate; row of uniseriate marginal papillae, with a dorsal gap; marginal papillae long, triangular, submarginal papillae absent. Tooth row formula 2(2)/3(1); A-1 shorter than A-2; P-2 longer than P-1 and P-3. Jaw sheaths narrow, with triangular serration; upper jaw sheath "arc" shaped and lower jaw sheath "V" shaped; upper and lower jaw sheath of the same width. Dorsal fin low with a convex margin, emerging on the posterior third of the body at a low slope; ventral fin low, margin parallel to the longitudinal axis of the tail muscle. Coloration of the body and tail muscle dark brown in the dorsal-half and brownish-cream in the ventral-half.

Comments. These tadpoles are similar to those described by Lescure (1973) from French Guyana (Surinam), differing from those studied herein by having a biseriate row of marginal papillae.

Leptodactylus labyrinthicus Spix, 1824 (Figures 5C, 10F)

Specimens examined. 10 tadpoles, stage 36 to 39, lot 542 (São José do Rio Preto: 49º22'45" W, 20º49'10" S).

Characteristics. Total length 48.10 ± 2.22 mm (45.30 – 50.00 mm). Body depressed, oval in dorsal view and globular/depressed in lateral view. Snout rounded in dorsal and lateral views. Eye small, dorsal, dorsolaterally directed. Nares small, oval, positioned dorsally with opening dorsolaterally directed, without projection on the marginal rim. Spiracle sinistral, lateroventral, short and wide, posterodorsally directed, opening on the middle third of the body, centripetal wall totally fused with the body wall and longer than the external wall. Vent tube long, medial, fused to the ventral fin, opening medially directed and ventral wall longer than dorsal wall. Oral disc anteroventral, emarginate ventrally; row of marginal papillae uniseriate, with dorsal gap, marginal papillae short, conical, submarginal papillae absent. Tooth row formula 1/2(1); P-1 longer than P-2. Jaw sheaths narrow, with conical serration; upper jaw sheath "arc" shaped and lower jaw sheath "V" shaped; upper and lower jaw sheath of the same width. Dorsal fin low with margin parallel to the longitudinal axis of the tail muscle, emerging on the posterior third of the body at a low slope; ventral fin low, margin parallel to the longitudinal axis of the tail muscle. Coloration uniformly grayish-brown, with light blotches and stripes. Fins translucent, slightly pigmented, with accumulation of pigments on the posterior third.

Comments. These tadpoles differ from those studied by Vizotto (1967) from the northwestern region of São Paulo State, Brazil, only in total length (65 mm, stage 38) and eye size, which the author considered to be large.

Leptodactylus ocellatus (Linnaeus, 1758) (Figures 6A, 10G)

Specimens examined. 10 tadpoles, stage 38 and 39, lot 130.3 (Nova Itapirema: 21º04'40'' S, 49º32'23'' W).

Characteristics. Total length 58.68 ± 2.08 mm (55.5 – 61.2 mm). Body depressed, elongated-oval in dorsal view and globular/depressed in lateral view. Snout oval in dorsal view and rounded in lateral view. Eye small, dorsal, dorsolaterally directed. Nares small, rounded, dorsally positioned with opening dorsally directed, without projection on the marginal rim. Spiracle sinistral, lateroventral, posterodorsally directed, long and wide, opening on the middle third of the body, centripetal wall fused to the body wall with free distal edge and the same length as the external wall. Vent tube long, medial, fused to the ventral fin, opening medially directed, and ventral wall longer than dorsal wall. Oral disc anteroventral, emarginate ventrally; row of marginal papillae biseriate ventrally and triseriate laterally, with dorsal gap; marginal papillae long, triangular; one submarginal papilla longer than the marginal one. Tooth row formula 2/3; A-1 and A-2 of the same length; P-2 of the same length as P-1 and slightly longer than P-3. Jaw sheaths narrow, with triangular serration; upper jaw sheath "arc" shaped and lower jaw sheath "U" shaped; upper and lower jaw sheath of the same width. Dorsal fin low with convex margin, emerging at the tail-body junction at a low slope; ventral fin low, with convex margin. Coloration black. Fins translucent and heavily pigmented.

Comments. These tadpoles differ from those described by Fernandez & Fernandez (1921) only by the shorter length of the Argentinean specimens (54 mm), and from those studied by Cei (1980), also from Argentina, only by body shape, which that author considered to be ovoid in dorsal view.

Leptodactylus podicipinus (Cope, 1862) (Figures 6B, 10H)

Specimens examined. 10 tadpoles, stage 37, lot 123.3 (Nova Itapirema: 21º04'40'' S, 49º32'23'' W).

Characteristics. Total length 25.03 ± 0.85 mm (24.02 – 26.50 mm). Body depressed, elongated-oval in dorsal view and globular/depressed in lateral view. Snout oval in dorsal view and sloped in lateral view. Eye small, dorsal, dorsolaterally directed. Nares small, oval, dorsally positioned with opening laterally directed, without projection on the marginal rim. Spiracle sinistral, short and narrow, posterodorsally directed, opening on the middle third of the body, centripetal wall fused to the body wall with free distal edge and of the same length as the external wall. Vent tube long, medial, fused to the ventral fin, with medial opening and ventral wall longer than dorsal wall. Oral disc anteroventral, emarginate ventrally; row of marginal papillae biseriate ventrally, triseriate laterally, with dorsal gap; marginal papillae short and conical, submarginal papillae absent. Tooth row formula 2(2)/3; A-1 and A-2 of the same length and P-3 slightly shorter than P-2. Jaw sheaths narrow, with conical serration; upper jaw sheath "arc" shaped and lower jaw sheath "V" shaped; upper and lower jaw sheaths of the same width. Dorsal fin low, with convex margin, emerging on the posterior third of the body at a low slope; ventral fin low with margin parallel to the longitudinal axis of the tail muscle. Coloration black, with fins heavily pigmented.

Comments. These tadpoles are similar to those described by Vizotto (1967), from northwestern region of São Paulo State, Brazil. Tadpoles from Trinidad (Kenny 1969) are larger (max. length of 35 mm) than tadpoles from other localities, they have a ventral gap on the row of marginal papillae, and have ventral papillae shorter than the lateral ones.

Physalaemus centralis Bokermann, 1962 (Figures 6C, 11A)

Specimens examined. 13 tadpoles, stage 37, lot JJ6942 (Nova Itapirema: 21º04'40'' S, 49º32'23'' W).

Characteristics. Total length 20.20 ± 0.93 mm (18.60 – 21.70 mm). Body depressed, ovoid in dorsal view and globular/depressed in lateral view. Snout rounded in dorsal and lateral views. Eye small, dorsal, dorsolaterally directed. Nares small, circular, dorsally positioned with opening dorsally directed, with a very small projection on the marginal rim. Spiracle lateroventral, short and narrow, opening on the middle third of the body, ventrally directed, centripetal wall totally fused to the body wall and the same length as the external wall. Vent tube long, medial, with free distal edge and ventral and dorsal membrane of the same length. Oral disc ventral, emarginate laterally; row of marginal papillae uniseriate, with dorsal and lateroventral gap, forming a ventral ridge with a variable number of papillae, no more than ten; marginal papillae long, conical, submarginal papillae absent. Tooth row formula 2(2)/2; A-1 and A-2 of the same length, P-2 slightly shorter than P-1. Jaw sheaths wide, with triangular serration; upper jaw sheath "arc" shaped and lower jaw sheath "V" shaped; lower jaw sheath wider than the upper one. Dorsal fin low, with convex margin, emerging at the posterior third of the body at a low slope; ventral fin low, with margin parallel to the longitudinal axis of the tail muscle. Coloration brown, fins translucent, with marginal dark blotches, concentrated in the posterior third of the tail.

Comments. These tadpoles were described by Rossa-Feres & Jim (1993) and no further references were found.

Physalaemus cuvieri Fitzinger, 1826 (Figures 7A, 11B)

Specimens examined. 11 tadpoles, stage 37 to 39, lot 78.4 (Nova Itapirema: 21º04'40'' S, 49º32'23'' W).

Characteristics. Total length 23.49 ± 0.86 mm (21.79 – 24.86 mm). Body depressed, ovoid in dorsal view and globular/depressed in lateral view. Snout rounded in dorsal and lateral views. Eye small, dorsal, dorsolaterally directed. Nares large, oval, dorsally positioned with opening dorsally directed, with a small projection on marginal rim. Spiracle sinistral, long and wide, opening on the posterior third of the body, posterodorsally directed, centripetal wall fused to the body wall with free distal edge and longer than the external wall. Vent tube long, medial, with opening medially directed and ventral and dorsal wall of the same length. Oral disc ventral, emarginate laterally; row of marginal papillae uniseriate, with ventral, lateroventral and dorsal gaps; marginal papillae long, conical, submarginal papillae absent. Tooth row formula 2(2)/3(1); A-1 and A-2 of the same length and P-3 about a third of P-2 length. Jaw sheaths narrow, with triangular serration; upper jaw sheath "arc" shaped and lower jaw sheath "U" shaped; lower jaw sheath wider than the upper one. Dorsal fin low, with convex margin, emerging on the posterior third of the body at a low slope; ventral fin low with margin parallel to the longitudinal axis of tail muscle. Coloration brown, with translucent fins slightly pigmented.

Comments. The tadpoles described by Bokermann (1962) from Coluene river, at Posto Jacaré, Mato Grosso State, Brazil, differ from those studied herein by the longer total length and tooth row formula 2/3(1). Cei (1980), for Argentinean populations, reports a dextral vent tube with opening directed dextrally, instead of the medial vent tube with opening medially directed, as in the population studied herein.

Physalaemus fuscomaculatus (Steindachner, 1864) (Figures 7B, 11C)

Specimens examined. 43 tadpoles, stage 37 to 40, lots: 15.6, 118.4 (Nova Itapirema: 21º04’40” S, 49º32’23” W).

Characteristics. Total length 23.32 ± 1.37 mm (22.0 – 25.59 mm). Body depressed, ovoid in dorsal view and globular/depressed in lateral view. Snout oval in dorsal view and rounded in lateral view. Eye small, dorsal, dorsolaterally directed. Nares large, circular, dorsally positioned with opening dorsally directed, with a very small projection on the marginal rim. Spiracle sinistral, long and narrow, opening on the middle third of the body, posterodorsally directed, centripetal wall fused to the body wall with free distal edge and the same length as the external wall. Vent tube, medial, fused to the ventral fin, opening dextrally directed, with ventral wall longer than the dorsal one. Oral disc ventral, emarginate laterally, row of marginal papillae uniseriate, with dorsal gap and two narrow ventral gaps, forming a ventral ridge with a variable number of papillae, 8 to 18, marginal papillae long and conical, one to five submarginal papillae, longer than the marginal ones, laterally on the oral disc. Tooth row formula 2(2)/2(1); A-1 and A-2 of the same length, P-2 slightly shorter than P-1. Jaw sheaths wider, upper jaw sheath “M” shaped and lower jaw sheath “V” shaped; upper and lower jaw sheaths of the same width, with triangular serration. Dorsal fin low with convex margin, emerging on the posterior third of the body at a low slope; ventral fin low with margin parallel to the longitudinal axis of the tail muscle. Coloration brown, with dorsum scattered with dark dots, forming a semicircular arch around the internal margin of the nares. Belly translucent. Tail muscle light brown, with scattered blotches. Fins translucent, with light reticulate formed by blood vessels and with some blotches marginally to the dorsal and ventral fins.

Comments. These tadpoles were described by Nomura et al. (2003) and no further references were found.

Microhylidae Günther, 1858

Dermatonotus muelleri (Boettger, 1885) (Figures 7C, 11D)

Specimens examined. 10 tadpoles, stage 37 to 40, lot 481 (Vitória Brasil: 20º11’24" S, 50º28’48" W).

Characteristics. Total length 38.38 ± 2.47 mm (33.2 – 41.7 mm). Body globular, rounded in dorsal view and globular/depressed in lateral view. Snout rounded in dorsal view and truncate in lateral view. Eyes small, lateral, laterally directed. Nares absent. Spiracle ventral, long and wide, opening on the posterior third of the body, posteriorly directed, centripetal wall not fused with the body wall and the same length as the external wall. Vent tube short, medial, fused with the ventral fin, with a medial opening and with ventral and dorsal membranes of the same length. Oral disc absent, without keratinized mouthparts or papillae; dermal flap in front of the mouth, dermal flap edges not jagged. Dorsal and ventral fins low, with a convex margin. Dorsal fin emerging at the body-tail junction at a low slope. Dorsal-half coloration reddish-brown and ventral-half light cream. Fins translucent, slightly pigmented, mostly in the anterior third.

Comments. These tadpoles are smaller than those described by Vizotto (1967), from Santa Fé do Sul, São Paulo State, Brazil, which measured 40 mm in total length (stage 37), but the same length as the tadpoles from Embarcación, Argentina, studied by Lavilla (1992). Vizotto (1967) considered the tadpoles to have large eyes (see comment in *Pseudis paradoxa*, above) and Cei (1980) considered the eyes to be dorsolaterally directed rather than laterally, and the mouth ventrally rather than anteroventrally directed, as in the present description. Lavilla (1992) also considered these tadpoles to have large eyes, laterally positioned, but dorsolaterally directed, as also reported by Cei (1980).

Elachistocleis bicolor (Guérin-Méneville, 1838) (Figures 8A, 11E)

Specimens examined. 10 tadpoles, stage 36 to 38, lots: 21.1, 65.1 (Nova Itapirema: 21º04’40” S, 49º32’23” W).

Characteristics. Total length 21.81 ± 0.22 mm (21.51 – 22.05 mm). Body depressed, rounded in dorsal view and triangular/depressed in lateral view. Snout rounded in dorsal view and truncate in lateral view. Eyes small, lateral, laterally directed. Nares absent. Spiracle ventral, long and wide, sinistral, opening dorsally directed, centripetal wall fused to the vent tube and shorter than the external wall. Vent tube long, medial, fused to the ventral fin, with sinistral opening and ventral and dorsal wall of the same length. Oral disc without keratinized mouthparts or papillae; paired dermal flap suspended in front of the mouth, dermal flap edges mostly not jagged. Dorsal fin low, with convex margin, emerging on the posterior third of the body at a low slope; ventral fin low, with a convex margin. Coloration dark brown, with light stripes and dots between the snout and eye and ventrolaterally on the body; medial stripe on the anterior third of the tail muscle, fins translucent and slightly pigmented, marginally mottled with dark brown blotches on the anterior third of the dorsal fin.

Comments. According to Frost (2004), the cited nomenclature and distribution for the *Elachistocleis* species are provisory and almost certainly partially wrong. Three major factors contribute to this taxonomic difficulty: the nomenclatural uncertainty, the distribution of *Elachistocleis* species, which is more complex than any continental-level synthesis has proposed, and the absence of statistical analysis of the intra- and inter- variation of the proposed *Elachistocleis* species (Frost 2004). The tadpoles studied were assigned to *E. bicolor* based on the distributional range presented by Lavilla et al. (2003). The characterization of the tadpoles is also confuse: according to Orton (1953), tadpoles of Microhylidae have medial spiracle and vent tube with opening directed medially, a condition considered typical for this family and utilized by Orton (1953) in her proposal of anuran classification. However, Griffiths & Carvalho (1965), Kenny (1969) and Rada de Martinez (1981) described the spiracle and the vent tube sinistral, with a sinistral opening. Lavilla & Langone (1991) proposed that these differences are a consequence of a change in the direction of the spiracle and the vent tube openings from sinistral to medial during tadpole development. Lavilla & Langone (1991) considered the spiracle, as described and illustrated by Griffiths & Carvalho (1965), to be simply sinistral, without mention the fact that the vent tube and spiracle were fused together in a single tube in the tadpole drawing, differing from those studied by the authors, that open in distinct tubes. These tadpoles are associated with adult forms having an uniform yellow, spotless (immaculated) venter.

Elachistocleis sp. (Figures 8B, 11F)

Specimens examined. 10 tadpoles, stage 37, lots: 486, 487, 488, 489, 490 (Vitória Brasil: 20º11’24" S, 50º28’48" W).

Characteristics. Total length 29.65 ± 1.47 mm (27.2 – 30.5 mm). Body depressed, rounded in dorsal view and triangular/depressed in lateral view. Snout pointed, with a medial depression, in dorsal view and truncate in lateral view. Eyes small, lateral, dorsolaterally directed. Nares absent. Spiracle ventral, medial, long and wide, sinistral, opening dorsally directed, with centripetal wall fused with the vent tube and shorter than the external wall. Vent tube long, medial, fused to the ventral fin, with sinistral opening and ventral wall longer than the dorsal wall. Oral disc without keratinized mouthparts or papillae; paired dermal flap in front of the mouth; dermal flap edges jagged. Dorsal fin low, with convex margin, emerging at the body-tail junction at a low slope; ventral fin low, with a convex margin. Dark brown coloration, with light stripes and blotches between the eye and the snout and ventrally on the body, medial light cream stripe on the vertebral line and, in lateral view, on the anterior third of the tail muscle, fins translucent and slightly pigmented, mottled with marginal dark brown blotches on the anterior third of the dorsal fin and posterior third of the ventral fin.

Comments. Tadpoles of the genera *Elachistocleis*, collected in Vitória Brasil, São Paulo State, Brazil, have the vent tube and spiracle fused according to the drawing for *E. ovalis* published by Griffiths & Carvalho (1965). These tadpoles are associated with adult forms presenting a dark gray, with orange spots (maculated) venter.

Taxonomic key

1 Without nares; spiracle ventral; body rounded in dorsal view; dermal flap in front of the mouth 2

- With nares; spiracle sinistral; body not rounded in dorsal view; mouth without dermal flap 4

2 Single mouth flap; spiracle and vent tube not fused; total length more than 35 mm .... *Dermatonotus muelleri*

- Paired mouth flap; spiracle and vent tube fused; total length less than 31 mm 3

3 Mouth dermal flap not jagged; eyes laterally directed; snout rounded in dorsal view .... *Elachistocleis bicolor*

- Mouth dermal flap jagged; eyes dorsolaterally directed; snout pointed in dorsal view .... *Elachistocleis* sp.

4 Large tadpoles, with total length more than 100 mm; ....*Pseudis paradoxa*

- Tadpoles with total length below 70 mm; 5

5 Oral disc without marginal papillae or labial tooth rows, oral tube present .... *Dendropsophus nanus*

- Oral disc with marginal papillae and labial tooth rows, oral tube absent 6

6 Eyes lateral; body triangular in lateral view 7

- Eyes dorsal; body not triangular in lateral view 11

7 Oral disc anterior; tooth row formula 0/0, 0/1 or 1/2 .... *Dendropsophus minutus*

- Oral disc ventral; tooth row formula not as above 8

8 Tooth row formula 4(1,2,4)/6(1,6); nares opening anterolaterally .... *Trachycephalus venulosus*

- Tooth row formula 2(2)/3(1); nares opening laterally 9

9 Body height one-half the body length; snout rounded in lateral view; jaw sheaths narrow .... *Scinax fuscomarginatus*

- Body height almost two-thirds the body length; snout sloped in lateral view; jaw sheaths wide 10

10 Total length of more than 31 mm; dorsal fin emerging at the eye plane, with a slope of more than 30º; submarginal papillae of unequal size .... *Scinax fuscovarius*

- Total length of more than 28 mm; dorsal fin emerging posteriorly to the eye plane, with a less than 30º slope; submarginal papillae of equal size .... *Scinax similis*

11 Spiracle with centripetal wall not fused to the body wall 12

- Spiracle with centripetal wall totally fused to the body wall or only with distal edge free 14

12 Tooth row formula 2(2)/4; oral disc with three ventral emarginations, with many submarginal papillae; marginal papillae biseriate; nares small, with nares length shorter than one-half the ocular diameter; spiracle wider than longer .... *Hypsiboas lundii*

- Tooth row formula 2(1,2)/3(1); oral disc with two ventral emargination, with one or two submarginal papillae or submarginal papillae absent; nares large, with nares length longer than one-half the ocular diameter; spiracle longer than wider 13

13 Tail muscle wide in dorsal view, more than one-third the body width; margin of dorsal fin convex .... H*ypsiboas albopunctatus*

- Tail muscle narrow in dorsal view, less than one-third the body width; margin of dorsal fin triangular .... *Hypsiboas raniceps*

14 Oral disc with three rows of posterior labial teeth not interrupted 15

- Oral disc with three rows of posterior labial teeth, with at least one row interrupted, or with two rows of posterior labial teeth 17

15 Body oval in dorsal view; caudal fins not pigmented; marginal papillae of oral disc with dorsal and ventral gaps; nares length longer than one-half the ocular diameter .... *Bufo schneideri*

- Body oval-elongated in dorsal view; caudal fins pigmented; marginal papillae of oral disc with dorsal gap only; nares length shorter than one-half the ocular diameter 16

16 Total length more than 53 mm; labial tooth row A-2 not interrupted .... *Leptodactylus ocellatus*

- Total length below 26 mm; labial tooth row A-2 interrupted .... *Leptodactylus podicipinus*

17 Tooth row formula 1/2(1); oral disc not emarginate laterally; tail length almost four-fold longer than body length; vertical white stripes around the snout .... *Leptodactylus labyrinthicus*

- Tooth row formula not as above; oral disc emarginate laterally; tail length up to two-fold the body length; without vertical white stripes around the snout 18

18 Tooth row formula with three posterior labial tooth rows 19

- Tooth row formula with two posterior labial tooth rows 21

19 Oral disc with reduced P-3 labial tooth row, almost one-third the P-2; row of marginal papillae with ventral gap; nares length longer than one-half the ocular diameter; centripetal wall of the spiracle fused to body wall, but with free distal edge .... *Physalaemus cuvieri*

- Oral disc with labial teeth row P-3 not reduced, with almost the same length of the P-2; row of marginal papillae without ventral gap; nares length shorter than one-half the ocular diameter; centripetal wall of the spiracle totally fused to the body wall 20

20 Nares opening directed dorsally; internarial distance shorter than one ocular diameter; body ovoid in dorsal view and globular in lateral view ... *Eupemphix nattereri*

- Nares opening directed laterally; internarial distance longer than an ocular diameter; body oval in dorsal view and depressed in lateral view .... *Leptodactylus fuscus*

21 Nares diameter shorter than one-third the ocular diameter; spiracle with opening directed ventrally; submarginal papillae absent ...... *Physalaemus centralis*

- Nares diameter longer than one-third the ocular diameter; spiracle with opening directed dorsally; submarginal papillae present ....*Physalaemus fuscomaculatus*

Discussion

The northwestern of São Paulo State is one of the most deforested regions from Brazil, as result of agricultural and pasture activities (PROBIO 1998). This condition restricts the majority of habitats available for anuran reproduction to temporary ponds and, together with the pronounced dry season, limits the occurrence of the majority of species to the rainy season (Figure 12). Among the tadpoles found in this region, five from 15 exotrophic ecomorphological guilds revised by McDiarmid & Altig (1999) are represented: benthic, carnivorous, nektonic, macrophagous and suspension feeders (type 1) tadpoles (Table 1). In this manner, considering the extension of the sampled area, the severity of the dry season and the predominance of temporary ponds, the morphological diversity found among tadpoles can be considered great. Even under the influence of these restrictive conditions, the tadpoles explore the different types of available resources in the ponds, using different microhabitats or food resources, or presenting different feeding behaviors (Rossa-Feres et al. 2004). Despite the absence of historical records for the herpetofauna from this region, the occurrence of only five (Table 2) from 39 reproductive modes (Haddad & Prado 2005) can be explained by climate severity and impacts due to extensive land use.

Acknowledgements

We thank Profs. Drs. R.J.F. Feres, S.P. de Carvalho-e-Silva and L. Casatti by the critical review of the manuscript, F.A. Hernandes and A.A. Bispo for the computer software assistance, and R.T. Saito for initial incentive. Research support was provided by Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) grant 01/07944-7 (D.C.R.F.) and by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) grant 3300415-3 (F.N.). All drawings by F.N.

References

ALTIG, R. & MCDIARMID, R.W. 1999a. Diversity: Familial and Generic Characterizations. In Tadpoles. The Biology of Anuran Larvae (R.W. McDiarmid & R. Altig, eds.). University of Chicago Press, Chicago and London, p.295-337.

ALTIG, R. & MCDIARMID, R.W. 1999b. Body Plan: Development and Morphology. In Tadpoles. The Biology of Anuran Larvae (R.W. McDiarmid, & R. Altig, eds.). University of Chicago Press, Chicago and London, p.24-51.

ALVES, A.C.R. & CARVALHO-E-SILVA, S.P. 1999. Descrição da larva de *Scinax similis* (Cochran) com notas comparativas sobre o grupo "ruber" no sudeste do Brasil (Amphibia, Anura, Hylidae). Rev. Bras. Zool. 16(2):507-512.

BARCHA, S.F. & ARID, F.M. 1971. Estudo da evapotranspiração na região norte-ocidental do Estado de São Paulo. Rev. C. Fac. Ciênc. Let. 1:94-122.

BERNARDE, P.S. & KOKUBUM, M.N.C. 1999. Anurofauna do município de Guararapes, Estado de São Paulo, Brasil (Amphibia: Anura). Acta Biol. Leopoldensia 21(1):89-97.

BOKERMANN, W.C.A. 1963. Girinos de anfíbios brasileiros I. (Amphibia: Salientia). Anais Acad. Bras. Ciência 35(3):465-474.

BOKERMANN, W.C.A. 1962. Sobre uma pequena coleção de anfíbios do Brasil Central, com a descrição de uma espécie nova de *Physalaemus*. Rev. Bras. Biol. 22(3):213-219.

BOKERMANN, W.C.A. & SAZIMA, I. 1973. Anfíbios da Serra do Cipó, Minas Gerais, Brasil. 1 – Espécies novas de "*Hyla*" (Anura, Hylidae). Rev. Bras. Biol. 33(3):329-336.

BRANDÃO, R.A. & ARAÚJO, A.F.B. 1998. Herpetofauna da estação ecológica de águas emendadas. In Vertebrados da Estação Ecológica de Águas Emendadas (J. Marinho-Filho, F. Rodrigues & M. Guimarães, eds.). Governo do Distrito Federal, Brasília, p.9-18.

CAIS, A. 1992. Aspectos biológicos e status taxonômico de *Hyla biobeba* Bokermann & Sazima, 1973 (Amphibia - Anura). Tese de Doutorado, UNESP, Rio Claro.

CEI, J.M. 1980. Amphibians of Argentina. Monit. Zool. Ital. N.S.:1-609.

DE SÁ, R.O. 1995. *Hyla albopunctata*. Catal. Am. Amphib. Rept. 602:1-5.

DUELLMAN, W.E. 1970. The hylids frogs of Middle America. Monog. Mus. Nat. Hist. 1:1-753.

DUELLMAN, W.E. 1978. The biology of an Equatorial Herpetofauna in Amazonian Ecuador. Misc. Publ. 65:1-352.

DUELLMAN, W.E. 1997. Amphibians of La Escalera Region, southeastern Venezuela: Taxonomy, Ecology, and Biogeography. Scient. Papers. 2:1-52.

FAIVOVICH, J., HADDAD, C.F.B., GARCIA, P.C.A., FROST, D.R., CAMPBELL, J.A. & WHEELER, W.C. 2005. Systematic review of the frog family Hylidae, with special reference to Hylinae: Phylogenetic analysis and taxonomic revision. Bull. Am. Mus. Nat. Hist. 294:1-240.

FERNANDEZ, K. & FERNANDEZ, M. 1921. Algunos batracios argentinos. I. Cystignathidae. Imprenta y Casa editora "Coni", Buenos Aires.

FROST, D.R. 2004. Amphibian Species of the World: an Online Reference. Version 3.0. American Museum of Natural History, New York, New York. http://research.amnh.org/herpetology/amphibia (accessed 23 November 2004).

GOSNER, K.L. 1960. A simplified table for staging anuran embryos and larvae. Herpetol. 16:183-190.

GRIFFITHS, I. & CARVALHO, A.L. 1965. On the validity of employing larval characters as major phyletic índices in Amphibia, Salientia. Rev. Bras. Biol. 25(2):115-121.

HADDAD, C.F.B. 1998. Biodiversidade dos anfíbios no Estado de São Paulo. In Biodiversidade do Estado de São Paulo, Brasil: síntese do conhecimento ao final do século XX. 6: Vertebrados (C.A. Joly & C.E.M. Bicudo, org.). FAPESP, São Paulo, p. 15-26.

HADDAD, C.F.B. & PRADO, C.P.A. 2005. Reproductive modes in frogs and their unexpected diversity in the Atlantic Forest of Brazil. Bioscience 55(3):207-217.

HADDAD, C.F.B. & SAZIMA, I. 1992. Anfíbios anuros da Serra do Japi. In História Natural da Serra do Japi (L.P.C. Morellato, org.). Editora da UNICAMP/FAPESP, Campinas, v.3, p:188-211.

HEYER, W.R., RAND, A.S., CRUZ, C.A.G., PEIXOTO, O.L. & NELSON, C.E. 1990. Frogs of Boracéia. Arq. Zool. 31(4):231-410.

KENNY, J.S. 1969. The amphibia of Trinidad. Stud. Fauna Cur. Carib. Is. 108(29):66-70.

LAVILLA, E.O. 1990. The tadpole of *Hyla nana* (Anura: Hylidae). J. Herpetol. 24(2):207-209.

LAVILLA, E.O. 1992. The tadpole of *Dermatonotus muelleri* (Anura: Microhylidae). Mus. Reg. Sci. Nat. Boll. 10(1):63-71.

LAVILLA, E.O. & LANGONE, J.A. 1991. Ontogenic changes in spiracular and proctodeal tube orientation in *Elachistocleis bicolor* (Anura: Microhylidae). J. Herpetol. 25(1):119-121.

LAVILLA, E.O., VAIRA, M. & FERRARI, L. 2003. A new species of *Elachistocleis* from the Andean Yungas of Argentina, with comments on the *Elachistocleis ovalis-E. bicolor* controversy. Amphibia-Reptilia 24:269-284.

LESCURE, J. 1973. Contribution a l´étude des amphibians de Guyane Française. II. *Leptodactylus fuscus* (Schneider) observation écologiques et éthologiques. Annales Mus. Hist. Nat. Nice 1:91-100.

LIPS, K.R. & SAVAGE, J.M. 1996. Key to known Tadpoles (Amphibia: Anura) of Costa Rica. Stud. Neotrop. Fauna Envir. 31:17-26.

MCDIARMID, R.W. & ALTIG, R. 1999. Research: Materials and Techniques. In Tadpoles. The Biology of Anuran Larvae (R.W. McDiarmid & R. Altig, eds.). University of Chicago Press, Chicago and London, p.7-23.

MIRANDA-RIBEIRO, A. 1926. Notas para servirem ao estudo dos Gymnobatrachios (Anura) brasileiros. Arq. Mus. Nac. 27:201-305.

NASCIMENTO, L.B., CARAMASCHI, U. & CRUZ, C.A.G. 2005. Taxonomic review of the species groups of the genus *Physalaemus* Fitzinger, 1826 with revalidation of the genera *Engystomops* Jiménez-de-La-Espada, 1872 and *Eupemphix* Steindachner, 1863 (Amphibia, Anura, Leptodactylidae). Arq. Mus. Nac. 63(2):297-320.

NOMURA, F., ROSSA-FERES, D.C. & PRADO, V.H. 2003. The tadpole of *Physalaemus fuscomaculatus* (Anura: Leptodactylidae) with a description of internal oral morphology. Zootaxa 370:1-8.

ORTON, G.L. 1953. The systematics of vertebrate larvae. Syst. Zool. 2:63-75.

PROBIO. 1998. Áreas de domínio do cerrado no Estado de São Paulo. Imprensa Oficial, São Paulo.

RADA DE MARTINEZ, D. 1981. Renacuajos de algunos anfíbios de Clarines (Edo. Anzoategui, Venezuela). Mem. Soc. C. Nat. Salle 41(115):58-75.

ROSA, C.N. 1965. Sistemática e biologia de alguns girinos do Estado de São Paulo. Bol. PUC SP – Zool. 25:467-487.

ROSSA-FERES, D.C. & JIM, J. (1993) Tadpole of *Physalaemus centralis* (Anura, Leptodactylidae). Copeia 2:566-569.

ROSSA-FERES, D.C. & JIM, J. 2001. Similaridade no sítio de vocalização em uma comunidade de anfíbios anuros na região noroeste do Estado de São Paulo, Brasil. Rev. Bras. Zool. 18(2):439-454.

ROSSA-FERES, D.C.; JIM, J. & FONSECA, M.G. 2004. Diets of tadpoles from a temporary pond in southeastern Brazil (Amphibia, Anura). Rev. Bras. Zool. 21(4):745-754.

VIZOTTO, L.D. 1967. Desenvolvimento de anuros da região norte-ocidental do Estado de São Paulo. Tipografia Rio Preto, São José do Rio Preto.

Title: Characterization and taxonomic key for tadpoles (Amphibia: Anura) from the northwestern region of São Paulo State, Brazil.[1]

Authors: Denise de Cerqueira Rossa-Feres & Fausto Nomura

Biota Neotropica, Vol. 6 (number 1): 2006
http://www.biotaneotropica.org.br/v6n1/pt/abstract?identification-key+bn00706012006

Date Received 05/15/2005 - Revised 10/10/2005
Accepted 01/01/2006

ISSN 1676-0611

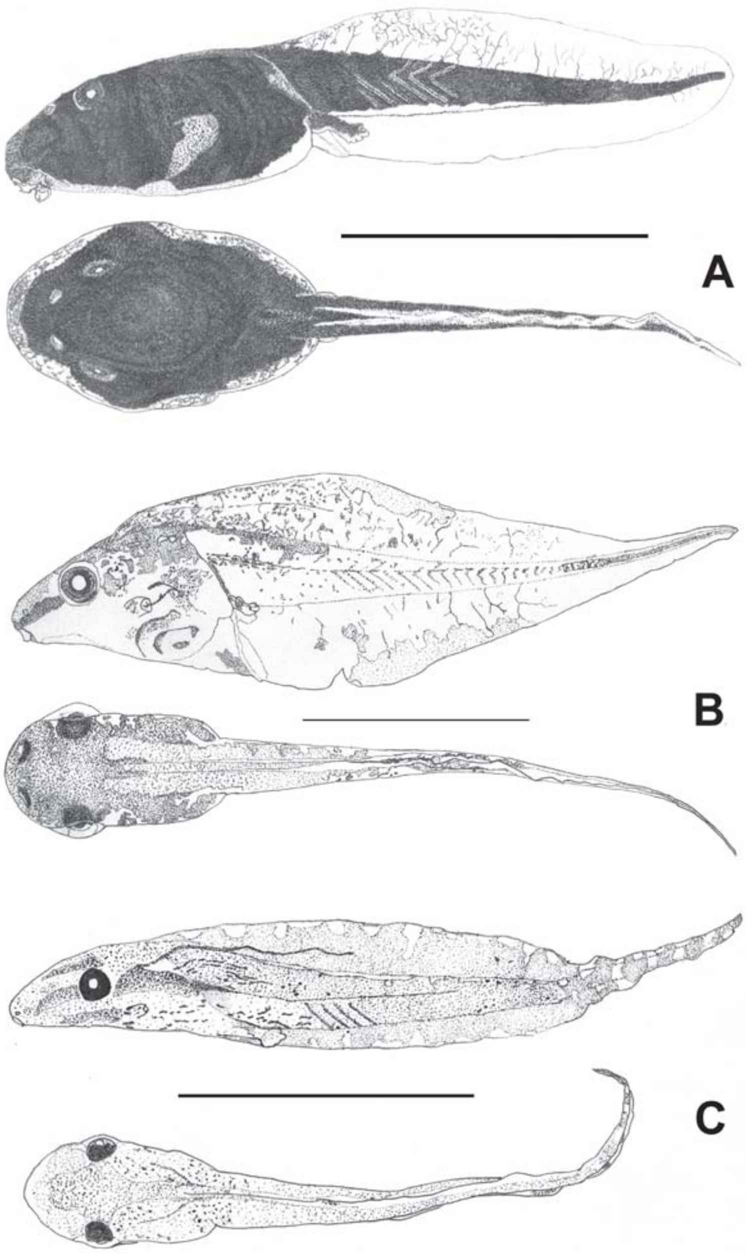


Figure 1. Tadpoles' lateral and dorsal view of: A) Bufo schneideri, B) Dendropsophus minutus, and C) D. nanus. Scale = 10 mm.

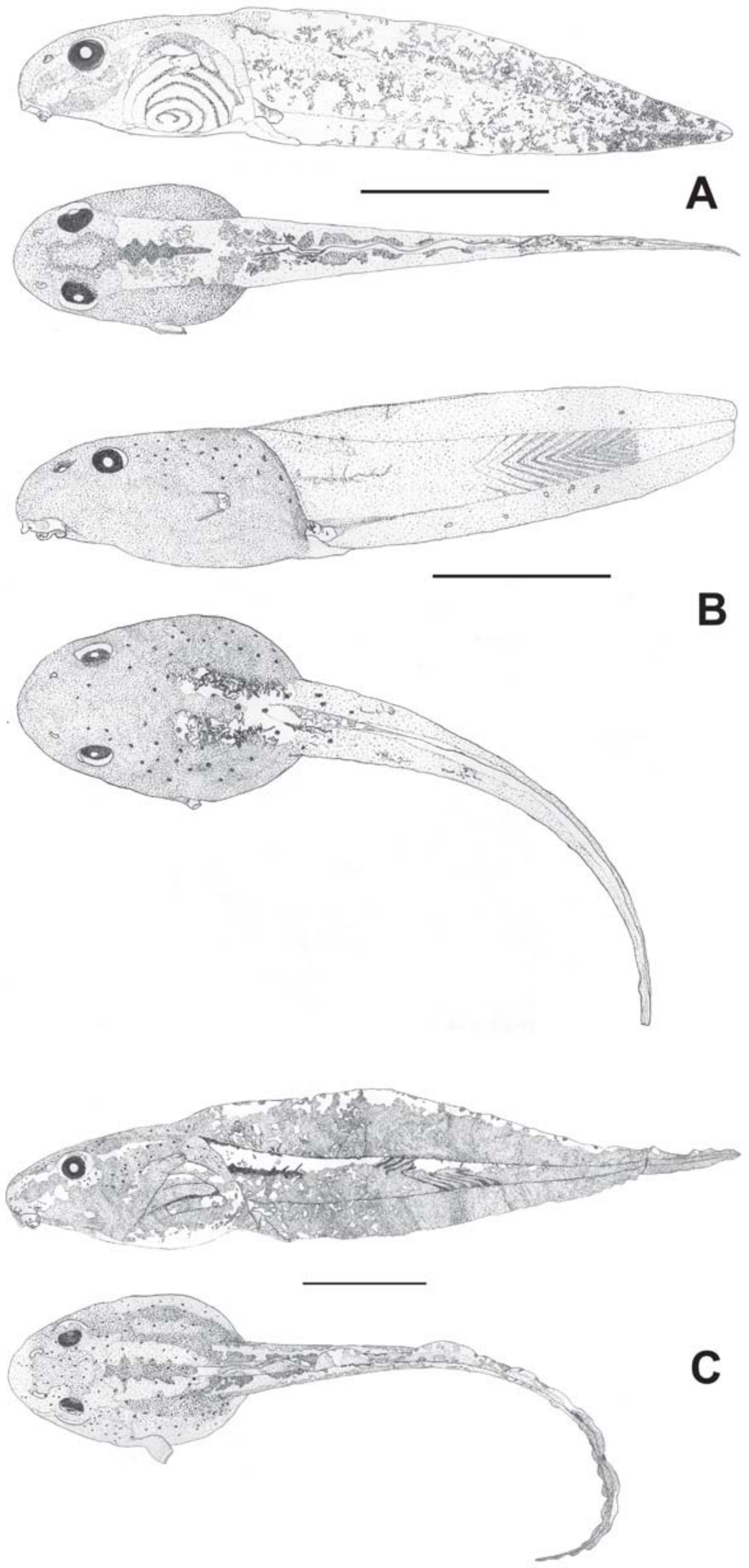


Figure 2. Tadpoles' lateral and dorsal view of: A) Hypsiboas albopunctatus, B) H. lundii, and C) H. raniceps. Scale = 10 mm.

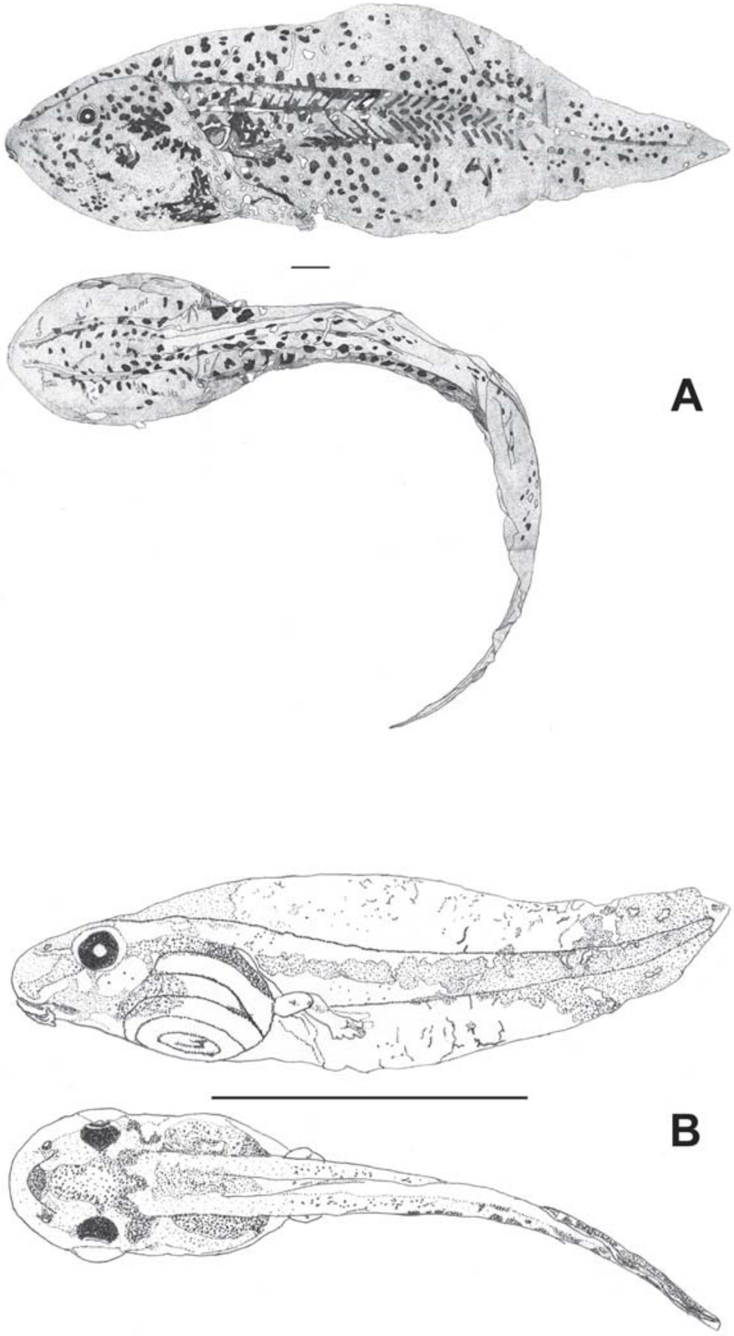


Figure 3. Tadpoles' lateral and dorsal view of: A) Pseudis paradoxa and B) Scinax fuscomarginatus. Scale = 10 mm.

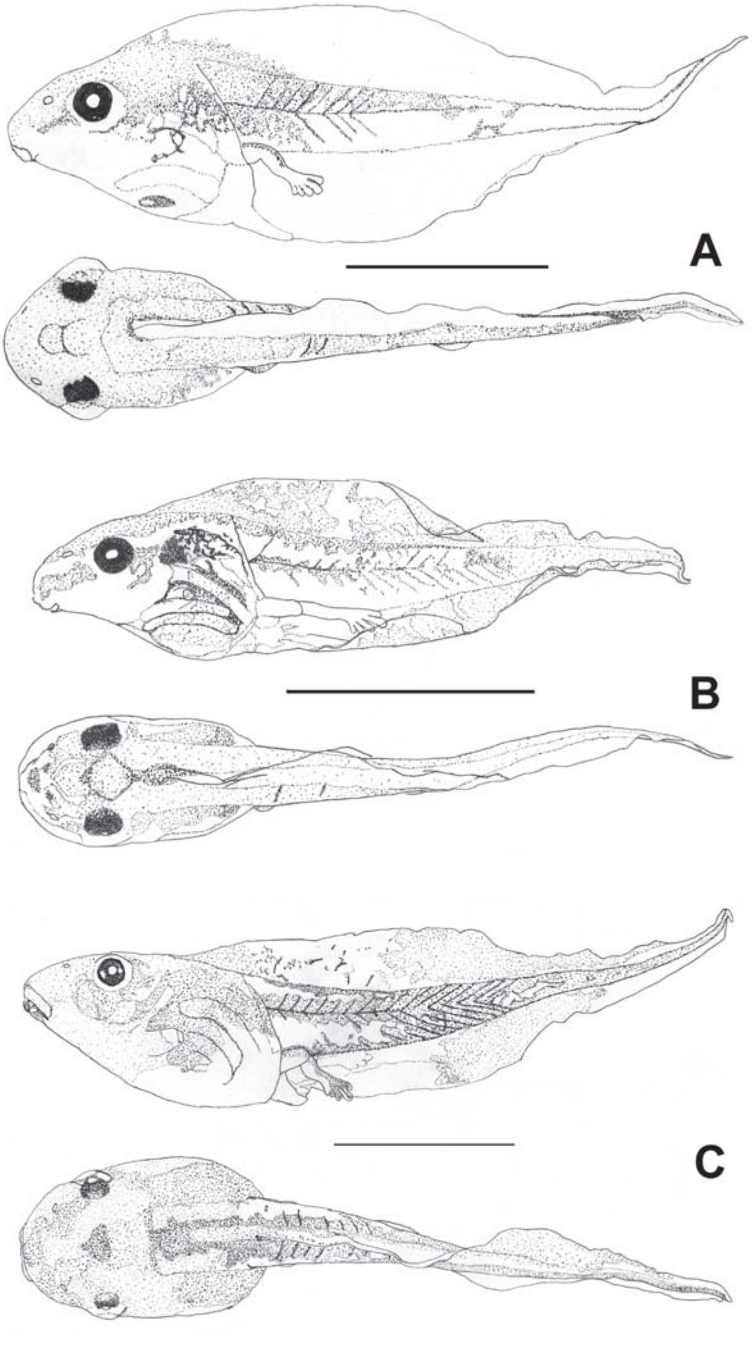


Figure 4. Tadpoles' lateral and dorsal view of: A) Scinax fuscovarius, B) S. similis, and C) Trachycephalus venulosus. Scale = 10 mm.

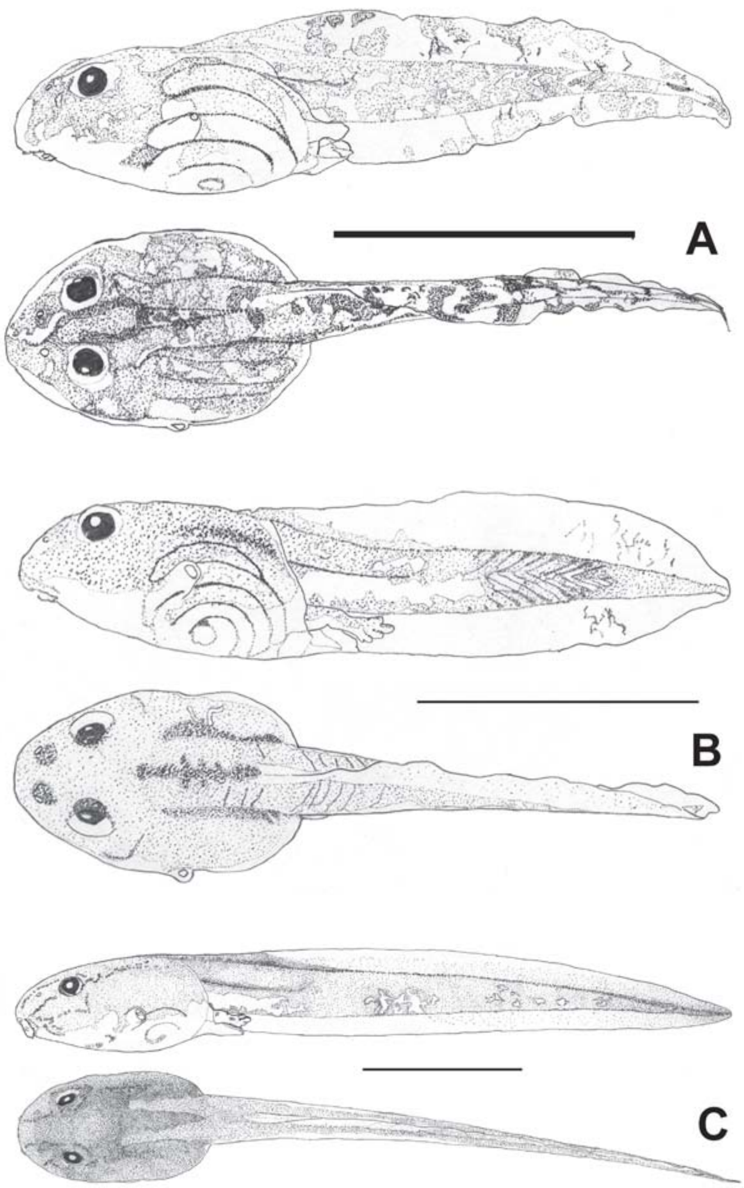


Figure 5. Tadpoles' lateral and dorsal view of: A) Eupemphix nattereri, B) Leptodactylus fuscus, and C) L. labyrinthicus. Scale = 10 mm.

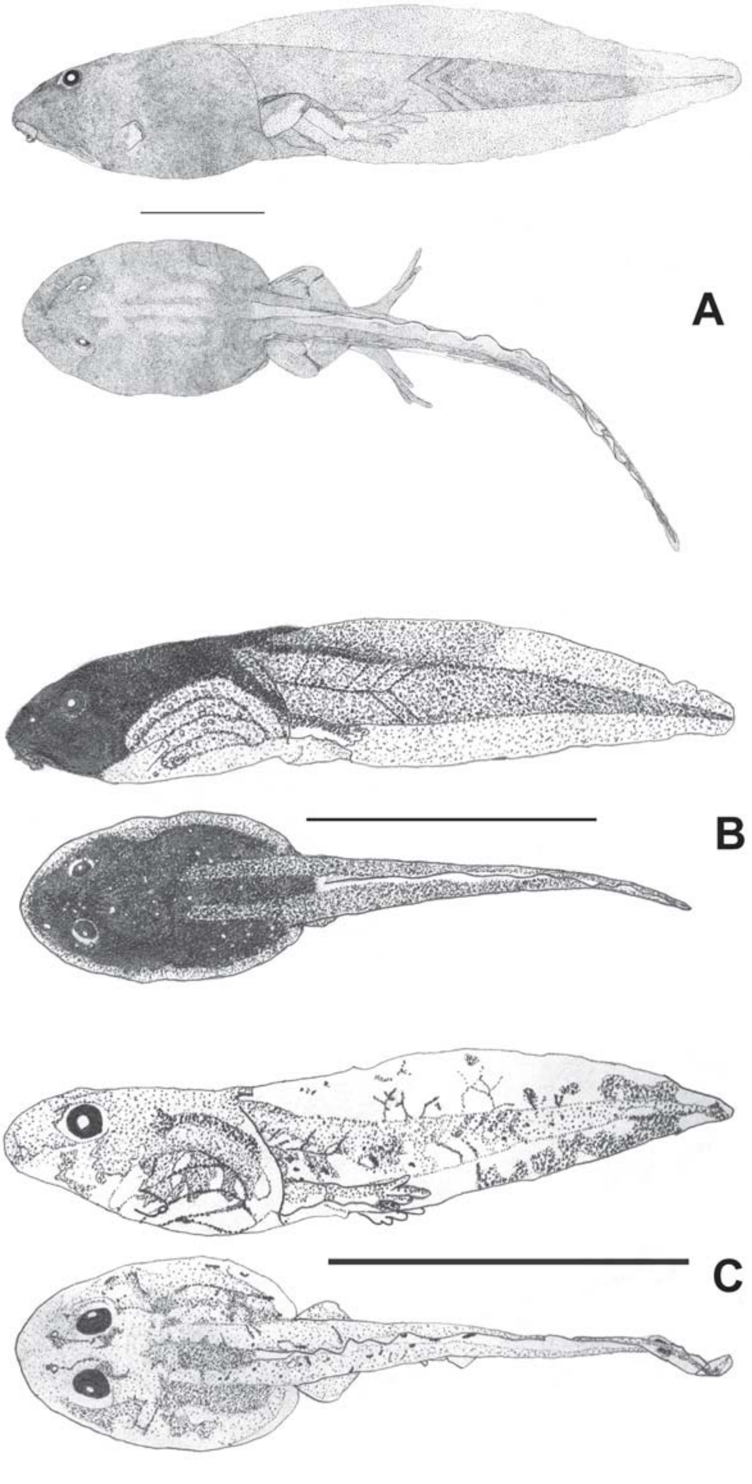


Figure 6. Tadpoles' lateral and dorsal view of: A) Leptodactylus ocellatus, B) L. podicipinus, and C) Physalaemus centralis. Scale = 10 mm.

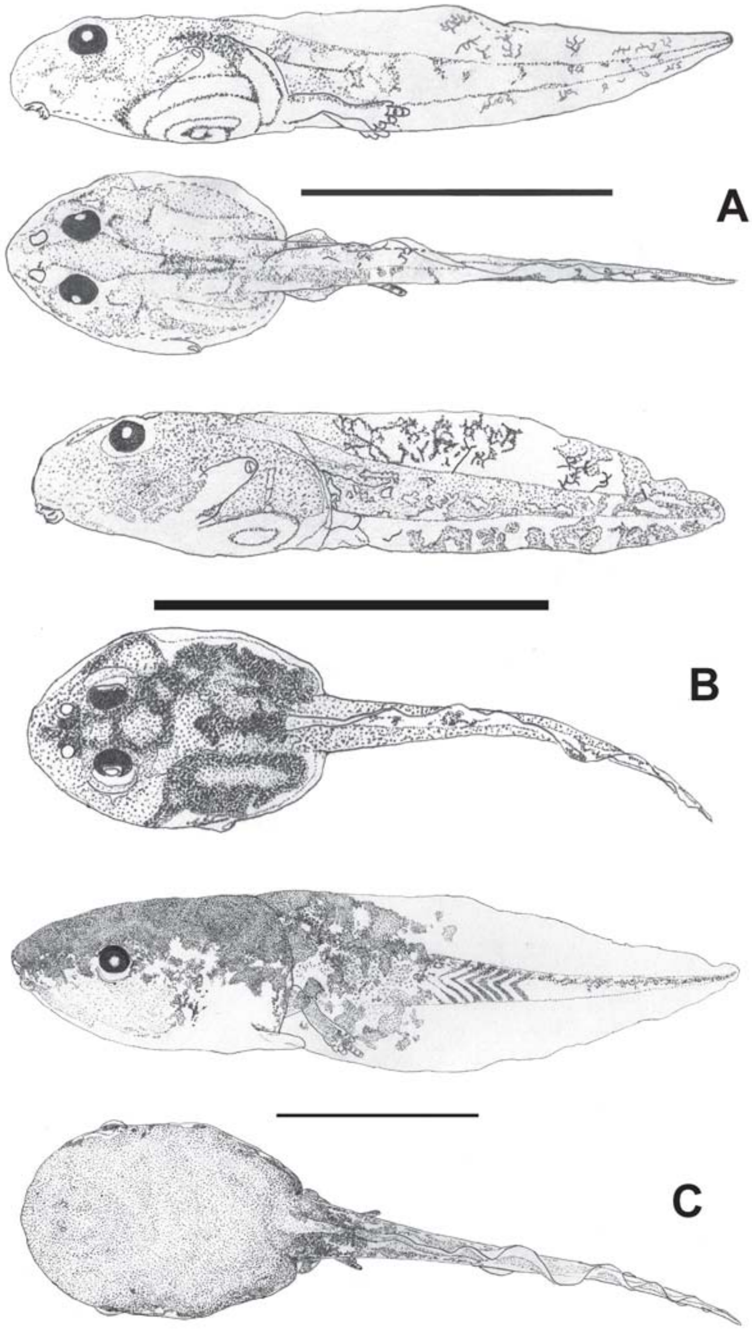


Figure 7. Tadpoles' lateral and dorsal view of: A) Physalaemus cuvieri, B) P. fuscomaculatus, and C) Dermatonotus muelleri. Scale = 10 mm.

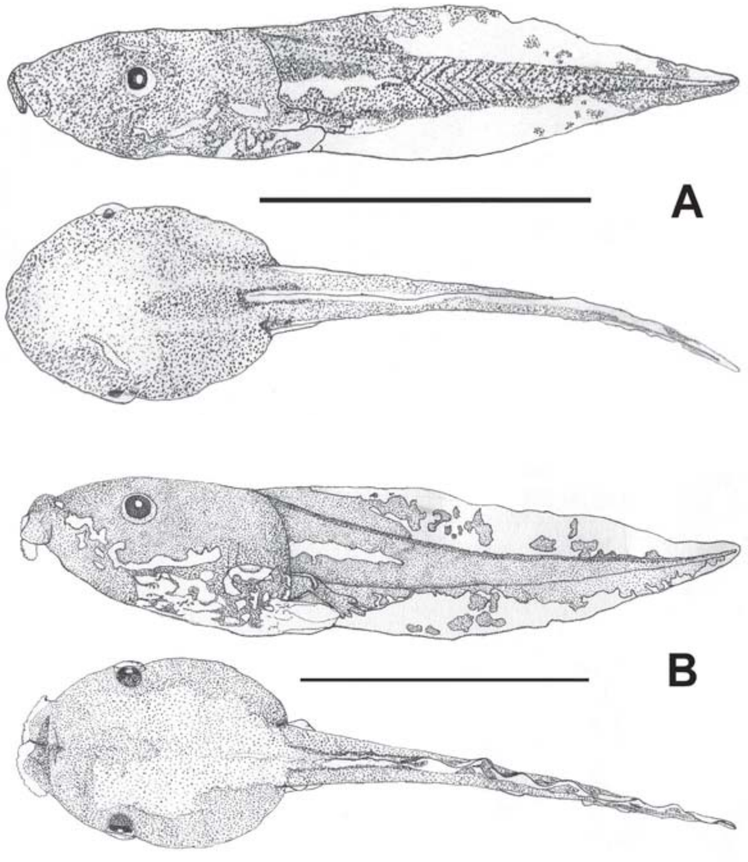


Figure 8. Tadpoles' lateral and dorsal view of: A) Elachistocleis bicolor, and B) Elachistocleis sp. Scale = 10 mm.

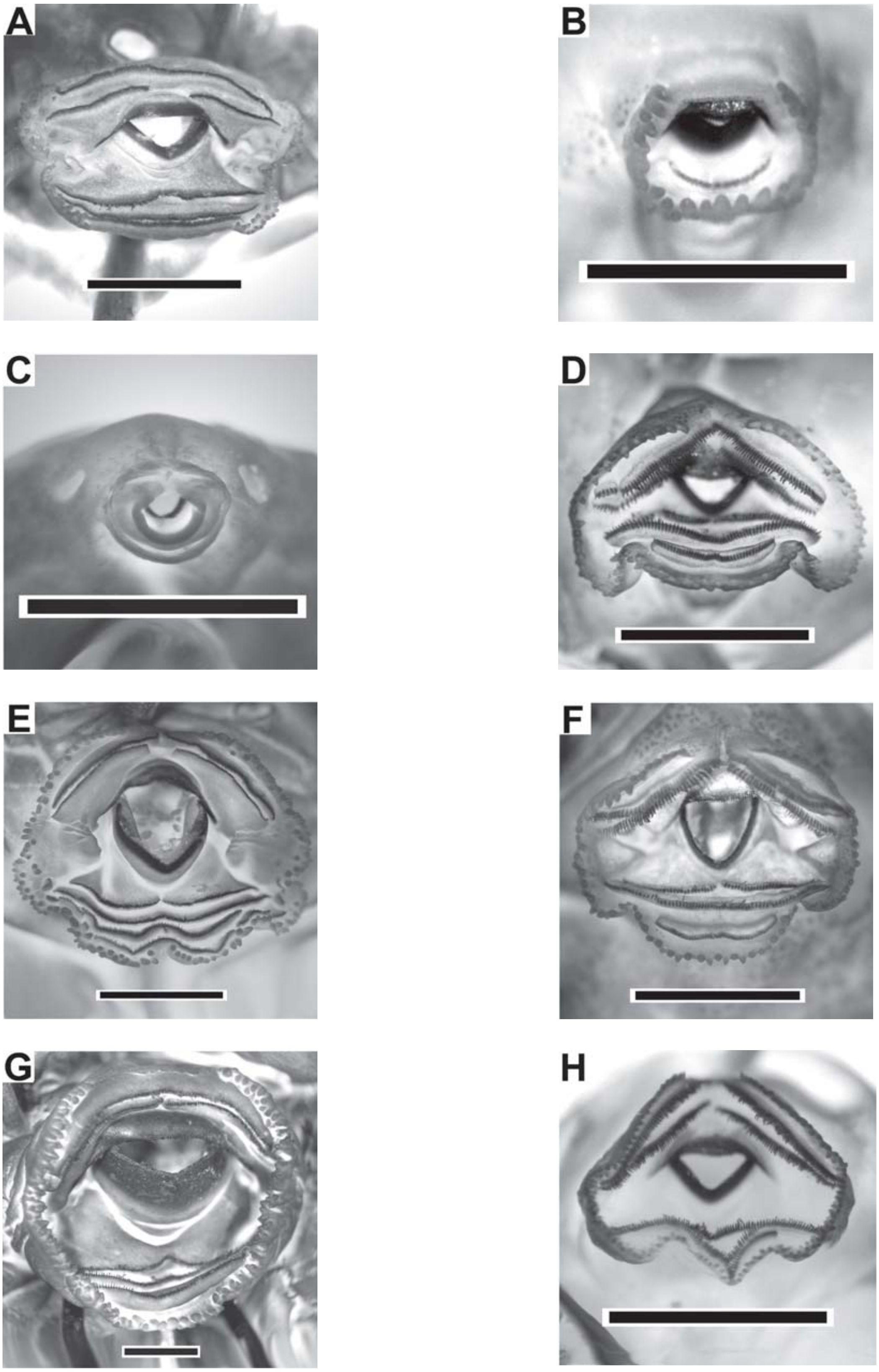


Figure 9. Tadpoles' oral apparatus of: A) Bufo schneideri, B) Dendropsophus minutus, C) D. nanus, D) Hypsiboas albopunctatus, E) H. lundii, F) H. raniceps, G) Pseudis paradoxa, and H) Scinax fuscomarginatus. Scale = 1 mm.

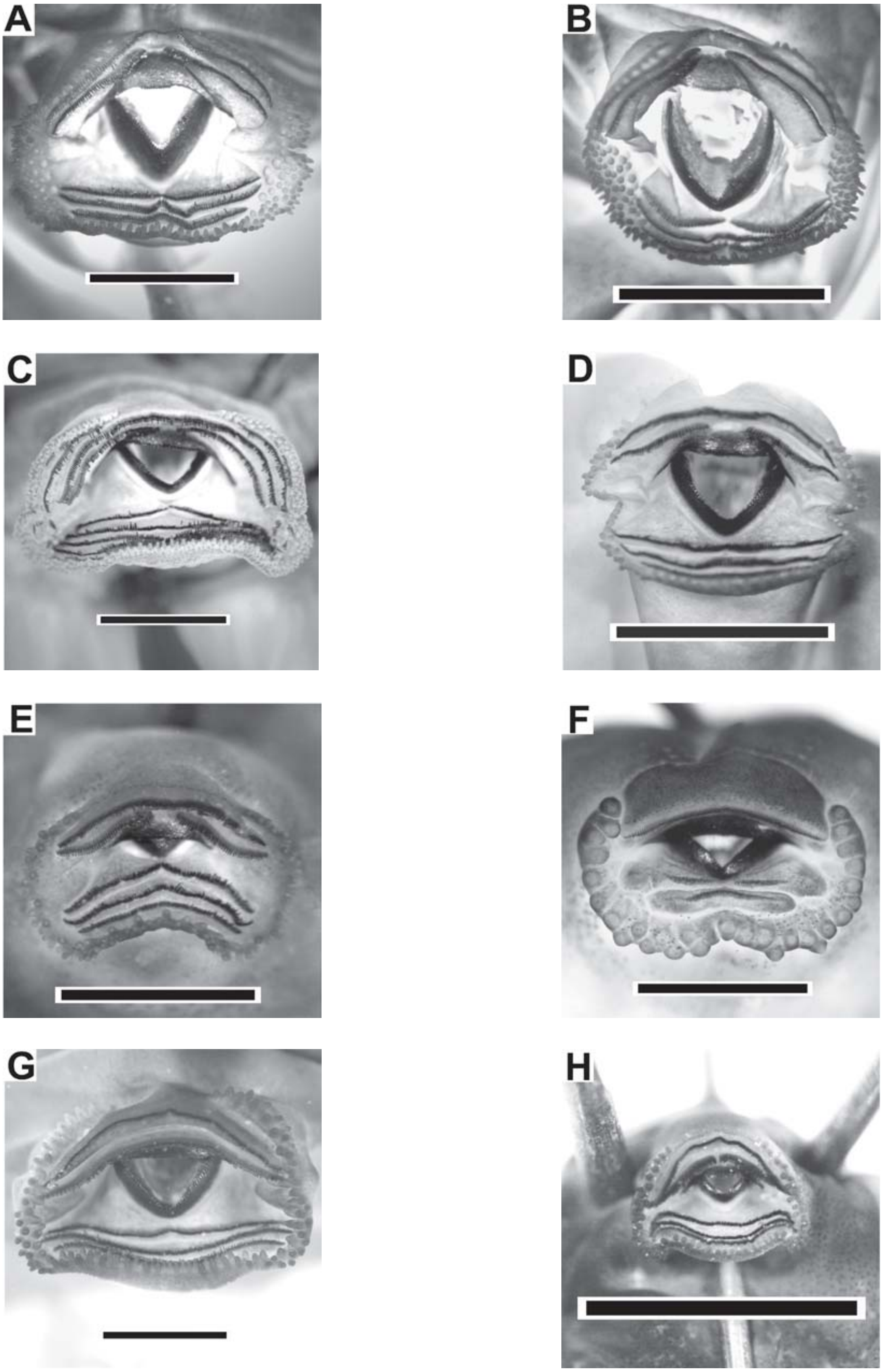


Figure 10. Tadpoles' oral apparatus of: A) S. fuscovarius, B) S. similis, C) Trachycephalus venulosus, D) Eupemphix nattereri, E) Leptodactylus fuscus, F) L. labyrinthicus, G) L. ocellatus and H) L. podicipinus. Scale = 1 mm.

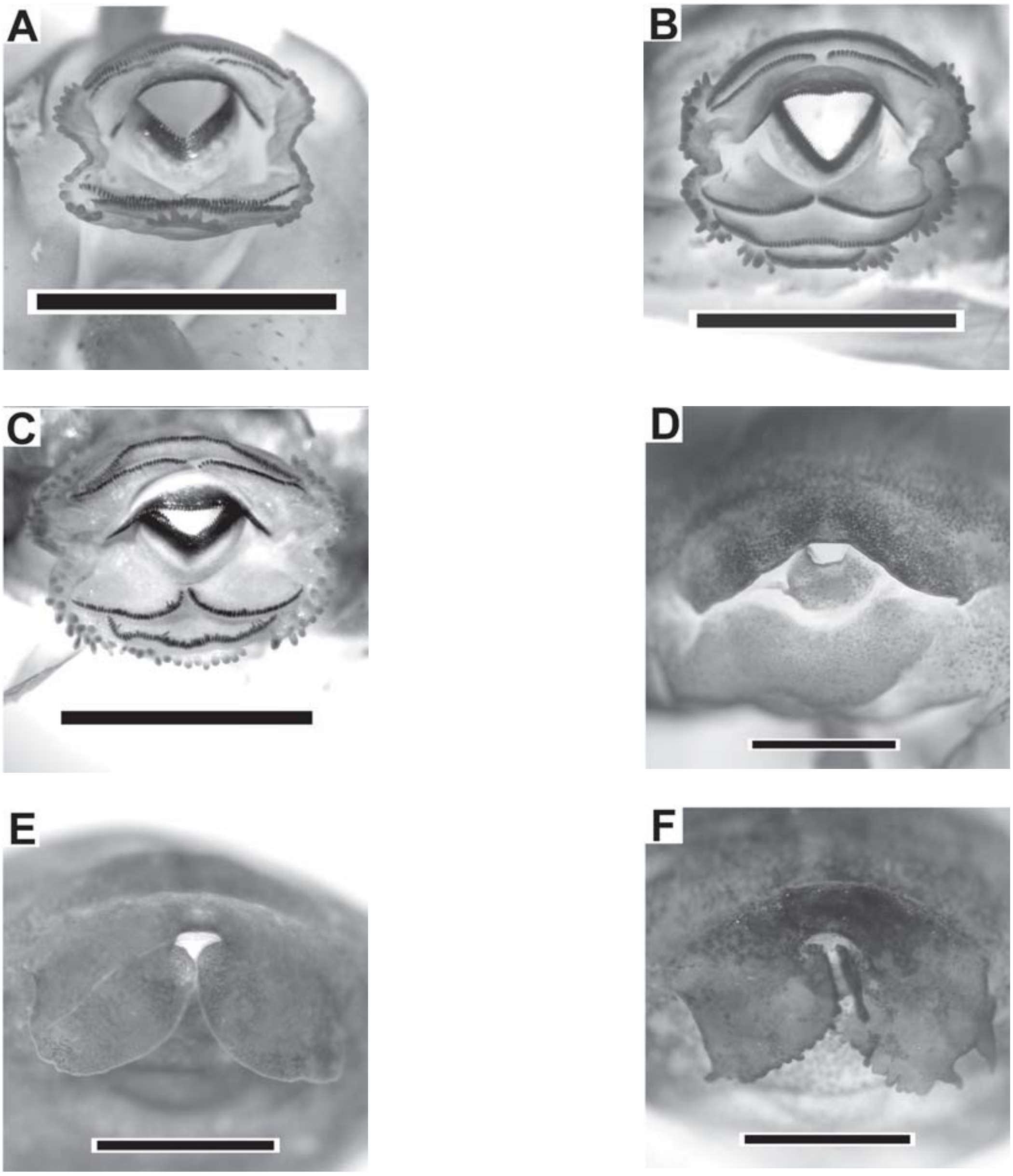


Figure 11. Tadpoles' oral apparatus of: A) Physalaemus centralis, B) P. cuvieri, C) P. fuscomaculatus, D) Dermatonotus muelleri, E) Elachistocleis bicolor, and F) Elachistocleis sp. Scale = 1 mm.

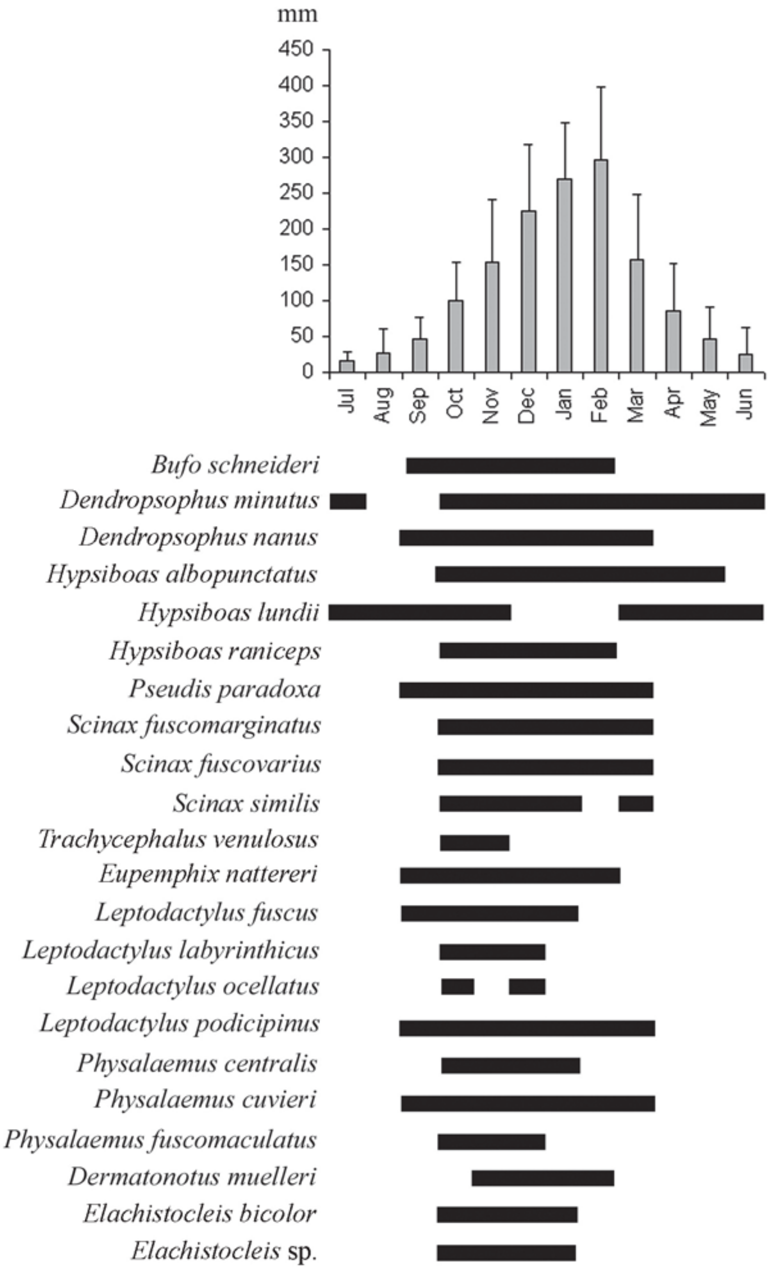


Figure 12. Temporal distribution of 22 anuran species from the northwestern region of São Paulo State, Brazil. The histogram represents mean pluviometric precipitation (n = 11 years) of three localities (Jales, Nova Aliança and São José do Rio Preto). Vertical bar = standard deviation. Source of pluviometric data: Embrapa Uva e Vinho (Jales) and Coordenadoria de Assistência Técnica Integral - CATI (São José do Rio Preto). Temporal distribution of Hypsiboas lundii according to Cais (1992).

Table 1. Ecomorphological guilds, according McDiarmid & Altig (1999), recorded for 22 known tadpoles from northwestern region of São Paulo state, Brazil. *according Rossa-Feres et al. (2004).

Ecomorphological guild	**Species**
Benthic	*Hypsiboas albopunctatus*
	H. lundii
	H. raniceps
	Eupemphix nattereri
	Leptodactylus fuscus
	L. ocellatus
	L. podicipinus
	Physalaemus centralis
	P. cuvieri
	P. fuscomaculatus
Nektonic	*Dendropsophus minutus*
	Pseudis paradoxa
	Scinax fuscomarginatus
	S. fuscovarius
	S. similis
	Trachycephalus venulosus
Carnivorous	*Leptodactylus labyrinthicus*
Macrophagous	*Dendropsophus nanus*
Suspension feeder (Type 1)	*Dermatonotus muelleri*
	Elachistocleis bicolor
	Elachistocleis sp.
Benthic and neustonic*	*Bufo schneideri*

Table 2. Reproductive modes recorded for anurans from northwestern region of São Paulo State, Brazil (according Haddad & Prado, 2002).

Mode	**Family**	**Species in the region**
AQUATICS EGGS		
Eggs deposited in water		
Mode 1: Eggs and exotrophic tadpoles in lentic water.	Hylidae	*Dendropsophus minutus*
		D. nanus
		Hypsiboas albopunctatus
		H. raniceps
		Pseudis paradoxa
		Scinax fuscomarginatus
		Scinax fuscovarius
		Scinax similis
		Trachycephalus venulosus
		Dermatonotus muelleri
	Microhylidae	*Elachistocleis bicolor*
		Elachistocleis sp.
	Bufonidae	*Bufo schneideri*
Mode 4: Eggs and hatchlings in constructed basins.	Hylidae	*Hypsiboas lundii*
Eggs in foam nests (aquatic).		
Mode 11: Foam nests on pond; exotrophic tadpoles in pond.	Leptodactylidae	*Eupemphix nattereri*
		Leptodactylus ocellatus
		Physalaemus centralis
		Physalaemus cuvieri
		Physalaemus fuscomaculatus
Mode 13: Foam nest in water-filled basins adjacent to water.	Leptodactylidae	*Leptodactylus labyrinthicus*
		L. podicipinus
TERRESTRIAL OR ARBOREAL EGGS		
Eggs on ground, on rocks, or in burrows		
Mode 17: Eggs and hatchlings in excavated nests; exotrophic tadpoles in ponds.	Leptodactylidae	*Leptodactylus fuscus*

Estrutura de comunidades de aves em áreas de cerrado da região nordeste do Estado de São Paulo

Maria Elisa de Castro Almeida

Resumo

Considerando que o Cerrado é um dos ecossistemas mais ameaçados e que a Estação Ecológica de Jataí abrange uma das maiores áreas deste bioma no Estado de São Paulo, este trabalho teve dois objetivos: caracterizar a estrutura das comunidades de aves da Estação Ecológica de Jataí e entorno, e criar um banco de dados geo-referenciados da avifauna local. Foram estudadas quatro áreas, caracterizadas por mata ciliar e cerradão, localizadas no município de Luiz Antônio (SP): Estação Ecológica de Jataí e Experimental de Luiz Antônio (EEJ/EELA), Oitocentos Alqueires (OIT), fragmento da Fazenda Umuarama (UMU) e fragmento da Fazenda Nossa Senhora da Aparecida (NSA). Através de levantamentos qualitativo e quantitativo foram registradas 211 espécies na EEJ/EELA, 55 espécies no OIT, 41 na UMU e 62 na NSA. Quanto à diversidade de espécies, a EEJ/EELA apresentou índice de 3,81; no OIT o índice de diversidade encontrado foi 3,31, e nos fragmentos os índices obtidos foram 3,63 (UMU) e 3,45 (NSA). Em relação ao IPA, dentre as espécies menos abundantes encontradas nas quatro áreas estão pequenos frugívoros e nectarívoros, representados principalmente pelas famílias Thraupidae e Trochilidae, e insetívoros, representados pelas famílias Picidae e Dendrocolaptidae. Apesar da baixa densidade destas espécies, a presença de alguns frugívoros como *Penelope superciliaris* e *Trogon surrucura* pode indicar que a área de estudo ainda está relativamente bem conservada. Algumas espécies foram consideradas como de Interesse Especial para a Conservação (IECO), recomendando-se estudos futuros voltados à abundância e densidade de suas populações, deslocamentos, genética e comportamento. Salienta-se, ainda, a necessidade de um monitoramento e acompanhamento destas espécies ao longo dos anos, através de observações regulares e censos populacionais anuais.Todas as informações obtidas através dos levantamentos realizados na pesquisa foram utilizadas para a construção do Banco de Dados Geo-referenciados Jataí-Aves (BD-JATAÍ-AVES). Com esta ferramenta foi possível: relacionar as diferentes espécies e seus ambientes; determinar as espécies ameaçadas e de Interesse Especial para a Conservação; elaborar mapas com a localização das espécies; e definir propostas para a conservação da avifauna local. O BD-JATAÍ-AVES é um repositório aberto, no qual novas informações sobre a avifauna das áreas estudadas poderão ser acrescentadas progressivamente, contribuindo assim para a elaboração de critérios que subsidiem a tomada de decisões de manejo, visando conservar a biodiversidade. O banco de dados poderá, ainda, auxiliar a produção de materiais de divulgação e educação ambiental.

Palavras-chave: aves, unidades de conservação, sistema de informação geográfica, estrutura de comunidades

FICHA CATALOGRÁFICA

Almeida, Maria Elisa de Castro.

A447ae
Estrutura de comunidades de aves em áreas de cerrado da região nordeste do Estado de São Paulo / Maria Elisa de Castro Almeida . -- São Carlos : UFSCar, 2003.
134 p.
Tese (Doutorado) -- Universidade Federal de São Carlos,

2002.
1. Aves. 2. Unidades de conservação. 3. Sistema de Informação Geográfica. 4. Estrutura de comunidades.
I. Título.

CDD: 598 (20a)

Key to the genera of Ephemerelloidea (Insecta: Ephemeroptera) from Brazil

Lucimar G. Dias[1,2], Frederico F. Salles[1,2], Cesar N. Francischetti[1,2] & Paulo Sérgio F. Ferreira[1]

Biota Neotropica v6 (n1) – http://www.biotaneotropica.org.br/v6n1/pt/abstract?identification-key+bn00806012006

Date Received 04/01/2005
Revised 11/22/2005
Accepted 01/01/2006

1 Museu de Entomologia, Departamento de Biologia Animal, Universidade Federal de Viçosa, 36571-000 Viçosa, MG, Brazil. (lucimar@insecta.ufv.br) (ffsalles@insecta.ufv.br) (cnfrancischetti@hotmail.com) (pfiuza@ufv.br)
2 Programa de Pós-Graduação em Entomologia, Departamento de Biologia Animal, Universidade Federal de Viçosa, 36571-000 Viçosa, MG, Brazil

Abstract

Dias, L. G.; Salles, F. F.; Francischetti, C. N.; & Ferreira, P. S. F. **Key to the genera of Ephemerelloidea (Insecta: Ephemeroptera) from Brazil**. *Biota Neotrop*. Jan/Abr 2006, vol. 6, no. 1 http://www.biotaneotropica.org.br/v6n1/pt/abstract?identification-key+bn00806012006. ISSN 1676-0611

A key to the Brazilian genera of Ephemerelloidea, nymphs and adults, belonging to the families Coryphoridae, Leptohyphidae and Melanemerellidae is presented. Currently, seven genera of this superfamily are known in Brazil. The Leptohyphidae is the most representative family, with five genera registered from the country, *Leptohyphes* Eaton, 1882, *Leptohyphodes* Ulmer, 1920, *Traverhyphes* Molineri, 2001, *Tricorythodes* Ulmer, 1920 and *Tricorythopsis* Traver, 1958. The families Coryphoridae and Melanemerellidae are monotypic, represented by *Coryphorus* Peters, 1981and *Melanemerella* Ulmer, 1920.

Key words: *Ephemerelloidea, nymphs, adults, illustrated key, Brazil.*

Resumo

Dias, L. G.; Salles, F. F.; Francischetti, C. N.; & Ferreira, P. S. F. **Chave para os gêneros de Ephemerelloidea (Insecta: Ephemeroptera) do Brasil**. *Biota Neotrop*. Jan/Abr 2006, vol. 6, no. 1 http://www.biotaneotropica.org.br/v6n1/pt/abstract?identification-key+bn00806012006. ISSN 1676-0611

Neste trabalho é apresentada uma chave para identificação dos gêneros brasileiros de Ephemerelloidea, ninfas e adultos, pertencentes às famílias Coryphoridae, Leptohyphidae e Melanemerellidae. Atualmente, sete gêneros desta superfamília são conhecidos no Brasil. Leptohyphidae é a família mais representativa, com cinco gêneros registrados para o país, *Leptohyphes* Eaton, 1882, *Leptohyphodes* Ulmer, 1920, *Traverhyphes* Molineri, 2001, *Tricorythodes* Ulmer, 1920 and *Tricorythopsis* Traver, 1958. Coryphoridae e Melanemerellidae são monotípicas, representadas por *Coryphorus* Peters, 1981e *Melanemerella* Ulmer, 1920.

Palavras-chave: *Ephemerelloidea, ninfas, adultos, chave ilustrada, Brasil*

Introduction

The superfamily Ephemerelloidea (Ephemeroptera) is a cosmopolitan and very basal group of mayflies (McCafferty & Wang 2000). Together with the superfamily Caenoidea, the Ephemerelloidea are inserted in the suborder Pannota, a group where the mature nymphs have less than half of their forewingpads freely extended beyond their fusion, although the wingpads remain externally recognizable as do the pro- and mesothoracic mesothoracic segments (McCafferty and Edmunds 1979, McCafferty & Wang 2000).

Other representative of Pannota in South America, besides Ephemerelloidea, is the family Caenidae. Despite the similarity between both groups having operculate gills on segment 2, nymphs of South American Ephemerelloidea can be distinguished from those of Caenidae by the absence of filamentous gills 1. The adults of Ephemerelloidea can be differentiated by lacking an ommation on the mesonotum, the vein MP2 of the forewings not extending to the base and not curving from near the base of MP1, and by the vein CuP strongly curved to the inner margin of the wing (McCafferty & Wang 2000).

Of the three families, eleven genera and 70 species of the superfamily Ephemerelloidea represented in South America (Dominguez et al. 2004, Emmerich 2004), all families, seven genera, and 20 species are registered from Brazil (Molineri 2004, Salles et al. 2004). Coryphoridae and Melanemerellidae are represented by one species, each, whereas Leptohyphidae is the most diverse, with five genera and 18 species (Molineri 2004, Salles et al. 2004).

Coryphoridae, represented only by *Coryphorus aquilus* Peters, 1981, is known in Brazil from the states of Amazonas and Pará, Northern Region. *C. aquilus* Peters, 1981, is also recorded from Colombia (Peters 1981, Molineri et al. 2002) and French Guiana (Orth et al. 2000).

Melanemerellidae is represented by *Melanemerella brasiliana* Ulmer, 1920, endemic to Brazil and reported from the states of São Paulo and Espírito Santo, Southeastern Region (Ulmer 1920, Molineri & Domínguez 2003).

With regard to Leptohyphidae, the genera *Leptohyphes* Eaton, 1982, *Tricorythodes* Ulmer,1920 and *Tricorythopsis* Traver, 1958, have five species each. They are widely distributed in Brazil (Banks 1913, Ulmer 1920, Needham & Murphy 1924, Traver 1959, Allen 1967, 1973, Da-Silva 1993, Molineri 1999, 2001a, 2002, 2003). *Traverhyphes* Molineri, 2001, is represented by two species, one from the Southern Region, and another from the Southeastern Region (Molineri 2001b, 2004). The genus *Leptohyphodes* Ulmer, 1920, is monotypic and known only from Brazil, being represented by *L. inanis* (Pictet, 1843). Although the type-locality of *L. inanis* was referred only to "Brazil" in the original description (Pictet 1843), Traver (1944) described the nymph of the genus, based on specimens from the state of Minas Gerais, Southeastern Region.

In order to contribute to currents and future studies of systematics and ecology of the group in Brazil, a key for the identification of the Brazilian ephemerelloidea genera is necessary. The aim of this paper is to present a key to nymphs and adults of the Ephemerelloidea genera recorded from the country.

Material and methods

All genera of Ephemerelloidea from Brazil were studied for the elaboration of the key. The specimens examined were borrowed from the following institutions: Museu Regional de Entomologia, Universidade Federal de Viçosa, MG and of the Departamento de Zoologia, Instituto de Biologia da Universidade Federal do Rio de Janeiro, RJ. .Drawings were made on white paper with the aid of a Leica camera lucida attached to a MZ8 microscope.

Results

Key to the genera of Ephemerelloidea (Insecta: Ephemeroptera) from Brazil

Acknowledgements

We thank Dr. Carlos Molineri (Faculdade de Ciências Naturales e Instituto Miguel Lillo – San Miguel de Tucumán, Argentina) and Dr. Teresinha Maria Castro Della Lúcia (Universidade Federal de Viçosa – Minas Gerais, Brasil) for their helpful review of the manuscript. We also thank the Brazilian Council of Scientific and Technological Development (CNPq) for providing funds to Lucimar G. Dias, Frederico F. Salles and Cesar N. Francischetti to conduct postgraduate studies at the Programa de Pós-graduação em Entomologia, Universidade Federal de Viçosa.

References

ALLEN, R.K. 1967. New species of New World Leptohyphinae (Ephemeroptera: Tricorythidae). Can. Entomol. 99: 350-375.

ALLEN, R.K. 1973. New species of *Leptohyphes* Eaton (Ephemeroptera: Tricorythidae). Pan-Pac. Entomol., 49: 363-372.

BANKS, N. 1913. The Stanford Expedition to Brazil. 1911. Neuropteroid insects from Brazil. *Psyche*. 20: 83-89.

DA-SILVA, E.R. 1993. Efemerópteros da Serra dos Órgãos, Estado do Rio de Janeiro. II. Descrição de uma nova espécie de *Leptohyphes* Eaton, 1882 (Ephemeroptera, Tricorythidae). Rev. Bras. Entomol. 37(2): 313-316.

DOMÍNGUEZ, E., HUBBARD, M.D., PESCADOR, M.L. & MOLINERI, C. 2004. Checklist of the Ephemeroptera of South America (edition date 16 June 2004) . URL http://www.famu.org/mayfly/sacat.asp

EATON, A. E. 1882. An announcement of new genera of the Ephemeridae. Entomol. Mon. Mag. 18: 207-208.

EMMERICH, D. 2004. Primer reporte de *Vacupernius* Wiersema y McCafferty 2000 (Ephemeroptera: Leptohyphidae) para América del Sur. Entomotropica. 19(2): 105-106.

MCCAFFERTY, W.P. & EDMUNDS JR, G.F. 1979. The higher classification of the Ephemeroptera and its evolutionary basis. Ann. Entomol. Soc. Am. 72: 5-12.

MCCAFFERTY, W.P. & WANG T.-Q. 2000. Phylogenetic systematics of the major Lineages of Pannote mayflies (Ephemeroptera: Pannota). Trans. Am. Entomol. Soc. 126(1): 9-101.

MOLINERI, C. 1999. Revision of the genus *Tricorythopsis* (Ephemeroptera: Leptohyphidae) with the description of four new species. Aquat. Insect. 21: 285-300.

MOLINERI, C. 2001a. El género *Tricorythopsis* (Ephemeroptera: Leptohyphidae): nuevas combinaciones y descripción de nuevas especies y estadios. Rev. Soc. Entomol. Argent. 60: 217-238.

MOLINERI, C. 2001b. *Traverhyphes*: a new genus of Leptohyphidae for *Leptothyphes indicator* and related species (Insecta, Ephemeroptera). Spixiana. 24(2): 129-140.

MOLINERI, C. 2002. Cladistic analysis of the South American species of *Tricorythodes* (Ephemeroptera: Leptohyphidae) with the descriptions of new species and stages. Aquat. Insect. 24(4): 273-308.

MOLINERI, C. 2003. Revision of the South American species of *Leptohyphes* Eaton (Ephemeroptera: Leptohyphidae) with a key to the nymphs. Stud. Neotrop. Fauna Environ. 38(1): 47-70.

MOLINERI, C. 2004. Phylogeny of the *Allenhyphes-Traverhyphes* group (Ephemeroptera: Leptohyphidae), with new subgenera, species and combinations. Tijdsch. Entomol. 147: 197-220.

MOLINERI, C. & DOMINGUEZ, E. 2003. Nymph and egg of *Melanemerella brasiliana* (Ephemeroptera: Ephemerelloidea: Melanemerellidae), with comments on its systematic position and the higher classification of Ephemeroptera. J. N. Am. Benthol. Soc. 22(2): 263-275.

MOLINERI, C., PETERS, J.G. & ZUÑIGA DE CARDOSO, M.C. 2002. A new family, Coryphoridae (Ephemeroptera: Ephemerelloidea), and description of the winged and egg stages of *Coryphorus*. Insect. Mundi. 15(2): 117-122.

NEEDHAM, J.G. & MURPHY, H.E. 1924. Neotropical mayflies. Bull. Lloyd. Libr. Bot. Pharm. Mater. Med. 24, Entomol. Ser. 4: 1-79.

ORTH, K., THOMAS, A., DAUTA, C., HOREAU, V., BROSSE, S. & ADEMMER, C. 2000. Les Ephémères de la Guyane Française. 1. Premier inventaire générique, a but de biosurveillance (Ephemeroptera). Ephemera. 2(1): 25-38.

PETERS, W.L. 1981. *Coryphorus aquilus*, a new genus and species of Tricorythidae from the Amazon Basin (Ephemeroptera). Aquat. Insect. 3: 209-217.

PICTET F.J. 1843. Histoire naturelle générale et particulière des insectes névroptères. Famille des éphémérines. Chez J. Kessmann et Ab. Cherbuliz, Geneva.

SALLES, F.F., DA-SILVA, E.R., HUBBARD, M.D. & SERRÃO, J.E. 2004. As espécies de Ephemeroptera (Insecta) registradas para o Brasil. Biota Neotrop. 4(2): 1-34.

TRAVER, J.R. 1959. The subfamily Leptohyphinae. Part II: Five new species of *Tricorythodes* (Ephemeroptera, Tricorythidae). Proc. Entomol. Soc. Wash. 61: 121-131.

TRAVER, J.R. 1944. Notes on Brazilian mayflies. Bol. Mus. Nac. N. S. Zool. 22: 2-53.

ULMER, G. (1920) Neue Ephemeropteren. Arch. Naturgesch. 85(11): 1-80.

Title: Key to the genera of Ephemerelloidea (Insecta: Ephemeroptera) from Brazil

Authors: Lucimar G. Dias, Frederico F. Salles, Cesar N. Francischetti & Paulo Sérgio F. Ferreira

Biota Neotropica, Vol. 6 (number 1): 2006
http://www.biotaneotropica.org.br/v6n1/pt/abstract?identification-key+bn00806012006

Date Received 04/01/2005 - Revised 11/22/2005
Accepted 01/01/2006

ISSN 1676-0611

Key to the genera of Ephemerelloidea from Brazil

Nymphs

1. Eyes elevated (Fig. 1); posterolateral projection of abdominal terga 2-5 curved dorsally (Fig. 2); dorsal tubercles present in all regions of the body (Fig. 2)…Coryphoridae, *Coryphorus*

1'. Eyes not elevated (Fig. 3); posterolateral projection of abdominal terga 2-5 not curved dorsally (Fig. 4-6); tubercles usually absent or present in one or two regions of the body (Figs. 4, 5); if tubercles present in all regions of the body, then tubercles paired (Fig. 6)…2

2(1'). Abdominal terga 2-9 with a pair of submedian tubercles, more evident in the abdominal terga 3-9 (Fig. 6); gills with ventral lamellae fringed (Fig. 7); femora strongly expanded (Fig. 8)…Melanemerellidae, *Melanemerella*

2'. Abdominal terga never with paired tubercles (Figs. 4, 5, 10); ventral gills without fringed lamellae (Figs. 13b, 14b); femora generally not expanded (Fig. 9) …Leptohyphidae …3

3(2'). Operculate gills subquadrangular, internal margins reaching median line (Fig. 10); gills present on abdominal segments 2-5; eyes of males divided (Fig. 11) …*Leptohyphodes*

3'. Operculate gills triangular, oval or rounded (Figs. 12-15), internal margins not reaching median line; gills present on abdominal segments 2–6; eyes of males generally not divided …4

4(3'). Body smaller than 4 mm; operculate gills with a weakly sclerotized transversal line (Fig. 15) …*Tricorythopsis*

4'. Body generally larger than 4 mm; operculate gills without a transversal line (Figs. 12-14) …5

5(4'). Operculate gills generally triangular (Fig. 12); if operculate gills ovoid, then femora circular and bordered with long setae (Fig. 16) ...*Tricorythodes*

5'. Operculate gills ovoid (Figs. 13, 14); femora never bordered with long setae ...6

6(5'). Ventral lamellae of operculate gills with a basal beak-like process (Fig. 13b); operculate gills without dorsal ribs (Fig. 13a) …*Leptohyphes*

6'. Ventral lamellae of operculate gills without a basal beak-like process (Fig. 14b); operculate gills generally with one or two dorsal ribs (Fig. 14a) ...*Traverhyphes*

Adults

1. Forewings with 2-3 detached marginal intercalaries between apex of main intercalary veins (Fig. 17a); hind wings present in both sexes (Fig. 17b) ...Melanemerellidae, *Melanemerella*

1'. Forewings without marginal intercalaries (Fig.18a, 20, 23, 24); hind wings variable, present only in males, absent in both sexes, or, rarely, present in both sexes ...2

2(1'). Compound eyes of male greatly enlarged and undivided, separated on dorsum of head by width of an eye (Fig. 19); cubital area of fore wings without intercalaries (Fig. 20); penis large, fused and distally broadened (Fig. 21) ...Coryphoridae, *Coryphorus*

2'. Eyes of male similar to females, usually not enlarged (Fig. 22); if so, then eyes divided and close to each other in dorsal view; intercalaries present on cubital area (Figs. 18, 23, 24); penis not as above (Figs. 25-29) ...Leptohyphidae ...3

3(2'). Mesoscutellum with relatively long membranous filaments (Fig. 30); base of male forewings not broadened (Fig. 18) ...4

3'. Mesoscutellum without membranous filaments (Fig. 31); male forewings broadened at base (Fig.23, 24) ...6

4(3). Eyes of males divided (Fig. 32); forceps two-segmented; hind wings absent in both sexes ...*Leptohyphodes*

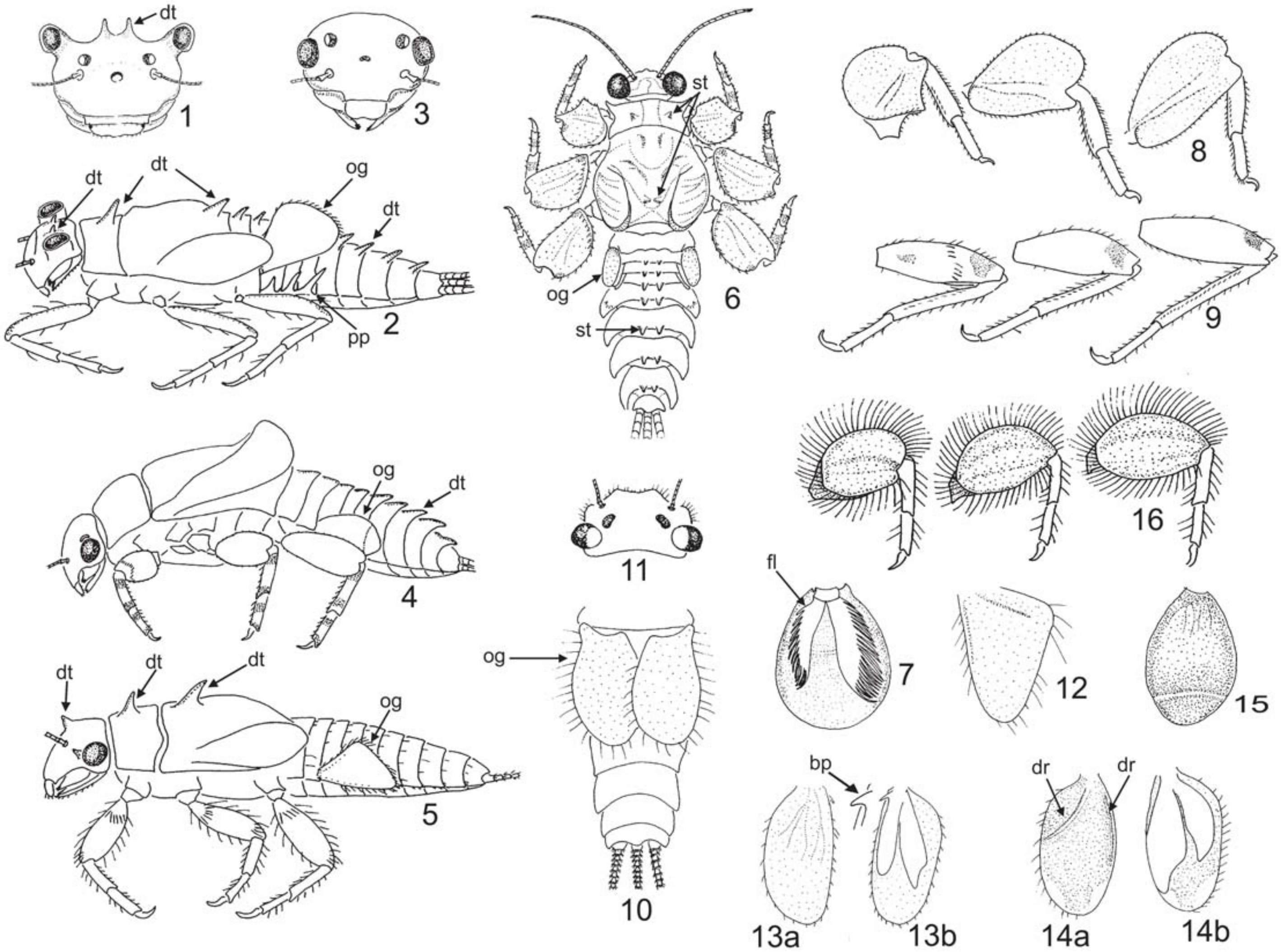
4'. Eyes of males usually not divided (Fig. 22); forceps three-segmented; hind wings present at least in males (Fig. 18) ...5

5(4’). Penis “Y” shaped, with apical spine and without dorsal spine (Fig. 25) ...*Leptohyphes*

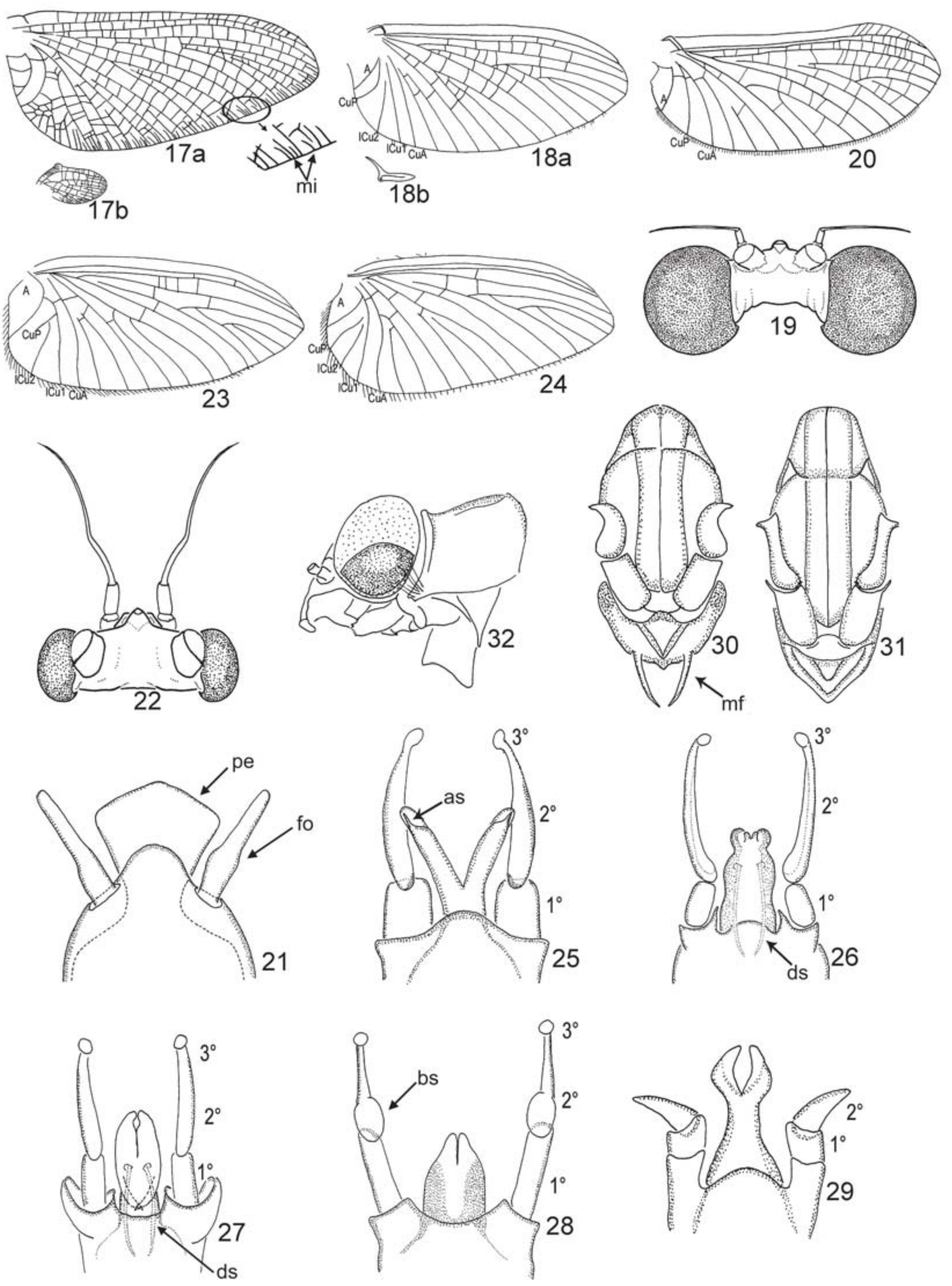
5’. Penis not as above (almost totally fused), without apical spine and with dorsal spine (Fig. 26, 27) …*Traverhyphes*

6(5’). Forceps three-segmented, basal swelling usually present at base of second joint (Fig. 28) ...*Tricorythodes*

6’. Forceps two-segmented, basal swelling absent at base of second joint (Fig. 29) …*Tricorythopsis*



Figures 1-16. *Ephemerelloidea, nymphs: 1.* Coryphorus aquilus *(head, frontal view); 2.* C. aquilus *(lateral view); 3.* Tricorythopsis gibbus *(head, frontal view); 4.* T. gibbus *(lateral view); 5.* Tricorythodes bullus *(lateral view); 6.* Melanemerella brasiliana *(dorsal view); 7.* M. brasiliana *(operculate gill in ventral view); 8.* M. brasiliana *(legs: fore, middle and hind); 9.* Traverhyphes sp. *(legs: fore, middle and hind); 10.* Leptohyphodes inanis *(abdomen in dorsal view); 11.* L. inanis *(head, dorsal view); 12.* Tricorythodes sp. *(operculate gill, dorsal view); 13.* Leptohyphes plaumanni *(a — operculate gill, dorsal view, b — operculate gill, ventral view); 14.* Traverhyphes sp. *(a — operculate gill, dorsal view, b — operculate gill, ventral view); 15.* Tricorythopsis sp. *(operculate gill, dorsal view); 16* Tricorythodes santarita *(legs: fore, middle and hind). Abbreviations: bp - basal beak-like process, dr – dorsal ribs, dt - dorsal tubercles, fl – fringed lamella, og – operculate gills, pp - posterolateral projection of abdominal, st – submedian tubercles.*



Figures 17-32. *Ephemerelloidea, adults: 17.* Melanemerella brasiliana *(a – forewing, b - hind wing); 18.* Traverhyphes sp. *(a – forewing, b - hind wing); 19.* Coryphorus aquilus *(head, dorsal view); 20.* C. aquilus *(forewing); 21.* C. aquilus *(genitalia); 22. Leptohyphidae (head, dorsal view); 23*. Tricorythodes bullus *(forewing); 24*. Tricorythopsis sp. *(forewing); 25*. Leptohyphes plaumanni *(genitalia); 26*. Traverhyphes (Mocohyphes) sp. *(genitalia); 27*. Traverhyphes (Traverhyphes) pirai *(genitalia); 28*. Tricorythodes sp. *(genitalia); 29*. Tricorythopsis sp. *(genitalia); 30*. Traverhyphes sp. *(thorax, dorsal view); 31*. Tricorythodes sp. *(thorax, dorsal view); 32*. Leptohyphodes inanis *(head, lateral view). Abbreviations: as – apical spine, bs - basal swelling of second joint, ds - dorsal spine, fo – forceps, mf – membranous filaments, mi – marginal intercalaries, pe - penis.*

The rise and fall of the Refugial Hypothesis of Amazonian Speciation: a paleoecological perspective

***Mark B. Bush*[1] *& Paulo E. de Oliveira*[2]**

Biota Neotropica v6 (n1) – http://www.biotaneotropica.org.br/v6n1/pt/abstract?point-of-view+bn00106012006

Date Received 05/12/2005 - Revised 10/20/2005 - Accepted 01/01/2006

[1]Department of Biological Sciences, Florida Institute of Technology, Melbourne, Fl 32901, USA.
e-mail: mbush@fit.edu; website: http://research.fit.edu/bushlab/
[2]Laboratório de Geociências, Universidade Guarulhos, Guarulhos, São Paulo 07023-070,Brazil.e-mail: paulo@bjd.com.br

Abstract -Bush, M.B and Oliveira, P.E. **The rise and fall of the Refugial Hypothesis of Amazonian Speciation: a paleoecological perspective.** *Biota Neotrop*. Jan/Abr 2006 vol. 6, no. 1,http://www.biotaneotropica.org.br/v6n1/pt/abstract?point-of-view+bn00106012006. ISSN 1676-0611

The refugial hypothesis is treated as the definitive history of Amazonian forests in many texts. Surprisingly, this important theoretical framework has not been based on paleoecological data. Consequently, a model of Amazonian aridity during the northern hemispheric glaciation has been accepted uncritically.

Ironically, the Refuge Hypothesis has not been tested by paleobotanical data. We present a revision of the concept of Neotropical Pleistocene Forest Refuges and test it in the light of paleocological studies derived from pollen analysis of Amazonian lake sediments deposited during the last 20,000 years. Our analysis is based primarily on paleoenvironmental data obtained from sites in Brazil and Ecuador. These data are contrasted with those that favor the hypothesis of fragmented tropical forests in a landscape dominated mainly by tropical savannas under an arid climate.

The Ecuadorian data set strongly suggests a 5°C cooling and presence of humid forests at the foot of the Andes, during the last Ice Age. The same climatic and vegetational scenario was found in the western Brazilian Amazon. On the other hand, somewhat drier conditions were observed in the central Amazon, but the landscape remained a forested landscape during the supposedly arid phases of the Late Quaternary. Data obtained from the Amazon Fan sediments containing pollen derived from extensive sections of the Amazon Basin, were fundamental to the conclusion that the predominance of savannas in this region is not supported by botanical data.

Our revision of the assumptions derived from the Refuge Hypothesis indicates that it has succumbed to the test now permitted by a larger paleocological data set, which were not available during the golden age of this paradigm, when indirect evidence was considered satisfactory to support it.

Key words: *Amazonia, refugia, fossil pollen, glaciations, Pleistocene, Holocene, Miocene, phylogeny, speciation diversity*

Resumo - Bush, M.B and Oliveira, P.E. **Apogeu e declínio da Hipótese dos Refúgios para a especiação na Amazônia: uma perspectiva paleoecológica.** *Biota Neotrop*. Jan/Abr 2006 vol. 6, no. 1, http://www.biotaneotropica.org.br/v6n1/pt/abstract?point-of-view+bn00106012006. ISSN 1676-0611

A Hipótese dos Refúgios Florestais do Pleistoceno é aceita como a história definitiva da Amazônia por muitos autores. Surpreendentemente, este importante conceito não foi baseado em dados paleoecológicos. Como conseqüência, hoje temos um modelo teórico intimamente conectado à visão de uma Amazônia árida, durante o período de maior atividade glacial no hemisfério norte.

Ironicamente, a Hipótese dos Refúgios não foi testada por dados paleobotânicos. Por isso, apresentamos uma revisão desse conceito e testamos a sua validade frente aos estudos paleoecológicos, derivados de análises palinológicas de sedimentos lacustres da Amazônia, depositados nos últimos 20.000 anos.

Nossa análise baseia-se, principalmente, em dados paleoambientais obtidos em regiões da Amazônia do Brasil e do Ecuador, os quais são contrastados com informações que apóiam a hipótese da fragmentação florestal amazônica em uma paisagem dominada por savanas, sob clima predominantemente árido.

Os dados do Ecuador sugerem enfaticamente um esfriamento da ordem de 5°C e presença de florestas nos sopés dos Andes, durante a última glaciação. Este mesmo cenário climático e vegetacional foi encontrado na Amazônia Oriental Brasileira. Por outro lado, condições relativamente mais secas foram detectadas na Amazônia Central, mas ainda sugerem uma paisagem florestada durante as fases supostamente mais secas do Quaternário Tardio.

Dados obtidos nos sedimentos do delta do Rio Amazonas, que contém pólen oriundo de extensas áreas da bacia, foram fundamentais à conclusão que a hipótese da predominância de savanas nessa região não tem apoio em dados botânicos.

Nossa revisão das expectativas derivadas da Hipótese dos Refúgios indica que o modelo sucumbiu frente ao teste permitido por um banco de dados paleoecológicos, o qual não estava disponível durante a “idade dourada” deste paradigma, quando evidências indiretas eram consideradas satisfatórias para mantê-lo.

Palavras-chave:*Amazônia, refúgios, pólen fóssil, glaciação, Pleistoceno, Holoceno, Mioceno, filogenia, diversidade e especiação*

Introduction

One of the great biological patterns that ecologists strive to explain is the latitudinal gradient in diversity. The incredible diversity of tropical systems and the tapering of that richness poleward has been observed and debated by Wallace and Darwin and others following in their footsteps. Various hypotheses have been established: that the tropics accumulate species without much extinction (museum hypothesis); that the area of the tropics is greater than at other latitudes (Rosenzweig & Sandlin 1997); that most modern lineages originated in the tropics and relatively few have been able to leave (Ricklefs 1987); and that intermediate levels of disturbance maintain diversity but do not cause extinction (Connell 1978). All of these hypotheses have merit, yet none provides a completely satisfactory answer. What was lacking from all of them was an explanation of why speciation rates may have been higher in a tropical setting than in a temperate one.

Conventional wisdom of the 1960s stated that tropical regions were rich in biodiversity because they were ecologically stable. Climate never changed, therefore species never went extinct and simply accumulated. The stability of tropical climates was challenged by findings in Africa that both precipitation and temperature had changed during the last ice-age (Livingstone 1967). Africa was drier and colder in the last ice age. Forests were forced downslope in the Ruwenzori and grasslands invaded. In the Andes on the High Plain of Bogotá, Colombia, van der Hammen and Gonzalez (1959) described a long pollen history of warm and cold oscillations. Each cold oscillation was an ice age that caused forests to die out at high elevations and to be replaced by Paramo grasslands. These findings of changeable tropical climates and forests being replaced by grassland set the scene for new thinking about tropical lowland systems.

In 1969, Jurgen Haffer, a petroleum geologist and ornithologist, introduced an elegant theory of ice-age speciation events based on climate change (Haffer 1969). He observed that modern bird distributions of closely related species (congeners and superspecies) often had ranges that abutted one another but did not overlap (i.e. parapatric). He also noted that there was a predictable pattern in which certain areas held more endemic species than others. From these observations he made the intellectual leap to observe that for these species to have speciated they must have been spatially separated from their parapatric counterparts at some time in the past. Haffer assumed, as would many biologists, that allopatry (reproductive isolation from other gene pools of the same species) was an essential precursor for speciation. He invoked the new climatic data emerging from Africa of a dry glacial period (ca. 100,000-20,000 years ago) to argue that the Amazon Basin was similarly arid, and it was seas of savanna surrounding islands of forest that provided the genetic isolation required for speciation.

Haffer hypothesized that the wettest areas would be hilltops that caught orographic rainfall, and therefore remained wet enough to support evergreen forest. The interstices between the hilltops became too dry to support forests, and savanna grasslands expanded. Those wettest locations where evergreen forest survived, would have formed isolated refuges for all forest wildlife; hence they were termed refugia. Within these refugia, Haffer suggested, populations of birds, insects, and plants were isolated. Cut off from the populations of other forest organisms in other refugia, the fragmented populations underwent speciation. The model was the first comprehensive attempt to provide a mechanism that would lead to unusually high rates of speciation in some tropical areas.

The elegance of the model attracted many other workers to develop similar refugial maps for butterflies, frogs, lizards, and some families of plants (Vanzolini 1970, Haffer 1974, Prance 1982, Haffer 1985, Brown 1987a, Brown 1987b, Haffer 1991, Haffer & Prance 2001) (Figure 1). The refugial hypothesis is included as the definitive history of Amazonian forests in many texts; however, it is important to note that it is not based on any paleoecological data (Colinvaux 1989). The refugial model and associated Amazonian aridity became a paradigm, but one that was founded on hypothesis not empirical data. We will review the assumptions of the model because the most attractive features of the refugial hypothesis were that it was both explanatory and predictive, and hence testable.

Assumptions of the model

The refugial model has been considerably revised since its first formulation. However, at the core of the model are 6 key assumptions that have remained constant.

1) The biogeographic data are sufficient for hypothesis generation.

2) Process of speciation: all speciation must result from spatial allopatry.

3) The spatial pattern of speciation: Speciation occurred in identifiable centers that are independent of major modern landscape barriers.

4) The temporal pattern of speciation: Amazonian genera (especially the ones used to generate the hypothesis) experienced sudden bursts of speciation centered on the ice ages.

5) Changes in precipitation and seasonality: In the interstices between the hilltops the replacement of forest with savanna would require a shift from the “normal” Amazonian precipitation of 2200-3000 mm and 0-3 months dry season, to a system receiving <1500 mm and a 5 month dry season.

6) Unchanging temperature: For the hilltops to remain suitable for the most sensitive of lowland species

requires temperatures in the lowland tropics to be about the same as those of the present during the ice ages.

It can be argued that the latest version of the model relaxes *Assumptions 3 and 4* (Haffer & Prance 2001), however, to do so invalidates the original worth of the model as a predictive tool (Bush 2005), and so we include them in this analysis.

Assumption 1: *The biogeographic data are sufficient for hypothesis generation.* Are the spatial and taxonomic patterns upon which the refugial hypothesis is built real? In an analysis of herbarium collections records (Nelson et al. 1990) showed strong congruence between geographic variation in collecting intensity and apparent species diversity. It is likely that botanists are drawn to locations of high diversity and so the implied pattern of diversity may be real. However, some of the sites of highest intensity were close to major points of entry or centers of research, and thus suggest that the collecting effort at those locations may have been disproportionately high. In truth, most areas of the Neotropics are so incompletely surveyed, and taxonomy is still so fluid for complex groups, that maps of diversity and distribution must be treated with some caution.

In a statistical analysis of the overlap of Amazonian bird distributions, instead of finding refugial centers, no pattern was found beyond randomness (Beven et al. 1984). While our knowledge of species composition and full diversity of any given location is imperfect and this could either strengthen or weaken refugial claims, the overall pattern of species richness across Amazonia is unlikely to alter radically as new data emerge. Hence we will accept *Assumption 1*. In so doing we accept that the major biogeographic regions of Amazonia (Figure 2a) require some explanation.

Assumption 2*: Process of speciation*. Ernst Mayr was a staunch advocate of both the importance of allopatry in speciation and in the refugial hypothesis (Mayr & O'Hara 1986). While sympatric speciation through polyploidy has been demonstrated in plants, and post-zygotic isolation is probably possible without allopatry, the consensus among biologists is that allopatry is necessary for speciation (Coyne & Orr 2004). As a detailed review of these arguments is beyond the scope of this paper we will accept this assumption, but note that our understanding of genetic isolation may be radically altered as more molecular studies are conducted on seemingly continuous populations (McLachlan & Clark 2005).

Assumption 3*: The spatial pattern of speciation*. Modern barriers such as edaphic types, while incorporated into later versions of refugial prediction are not seen as sufficient barriers to cause observed biogeographic patterns. Similarly, the large Amazonian rivers and the Andes mountains are not treated as standing constraints to genetic interchange.

Wallace (1852) and later Endler (1982) proposed that rivers were indeed major barriers to dispersal and subsequent studies have yielded mixed results. For some aquatic, amphibian and riparian taxa the rivers are clearly conduits not constraints (Gascon et al. 2000). Similarly the genetic isolation of a forest-floor dwelling antbird by a river several kilometers wide will be much more likely than for a highly motile bird such as a toucan (both these groups were used as examples of refugial species). Equally, spider monkey populations may be separated at the mouth of a major river, but are not greatly influenced by its headwaters (Ayers and Clutton-Brock 1992, Collins & Dubach 2000).

Phylogenetic studies have been conducted on many groups and some important trends emerge: 1) No single pattern of biogeographic origin is common to all taxa (for an excellent faunal review see Moritz et al. 2000); 2) Most phylogenies have a tree with a basal division that separates Central American and Chocó populations from those of Amazonia and the Atlantic forests (Figure 2b); 3) Genotypes from the Guianan highlands and the Atlantic Coastal forest and the dry forests fringing Amazonia need to be included in the analyses (Costa 2003). The importance of the connectivity of eastern Brazilian ecosystems has also been demonstrated through the study of fossil pollen and speleothem data (de Oliveira et al. 1999, Auler et al. 2004). Again we point to the study by Beven et al. (1984) that found the distribution of taxa to be random rather than falling within predictable centers. None of these studies pinpoint refugial locations, but they do bear out the major biogeographic provinces of Amazonia, albeit with major watersheds shifting between provinces according to the phylogeny. Thus *Assumption 3* is neither supported by, nor refuted, by the available data.

Assumption 4*: That "Amazonian genera (especially the ones used to generate the hypothesis) experienced sudden bursts of speciation centered on the ice ages"*. This is an area where research is advancing rapidly, data are still sparse, and there are many interesting issues yet to resolve. However, preliminary data show that speciation events among bats, birds, snakes, and mammals (Bates & Zink 1994, Patton et al. 1994, Zink & Slowinski 1995, Bates et al. 1998, Bates 2000, Patton et al. 2000, WWF 2003, Zink et al. 2004, Gosling & Bush 2005) in Amazonia have been a continuous process, without a clear surge of new forms in the Quaternary.

Phylogenetic trees provide a rough hierarchy of separation. According to the phylogeny, basal splits are generally 8-15 million years ago (Knapp & Mallett 2003). The orogeny of the Andes progressively isolated Amazonia from the Chocó and Central America on a similar timeframe (Hoorn et al. 1995). The rise of the Andes not only caused vicariance among populations, but also changed the drainage of Amazonia causing the formation of the modern mighty river system. This period of 20 to10 million years ago was also a time of a marine highstand with sea-level probably at its highest around 14 million years ago (30-50 m above present level). That highstandcoupled with forebasin downwarping, resulted in extensive epicontinental seas within Amazonia (Figure 3). While some debate exists regarding the full extent and connectivity of these water bodies (e.g. Hoorn et al. 1995, Rasanen et al. 1995), it is apparent that they would have been potentially much greater barriers to dispersal than any modern river of the Amazon Basin (Rasanen et al. 1995, Hovikoski et al. 2005).

Much of the proto Andes would have supported lowland forests prior to the mid-Miocene and these areas may subsequently have provided species for the expanding western Amazon forests that colonized land left by falling mid-Miocene to late-Miocene sea-levels.

Other major changes took place as epicontinental seas in eastern and southern Amazonia formed and subsequently drained (Nores 1999, Hovikoski et al. 2005). The upwarp of the Andes and the drainage of the Pebasian Sea were closely linked. Lineages previously to the west of the Pebasian and Paranense Seas, and separate from eastern Amazonia, might account for the basic east-west biogeographic split in some Amazonian clades. Similarly the seaway or the great wetlands if this were not an actual sea, that lay in the modern Amazon channel could have provided the basic north-south discontinuity. As we realize that many modern clades are rooted in the Miocene it is important to build these ancient landscapes into our evolutionary vision (Figure 3).

The phylogenetic data clearly reveal that there was no sudden wave of glacially-induced speciation in Amazonia and that focusing on the Quaternary as a source of Amazonian diversity is temporally myopic. This realization clearly violates *Assumption 4* of the refugial hypothesis.

Assumptions 5 and 6: *The past ice-age climates of Amazonia*. A discussion of these data follows, but it is not quite so straightforward as those given above, hence the data will be presented in a somewhat different format in which the view of the original author is reported and then we provide an updated re-interpretation or commentary.

Paleoecological data

In a perfect world, the refugial hypothesis would be simple to test. Lake-sediment core samples would yield fossil pollen that would allow description of regional vegetation through time. Replicated core samples that spanned the last ice age would be collected from areas inside and outside of postulated refugia. If the refugial samples were not always lowland forest, or if the outside samples did not show an oscillation to grassland during ice ages, then the hypothesis would be falsified.

Despite 30 years of actively searching for such sites, paleoecologists still have not found enough ancient lakes in appropriate settings to make this a simple test of *Assumptions 5 and 6.* The processes that provide ancient lakes in temperate areas, such as glacial activity, solution basins, and volcanoes are largely absent from the Amazon Basin. Furthermore vigorous bankside erosion by vast meandering rivers, obliterates lakes in floodplains every few thousand years. Only a handful of lakes of sufficient age to test the refugial hypothesis have been found in Amazonia. These lakes are all somewhat ecotonal relative to proposed refugia (Figure 4). The fossil records of these systems provide detailed histories of those sites, but they have to be interpreted in a larger context. In other words, just because you see a pattern consistent with, or contrary to, the expectations of the refugial hypothesis at a single marginal location, it does not substantiate or disprove the hypothesis. Ecotonal boundaries can migrate 10s even a 100 kilometers or more without indicating that the 1000’s of kilometers of forest were similarly impacted.

We briefly review sites that provide the principal evidence for and against refugia on the basis of paleoecology and distinguish the author’s interpretation from our commentary on the record.

Rondônia, Brazil

This area currently supports tropical rain forest, but the refugial hypothesis predicts that it would be savanna during ice age times. A fossil pollen record (van der Hammen 1974) that shows an oscillation between modern forest and grassland (Figure 5). Proportions of Poaceae (grass) pollen in this sequence are consistent with those documented from modern savanna habitats. Undoubtedly, this is the best palynological evidence to support the existence of refugia. The forest is clearly Holocene in age, while the grassland episode is undated but assumed to be part of a continuous depositional sequence and therefore attributable to the terminal portion of the ice age. The location of the site lies outside of any proposed refugium, and so this meets prediction 3 of the refugial hypothesis.

Our thoughts on the Rondônia sequence:

There is little doubt that this site once supported a grassland, but there is no datum to suggest when this occurred. Below, we will discuss the frequency of climate change in the Amazon Basin, and demonstrate that wet, dry, cold and warm climatic oscillations have occurred with great rapidity. Northern Amazonia is shown to have had active dune fields in some areas with a lot of activity between 17,000 BP and 8000 BP (Filho et al. 2002). This dune activity implies reduced precipitation, between 17,000 and 8,000 BP. The Rondônia site lies within 100 km of the modern savanna-forest ecotone and has a precipitation pattern that is only just sufficient to support closed canopy forest. In a location as close to an ecotone as this site, the drought at 15,000 BP could easily account for the undated expansion of savanna seen in this record.

What cannot be concluded from this site is that a) the transition to savanna lasted an evolutionarily significant amount of time; and b) that other, less ecotonal regions, were similarly affected.

Carajas, Brazil

The Carajas record comes from a 600 m high inselberg that rises above the Amazonian plain in south-eastern Amazonia that presently supports a mixture of savanna and open woodland habitats. This area was predicted to lie outside of any ice-age refugium.

The fossil pollen and paleolimnological data from this site exhibit a dry interval between ca. 26,000 and 15,000 BP (Absy et al. 1991, Sifeddine et al. 2001). In this episode the lake dried out, and the last pollen signature before a total gap in sedimentation is rich in Poaceae (grass), Asteraceae, and *Borreria* pollen (Figure 6). These three pollen types are used as indicators of the presence of savanna. Consequently, these data were interpreted to indicate a widespread savanna expansion at the LGM, fully consistent with the refugial hypothesis (Absy et al. 1991, Haffer & Prance 2001).

Our thoughts on the Carajas sequence:

An alternate interpretation of this data set accepts that there was a dry period between 26,000 and 15,000 BP, but questions whether the Asteraceae, *Borreria*, and Poaceae indicate savanna conditions. As a lake contracts it offers a smaller and smaller surface area onto which pollen falls. It is widely accepted that the smaller the lake surface area, the stronger is the input of local pollen types. In other words, large lakes (>100 m in diameter provide regional pollen records, whereas small lakes <20 m provide an image of the immediately adjacent marsh and little else (Jacobson and Bradshaw 1981, Prentice 1985). Thus, as the lake at Carajas dried out, the marsh plants (Poaceae, Asteraceae, and *Borreria*) increased in proportion in the pollen record, without necessarily influencing the local forest. Do we believe that you can dry out a lake on an inselberg that presently supports woody savanna and not have an expansion of grass savanna? Probably not. It is extremely likely that on that dry hilltop there was local expansion of savanna, but this does not tell us anything about what was happening in the wetter lowlands. Note also that the highest percentages of Poaceae pollen do not occur at the LGM but during the Holocene. No-one has suggested the existence of savanna in Holocene times, and so it appears that Poaceae pollen abundance is not directly correlated with the presence of refugia (Bush 2002).

A further point to consider is – what if we are wrong? What if the drying really did last from 26,000 BP to 15,000 BP and substantial areas of savanna spread into Amazonia, does this provide time enough for allopatric speciation? Turning this argument around we can say that a roughly equivalent time has passed in the Holocene (11,000 years) and ask if there has been a radiation of isolated savanna species within the Amazon Basin (there are large modern savanna islands within a sea of forests). The answer is, there has been no such speciation. Very rapid speciation has been reported for a few organisms such as African cichlids and fruit flies, but neither of these are well-defined, and where there is very tight co-evolution (Coyne & Orr 2004). In summary, it is very unlikely that 11,000 years of isolation is enough to cause widespread speciation among butterflies and birds, let alone among such long-lived organisms as trees. The evidence for drying in ice-age Amazonia indicates neither the intensity nor the duration sufficient to bring about allopatric speciation.

The Carajas data, rather than supporting the refugial hypothesis, are in fact a further refutation of Prediction 5 that Amazonian genera (especially the ones used to generate the hypothesis) experienced sudden bursts of speciation centered on the ice ages.

In a more recent paper, additional information was released about the Carajas record (Ledru et al. 2001) indicating that a significant amount of *Podocarpus* pollen was also found in the ice-age sediments. *Podocarpus* is a gymnosperm tree that is most abundant in cloud forest above 1500-2200 m elevation. For *Podocarpus* to occur at this site strongly suggests a cooling at the LGM. In the tropics a rule of thumb is that a 1000 m increase in altitude results in a 5ºC drop in temperature. For *Podocarpus* to be found about 1000 m below its normal range suggests about a 5ºC cooling at the LGM. This cooling (originally denied for this site) is now seen as consistent with many other regional records (Colinvaux 1987, Bush et al. 2001). A 5ºC cooling may not sound all that much, but it is the equivalent of trading the climate of Atlanta with that of Washington DC, or Berlin with that of Moscow.

In summary, the data from Carajas refute *Assumption 5* and the observation that there was regional cooling refutes *Assumption 6* that ice-age temperatures were similar to those of the present.

Paleoecological data published that opposed refugia

Mera and San Juan Bosco, Ecuador

These two sites lie within the area of the postulated Napo refugium. For the refugial hypothesis to be true they should present an unchanging history of lowland forests.

However, these sites provided the first direct evidence that the lowlands were moist and cool during the latter part of the ice age. Now, better records exist for other locations, but these sites are important as they represented the turning of the tide.

Mera (Liu & Colinvaux 1985) and San Juan Bosco (Bush et al. 1990) lie at the foot of the Andes, at 1100m and 970 m respectively, immediately above the great Amazonian plains. These records are both cliff exposures in which a downcutting river has exposed ancient sediments. *Podocarpus* trunks poked out of the cliff and these provided the basis for secure radiocarbon ages spanning ca. 38,000 to 30,000 cal. yr BP (33,000 to 26,000 ^{14}C BP). The sediments around the wood were fine silts, indicating a very low energy depositional system (lake or marsh). Pollen and macrofossils of *Podocarpus*, *Drimys*, *Alnus* (alder), and other montane taxa were very abundant, particularly in the older sediments (Figure 7).

Grass phytoliths (silica bodies inside leaves of grasses) that were present were from C_3 grasses not from C_4 grasses. None of these plants currently grow below 1800-2500 m elevation in this section of the Andes, and all are found in moist cloud forest environments. These data strongly suggest a 5 ^{o}C cooling and abundant moisture at the foot of the Andes in the last ice age.

The Hill of Six Lakes Brazil

This 300 m high hill rises out of the northern Amazon plain and lies close to the boundary of one of the proposed refugia. The soils on the hill are very thin resulting in an edaphically dry woodland. Some dispute exists regarding whether this site is inside or outside of proposed refugia (Colinvaux et al. 2001, Haffer & Prance 2001). The boundaries of refugia have changed as maps are redrawn and in their latest manifestation Haffer and Prance state that this Hill lies within a refugium. However, the criteria to determine refugia are based on the overlap of endemic species, precipitation and soils. The thin soils of this hill result in a rather species poor, small stature forest, for which there is no evidence of high proportions of endemics. We will treat this as an ecotonal setting for which there are no expectations.

Three lake records have been analyzed, and all show similar histories. The pollen diagram from Lake Pata is representative and it shows the continuous presence of forest on this site throughout the last 50,000 years (Colinvaux et al. 1996). However, the forest did not remain unaltered and, as at Carajas, Mera and San Juan Bosco, the presence of cold elements *Podocarpus*, *Hedyosmum*, *Weinmannia*, *Myrsine*, and Ericaceae, strongly suggests a 5ºC cooling (Figure 8). Pata also revealed an intriguing pattern of lake-level changes, which allow us to draw inferences regarding changes in precipitation. Lake Pata is a small, shallow (mostly 3m deep) closed basin lake. Based on sedimentary oxidation, exceptionally high pollen concentrations, and algal blooms, a series of low-lake stands are evident in the Pata record (Bush et al. 2002). During each of these events there is a peak of K^+ cations in the sediment. Potassium normally weathers out of local rock at the same rate as sodium, and so the two concentrations normally co-vary. However, at Pata there appear a rhythmic set of K^+ peaks that are independent of Na+ concentrations. The most probable explanation is that during times of low lake level the photic zone of the lake extended down to the lake bed. Under these circumstances algae can access nutrients in the lake mud, and the system switches from being oligotrophic to eutrophic. Algae stored the K^+, but would not store Na^+, and so when the algal blooms die off there is increased concentration of K^+ in the mud. If this process is repeated for several thousand years there develops a significant spike of K^+ concentration.

A robust chronology based on 15 radiocarbon AMS dates shows that the driest time at Pata was between 35,000 and 23,000 BP. At this time the lake was so reduced that repeated sedimentary oxidation prevented net accrual of sediment. If the basal age of the core is calculated on extrapolation of the sedimentation rate in the AMS dated portion of the core, a basal age of 180,000 yr BP is suggested. Through the last 40,000 years the peaks of K+ coincide with the dry season, June-July-August (JJA), insolation maxima. If the peaks of K+ are assumed to follow the pattern observed in the radiocarbon dated section of the core, orbitally tuning the remaining peaks to JJA insolation maxima provides a basal age of 170,000 BP (Figure 9). The K+ peaks are lowstand events and the intervening periods of low K+ concentrations are wetter periods that coincide with the December-January-February insolation maxima.

To generate Figure 9, the only tuning beyond the range of the ^{14}C record was to align the seventh K^+ peak with the seventh insolation peak, all other samples were allowed to fall without adjustment, i.e. an even rate of sedimentation is assumed between 45,000 and 170,000 years. It is evident from this record that the cyclic droughts show a remarkable concurrence with the JJA insolation and of a weaker set of dry events coinciding with the DJF curve. This pattern faithfully replicates the observed relationship between seasonal insolation and lake level on the Bolivian Altiplano (Baker et al. 2001, Fritz et al. 2004, Chepstow-Lusty et al. 2005).

In the dry events at Lake Pata we know that lake level dropped, indicating a decrease in precipitation, yet the forest was not replaced by grassland. We hypothesize that the principal reduction in precipitation was in the wet season. During the wet season there is excess water in this system, some of which enters the lake and raises lake level. However it is the dry season and the thin soils that determine vegetation type. If wet season rains were reduced, it is probable that there would be little change in forest composition, but lake level would respond. Had it been a dry season reduction in precipitation the forest would have converted to grassland, and the system would have become fire-prone – but there is no cyclic occurrence of charcoal or reduction in forest cover to suggest such a pattern.

The paleoecological records from two other lakes, Verde and Dragao, on the Hill of Six lakes have now been published (Bush et al. 2004) and these are entirely consistent with the history from Lake Pata, though neither provides as sensitive a cation record. From these additional records the peak of the late glacial dry event is confirmed to have occurred between 35,000 and 23,000 cal. yr BP. The analysis of thee lakes provided an additional insight into the low-lake stands observed at Pata.

Lake Dragao was (and is) highly susceptible to lake level change. In a two-week field operation we observed its water level go down by 2 m – much more than could be explained by evaporation alone. A geological team played soccer on its dried out lake bed in the 1982 El Nino drought. Clearly this lake is leaking and its hydrology is a finely tuned balance between input (rainfall) and leakage. A clear inference is that lakes more susceptible to drought will contain greater durations of sedimentary hiatus in their history. Indeed Dragao has an apparent hiatus until c. 18,640 cal year BP, Similarly, Lake Verde, which is a nine meter deep lake today failed to accumulate sediment throughout the Holocene. If this lack of sedimentation is genuine and not an artefact of coring, it is probable that Verde has only recently refilled with water in the last millennium or so. Being dry in the early and mid Holocene, would be predicted from the precessional pattern. However, there is no suggestion of forest loss in the Holocene.

Again lake-level on these inselberg lakes is shown to be a sensitive proxy for a net change in the precipitation-evaporation-leakage balance, but an unreliable proxy for inferring vegetation change.

In summary: The lakes of the Hill of Six Lakes provide evidence of cooling, and establish that precipitation patterns oscillated cyclically, did not change in the manner predicted by the refugial hypothesis.

Maicuru

Maicuru (Colinvaux et al. 2001) is an inselberg that lies at 0° latitude in eastern Amazonia. This Hill rises to 500 m and has numerous small, shallow, lakes on its summit plateau. The largest of these lakes provided another long but discontinuous paleoecological record that indicates the presence of forest throughout the represented portion of the last ice age. In this record the peak of the last ice age is missing, as there is a sedimentary hiatus between 30,000 and 15,000 BP. Thus this record is palynologically similar to that of the Hill of Six lakes, but the duration of the dry event looks to be somewhat longer, starting at about the same time as the Hill of Six Lakes and ending at about the same time as Carajas, making it a longer climatic feature.

Data from the Amazon Fan

The Amazon river acts as a vast pollen trap, collecting pollen from the entire Amazon Basin. Pollen is carried seaward in the river water. So that at the Atlantic coast, the pollen of the turbid Amazon waters represents the vegetation types of the entire subcontinental area of Amazonia. When the riverwater discharges into the ocean, the sudden reduction in flow rate causes the sediments and pollen to be deposited. Sediment cores from the Amazon fan provide an insight on the past vegetation of Amazonia at the scale of that landscape. Simon Haberle undertook a study of modern sediments in Amazonian tributaries (upper panel Figure 10) and of fossil sediments raised from the Amazon fan (Haberle 1997).

These data show that in the modern rivers Poaceae pollen accounts for about 10% of the pollen sum, and that the ice age pollen spectra were similarly low in Poaceae pollen.

These data clearly demonstrate the fallacy that large areas of savanna replaced forest.

Haffer & Prance (2001) and van der Hammen & Hoogiemstra (2000) argue that the Amazon fan data only represent riparian vegetation and that there is no information in this data set about the Amazon Basin as a whole. The problem with this interpretation is that the Amazon and its major tributaries are huge rivers, several kilometers in width, which will trap pollen at the regional scale not the local scale. The source of pollen will be water draining from a vast riveraine network, and also airborne pollen that is scrubbed from the atmosphere during the frequent convective storms. To argue that this pollen record essentially riparian as opposed to regional is most improbable.

Conclusions

The Pata record shows very clearly that tropical climate change is not a simple switch between glacial and interglacial conditions. From studies of fossil pollen and plant remains in South and Central America, Africa, and Asia, it has become clear that ice ages cannot simply be classified as warm or cold, wet or dry. Ice ages were times of overall cooling in which there occurred warm, dry and wet events that lasted decades to millennia. Simple models portraying any kind of uniform condition will be wrong.

Furthermore, in an area as vast as Amazonia climate change was geographically heterogeneous, so that not all areas would have been experiencing drought, or flood, at the same time. For example, the low lake level event at Pata was between 35,000 and 26,000 BP whereas the low lake event at Carajas was between 26,000 and 15,000 BP.

And then there is the Maicuru dry event that appears to be a combination of both Pata and Carajas, however, whether the Maicuru drying is genuinely different from that of the other lakes, or if it is simply a function of a shallower lake in a drier part of Amazonia, remains to be tested. What is evident from the Hill of Six lakes is that though the three records show subtly different lengths of the driest of late Pleistocene events, the forest is not necessarily greatly altered. For example, the onset of the dry event at Verde is beset by several reversals in the ^{14}C record and cannot be reliably dated after about 40,000 cal. yr BP. However, despite this obviously being a period of low lake level at Verde, the records from Pata and Dragao (within 5 km of Verde) show no significant change in the forest. Thus simply because lake level falls does not mean that forest disappears.

The timing of inferred lake-level at the Hill of Six Lakes fits very well with regional changes in convection (Bush & Silman 2004) and meshes well with speleothem data from Rio de Janeiro (Cruz et al. 2005), and lake level in the High Andes (Baker et al. 2001). In both these extra-Amazonian records climate is driven by wet-season (December-February) precessional forcing, exactly the periodicity of highstands and lowstands observed at Pata (Bush 2005).

In conclusion, we observe that the refugial hypothesis fails on *Assumptions 4-6* and is not supported by available molecular or paleoecological data. Indeed, the latest manifestation of the refugial hypothesis, which relaxes *Assumptions 3 and 4*, and further modifies the matrix separating refugia from savanna to dry forest or riparian corridors (Haffer & Prance 2001), provides no mechanism to engender widespread allopatry and speciation.

If after almost 40 years we refute the refugial hypothesis as an explanation of Amazonian diversity, have we come full circle, and arrived back at the starting position of 1969? We do not believe that is the case. In the last 30 years the scientific community has done exactly what good scientists do, we have tested a good initial hypothesis by gathering a vast amount of data, and then rejected the hypothesis. We know much more about the history of Amazonia, the way that Amazonian climate works, and about the evolutionary history of a broad range of species, than at the start of this quest. We have rejected a simple hypothesis of speciation for a more realistic understanding of the complexity of evolutionary and climatic processes. We understand more about the migration of species, and the transience of tropical plant communities and can apply this new knowledge to the pressing issues of global climate change and conservation biology. But there is so much more to know!

Acknowledgements

This work was supported by National Science Foundation Grants BSR 9007019 and DEB9732951. We are indebted to our long-term collaborator Paul Colinvaux for his support, encouragement and insights. Very sincerely we wish to thank Jurgen Haffer for his visionary hypothesis that has promoted so much research.

References

ABSY, M.L., CLIEF, A., FOURNIER, M., MARTIN, L., SERVANT, M., SIFEDDINE, A., SILVA, F.D., SOUBIÈS, F., SUGUIO, K.T. & VAN DER HAMMEN, T. 1991. Mise en évidence de Quatre phases d'ouverture de la forêt dense dans le sud-est de L'Amazonie au cours des 60,000 dernières années. Première comparaison avec d'autres régions tropicales. Comptes Rendus Academie des Sciences Paris, Series II 312:673-678.

AULER, A. S., WANG, X., EDWARDS, R.L., CHENG, H., CRISTALLI, P.S., SMART, P.L., & RICHARDS, D.A. 2004. Palaeoenvironments in semi-arid northeastern Brazil inferred from high precision mass spectrometric speleothem and travertine ages and the dynamics of South American rainforests. Speleogenesis and Evolution of Karst Aquifers 2:1-4.

AYERS, J. M., & CLUTTON-BROCK, T.H.. 1992. River boundaries and species range size in Amazonian primates. Am. Nat. 140:531-537.

BAKER, P. A., RIGSBY, C.A., SELTZER, G.O., FRITZ, C.S., LOWENSTEIN, T.K., BACHER, N.P., & VELIZ, C. 2001. Tropical climate changes at millennial and orbital timescales on the Bolivian Altiplano. Nature 409:698-701.

BATES, J. M. 2000. Allozymic genetic structure and natural habitat fragmentation: Data for five species of Amazonian forest birds. Condor 102:770-783.

BATES, J. M., HACKETT, S.J., & CRACRAFT, J. 1998. Area-relationships in the Neotropical lowlands: an hypothesis based on raw distributions of Passerine birds. J. Biogeogr. 25:783-794.

BATES, J. M., & ZINK, R.M. 1994. Evolution into the Andes: molecular evidence for species relationships in the genus *Leptopogon*. Auk 111:507-515.

BEVEN, S., CONNER, E.F., & BEVEN, K. 1984. Avian biogeography in the Amazon Basin and the biological model of diversification. J. Biogeogr. 11:383-399.

BROWN, K.S.J. 1987a. Conclusions, synthesis and alternative hypotheses. In Biogeography and Quaternary history in tropical America (T.C. Whitmore & G.T. Prance, eds). Oxford Science Publications, Oxford, p.175-196.

BROWN, K.S.R., JR. 1987b. Biogeography and Evolution of Neotropical Butterflies. In Biogeography and Quaternary history in tropical America (T.C. Whitmore & G.T. Prance, eds). Oxford Science Publications, Oxford, p.66-104.

BUSH, M. B. 2002. On the interpretation of fossil Poaceae pollen in the humid lowland neotropics. Palaeogeogr. Palaeocl. 177:5-17.

BUSH, M.B. 2005. Of orogeny, precipitation, precession and parrots. J. Biogeogr. 32:1301-1302.

BUSH, M.B., MILLER, M.C., DE OLIVEIRA, P.E. & COLINVAUX, P.A. 2002. Orbital forcing signal in sediments of two Amazonian lakes. Journal of Paleolimnology 27:341-352.

BUSH, M.B. & SILMAN, M.R. 2004. Observations on Late Pleistocene cooling and precipitation in the lowland Neotropics. J. Quaternary Sci. 19:677-684.

BUSH, M.B., DE OLIVEIRA, P.E., COLINVAUX, P.A., MILLER, M.C. & MORENO, E. 2004. Amazonian paleoecological histories: one hill, three watersheds. Palaeogeogr. Palaeocl.

BUSH, M.B., STUTE, M., LEDRU, M.-P., BEHLING, H., COLINVAUX, P.A., DE OLIVEIRA, P.E., GRIMM, E.C., HOOGHIEMSTRA, H., HABERLE, S., EYDEN, B.W., SALGADO-LABOURIAU, M.-L. & WEBB, R.. 2001. Paleotemperature estimates for the lowland Americas between 30°S and 30°N at the last glacial maximum. In Interhemispheric Climate Linkages: Present and Past Interhemispheric Climate Linkages in the Americas and their Societal Effects (V. Markgraf, ed.). Academic Press, New York. p.293-306.

BUSH, M.B., WEIMANN, M., PIPERNO, D.R., LIU, K.-B. & COLINVAUX, P.A. 1990. Pleistocene temperature depression and vegetation change in Ecuadorian Amazonia. Quaternary Res. 34:330-345.

CHEPSTOW-LUSTY, A.J., BUSH, M.B., FROGLEY, M.R., BAKER, P.A., FRITZ, S.C. & ARONSON, J. 2005. Vegetation and climate change on the Bolivian Altiplano between 108,000 and 18,000 yr ago. Quaternary Res. 63:90-98.

COLINVAUX, P.A. 1987. Amazon diversity in the light of the paleoecological record. Quaternary Science Rev 6:93-114.

COLINVAUX, P.A. 1989. The past and future Amazon. Scientific American:101-108.

COLINVAUX, P.A., DE OLIVEIRA, P.E., MORENO, J.E., MILLER, M.C. & BUSH, M.B.. 1996. A long pollen record from lowland Amazonia: Forest and cooling in glacial times. Science 274:85-88.

COLINVAUX, P.A., IRION.G., RÄSÄNEN, M.E., BUSH, M.B. & NUNES DE MELLO, J.A.S. 2001. A paradigm to be discarded: geological and paleoecological data falsify the Haffer and Prance refuge hypothesis of Amazonian speciation. Amazoniana 16:609-646.

COLLINS, A. C., AND J. M. DUBACH. 2000. Biogeographic and Ecological Forces Responsible for Speciation in *Ateles*. International J. Primatol. 21:421-444.

CONNELL, J. H. 1978. Diversity in tropical rain forests and coral reefs. Science 199:1302-1310.

COSTA, L.P. 2003. The historical bridge between the Amazon and the Atlantic Forest of Brazil: a study of molecular phylogeography with small mammals. J Biogeogr. 30:71-86.

COYNE, J.A. & ORR, H.A.. 2004. Speciation. Sinauer Associates, Sunderland, Massachussetts.

CRUZ, F.W., JR, BURNS, S.J., KARMANN, I., SHARP, W.D., VUILLE, M., CARDOSO, A.O., FERRARI, J.A., SILVA DIAS, P.L. & VLANA,O. JR. 2005. Insolation-driven changes in atmospheric circulation over the past 116,000 years in subtropical Brazil. Nature 434:63-66.

DE OLIVEIRA, P.E., BARRETO, A.M.F. & SUGUIO, K. 1999. Late Pleistocene/Holocene Climatic and Vegetational History of the Brazilian Caatinga: the fossil dunes of the middle São Francisco River. Palaeogeogr. Palaeocl. 152:319-337.

ENDLER, J.A. 1982. Pleistocene forest refuges: fact or fancy? Pages 641-657 *in* G. T. Prance, editor. Biological diversification in the tropics. Columbia University Press, New York.

FILHO, A.C., SCHWARTZ, D., TATUMI, S.H. & ROSIQUE, T. 2002. Amazonian paleodunes provide evidence for drier climate phases during the late Pleistocene-Holocene. Quaternary Res. 58:205-209.

FRITZ, S.C., BAKER, P.A., LOWENSTEIN, T.K., SELTZER, G.O., RIGSBY, G.A., DWYER, G.S., TAPIA, P.M., ARNOLD, K.K., KU, T.L. & LUO, S. 2004. Hydrologic variation during the last 170,000 years in the southern hemisphere tropics of South America. Quaternary Res. 61:95-104.

GASCON, C., MALCOLM, J.R., PATTON, J.L., DA SILVA, M.N.F., BOGART, J.P., LOUGHEED, S.C., PERES, C.A., NECKEL, S. & BOAG, P.T.. 2000. Riverine barriers and the geographic distribution of Amazonian species. P. Natl. Acad. Sci. USA 97:13672-13677.

GOSLING, W.D. & BUSH, M.B. 2005. A biogeographic comment on: Wüster et al. (2005) Tracing an invasion: landbridges, refugia, and the phylogeography of the Neotropical rattlesnake (Serpentes: Viperidae: Crotalus durissus). J. Mol. Ecol. 14:3615-3617.

HABERLE, S.G. 1997. Late Quaternary vegetation and climate history of the Amazon Basin: correlating marine and terrestrial pollen records. In Proceedings of the Ocean Drilling Program, scientific results (R.D. Flood, D.J.W. Piper, A. Klaus & L.C. Peterson, eds). Ocean Drilling Program, College Station, Texas. p.381-396.

HAFFER, J. 1969. Speciation in Amazonian forest birds. Science 165:131-137.

HAFFER, J. 1974. Avian Speciation in Tropical South America. Nuttall Ornithological Club, Harvard University, Cambridge.

HAFFER, J. 1985. Avian Zoogeography of the Neotropical lowlands. Ornithological Monographs 36:113-146.

HAFFER, J. 1991. Avian species richness in tropical South America. Studies in Neotropical Fauna and Environment 25:157-183.

HAFFER, J. & PRANCE, G.T. 2001. Climatic forcing of evolution in Amazonia during the Cenozoic: On the refuge theory of biotic differentiation. Amazoniana 16:579-608.

HOORN, C., GUERRERO, J., SARMIENTO, G.A. & LORENTE, M.A. 1995. Andean tectonics as a cause for changing drainage patterns in Miocene northern South America. Geology 23:237-240.

HOVIKOSKI, J., RÄSÄNEN, M., GINGRAS, M., RODDAZ, M., BRUSSET, S., HERMOZA, W., ROMERO PITTMAN, L. & LERTOLA, K. 2005. Miocene semidiurnal tidal rhythmites in Madre de Dios, Peru. Geology 33:177-180.

JACOBSON, G.L. & BRADSHAW, R.H.W. 1981. The selection of sites for paleovegetational studies. Quaternary Res. 16:80-96.

KNAPP, S. & MALLETT, J. 2003. Refuting refugia? Science 300:71-72.

LEDRU, M.P., CORDEIRO, R.C., LANDIM, J.M., MARTIN, L., MOURGUIART, P., SIFEDDINE, A. & TURCQ, B. 2001. Late-glacial cooling in Amazonia inferred from pollen at Lagoa do Caçó, Northern Brazil. Quaternary Res. 55:47-56.

LIU, K. & COLINVAUX, P.A. 1985. Forest changes in the Amazon Basin during the last glacial maximum. Nature 318:556-557.

LIVINGSTONE, D.A. 1967. Postglacial vegetation of the Ruwenzori Mountains in equatorial Africa. Ecol. Monogr. 37:25-52.

MAYR, E. & O'HARA, R.J. 1986. The biogeographic evidence supporting the Pleistocene forest refuge hypothesis. Evolution 40:55-67.

MCLACHLAN, J.S. & CLARK, J.S. 2005. Molecular indicators of tree migration capacity under rapid climate change. Ecology 86:2088-2098.

MORITZ, C., PATTON, J.L., SCHNEIDER, C.J. & SMITH, T,B. 2000. Diversification of rainforest faunas: An integrated molecular approach. Annu. Rev. Ecol. Syst. 31:533-563.

NELSON, B.W., FERREIRA, C.A.C., DA SILVA, M.F. & KAWASAKI, M.L.. 1990. Endemism centers, refugia and botanical collection density in Brazilian Amazonia. Nature 345:714-716.

NORES, M. 1999. An alternative hypothesis for the origin of Amazonian bird diversity. J. Biogeogr. 26:475-485.

PATTON, J.L., DA SILVA, M.N.F. & MALCOLM, J.R. 1994. Gene genealogy and differentiation among arboreal spiny rats (Rodentia: Echymidae) of the Amazon Basin: a test of the riverine barrier hypothesis. Evolution 48:1314-1323.

PATTON, J.L., DA SILVA, M.N.F. & MALCOLM, J.R. 2000. Mammals of the Rio Juruá and the evolutionary and ecological diversification of Amazonia. Bulletin of the American Museum of Natural History 244.

PRANCE, G.T. 1982. Biological Diversity in the Tropics. Columbia University Press, New York.

PRENTICE, I.C. 1985. Pollen representation, source area, and basin size: Toward a unified theory of pollen analysis. Quaternary Res. 23: 76-86.

RÄSÄNEN, M.E., LINNA, A.M., SANTOS, J.C.R. & NEGRI, F.R. 1995. Late Miocene tidal deposits in the Amazon foreland basin. Science 269:386-390.

RICKLEFS, R.E. 1987. Community Diversity: Relative Roles of Local and Regional Processes. Science 235:167-171.

ROSENZWEIG, M.L. & SANDLIN, E.A.. 1997. Species diversity and latitudes: listening to area's signal. Oikos 80:172-176.

SIFEDDINE, A., MARTIN, L., TURCQ, B., VOLKMER-RIBEIRO, C., SOUBIES, F., CORDEIRO, R.C. & SUGUIO, K.. 2001. Variations of the Amazonian rainforest environment: A sedimentological record covering 30,000 years. Palaeogeogr. Palaeocl. 168:221-235.

VAN DER HAMMEN, T. 1974. The Pleistocene changes of vegetation and climate in tropical South America. J Biogeogr 1:3-26.

VAN DER HAMMEN, T. & GONZÁLEZ, E. 1959. Historia de clima y vegetación del Pleistocene Superior y del Holoceno de la Sabana de Bogotá y alrededeores. Dept. Cundinamarca. Official Report of the Servicio Geologico Nacional, Bogotá.

VANZOLINI, P.E. 1970. Zoologia sistematica, geografia e a origem das especies. Instituto Geografico São Paulo. Serie Teses e Monografias 3:1-56.

WALLACE, A.R. 1852. On the monkeys of the Amazon. P Zool. Soc. Lon. 20:107-110.

WWF. 2003. Ecoregions. *in*. World Wildlife Fund.

ZINK, R.M., KLICKA, J. & BARBER, B.R. 2004. The tempo of avian diversification during the Quaternary. Philosophiocal Transactions of the Royal Society, London. ser. B 359:215-220.

ZINK, R.M. & SLOWINSKI, J.B. 1995. Evidence from molecular systematics for decreased avian diversification in the Pleistocene Epoch. P. Natl. Acad. Sci. USA 92:5832-5835.

Title: The rise and fall of the Refugial Hypothesis of Amazonian Speciation: a paleoecological perspective.

Authors: Mark B. Bush & Paulo E. de Oliveira

Biota Neotropica, Vol. 6 (number 1): 2006
http://www.biotaneotropica.org.br/v6n1/pt/abstract?point-of-view+bn00106012006

Date Received 05/12/2005 - Revised 10/20/2005
Accepted 01/01/2006

ISSN 1676-0611

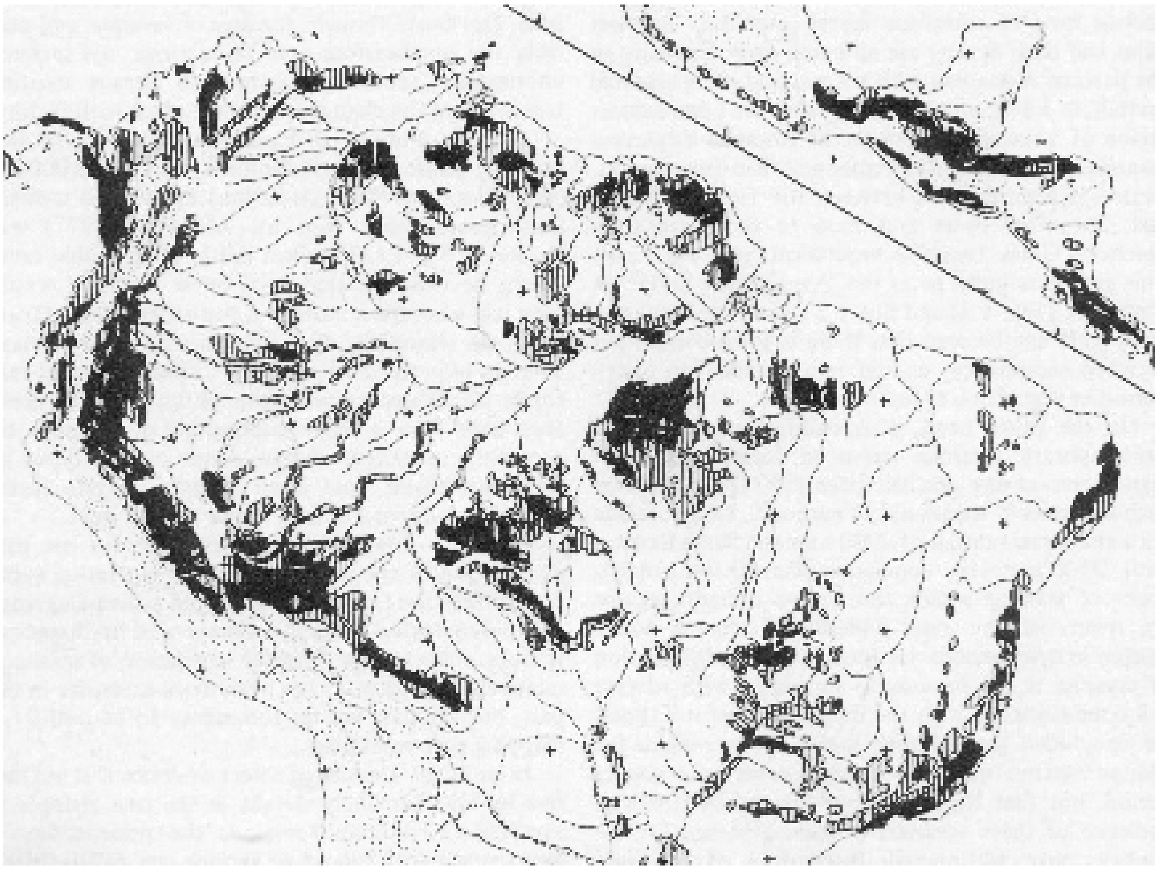
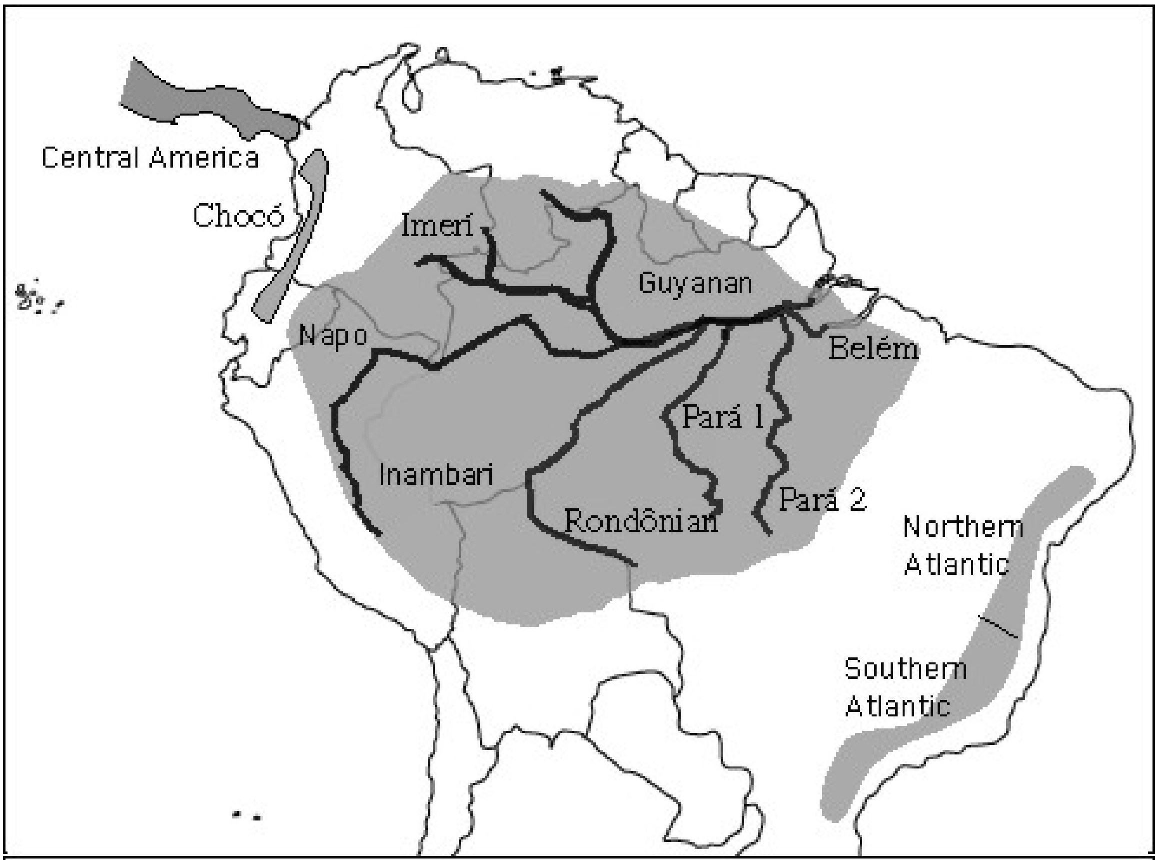


Figure 1. The Proposed distribution of refugia based on the overlap of postulated refugia for birds, butterflies and plants, taking into account soils and precipitation. Shading represents probability of locations being refugial. Black = 100-80% certainty, grey 60-80% certainty (Brown, 1987) reproduced from Whitmore, T.C. and Prance, G.T. Biogeography and Quaternary History in Tropical America. Blackwell Scientific (Publications; with permission).



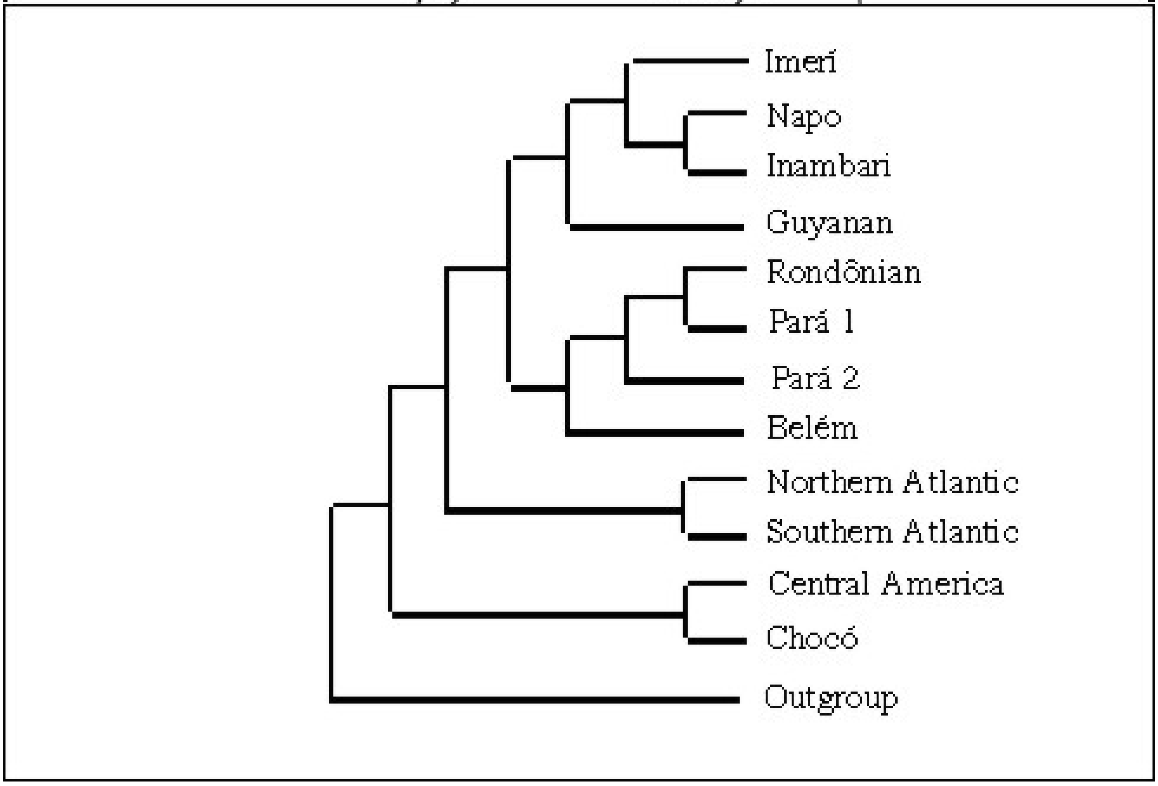


Figure 2a. The major biogeographic regions of Amazonia (after Haffer 1974).

Figure 2b. A typical pattern to emerge from cladistic analyses. There are many subtle variations, but this pattern holds as a generalization that would typify many analyses (Bates et al. 1998, Bush, 2005 #155).

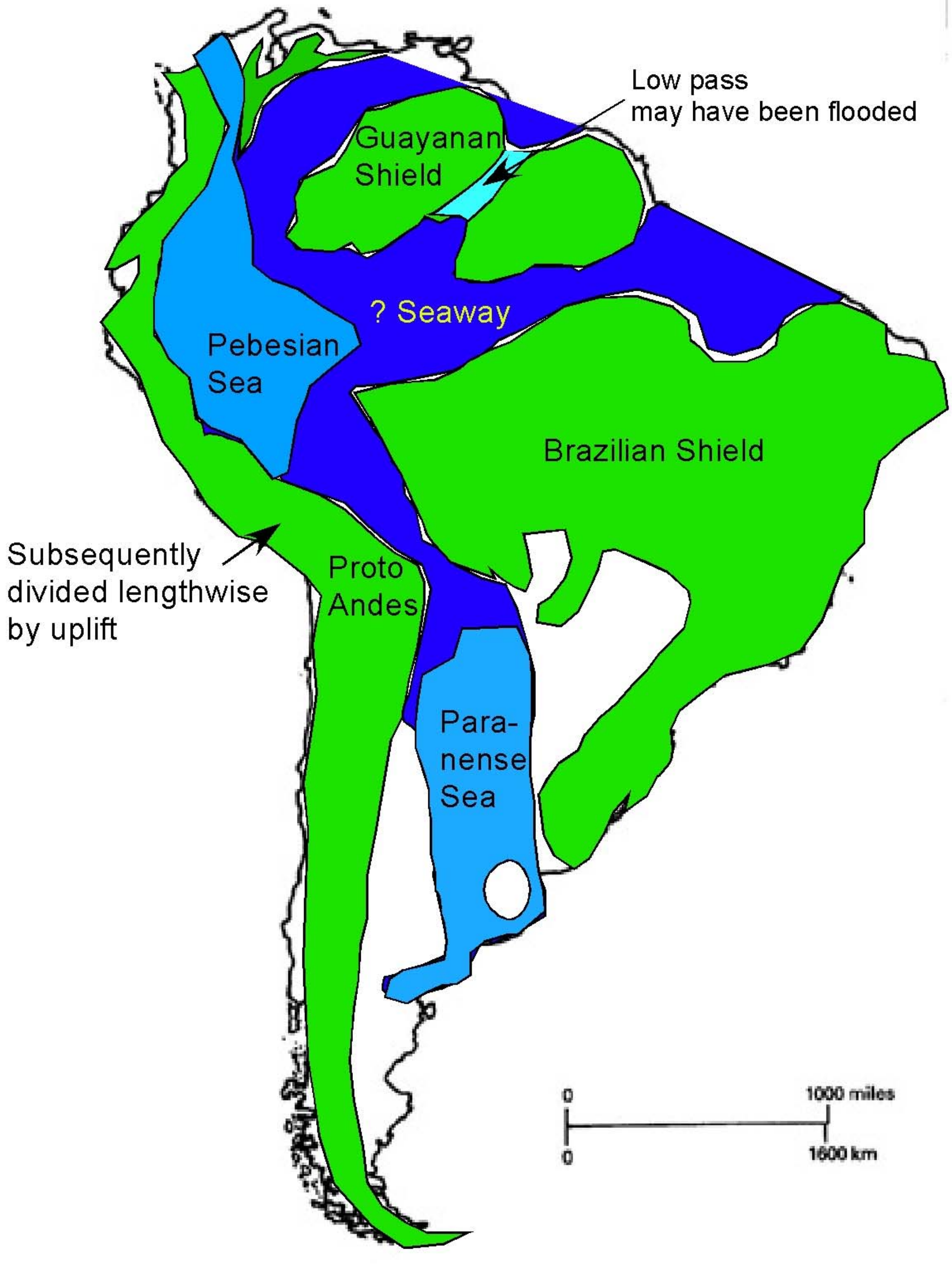


Figure 3. Miocene landscapes and epicontinental seas. Considerable uncertainty exists surrounding the formation and connectivity of the seas, but it is clear that these were large water bodies that broke up the Miocene forests (after Räsänen et al. 1995, Nores 1999).

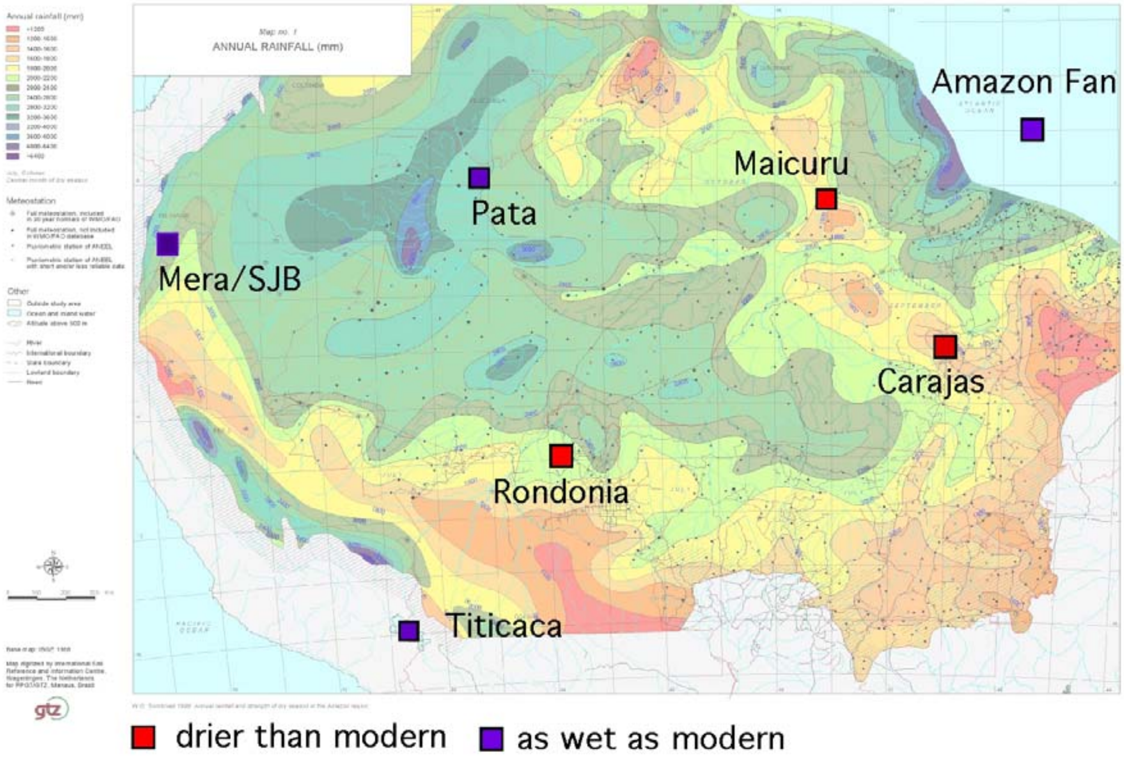


Figure 4. Sketch map showing the location of paleoecological sites discussed relative to modern precipitation.

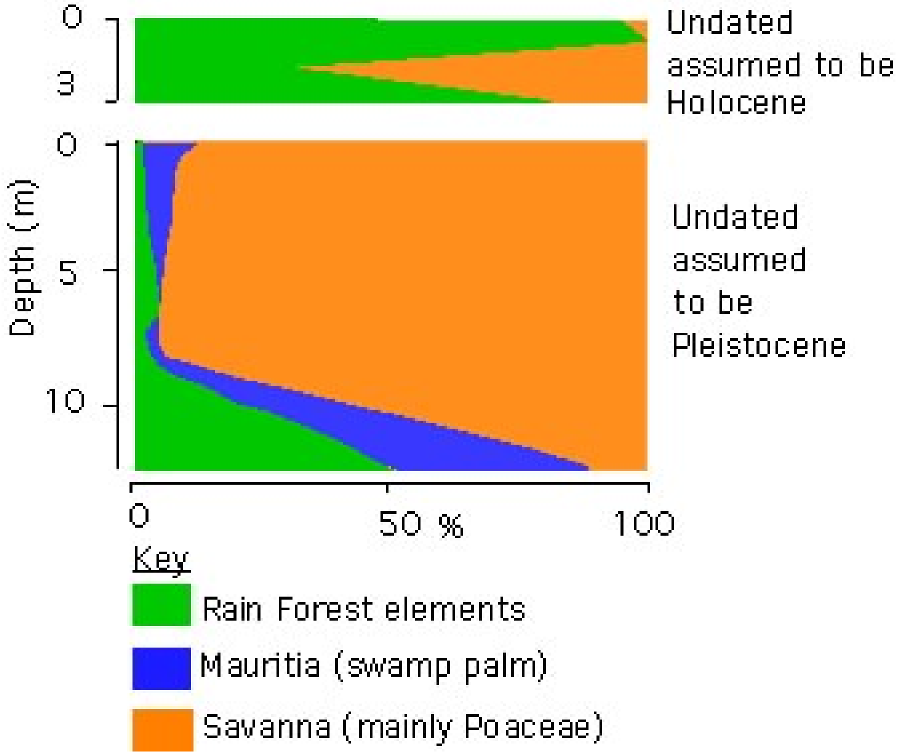


Figure 5. Summary pollen diagram from Rondônia, Brazil (40). A more detailed version has not been published (after van der Hammen 1974).

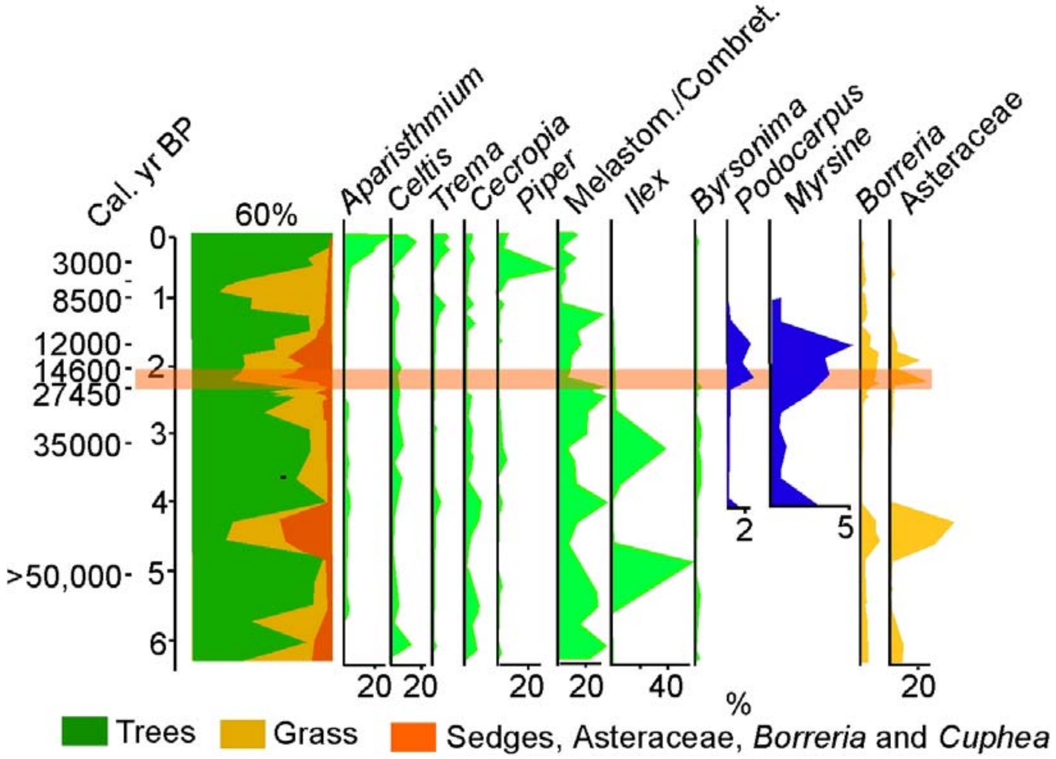


Figure 6. Pollen diagram from Carajas, Brazil (After Absy et al. 1991, Ledru et al. 2001). Taxa highlighted in blue are taken to indicate cooling (Ledru et al. 2001). Anorange line denotes the hiatus in sedimentation.

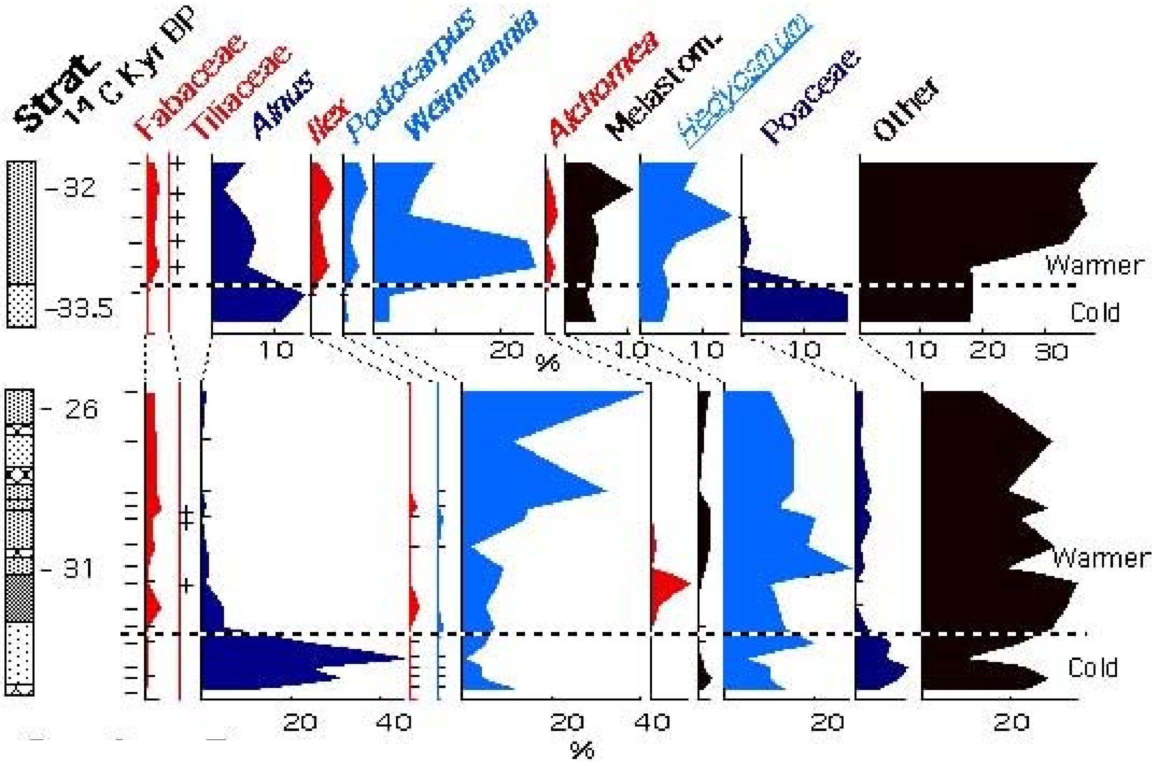


Figure 7. Fossil pollen data from Mera (1100 m elevation; upper panel) and San Juan Bosco (970 m elevation; lower panel), Ecuador. Color coding indicates species taxa that would have descended >1000 m to be common at this elevation (dark blue), taxa that would have descended < 1000 m to be found at this elevation (pale blue), and taxa that did not need to migrate (red). Poaceae are shown as dark blue because the phytoliths from these samples were from non-bambusoid C3 grasses (after Bush et al. 1990).

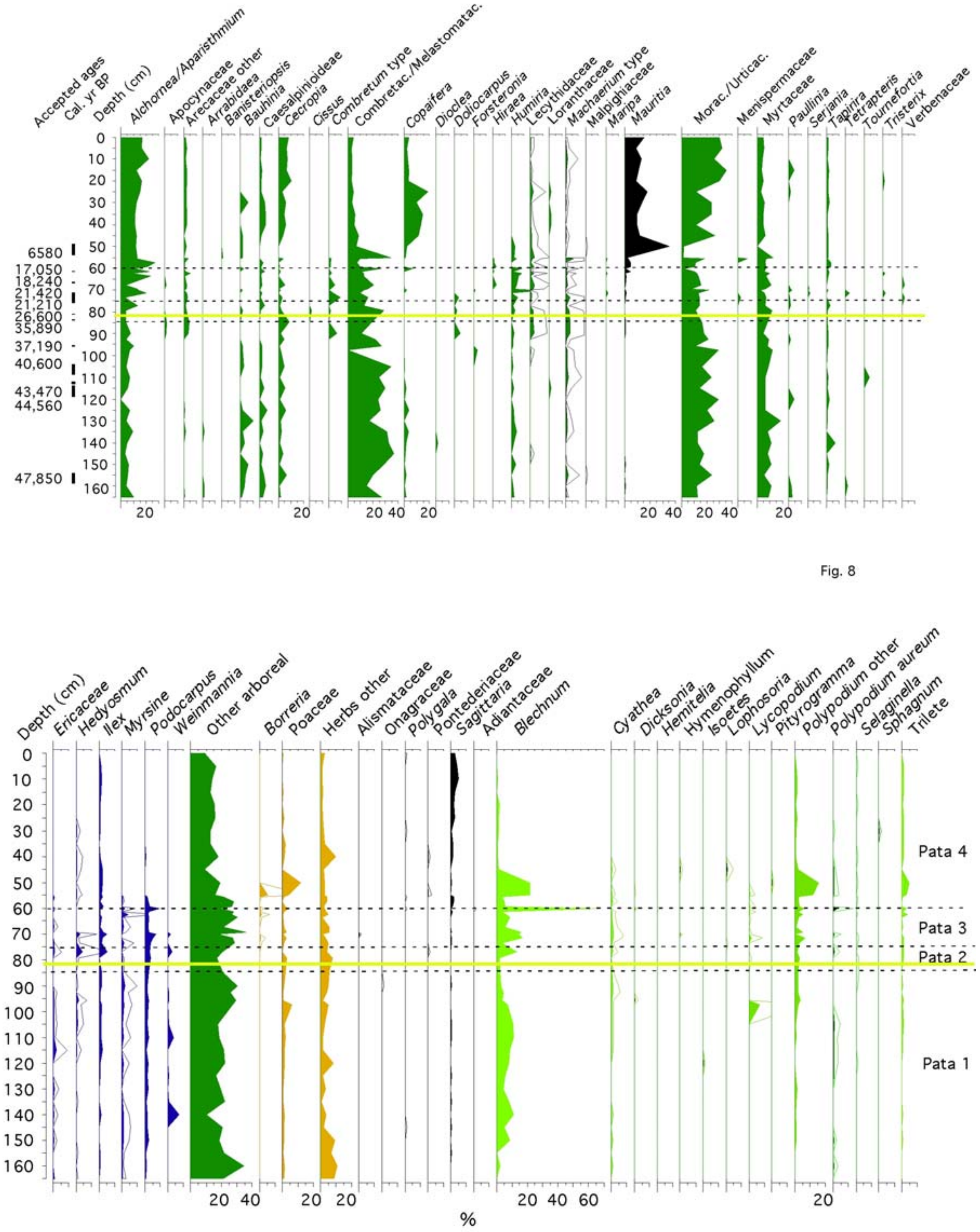


Fig. 8

Figure 8. The fossil pollen record for Lake Pata, Hill of Six Lakes, Brazil. A >50,000 year record from the upper 2 m of a 5 m core showing continuous forest cover and invasion by cool elements in the glacial maximum. Forest elements in green, ferns in pale green, swamp taxa in black, open ground species in brown and cold elements in blue. A dry episode is recorded in which lake level fell between c. 35,000 and 23,000 yr BP, marked by the yellow line. At this time the lake was reduced in size, but the forest still surrounded it.

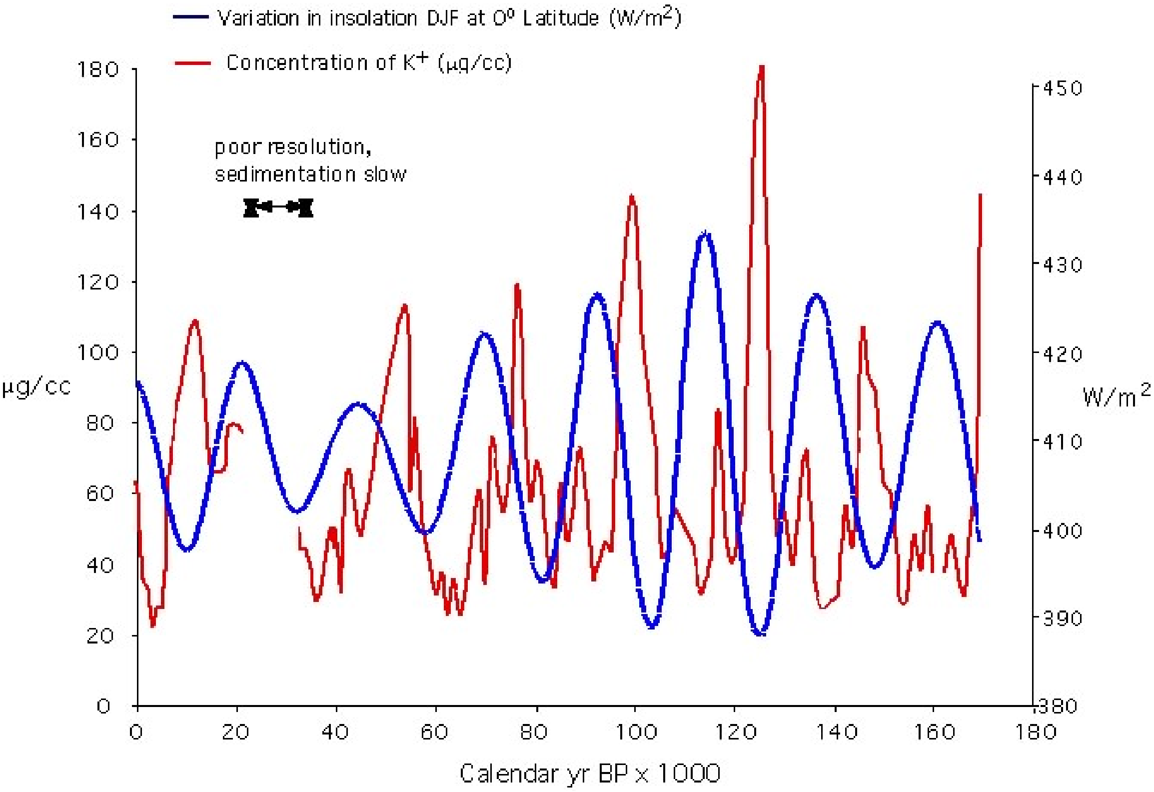


Figure 9. Evidence of precessional rhythms in the sediments of Lake Pata. The full 5 m long core yields regular peaks of K+ that coincide with layers of algal mud, that appear to follow a precessional rhythm for the last 170,000 years. Peaks of K+ are due suggested to be biogenic accumulation (not evaporation) during lowstands (after Bush et al. 2002).

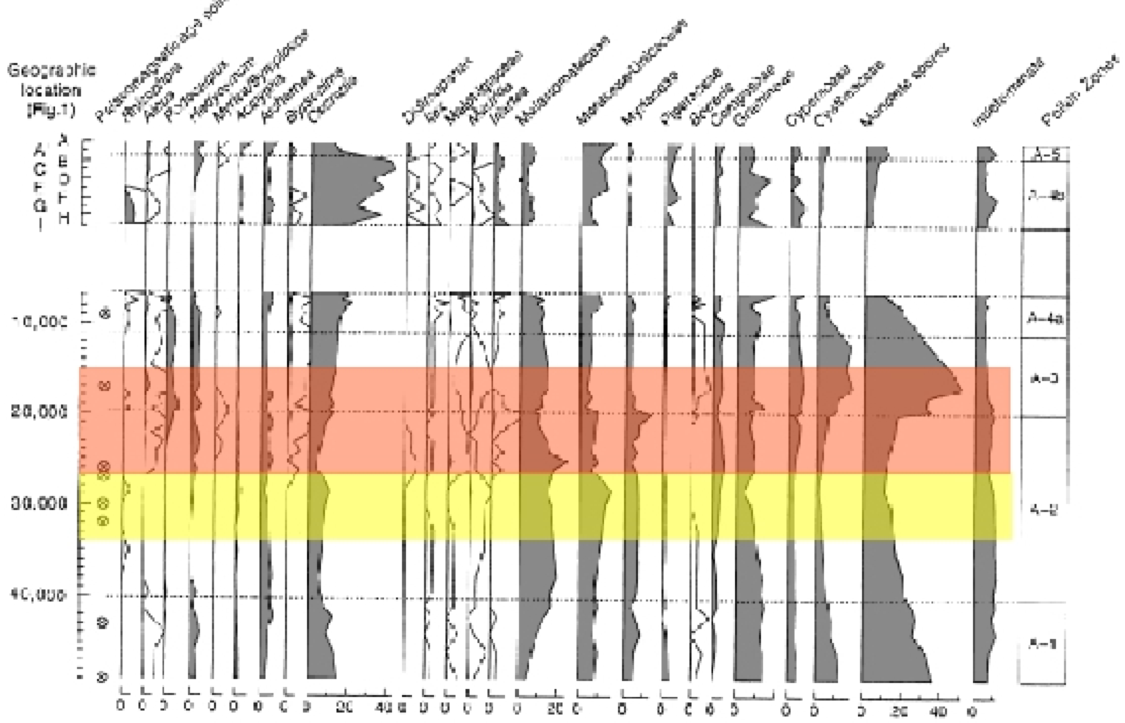


Figure 10. Pollen data from modern Amazonian river muds (upper panel) and from ice age deposits of the Amazon Fan (after Haberle et al. 1997). Poaceae pollen abundance does not change throughout this record strongly suggesting that there was little change in the areal extent of savanna. Driest period at Pata indicated by yellow bar, and at Carajas by orange bar.

Seleção de epífitas acumuladoras de elementos químicos na Mata Atlântica

Camila Elias, Elisabete A. De Nadai Fernandes, Elvis Joacir De França & Márcio A. Bacchi

Biota Neotropica v6 (n1) – http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn02106012006

Recebido em 11/08/05
Versão Modificada recebida 15/01/2006
Publicado em 17/02/06

Centro de Energia Nuclear na Agricultura, Universidade de São Paulo, Caixa Postal 96, 13400-970 Piracicaba, SP, Brasil.

Abstract

Elias, C.; De Nadai Fernandes, E.A.; França, E.J. and Bacchi, M.A. **Selection of epiphytes as accumulators of chemical elements in the Atlantic Forest.** *Biota Neotrop*. Jan/Abr 2006 vol. 6, no. 1, http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn02106012006. ISSN 1676-0603

Epiphytes are efficient indicators of atmospheric pollution because of their direct uptake of chemical elements from atmosphere. Leaves from eleven species of bromeliads and one species of orchid were collected in the Parque Estadual Carlos Botelho, SP, for determination of sixteen chemical elements. The selection of the best biomonitor species was based on the diversity and accumulation of chemical elements in the leaves. With an average accumulation index of 0.7, *Canistropsis billbergioides* has potential to be used as a biomonitor of chemical elements in the Atlantic Forest.

Key words: *INAA, Atlantic Forest, bromeliads, epiphytes, chemical elements*

Resumo

Elias, C.; De Nadai Fernandes, E.A.; França, E.J. and Bacchi, M.A. **Seleção de epífitas acumuladoras de elementos químicos na Mata Atlântica.** *Biota Neotrop*. Jan/Abr 2006 vol. 6, no. 1, http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn02106012006. ISSN 1676-0603

Epífitas são eficientes indicadores de poluição atmosférica devido à absorção de elementos químicos diretamente da atmosfera. Folhas de onze espécies de bromélias e uma espécie de orquídea foram coletadas no Parque Estadual Carlos Botelho, SP, para a determinação de dezesseis elementos químicos. A seleção foi baseada na diversidade e acumulação de elementos químicos encontrados nas folhas. Com um índice de acumulação de 0,7, a espécie *Canistropsis billbergioides* tem potencial para ser empregada como biomonitora de elementos químicos na Mata Atlântica.

Palavras-chave: *INAA, Mata Atlântica, bromélias, epífitas, elementos químicos*

Introdução

Organismos biomonitores podem ser utilizados para avaliar o impacto da poluição atmosférica em ecossistemas, permitindo estudar amplas áreas com a vantagem de esforço amostral reduzido (Wolterbeek 2002). Para tal avaliação, espécies podem ser selecionadas a partir da capacidade acumuladora de elementos químicos (Luoma & Rainbow 2005). A biomonitração pode ser passiva, quando o organismo empregado é nativo da área a ser avaliada, ou ativa, quando o biomonitor é transferido para o local (Markert 1991).

Organismos epifíticos não apresentam contato direto com o solo e formam um compartimento especial do ecossistema no contexto de estudos de ciclagem de elementos químicos. No caso de florestas tropicais, a aplicação desses organismos é recomendada dada a grande diversidade de espécies epifíticas, incluindo as famílias Bromeliaceae e Orchidaceae. Dentre as espécies biomonitoras de poluição, a bromeliácea *Tillandsia usneoides* já vem sendo utilizada, principalmente devido à sua adaptação morfológica para retirada de nutrientes da atmosfera por meio de escamas (Calasans et al. 1997, Pyat et al. 1999, Figueiredo et al. 2001). De acordo com os levantamentos fitossociológicos realizados nos principais tipos vegetacionais estudados no Projeto Temático BIOTA "Diversidade, Dinâmica e Conservação em Florestas do Estado de São Paulo: 40 ha de Parcelas Permanentes", a família Bromeliaceae é uma das mais freqüentes, apresentando grande diversidade de espécies, principalmente na Parcela Permanente do Parque Estadual Carlos Botelho PECB (Breier et al. 2002).

O caráter conservacionista da pesquisa em parcelas permanentes não recomenda a introdução de uma espécie exótica como *Tillandsia usneoides*, já que essa espécie não ocorre naturalmente no interior da floresta (Breier et al. 2002). Aproveitando-se da biodiversidade existente para gerar conhecimentos a serem revertidos para a sua própria preservação, a seleção de epífitas nativas da região com capacidade de acumulação promove a sustentabilidade da pesquisa científica em unidades de conservação, possibilitando seu emprego em estudos de biomonitoração de elementos químicos em ecossistemas naturais. Baseando-se na biomonitoração empregando folhas das espécies arbóreas mais relevantes, baixo nível de poluição foi encontrado na Parcela Permanente do PECB, embora algumas árvores tenham apresentado concentrações apreciáveis de elementos relacionados com a poluição atmosférica, como é o caso de bromo, cobalto e zinco (França et al. 2004). Desse modo, o presente trabalho teve como objetivo selecionar espécie epifítica nativa da Parcela Permanente do PECB com capacidade de acumulação de elementos químicos.

Material e Métodos

No Núcleo Sete Barras do PECB, uma parcela permanente de 10 ha foi instalada no contexto do projeto temático. Espécies epifíticas foram estudadas e identificadas no interior da Parcela Permanente (Breier et al. 2002) permitindo a utilização dos dados fitossociológicos para o desenvolvimento deste trabalho.

Foram amostrados 23 indivíduos completos de epífitas (Tabela 1) pertencentes à família Bromeliaceae (11 espécies) e à família Orchidaceae (1 espécie) no final do período fértil nas trilhas perimetrais da parcela permanente. Tipicamente, as bromélias estavam localizadas no sub-bosque, sendo também encontradas em clareiras naturais. A amostragem foi efetuada no entorno da área, de modo a não retirar indivíduos da parcela permanente. Paralelamente, pranchas com o material coletado foram preparadas para posterior identificação no herbário da Escola Superior de Agricultura Luiz de Queiroz (ESALQ/USP). Algumas espécies tiveram mais indivíduos coletados, como é o caso de *Canistropsis billbergioides* e *Billbergia amoema*, reflexo de suas abundâncias na área.

Todas as folhas foram lavadas com água de torneira, seguindo-se secagem em estufa à 60^{o}C até peso constante e redução de granulometria (0,5 mm) em moinho de rotor de titânio. Porções das amostras com aproximadamente 200 mg foram transferidas para cápsulas de polietileno de elevada pureza, fabricadas pela Vrije Universiteit, Amsterdã. A técnica de análise por ativação neutrônica instrumental (INAA) foi empregada na avaliação da composição química. A INAA é baseada no bombardeamento da amostra com nêutrons para a produção de radionuclídeos, sendo que a medição da radioatividade induzida permite a quantificação dos elementos. Para avaliar a qualidade do procedimento analítico, adicionaram-se porções de 300 mg dos materiais de referência certificados IAEA-336 *Lichen* e INCT-TL-1 *Tea Leaves*. Como monitores de fluxo de nêutrons foram empregados fragmentos de uma liga de Ni-Cr com massa aproximada de 10 mg (França et al. 2003).

As amostras, materiais de referência certificados e monitores de fluxo foram irradiados com nêutrons térmicos por período de 8 horas no reator nuclear de pesquisa IEA-R1m do Instituto de Pesquisas Energéticas e Nucleares, da Comissão Nacional de Energia Nuclear (IPEN/CNEN), São Paulo. A medição da radioatividade induzida foi realizada no Laboratório de Radioisótopos (LRi - CENA/USP) por meio de detectores de germânio hiperpuro, sendo dois coaxiais, com 45 e 50% de eficiência relativa, e um do tipo poço. Após a análise dos espectros de radiação gama, foram calculadas as concentrações dos elementos químicos nas amostras e nos materiais de referência certificados por método paramétrico k_0 (Bacchi et al. 2000) a partir do pacote computacional Quantu (Bacchi et al. 2003).

A avaliação das epífitas ocorreu pela diversidade de elementos químicos encontrados e a acumulação nas folhas. O método utilizado para medir a acumulação refere-se à computação de índices variando de 0 a 1 conforme comparação entre a concentração do elemento químico i para a espécie j e a concentração média do elemento químico i ($C_{ij} \geq \bar{x}_i$, índice $= 1$; $C_{ij} < \bar{x}_i$, índice $= 0$).

Empregando a função “Resampling Stats” do software EXCEL, foi realizada a aleatorização com substituição (Bootstrap) dos índices de acumulação obtidos (Manly 2004). De maneira resumida, a partir da geração de 10000 amostras simuladas, o método permite a realização de inferência sobre a média populacional e o cálculo de intervalos de confiança (95%).

Resultados e Discussão

Os resultados de concentração dos elementos químicos determinados nos materiais de referência certificados estão dentro das faixas de incerteza (Tabela 2), comprovando a qualidade do procedimento analítico adotado para a determinação de 16 elementos químicos nas amostras.

As concentrações encontradas nas folhas estão na Tabela 3. Concentração de K na ordem de 40000 mg kg^{-1} foi determinada em folhas da espécie *Billbergia amoema*, enquanto a máxima concentração observada em folhas de espécies arbóreas coletadas na área foi 25000 mg kg^{-1} (França et al. 2005). Este fato é indicativo de considerável fonte atmosférica do elemento para o ecossistema. Contudo, a concentração de K está, em geral, na faixa esperada de 5000 a 34000 mg kg^{-1} proposta por Markert (1998).

As espécies *Aechmea coelestis*, *Nidularium* cf. *inocentii*, *Nidularium krisgreeniae* e *Vriesea carinata* apresentaram altas concentrações de Br, enquanto concentração elevada de Na foi detectada nas espécies *Canistropsis billbergioides* e *Vriesea vagans*. As altas concentrações de Br e Na podem ser explicadas pela influência marinha (França et al. 2004), pois a parcela permanente está na vertente atlântica da Serra do Paranapiacaba, e há a predominância de ventos oceânicos. Verifica-se concentração acima de 40 mg kg^{-1} do elemento Zn na espécie *C. billbergioides*, podendo destacar poluição atmosférica já que o elemento, na maioria das vezes, possui origem antrópica (Wedepohl 1970). Elementos químicos de importância ambiental como Ba, Hg e Se também foram encontrados nas folhas de *C. billbergioides*, assim como nas folhas das espécies arbóreas da parcela (Ferrari et al. 2003).

A espécie *Canistropsis billbergioides* apresentou o maior índice de acumulação de elementos químicos em suas folhas (Figura 1). Após refinamento, pela simulação de 10000 amostras “bootstrap” (Figura 2), a espécie *Billbergia amoema* também apresentou elevado índice de acumulação. Este tipo de procedimento estatístico pode ser aplicado somente para espécies com mais de dois indivíduos analisados. Embora *B. amoema* seja uma espécie de bromélia tipo tanque (reservatório de água), não foi encontrada relação entre essa característica e a acumulação de elementos químicos nas demais espécies tanque (por exemplo, *Nidularium* sp. e *Aechmea* sp.). Escolheu-se *C. billbergioides* devido à sua abundância e facilidade na coleta da espécie no sub bosque da floresta.

Por ser freqüentemente utilizada em estudos de biomonitoração, a espécie *Tillandsia usneoides* foi comparada à espécie selecionada *C. billbergioides* (Tabela 4). Os resultados de *T. usneoides* referentes ao indivíduo controle cultivado em casa de vegetação do Instituto de Botânica/SMA de São Paulo, ou seja, material desprovido de qualquer tipo de contaminação (Figueiredo et al. 2004), mostraram concentrações similares a *C. billbergioides*. Os resultados de Sc indicam que *T. usneoides* não foi lavada, uma vez que este elemento químico é considerado traçador de terra contaminante em plantas (Wyttenbach & Tobler 1998). A presença de terra pode contribuir para o aumento na concentração de alguns elementos. Baseando-se no fato da acumulação de elementos químicos ser fator fundamental para a elegibilidade de um organismo biomonitor, *C. billbergioides* pode potencialmente ser utilizada como organismo biomonitor na parcela permanente do PECB, produzindo resultados comparáveis a *T. usneoides*.

Concluindo, dentre as espécies de epífitas avaliadas, *Canistropsis billbergioides* mostrou-se promissora para a biomonitoração de elementos químicos na Mata Atlântica, tendo como vantagens o fato de ser nativa da região e a sua abundância no sub bosque.

Agradecimento

Os autores agradecem à Fundação de Amparo à Pesquisa do Estado de São Paulo–FAPESP pelo auxílio concedido (Processo 04/11023-8).

Referências Bibliográficas

BACCHI, M.A., FERNANDES, E.A.N., OLIVEIRA, H. 2000. Brazilian experience on k_0 standardized neutron activation analysis. J. Radioanal. Nucl. Chem. 245:217-222.

BACCHI, M.A., FERNANDES, E.A.N., OLIVEIRA, H. 2003. Quantu – design and development of a software package dedicated to k_0-standardized NAA. J. Radioanal. Nucl. Chem. 257:577-582.

BREIER, T.B., SEMIR, J., RODRIGUES, R.R. 2002. Diversidade e estrutura do componente epifítico vascular em quatro formações florestais do Estado de São Paulo. In III Simpósio do Programa Biota-Fapesp. Apresentações orais. Universidade Federal de São Carlos, São Carlos, p.289-291.

CALASANS, C.F., MALM, O. 1997. Elemental mercury contamination survey in a chlor-alkali plant by the use of transplanted Spanish moss, *Tillandsia usneoides* (L.). Sci. Total Environ. 208:165-177.

FERRARI, A.A., DE NADAI FERNANDES, E.A., FRANÇA, E.J., BACCHI, M.A. 2003. Influência da contaminação superficial nos teores de mercúrio em folhas de espécies arbóreas da Mata Atlântica. In 11º Simpósio Internacional de Iniciação Científica da Universidade de São Paulo. Resumos. Universidade de São Paulo, Piracicaba, CD-Rom.

FIGUEIREDO, A.M.G., SAIKI, M., TICIANELLI, R.B., DOMINGOS, M., ALVES, E.S., MARKET, B. 2001. Determination of trace elements in *Tillandsia usneoides* by neutron activation analysis for environmental biomonitoring. J. Radioanal. Nucl. Chem. 249:391-395.

FIGUEIREDO, A.M.G., ALCALÁ, A.L., TICIANELLI, R.B., DOMINGOS, M., SAIKI, M. 2004. The use of *Tillandsia usneoides* L. as bioindicator of air pollution in São Paulo, Brazil. J. Radioanal. Nucl. Chem. 259:59-63.

FRANÇA, E.J., DE NADAI FERNANDES, E.A., BACCHI, M.A. 2003. Ni-Cr alloy as neutron flux monitor: composition and homogeneity assessment by NAA. J. Radioanal. Nucl. Chem. 257:113-115.

FRANÇA, E.J., DE NADAI FERNANDES, E.A., BACCHI, M.A., SAIKI, M. 2004. Native trees as biomonitors of chemical elements in the biodiversity conservations of the Atlantic Forest. J. Atmos. Chem. 49:579-592.

FRANÇA, E.J., DE NADAI FERNANDES, E.A., BACCHI, M.A., RODRIGUES. R.R., VERBURG, T.G. 2005. Inorganic chemical elements of native trees of the Atlantic Forest. Environ. Monit. Assess. 102:349-357.

LUOMA, S.N., RAINBOW, P.S. 2005. Why is metal bioaccumulation so variable? Biodynamics as a unifying concept. Environ. Sci. Tech. 39(7): 1921-1931.

MANLY, B. F. J. 2004. Randomization, bootstrap and Monte Carlo methods in Biology, New Zealand: University of Otago, 330p.

MARKERT, B. 1991. Inorganic chemical investigations in the Forest Biosphere Reserve near Kalinin, USSR. I. Mosses and peat profiles as bioindicators for different chemical elements. Vegetatio. 95:127-135.

MARKERT, B. 1998. Distribution and biogeochemistry of inorganic chemicals in the environment. In: SHÜÜRMANN, G., MARKERT, B. (eds) Ecotoxicology. John Wiley & Sons, Amsterdam, p.165-222.

PYATT, F.B., GRATTAN, J.P., LACY, D., PYATT, A.J., SEAWARD, M.R.D. 1999. Comparative effective of *Tillandsia usneoides* L. and *Parmotrema praesorediosum* (NYL.) Hale as bioindicators of atmospheric pollution in Lousiana (USA). Water, Air, Soil Pollut. 111:317-326.

WEDEPOHL, K.H. 1970. Handbook of Geochemistry – II. Springer Verlag, Berlim-Heidenberg.

WOLTERBEEK, B. 2002. Biomonitoring of trace element air pollution: principles, possibilities and perspectives. Environ. Pollut. (Amsterdam, Neth.). 120:11-21.

WYTTENBACH, A., TOBLER, L. 1998. Effect of surface contamination on results of plant analysis. Commun. Soil Sci. Plant Anal. 29:809-823.

Título: Seleção de epífitas acumuladoras de elementos químicos na Mata Atlântica

Autores: Camila Elias, Elisabete A. De Nadai Fernandes, Elvis Joacir De França & Márcio A. Bacchi

Biota Neotropica, Vol. 6 (number 1): 2006
http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn02106012006

Recebido em 11/08/05 - Recebido em 15/01/2006
Publicado em 17/02/06

ISSN 1676-0603

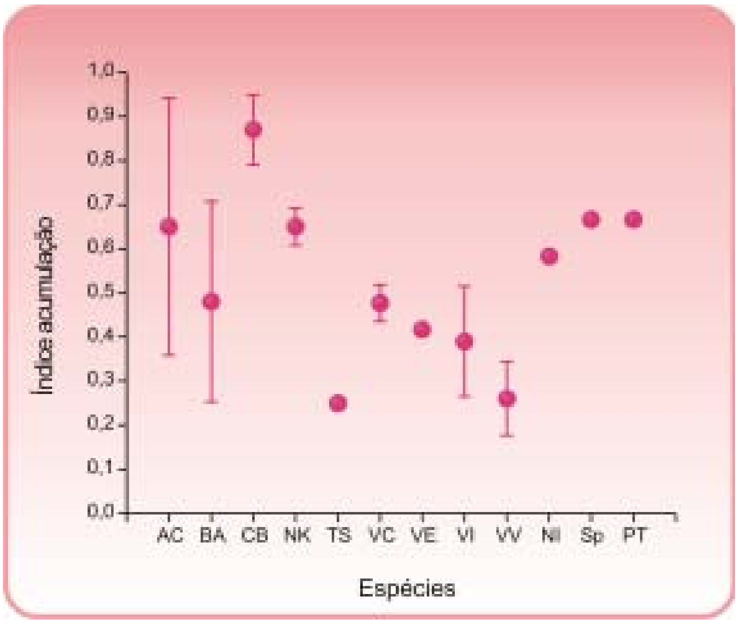


Figura 1. Comparação dos índices de acumulação de elementos químicos nas bromélias avaliadas. AC = Aechmea coelestis, BA = Billbergia amoema, CB = Canistropsis billbergioides, Sp = espécie não determinada, NI = Nidularium cf. inocentii, NK = Nidularium krisgreeniae, PT = Phymatidium cf. tillandsoides, TS = Tillandsia stricta, VC = Vriesea carinata, VE = Vriesea ensiformis, VI = Vriesea incurvata, VV = Vriesia vagans.

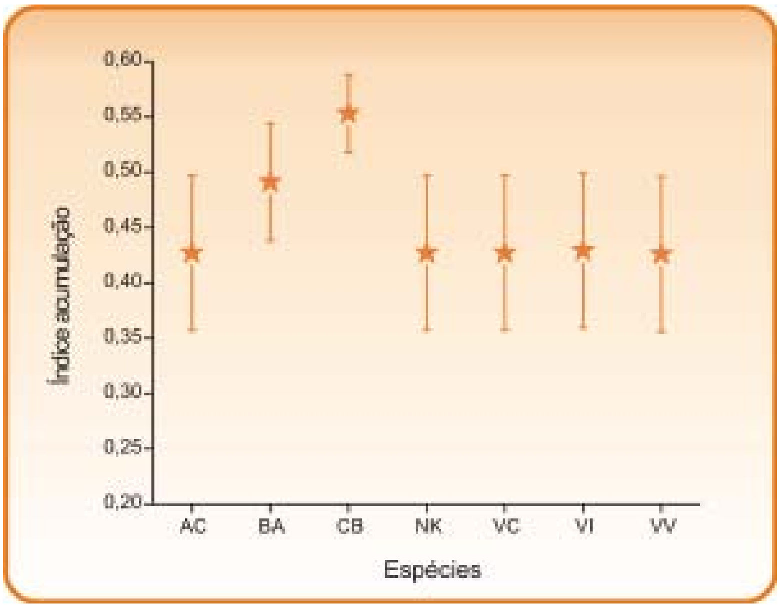


Figura 2. Índices de acumulação e seus respectivos intervalos de confiança (95%) estimados pelo método Bootstrap (iterações = 10000). AC = Aechmea coelestis, BA = Billbergia amoema, CB = Canistropsis billbergioides, NK = Nidularium krisgreeniae, VC = Vriesea carinata, VI = Vriesea incurvata, VV = Vriesia vagans.

Tabela 1. Espécies coletadas na parcela permanente do Parque Estadual Carlos Botelho

Espécie	Identificação	Número de replicatas	Ilustração
Aechmea coelestis	AC	2	
Billbergia amoema	BA	3	
Canistropsis billbergioides	CB	5	
Espécie não determinada	Sp	1	Não disponível
Nidularium cf. *inocentii*	NI	1	
Nidularium krisgreeniae	NK	2	
Phymatidium cf. *tillandsoides*	PT	1	
Tillandsia stricta	TS	1	
Vriesea carinata	VC	2	
Vriesea ensiformis	VE	1	
Vriesea incurvata	VI	2	
Vriesea vagans	VV	2	

Tabela 2. Concentrações (mg kg^{-1}) obtidas e certificadas dos elementos químicos para os materiais de referência certificados.

	IAEA-336		INCT-TL-1	
	Lichen		*Tea Leaves*	
	Obtida	*Certificada*	*Obtida*	*Certificada*
Ba	9 ± *5*	5,3 - 7,5	42 ± *4*	43,2 ± *3,9*
Br	13,7 ± *0,6*	11,2 - 14,6	13,3 ± *0,6*	12,3 ± *1,0*
Ca	2790 ± *190*	-	6320 ± *370*	5820 ± *520*
Ce	1,48 ± *0,10*	1,11 - 1,45	0,85 ± *0,07*	0,79 ± *0,08*
Co	0,39 ± *0,03*	0,24 - 0,34	0,39 ± *0,02*	0,387 ± *0,04*
Cs	0,114 ± *0,014*	0,097 - 0,123	3,7 ± *0,2*	3,61 ± *0,37*
Fe	445 ± *12*	380 - 480	534 ± *16*	432*
Hg	0,13 ± *0,03*	0,16 - 0,24	< 0,078	0,005 *0,001*
K	1970 ± *180*	1640 - 2040	17600 ± *700*	17000 ± *1200*
Na	342 ± *10*	280 - 360	22 ± *2*	24,7 ± *3,2*
Rb	2,0 ± *0,2*	1,54 - 1,98	88 ± *4*	81,5 ± *6,5*
Sc	0,187 ± *0,007*	0,15 - 0,19	0,26 ± *0,01*	0,266 ± *0,02*
Se	0,28 ± *0,04*	0,18 - 0,26	-	0,076*
Sm	0,123 ± *0,013*	0,092 - 0,12	0,154 ± *0,012*	0,177 ± *0,02*
Sr	16 ± *4*	8,2 - 10,4	32 ± *6*	20,8 ± *1,7*
Zn	31,5 ± *1,0*	27 - 33,8	35,7 ± *1,1*	34,7 ± *2,7*

* Valor de concentração não certificado

Tabela 3. *Concentrações e respectivas incertezas expandidas (k=2) dos elementos químicos encontrados nas folhas. AC* = Aechmea coelestis, *BA* = Billbergia amoema, *CB* = Canistropsis billbergioides, *Sp = espécie não determinada, NI* = Nidularium *cf.* inocentii, *NK* = Nidularium krisgreeniae, *PT* = Phymatidium *cf.* tillandsoides, *TS* = Tillandsia stricta, *VC* = Vriesea carinata, *VE* = Vriesea ensiformis, *VI* = Vriesea incurvata, *VV* = Vriesia vagans

Espécie	Ba	Br	Ca	Ce	Co	Cs	Fe	Hg
	mg kg^{-1}	*mg kg*$^{-1}$	*g kg*$^{-1}$	*mg kg*$^{-1}$	*mg kg*$^{-1}$	*mg kg*$^{-1}$	*mg kg*$^{-1}$	*mg kg*$^{-1}$
AC	24 ± *5*	30,8 ± *1,4*	7,5 ± *0,5*	0,17 ± *0,08*	0,69 ± *0,08*	0,29 ± *0,03*	62 ± *3*	< 0,035
AC	10 ± *2*	11,0 ± *0,5*	2,6 ± *0,2*	0,13 ± *0,03*	0,073 ± *0,007*	0,061 ± *0,005*	133 ± *4*	0,022 ± *0,012*
BA	16 ± *3*	21,4 ± *0,9*	5,7 ± *0,3*	0,19 ± *0,03*	0,20 ± *0,02*	0,122 ± *0,015*	68 ± *2*	< 0,035
BA	7 ± *3*	4,3 ± *0,2*	1,5 ± *0,1*	0,33 ± *0,04*	0,062 ± *0,005*	0,055 ± *0,006*	200 ± *6*	0,017 ± *0,014*
BA	28 ± *2*	15,2 ± *0,7*	8,1 ± *0,4*	0,25 ± *0,04*	0,029 ± *0,003*	0,084 ± *0,008*	80 ± *3*	0,027 ± *0,017*
CB	14 ± *2*	10,6 ± *0,5*	7,3 ± *0,4*	< 0,08	0,142 ± *0,009*	0,137 ± *0,010*	57 ± *2*	0,03 ± *0,02*
CB	45 ± *4*	22,0 ± *1,1*	5,3 ± *0,3*	0,16 ± *0,02*	0,229 ± *0,013*	0,177 ± *0,017*	148 ± *4*	< 0,035
CB	20 ± *3*	12,7 ± *0,6*	5,5 ± *0,3*	0,10 ± *0,03*	0,164 ± *0,011*	0,098 ± *0,009*	133 ± *4*	< 0,035
CB	11 ± *2*	21,2 ± *1,0*	4,0 ± *0,3*	0,12 ± *0,03*	0,086 ± *0,006*	0,186 ± *0,014*	123 ± *5*	0,031 ± *0,016*
CB	21 ± *2*	18,2 ± *0,8*	7,5 ± *0,4*	1,01 ± *0,07*	0,181 ± *0,011*	0,111 ± *0,010*	378 ± *10*	0,063 ± *0,018*
NI	13 ± *2*	12,2 ± *0,6*	5,2 ± *0,3*	< 0,08	0,017 ± *0,003*	0,146 ± *0,011*	76 ± *3*	0,035 ± *0,015*
NK	11 ± *4*	24,4 ± *1,1*	3,9 ± *0,2*	0,17 ± *0,04*	0,085 ± *0,006*	0,23 ± *0,02*	70 ± *3*	0,04 ± *0,02*
NK	14 ± *2*	17,1 ± *0,8*	3,3 ± *0,3*	0,07 ± *0,06*	0,122 ± *0,012*	0,083 ± *0,007*	67 ± *2*	0,026 ± *0,015*
PT	52 ± *5*	5,2 ± *0,3*	4,6 ± *0,3*	0,48 ± *0,08*	0,101 ± *0,010*	0,48 ± *0,03*	196 ± *7*	0,07 ± *0,03*
Sp	11 ± *5*	29,6 ± *1,3*	2,1 ± *0,2*	0,10 ± *0,06*	0,41 ± *0,03*	0,174 ± *0,013*	95 ± *3*	0,05 ± *0,02*
TS	15 ± *2*	11,8 ± *0,6*	3,5 ± *0,2*	0,63 ± *0,05*	0,081 ± *0,006*	0,074 ± *0,007*	123 ± *4*	< 0,035
VC	11 ± *2*	12,6 ± *0,6*	1,6 ± *0,2*	0,18 ± *0,08*	0,206 ± *0,012*	0,252 ± *0,019*	181 ± *7*	0,048 ± *0,019*
VC	5 ± *1*	23,0 ± *1,0*	2,0 ± *0,1*	0,15 ± *0,03*	0,142 ± *0,009*	0,113 ± *0,011*	173 ± *6*	0,049 ± *0,017*
VE	14 ± *6*	13,8 ± *0,6*	2,3 ± *0,2*	0,12 ± *0,04*	0,157 ± *0,010*	0,063 ± *0,006*	166 ± *5*	0,06 ± *0,02*
VI	10 ± *2*	7,3 ± *0,4*	3,7 ± *0,2*	0,08 ± *0,02*	0,238 ± *0,013*	0,145 ± *0,011*	178 ± *5*	< 0,035
VI	6 ± *2*	13,0 ± *0,6*	1,7 ± *0,1*	0,07 ± *0,03*	0,121 ± *0,007*	0,244 ± *0,018*	178 ± *5*	0,034 ± *0,02*
VV	36 ± *3*	7,5 ± *0,4*	1,9 ± *0,2*	0,16 ± *0,04*	0,066 ± *0,006*	0,056 ± *0,011*	112 ± *4*	0,054 ± *0,02*
VV	16 ± *2*	9,6 ± *0,5*	2,5 ± *0,2*	0,15 ± *0,02*	0,057 ± *0,004*	0,122 ± *0,012*	231 ± *7*	0,048 ± *0,01*

Espécie	K	Na	Rb	Sc	Se	Sm	Sr	Zn
	g kg^{-1}	*g kg*$^{-1}$	*mg kg*$^{-1}$	*μg kg*$^{-1}$	*mg kg*$^{-1}$	*μg kg*$^{-1}$	*mg kg*$^{-1}$	*mg kg*$^{-1}$
AC	35,8 ± *1,4*	5,03 ± *0,14*	68 ± *3*	5,2 ± *0,6*	< 0,107	4,5 ± *1,7*	156 ± *12*	24,5 ± *1,0*
AC	23,3 ± *0,8*	4,72 ± *0,17*	45 ± *2*	8,5 ± *0,5*	0,18 ± *0,06*	8,4 ± *1,3*	50 ± *4*	16,8 ± *0,6*
BA	39,7 ± *1,3*	2,75 ± *0,09*	74 ± *3*	4,4 ± *0,4*	< 0,107	6,7 ± *1,5*	156 ± *9*	15,2 ± *0,5*
BA	3,0 ± *0,3*	2,21 ± *0,06*	6,5 ± *0,3*	17,6 ± *0,9*	0,08 ± *0,03*	6,7 ± *1,1*	25 ± *3*	10,4 ± *0,4*
BA	29,2 ± *0,8*	4,90 ± *0,16*	45 ± *2*	5,7 ± *0,5*	< 0,107	7,1 ± *1,1*	218 ± *13*	15,6 ± *0,6*
CB	20,8 ± *0,7*	4,03 ± *0,13*	36,2 ± *1,7*	5,8 ± *0,4*	< 0,107	< 2,9	133 ± *8*	13,8 ± *0,5*
CB	21,5 ± *0,8*	8,5 ± *0,3*	24,7 ± *1,2*	10,1 ± *0,6*	0,17 ± *0,03*	5,5 ± *0,8*	98 ± *8*	27,2 ± *1,0*
CB	23,6 ± *0,7*	7,1 ± *0,3*	30,3 ± *1,4*	8,2 ± *0,5*	0,11 ± *0,03*	3,5 ± *1,7*	108 ± *6*	33,5 ± *1,2*
CB	29,6 ± *1,0*	5,3 ± *0,2*	51 ± *2*	5,9 ± *0,4*	0,11 ± *0,03*	3,5 ± *1,9*	86 ± *6*	40,3 ± *1,4*
CB	30,2 ± *0,9*	5,09 ± *0,16*	48 ± *2*	36,5 ± *1,5*	0,37 ± *0,09*	20 ± *2*	147 ± *9*	33,9 ± *1,0*
NI	27,3 ± *0,9*	2,92 ± *0,11*	63 ± *3*	2,6 ± *0,3*	0,21 ± *0,08*	5 ± *2*	166 ± *9*	22,4 ± *0,7*
NK	29,4 ± *0,9*	5,22 ± *0,18*	79 ± *4*	3,9 ± *0,3*	< 0,107	< 2,9	73 ± *8*	21,9 ± *0,8*
NK	29,4 ± *1,1*	4,69 ± *0,14*	51 ± *2*	3,5 ± *0,3*	< 0,107	< 2,9	90 ± *7*	18,6 ± *0,7*
PT	21,1 ± *0,8*	0,77 ± *0,03*	76 ± *4*	53 ± *3*	0,37 ± *0,09*	21 ± *2*	81 ± *8*	23,3 ± *0,7*
Sp	25,8 ± *0,7*	4,35 ± *0,15*	58 ± *3*	2,9 ± *0,3*	0,14 ± *0,03*	< 2,9	33 ± *3*	19,7 ± *0,7*
TS	10,9 ± *0,6*	4,82 ± *0,16*	18,1 ± *0,8*	23,4 ± *1,1*	0,25 ± *0,08*	17,2 ± *1,5*	58 ± *4*	17,7 ± *0,6*
VC	14,9 ± *0,5*	4,00 ± *0,14*	28,0 ± *1,3*	8,2 ± *0,7*	0,14 ± *0,03*	4,0 ± *0,9*	43 ± *13*	37,3 ± *1,2*
VC	14,2 ± *0,5*	4,75 ± *0,16*	32,4 ± *1,4*	5,9 ± *0,5*	0,12 ± *0,02*	5,1 ± *0,9*	43 ± *4*	21,4 ± *0,8*
VE	14,8 ± *0,5*	3,33 ± *0,10*	26,9 ± *1,2*	5,0 ± *0,4*	0,08 ± *0,02*	19 ± *2*	62 ± *6*	22,4 ± *0,9*
VI	6,6 ± *0,3*	3,62 ± *0,11*	16,2 ± *0,8*	5,6 ± *0,4*	0,21 ± *0,06*	< 2,9	81 ± *6*	19,5 ± *0,6*
VI	16,6 ± *0,6*	2,88 ± *0,09*	34,5 ± *1,6*	3,6 ± *0,4*	0,10 ± *0,02*	2,8 ± *0,8*	40 ± *9*	37,0 ± *1,3*
VV	7,2 ± *0,4*	2,59 ± *0,07*	15,4 ± *0,7*	10,9 ± *0,7*	0,07 ± *0,04*	6,0 ± *0,7*	< 2,8	14,7 ± *0,6*
VV	8,3 ± *0,3*	5,8 ± *0,2*	13,2 ± *0,6*	7,8 ± *0,5*	0,27 ± *0,07*	5,5 ± *0,8*	69 ± *4*	14,5 ± *0,6*

Tabela 4. Comparação entre as concentrações (mg kg $^{-1}$) nas espécies de bromélias *Canistropsis billbergioides* e *Tillandsia usneoides*

	Canistropsis billbergioides	*Tillandsia usneoides*		
		Figueiredo (2004)	Figueiredo (2001)	Calasans (1997)
	Média Inc.	Controle	São Paulo	Rio de Janeiro
Ba	22 ± *2*	16	49	-
Br	16,9 ± *0,8*	10,1	6,43	-
Ca	5930 ± *350*	3303	-	-
Ce	0,35 ± *0,04*	1,4	5,1	-
Co	0,16 ± *0,01*	0,61	1,1	-
Fe	168 ± *5*	650	2536	-
Hg	0,043 ± *0,019*	-	-	2,1
K	25100 ± *830*	5850	4713	-
Na	6020 ± *220*	421	601	-
Rb	38,1 ± *1,8*	37	89	-
Sc	0,0133 ± *0,0007*	0,13	0,18	-
Se	0,19 ± *0,05*	0,25	-	-
Sm	0,007 ± *0,002*	0,083	0,26	-
Zn	29,7 ± *1,0*	41	73	-

Bases cartográficas para armazenamento e análise espacial de dados da diversidade de palmeiras em um trecho de Mata Atlântica, Ubatuba-SP

Maria Cecília Barbosa de Toledo[1] & Simey Thury Vieira Fisch[2]

Biota Neotropica v6 (n1) – http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn01806012006

Recebido em 18/05/2005.
Versão revisada recebida em 20/12/2006.
Publicado em 01/01/2006

[1]Departamento de Biologia/Universidade de Taubaté - ceciliabt@vivax.com.br
[2]Departamento de Biologia/Universidade de Taubaté - simey@unitau.br
Endereço para correspondência:
Universidade de Taubaté - Departamento de Biologia
Grupo ecossistemas terrestres do Vale do Paraíba e Litoral Norte paulista
Praça Marcelino Monteiro, 63 -Taubaté - SP - 12030-010 – Brasil

Abstract

Toledo, M.C.B. and Fish, S.T.V. **Cartographic basis for storage and spatial analysis of data on diversity of palm trees in a stretch of Mata Atlântica, Ubatuba – SP**. *Biota Neotrop*. Jan/Abr 2006 vol. 6, no. 1,http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn01806012006. ISSN 1676-0603

The aim of this work was to elaborate a cartographic basis for storage and spatial analysis of data on diversity of palm trees in altitudinal gradient. The work was carried out in Serra do Mar, located on the northeast of São Paulo. In order to create a databases an altimetric letter from IBGE 1:50.000 and a Landsat ETM+ image from 2002 in bands 3,4 and 5 have been used. Data have been analyzed in the SPRING System of Geographic Information 3.6 version, developed by the National Institute for Space Research (INPE), Brazil. The sequence of elaboration consisted of register, digitalization of level curves, and creation of a rectangular, triangular and data table. From this sequence declivity and hypsometric thematic maps have been obtained. Later on the association of the number of species by altitudinal class giving origin to a map of palm tree species distribution in an altitudinal gradient was carried out. The databases are available for association to other parameters with climate, soil, distribution, and abundance of palm tree species for more elaborated spatial analysis.

Key words: *thematic maps, altitudinal gradient, diversity of Arecaceae, GIS*

Resumo

Toledo, M.C.B. and Fish, S.T.V. **Bases cartográficas para armazenamento e análise espacial de dados da diversidade de palmeiras em um trecho de Mata Atlântica, Ubatuba-SP**. *Biota Neotrop*. Jan/Abr 2006 vol. 6, no. 1 http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn01806012006. ISSN 1676-0603

O objetivo desse trabalho foi a elaboração de uma base cartográfica para armazenamento e análise espacial dos dados de diversidade de palmeiras em um gradiente altitudinal. O trabalho foi realizado na Serra do Mar na região nordeste do Estado de São Paulo. Para montagem do banco de dados utilizou-se uma carta altimétrica do IBGE 1:50.000 e uma imagem Landsat ETM+ de 2002 nas bandas 3,4 e 5. Os dados foram analisados no Sistema de Informação Geográfica SPRING versão 3.6 desenvolvido pelo Instituto Nacional de Pesquisas Espaciais. A seqüência de elaboração consistiu de registro, digitalização das curvas de nível, criação da grade retangular, grade triangular e fatiamento. Dessa seqüência obteve-se mapas temáticos de declividade e hipsométrico. Esse último foi vetorizado e poligonizado. Posteriormente foi realizada a associação do número de espécies de palmeiras por classe altitudinal, originando um mapa de distribuição de espécies por gradiente altitudinal. O banco de dados encontra-se disponível para associar outros parâmetros como clima, solo, distribuição e abundância das espécies de palmeiras, objetivando análises espaciais mais elaboradas.

Palavras-chave: *mapas temáticos, gradiente altitudinal, diversidade de Arecaceae, SIG*

Introdução

O avanço tecnológico na representação do espaço possibilitou não somente a ampliação do uso de informações cartográficas já existentes (cartas planialtimétricas e levantamentos aerofotográficos) como também a intergração dessas com novas tecnologias tais como os sistemas de posicionamento global – *GPS*. Atualmente, sensores sofisticados sejam aerotransportados ou satelitais utilizados para a obtenção de imagens, *scanners* de alta resolução que permitem a transformação de cartas em papel em formato digital aumentam a quantidade de dados analisados, de forma a permitir um melhor entendimento dos processos naturais e antrópicos em escalas mais amplas. Os Sistemas de Informação Geográfica (SIGs) permitem realizar análises espaciais, criar uma relação topológica entre os elementos gráficos além de permitir uma descrição de suas entidades: pontos, linhas e polígonos (Rodrigues, 1990). Dessa forma, os SIGs possibilitam a associação dos dados espaciais com atributos observados em campo, como por exemplo, dados ecológicos.

A utilização de técnicas de análise de dados distribuídos espacialmente por meio de SIGs integrado a ecologia é relativamente recente e permite um melhor entendimento das inter-relações dos diferentes elementos físicos e biológicos. Segundo Metzger (2001), foi a partir da década de 80 que os ecólogos vêm ampliando o uso dessa integração, porém a complexidade da ferramenta e a demanda de tempo para assimilar as novas técnicas de georreferenciamento e sensoriamento remoto muitas vezes inviabilizam sua utilização mais freqüente. O interesse na análise espacial e temporal é o de obter respostas para questões ecológicas, utilizando escalas mais amplas. Johnston (1998) refere-se a algumas dessas perguntas: (1) Como está distribuída a comunidade A? (2) Como está distribuída a comunidade A em relação à comunidade B? (3) Como está distribuída a espécie A em relação aos fatores ambientais X,Y e Z? (4) Como tem mudado a distribuição de plantas da comunidade A no tempo passado? (5) Como será a distribuição da comunidade de plantas A no futuro, se as condições ambientais continuarem as mesmas? (6) Como será a distribuição de plantas da comunidade A se o fator ambiental X for alterado? Em médio prazo e com trabalhos de campo aliados a informações obtidas em bases cartográficas, estas questões poderão ser respondidas.

Uma base de dados georreferenciada é fundamental para analisar a distribuição espacial de vegetais ou animais. A partir da consulta a um banco de dados espaciais informações como localização, altitude e declividade são resultados imediatos que podem ser associados a dados de ocorrência e abundância de uma determinada espécie.

É na América do Sul onde a família Arecaceae, tipicamente pantropical, ocorre em hábitats diversos e em diferentes altitudes (Moore 1973). Na floresta atlântica, que se estende ao longo da costa brasileira, a presença da Serra do Mar permite um ambiente úmido ocasionado pela brisa marítima e contra-forte montano, sendo comum em suas encostas a presença de palmeiras dos gêneros *Euterpe*, *Bactris*, *Geonoma* e *Attalea* (Henderson et al. 1995).

Dessa forma, o objetivo do presente trabalho foi descrever e verificar a viabilidade do uso e interpretação de dados georreferenciados e espacialmente distribuídos por meio da construção de uma base de dados e do mapeamento de variáveis discretas como declividade, altitude e número de espécies de palmeiras.

Material e método

Área de estudo:

A área compreende a bacia do rio Grande de Ubatuba, região no domínio de Mata Atlântica, localizada na escarpa da Serra do Mar entre as coordenadas 45W 11’22"; 23S 28’02" e 45W 03’55"; 23S 20’44". O clima dessa região é tropical chuvoso com temperaturas altas, e muito úmido no verão. Nessa área uma parcela significativa das chuvas é oriunda de convecção topográfica (Fisch 2003).

As regiões da faixa da Serra do Mar e bacia do Paraíba do sul apresentam uma variação altitudinal de 0 a 1.300 metros acima do nível do mar, estando sujeitas aos mais fortes processos de erosão e de movimentos coletivos de solo. A área caracteriza-se pela ocorrência de decomposição das rochas cristalinas ou cristalofilianas de 3 a 60 m de profundidade; pela presença de solos tipo latossolo, pela freqüente presença de solos superpostos, ou seja, coberturas coluviais soterrando *stone lines* e por precipitações que variam entre 1100 e 1500 mm ao ano. Quanto à unidade morfoclimática e climato-botânicas, caracterizam-se como regiões serranas, de morros mamelonares do Brasil Sudeste (Ab’Sáber 2003).

A vegetação na área de estudo classifica-se como Floresta Ombrófila Densa, também denominada de Mata Atlântica (Silva & Leitão-Filho 1982, Veloso *et al.* 1991, Simonetti 2001). A família Arecaceae, dentre outras, é uma das famílias mais importantes na composição florística e estrutural desse trecho de Mata Atlântica, no município de Ubatuba. Além desta família, é característica a representatividade de famílias de dispersão universal, com um número de espécies significativas de Myrtaceae, Rubiaceae, Lauraceae e Melastomataceae (Silva & Leitão-Filho 1982, Lacerda 2001).

Amostragem das palmeiras:

Para o estudo da distribuição da comunidade de palmeiras no gradiente altitudinal, as espécies foram amostradas nas cotas 0 (2m do nível do mar) 100, 200, 400, 600 e 850 m na trilha da vargem grande (Tabela 1). Em função da ocupação humana, no caso da cota de 0m de altitude a amostragem na foi realizada em outra área (restinga da

Picinguaba). Em cada altitude, foi estendida uma linha de 200 m acompanhando a superfície do terreno, ao longo da qual foram sorteados 10 pontos de onde partiram transectos com 50 m de comprimento, perpendiculares aos 200 m. Nos transectos foram sorteados 25 pontos nos quais foram alocados os centros das parcelas circulares de 100 m^2 (adaptado de Gentry 1990), onde todas as palmeiras, plântulas e adultos, tiveram sua presença registrada.

Elaboração do banco de dados:

Para o geoprocessamento foi utilizado o Sistema de informação Geográfica SPRING 3.6 – (INPE 2000) e disponível gratuitamente na rede mundial. Utilizou-se uma carta planialtimétrica 1:50.000 da região de Ubatuba fornecida pelo IBGE, a qual foi transformada em imagem matricial e importada para o ambiente SPRING. A partir da entrada da carta no SIG, iniciou-se o trabalho de digitalização dos dados. Também foi criado um plano de informação para entrada da imagem Landsat ETM+ do ano de 2002 nos canais TM3, TM4 e TM5 para elaboração da imagem tridimensional, segundo esquema apresentado na Figura 2.

Resultados e Discussão

Espécies de palmeiras

Nove espécies de palmeiras foram amostradas (*Euterpe edulis, Syagrus peseudococos, Attalea dubia, Bactris setosa, B. hatschbachii, Astrocaryum aculeatissimum, Geonoma gamiova, G. pohliana, G. elegans*) ao longo da encosta montana. O maior número de espécies (n=8) foi observado nas altitudes 100 e 200m, e o menor número (n= 4) foi obtido na cota 850m (Tabela 2).

Banco de dados

A partir da digitalização das curvas de nível da carta Ubatuba do IBGE foi obtido um plano de informação associado à categoria de Modelo Numérico de Terreno, como mostra a Figura 3. Os mapas topográficos geralmente representam dados de elevação dentro de um intervalo e este intervalo é representado por isolinhas, sendo perfeitamente aceitável para representar características tridimensionais sobre uma superfície bidimensional fornecendo um bom entendimento do relevo (Johnston, 1998).

Para a representação tridimensional é necessária a criação de um Modelo Numérico do Terreno. Este pode ser uma grade retangular (matriz de altitude) e/ou uma grade triangular (TIN – Triangular Irregular Networks) (Burrough & McDonnell, 1998). A grade retangular, no modelo *raster*, foi obtida utilizando o vizinho mais próximo como interpolador e posteriormente uma grade triangular usando o interpolador linear, Figuras 4 e 5, respectivamente.

Através da imagem Landsat registrada, de acordo com a carta do IBGE, e realçada obteve-se uma imagem sintética. A partir da sobreposição da imagem à grade retangular foi gerada a imagem 3D. A imagem em três dimensões que permite que o relevo da área de trabalho seja observado de acordo com a realidade de campo, está apresentada na Figura 1.

Para a criação do mapa altitudinal foi feito o fatiamento a partir da cota mínima (0 m) até a cota máxima (1200m) com um intervalo de 100 m. Para cada intervalo de 100 metros foi atribuída uma classe, como segue a legenda da Figura 6. Observou-se que nas faixas mais estreitas a altitude atinge de 500 a 900m em um pequeno trecho no terreno e o platô conservou-se entre 800 a 1100m, com alguns picos chegando a 1200m de altitude.

O mapeamento da declividade da área de estudo foi obtido a partir da grade triangular, com o dado de saída da declividade em percentagem em um modelo temático de representação. Para tanto, foram definidos 8 intervalos de classes de 0 a 80% de declividade. As áreas mais declivosas (80%) foram detectadas na crista da serra onde pôde ser observado a existência de uma linha de afloramento rochoso (Figura 7). Esta área não foi avaliada quanto à ocorrência de palmeiras pela inviabilidade de acesso.

Quanto ao mapa hipsométrico foi criado um plano de informação vetorizado e poligonizado, criando-se classes de número de espécies por faixa de 100 m de altitude, num total de 12 classes, indo de 0 até 1200m de altitude. A distribuição das espécies foi obtida a pela sobreposição do número de espécies (Tabela 2) e o mapa hipsométrico (Figura 6). A figura 8 apresenta a distribuição das espécies segundo a sua localização geográfica e o nível altitudinal de ocorrência.

Segundo Burrough & McDonnell (1998) um dos usos mais comuns dos modelos de elevação é como base para visualização de informações temáticas ou para combinar dados de relevo com dados temáticos como solo, uso do terreno ou vegetação. Os dados obtidos em campo foram utilizados para definir as classes de ocorrência do número de espécies de palmeiras em cada faixa de 100 m de altitude.

Toledo (2003) realizou uma análise de entidades discretas no espaço como a diversidade biológica por meio da criação de um banco de dados contendo informações de variáveis como abundância de espécie, distribuição, freqüência, índice de diversidade, entre outras tanto da fauna como da flora. Pivello & Bitencourt (1999) também construíram um banco de dados para uma área de cerrado, utilizando dados do ambiente físico e biológico com o objetivo de zoneamento e manejo de uma área de conservação por meio da elaboração de um plano de informação cadastral em que os polígonos, representantes de classes distintas, foram associados a atributos como estádios florestais, solo e relevo, entre outros, que foram integrados a uma matriz de variáveis.

A partir da construção desta base cartográfica será possível a elaboração de uma tabela de dados com uma maior representatividade de parâmetros físicos como declividade, clima e solo, e biológicos como distribuição e abundância das espécies de palmeiras em toda a microbacia, permitindo realizar não só mapeamentos temáticos como também uma análise espacial desses parâmetros.

Agradecimentos

À Dra Silvia María Lacruz pelas sugestões no manuscrito. A equipe de coleta de dados de palmeira do projeto “Distribuição a comunidade de palmeiras do gradiente altitudinal da floresta atlântica na região nordeste do Estado de São Paulo” (proc. 01/06023-5). Ao Programa BIOTA/FAPESP pelos recursos financeiros que permitiram a realização dos trabalhos.

Referências Bibliográficas:

AB’SABER, A. 2003. **Os domínios de natureza no Brasil. Potencialidades paisagísticas**. Ateliê Editorial. São Paulo. 159pp.

BURROUGH, P.A.; McDONNELL, R.A. 1998. **Principles of geographic information systems**. Oxford University Press, New York. .

FISCH, G. 2003. Distribuição da comunidade de palmeiras no gradiente altitudinal da Floresta Atlântica na região nordeste do estado de São Paulo. Resumo **In** IV Simpósio e IV Reunião de Avaliação do Programa Biota/Fapesp. Águas de Lindóia.

GENTRY, A.H. 1990. Floristic similarities and differences between Southern Central America and upper and Central Amazonia. **In: Four neotropical rain forest**. Ed. Yale University Press, London, p. 141-160.

HENDERSON, A.; GALEANO, G.; BERNAL, R. 1995. **Field Guide to the Palms of the Americas**. New Jersey, Princeton University Press, 352 p.

INPE. 2000. **Manual do SPRING**. Versão 5.3.1. São José dos Campos, .

JOHNSTON, C.A. 1998. **Geografic information systems in ecology – methods in ecology series**. Blackwell Science Ltd. Oxford, UK. 239 p.

LACERDA, M. S. 2001. **Composição florística e estrutura da comunidade arbórea num gradiente altitudinal da Mata Atlântica.** Tese de Doutorado. Campinas, SP.Referências Bibliográficas

METZGER, J.P. 2001. O que é ecologia de paisagens? **Biota Neotropica** 1/2 http://www.biotaneotropica.org.br/v1n12/pt/fullpaper?bn00701122001+pt

MOORE, H.E. 1973. Palms in the tropical forest ecosystems in Africa and South America. ***In:*** MEGGERS, B.J.; AYENSY, E.S.; DUCKWORTH, W.D. (eds.). **Tropical forest ecosystems in Africa and South America: a comparative review**. Washington DC, Smithsonian Institution Press, p. 63-88.

PIVELLO, V.R. & BITENCOURT, M.D. 1999. Banco de dados em SIG para ecologia aplicada: exemplo do cerrado Pé-de-Gigante, SP. **Caderno de Informações Georreferenciadas – CIG**. 1(3): disponível em www.cpa.unicamp.br/revista/cigv1n3a4.html. Acessado em 13 de dezembro de 2004.

RODRIGUES, M. 1990. Introdução ao geoprocessamento. **In***:* SIMPOSIO BRASILEIRO DE GEOPROCESSAMENTO, 1, São Paulo. Anais. São Paulo: EDUSP, v.1, p.1-26.

SILVA, A.F. & LEITÃO FILHO, H.F. 1982. Composição florística e estrutura de um trecho de mata atlântica de encosta no município de Ubatuba (São Paulo, Brasil). **Rev. bras. Bot.** 5(1):43-52.

SIMONETTI, C. 2001. **As relações entre o relevo, os solos e a Floresta Atlântica na Serra do Mar (Bacia do rio Itamambuca, Ubatuba, SP)**. Tese de doutorado. Universidade de São Paulo, SP.

TOLEDO, M.C.B., 2003. **Comunidade de aves como bioindicadoras para diagnóstico e avaliação da diversidade em uma paisagem urbana.** Tese de Doutorado. Universidade de Taubaté, São Paulo, SP.

VELOSO, H. P.; RANGEL FILHO, A. L. R.; LIMA, J. C. A. 1991. **Classificação da vegetação brasileira, adaptada a um sistema universal.** IBGE, Rio de Janeiro.

Título: Bases cartográficas para armazenamento e análise espacial de dados da diversidade de palmeiras em um trecho de Mata Atlântica, Ubatuba-SP

Autores: Maria Cecília Barbosa de Toledo & Simey Thury Vieira Fisch

Biota Neotropica, Vol. 6 (número 1): 2006
http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn01806012006

Recebido em 18/05/2005 - Revisado em 20/12/2006
Publicado em 01/01/2006

ISSN 1676-0603

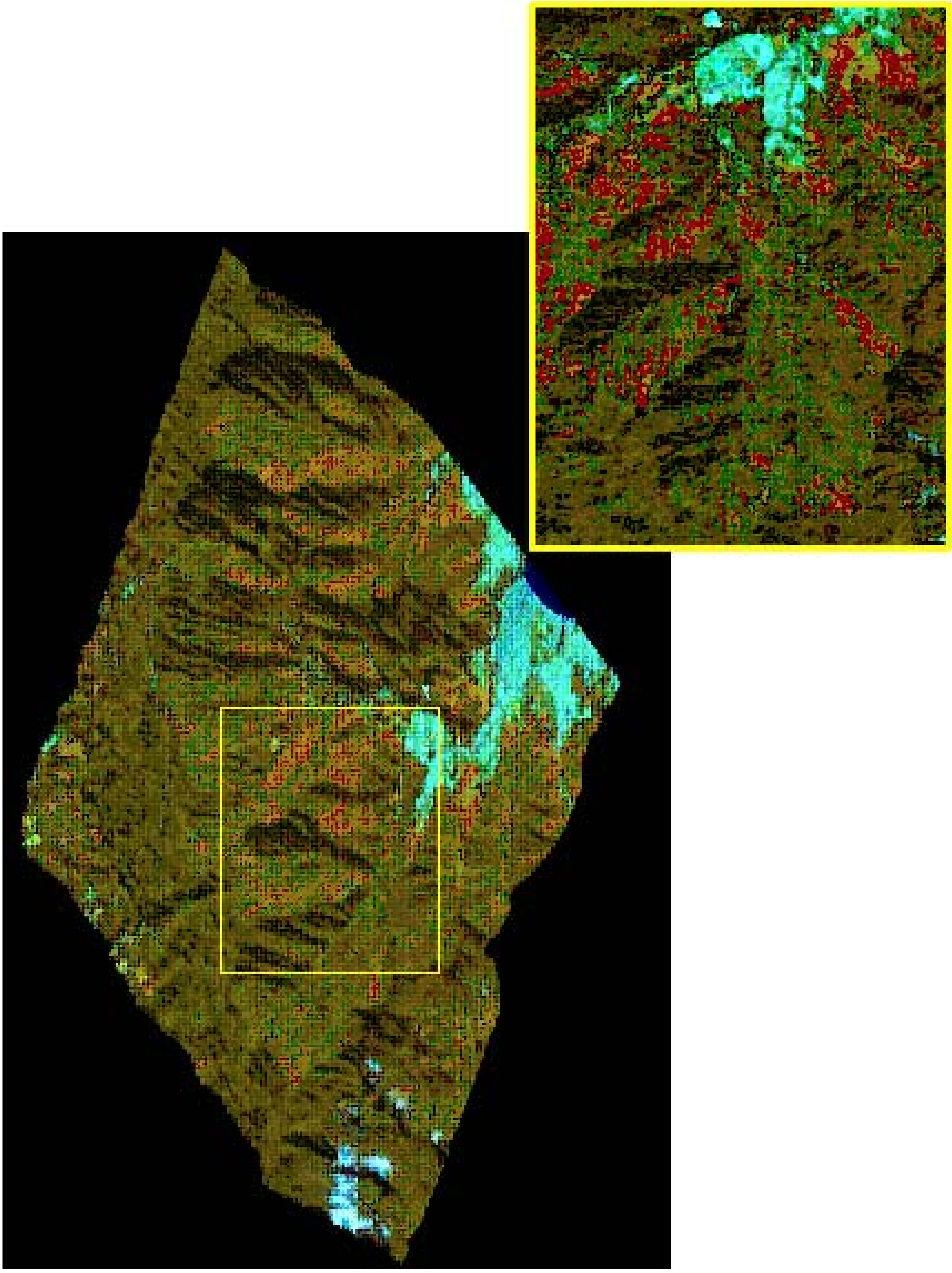


Figura 1: Visualização em 3D da bacia hidrográfica do Rio Grande de Ubatuba (acima) e a área de estudo com a localização dos pontos de coleta de dados (abaixo)
Figure 1: Visualization in 3D of the Rio Grande watershed in Ubatuba (above) and the study area with locations of the points for data acquisition (below).

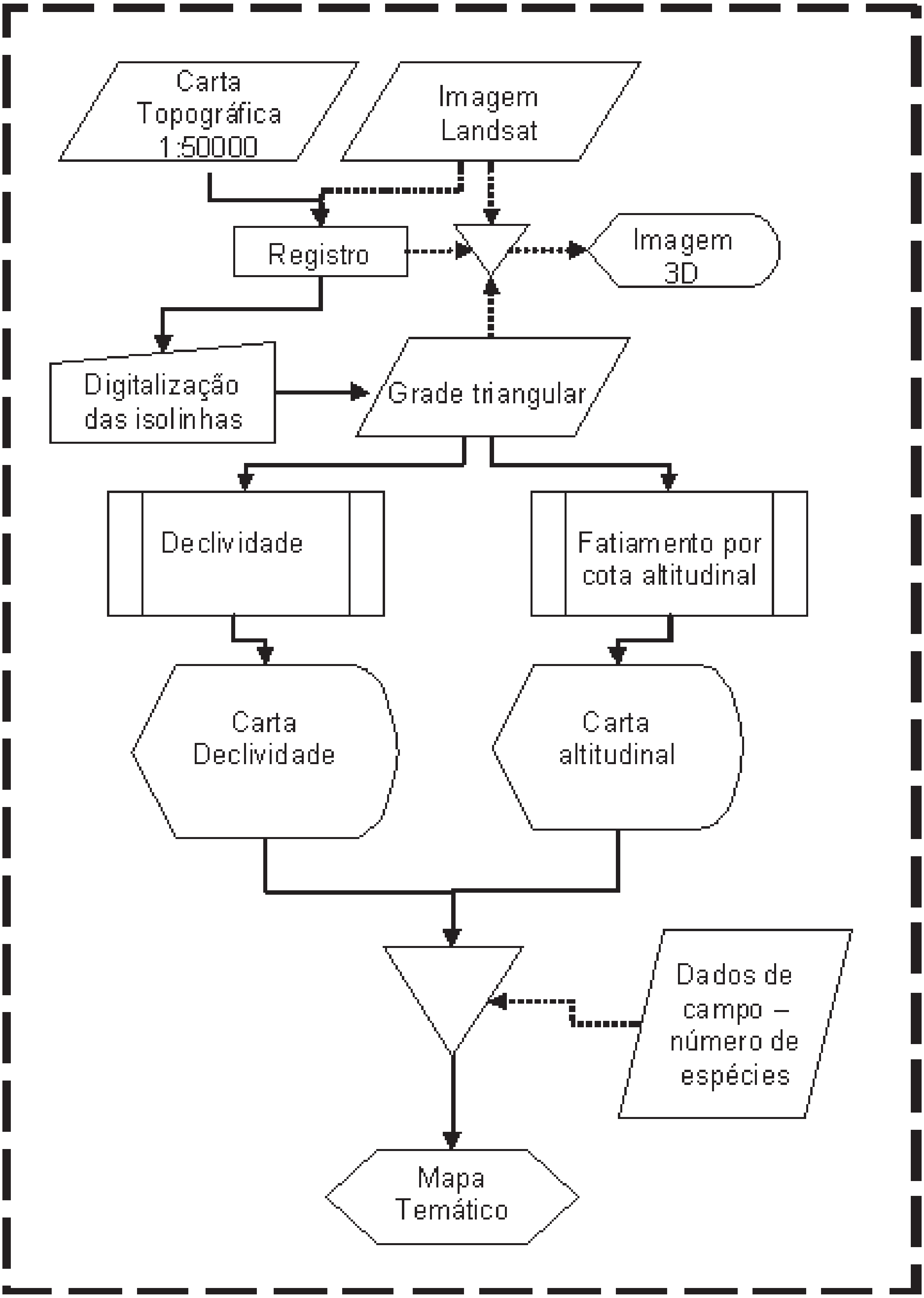


Figura 2: Fluxograma da metodologia utilizada para construção mapa de distribuição altitudinal do número de espécies de palmeiras.
Figure 2: Methodology flowchart used for building altitudinal maps of palms species distribution.

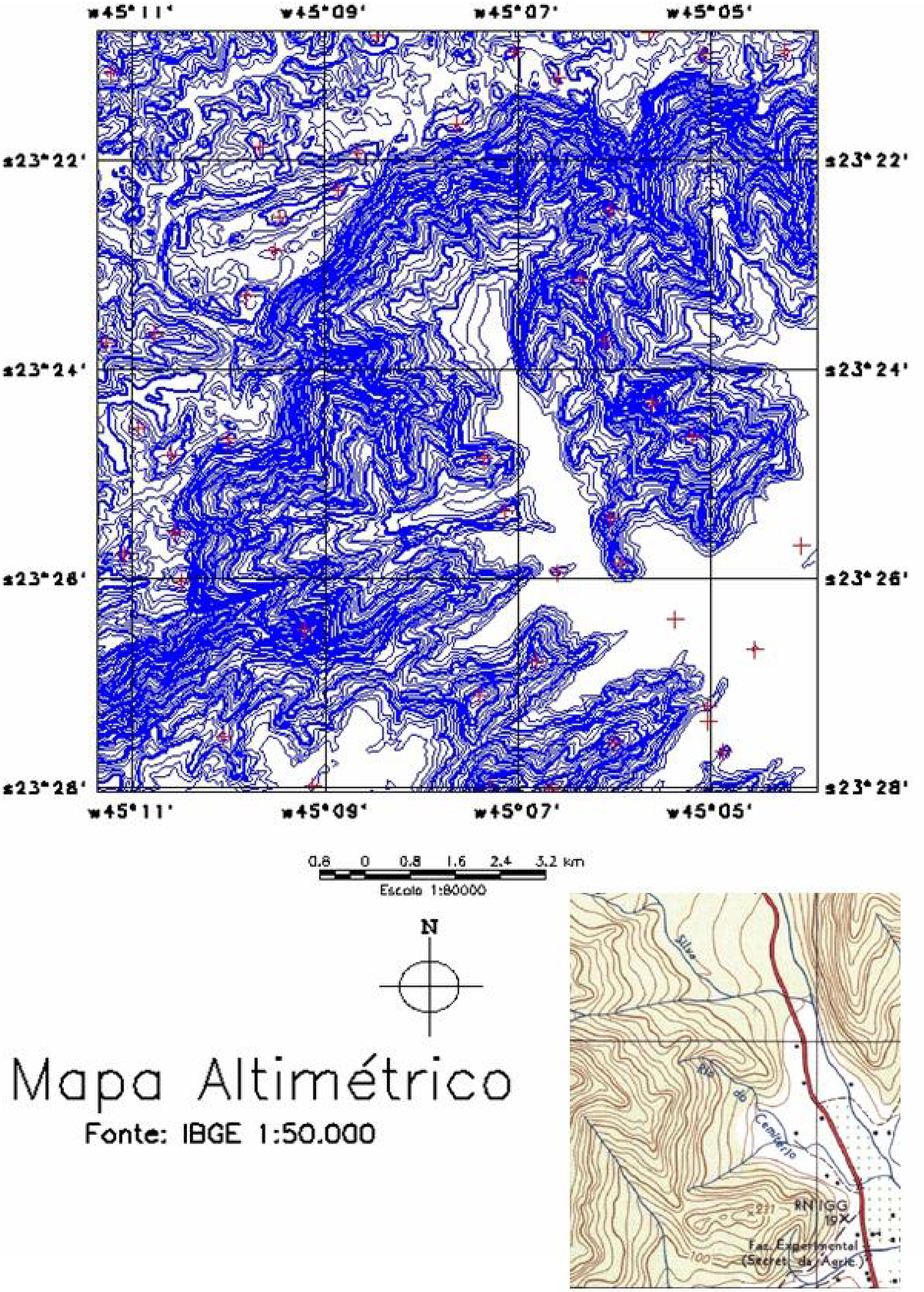


Figura 3: Mapa topográfico digitalizado a partir da carta do IBGE. Em azul as isolinhas e os sinais de soma em vermelho correspondem aos pontos de controle.

Figure 3: Topographic map generated from the digitalized IBGE/Ubatuba chart. The blue isolines and the red plus signs are related to control points.

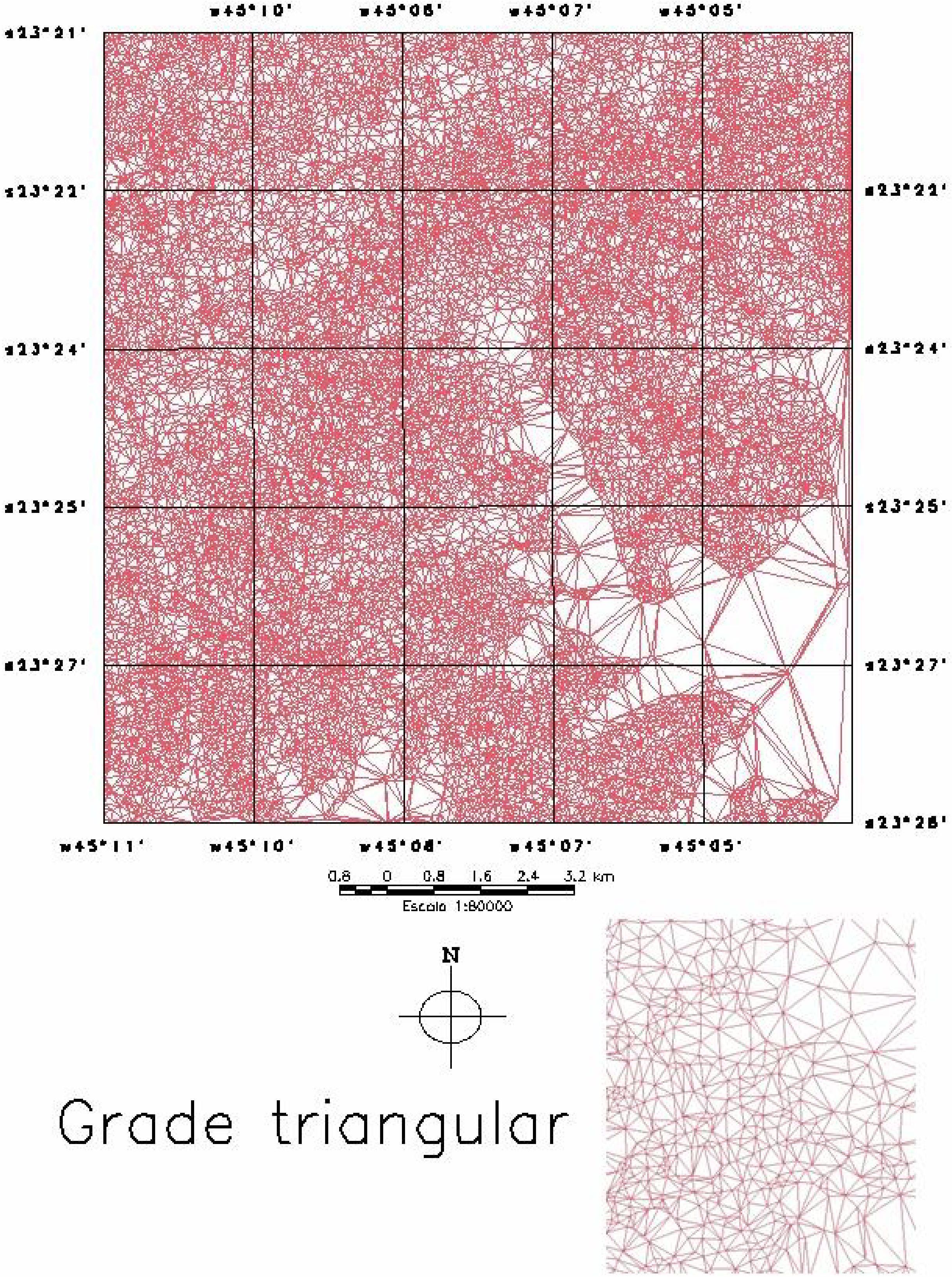


Figura 4: Grade triangular gerada a partir da digitalização da carta de Ubatuba do IBGE.
Figure 4: Triangular grade generated from the digitalized IBGE/Ubatuba chart.

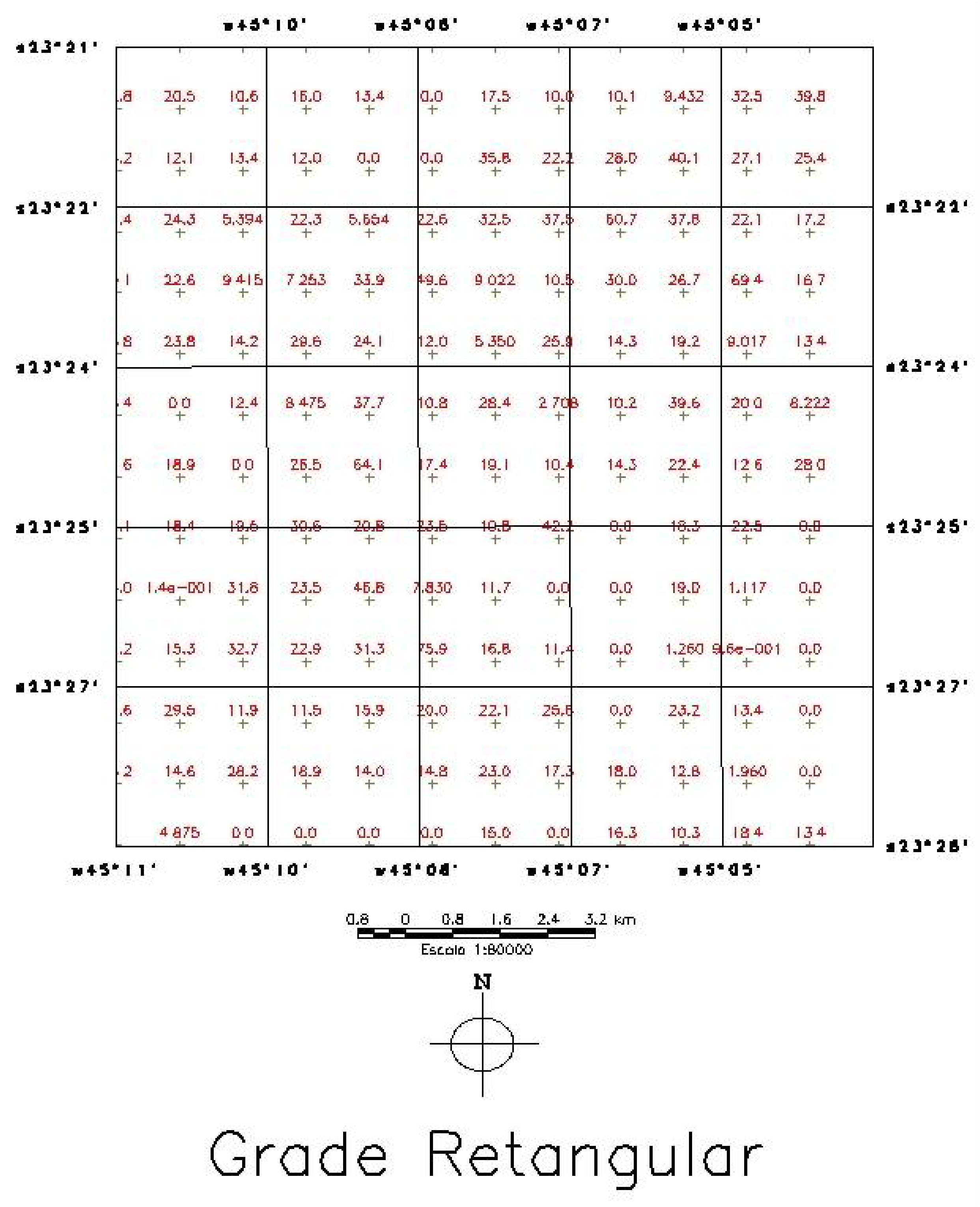


Figura 5: Grade retangular gerada a partir da digitalização da carta Ubatuba do IBGE
Figure 5: Rectangular grade generated from the digitalized IBGE/Ubatuba chart.

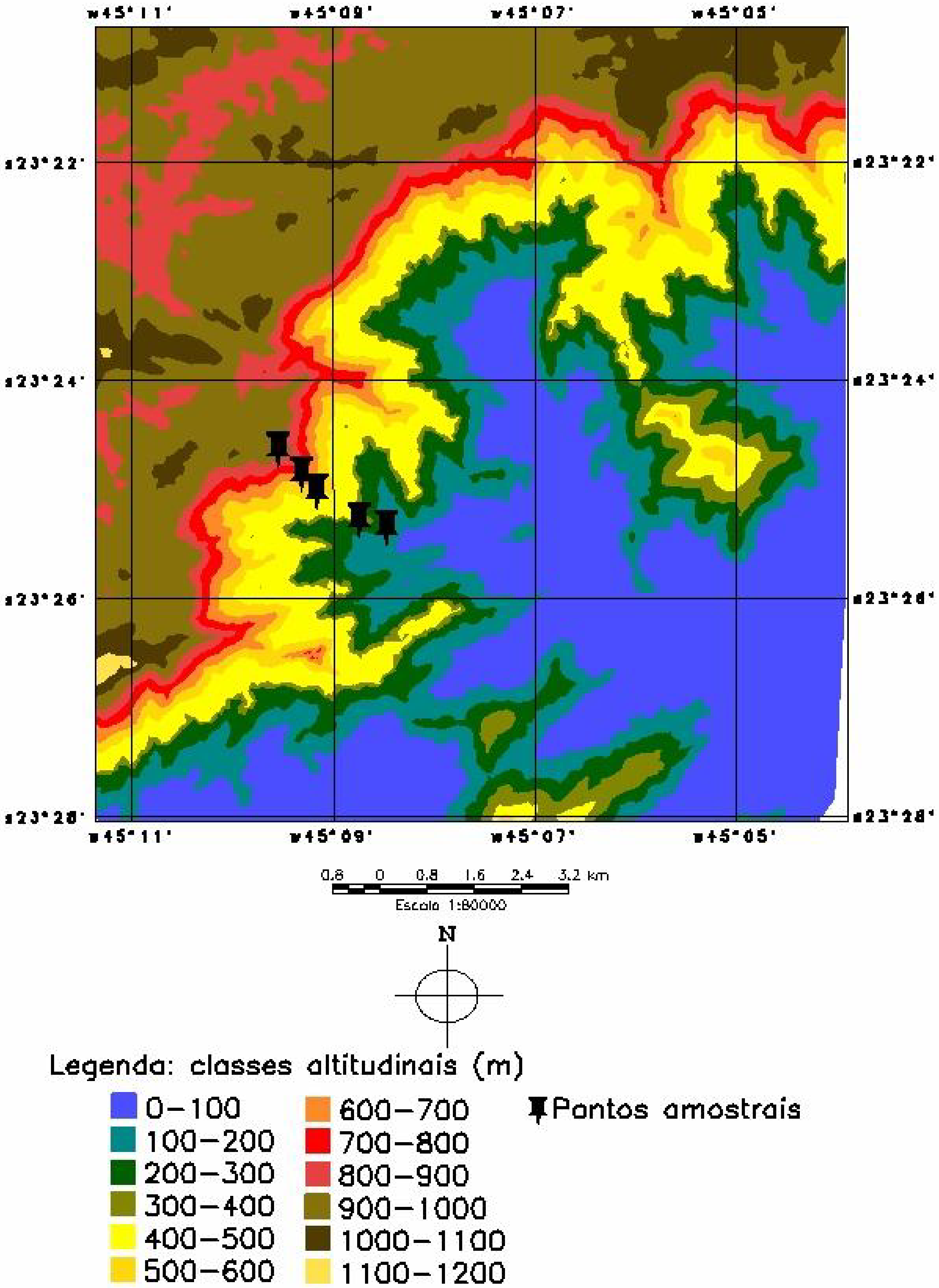


Figura 6: Mapa hipsométrico e os pontos de coleta de dados, indo do nível do mar até 1200 m.
Figure 6: Hypsometric maps and the points used for data acquisition going from sea level to 1.200 meters of altitude.

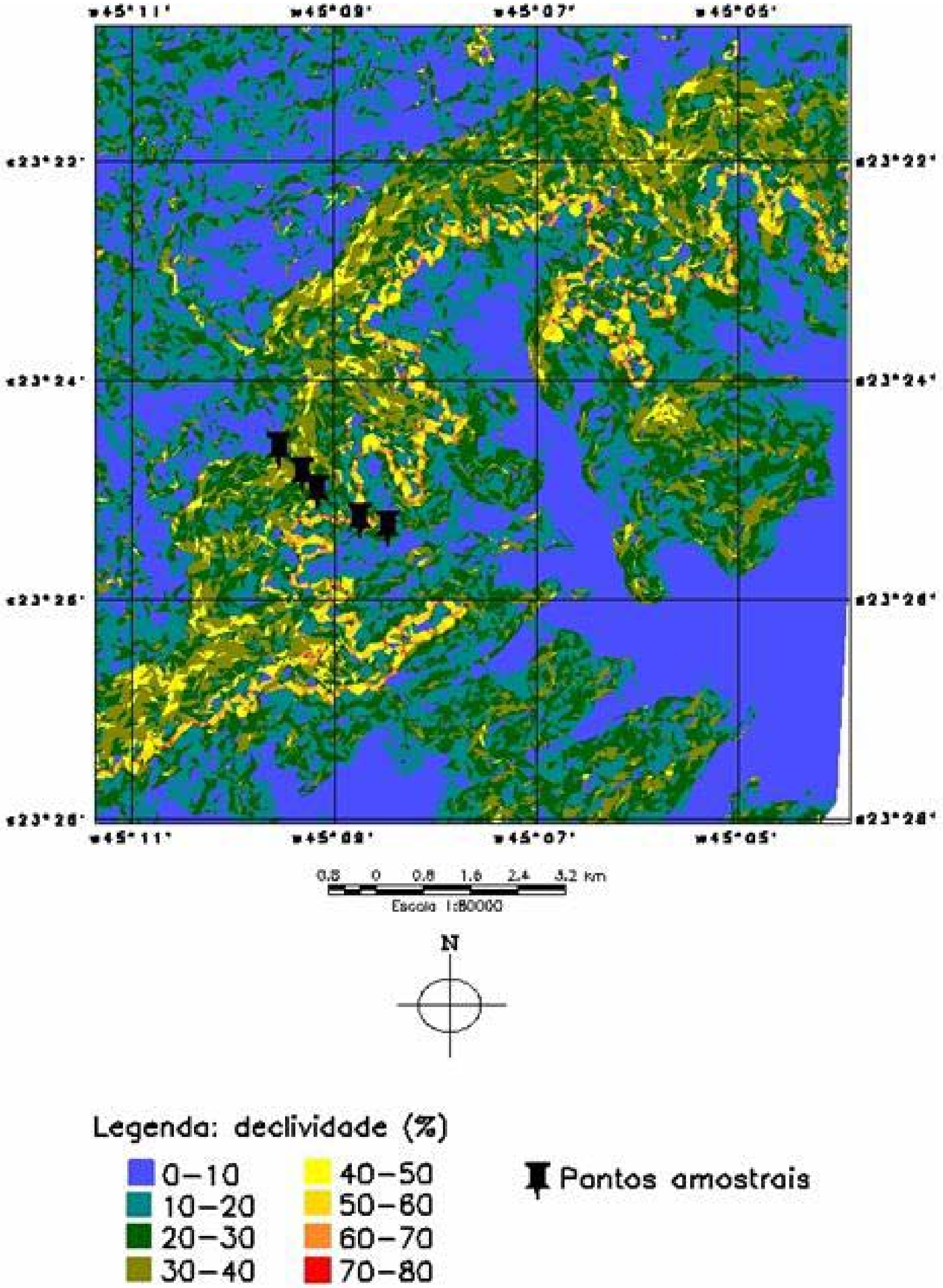


Figura 7: Mapa de declividade da área de estudo indo de 0 a 80% de inclinação.
Figure 7: Declivity maps of the study area going from 0 to 80% of slope.

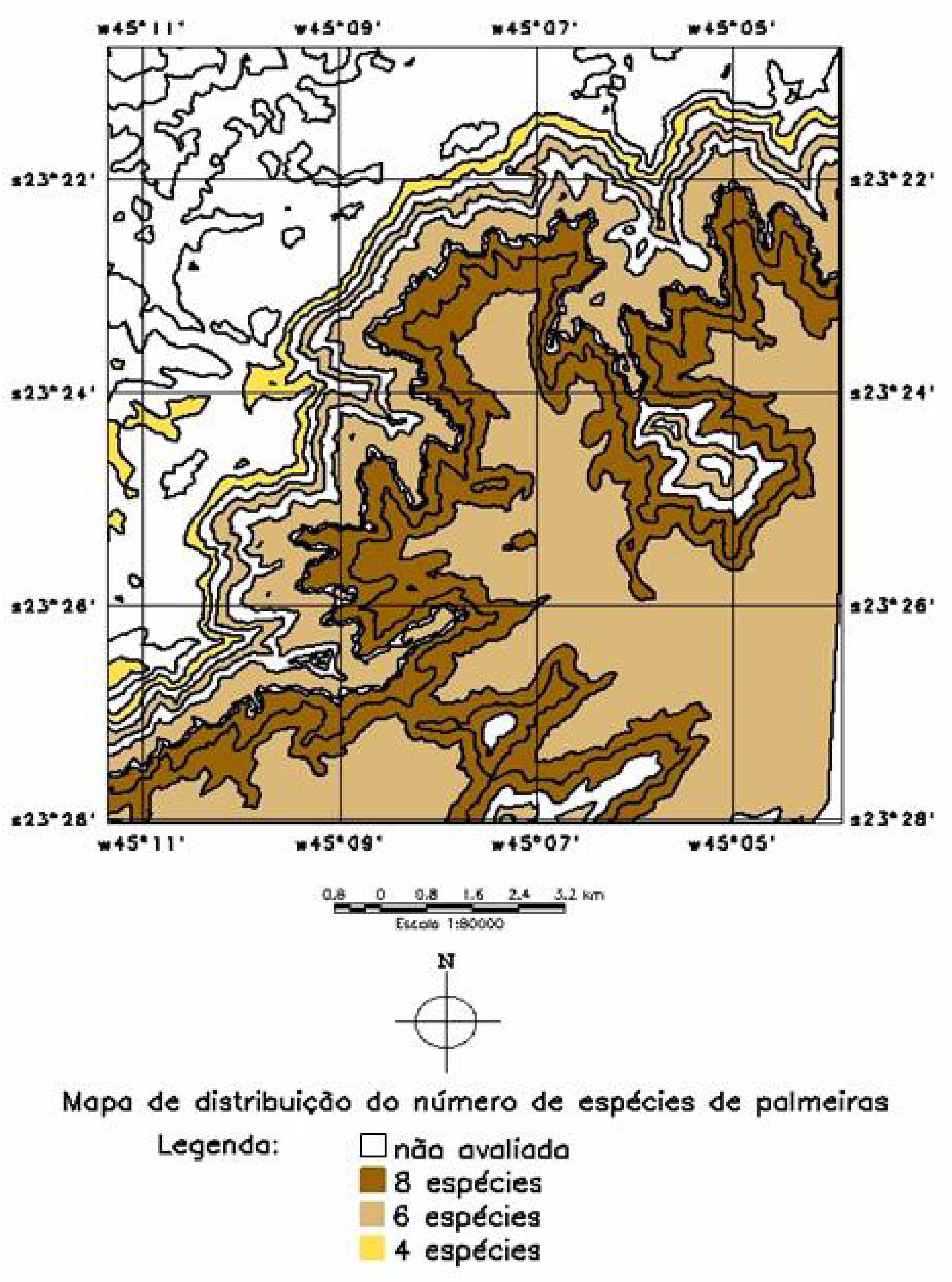


Figura 8: Mapa de distribuição do número de espécies de palmeiras segundo as classes de altitudinais avaliadas
Figure 8: Distribution map of the number of palms species according to class of altitude evaluated.

Tabela 1: Coordenadas geográficas e altitude das linhas de amostragem de palmeiras, município de Ubatuba/SP
Table 1: Geographic coordinates and altitude of the palm trees sampling lines in Ubatuba, São Paulo State

Altitude (m)	Longitude	Latitude
0	-	-
100	45W08’28”	23S25’30”
200	45W08’45”	23S25’26”
400	45W09’10”	23S25’10”
600	45W09’19”	23S25’00”
50	45W09’33”	23S24’47”

Tabela 2: Ocorrência de palmeiras no gradiente altitudinal: 0m – Restinga de Picinguaba; 100m-850m - Trilha da Vargem-Grande, município de Ubatuba/SP
Table 2: Occurrence of palm along an altitudinal gradient in Ubatuba: 0 meters – Picinguaba restinga; 100 – 850 meters – Vargem-Grande transect.

ESPÉCIES	**ALTITUDE**					
	0m	**100**	**200**	**400**	**600**	**850**
Astrocaryum aculeatissimum	X	X	X	X	X	
Geonoma gamiova		X	X	X	X	X
G. pohliana		X				X
G. elegans	X	X	X	X	X	
Attalea dubia		X	X			
Euterpe edulis	X	X	X	X	X	X
Syagrus peseudococos	X	X	X	X	X	X
Bactris setosa	X	X	X			
B. hatschbachii	X		X	X	X	
Total de Espécies	**6**	**8**	**8**	**6**	**6**	**4**

Caracterização florística e estrutural de onze fragmentos de mata estacional semidecídua da Área de Proteção Ambiental do Município de Campinas – SP

Karin dos Santos

Resumo

O processo de fragmentação de florestas tem sido freqüentemente relacionado a efeitos deletérios sobre as comunidades bióticas. Tais efeitos seriam: perda de espécies, alterações na estrutura e composição da vegetação e aumento da proporção de árvores mortas ou danificadas. A magnitude de tais alterações tem sido associada principalmente ao tamanho dos remanescentes florestais. Afirma-se que fragmentos pequenos apresentariam um número menor de espécies, pois muitas não sobreviveriam em áreas reduzidas. Além disso, florestas pequenas estariam mais expostas ao efeito de borda, devido sua maior razão borda:interior. O objetivo deste trabalho foi verificar se as variações de composição florística, riqueza, diversidade, estrutura florestal e aspectos qualitativos (qualidade e porcentagem de abertura de dossel) entre fragmentos de mata poderia estar associada à área total dos mesmos. Na região da Área de Proteção Ambiental do município de Campinas, SP, foram escolhidos dez fragmentos com áreas inferiores à 100ha, agrupados em três classes de tamanho: pequenos (10-15ha), médios (16-25ha) e grandes (40-65ha) e um fragmento com 244,9ha. Em cada fragmento foram amostrados 125 pontos quadrantes, onde foram incluídos indivíduos arbóreos com DAP≥10cm. As amostras de 500 indivíduos foram comparadas com amostras realizadas nas mesmas condições em três áreas diferentes do fragmento de 244,9ha. Ao todo, foram coletados 6500 indivíduos pertencentes a 248 espécies e 55 famílias. O número de espécies coletadas por amostra de 500 indivíduos variou de 47 a 110 espécies. A maioria dos fragmentos apresentou em torno de 100 espécies, independentemente de sua área total. Entretanto, um fragmento pequeno (47 espécies) e um fragmento grande (65 espécies) apresentaram menor número de espécies em relação aos demais. A maioria dos fragmentos apresentou cerca de 40% do total de espécies coletadas, indicando grande contribuição para o estoque regional de espécies. Das espécies coletadas, 25% (65 espécies) raramente são citadas em levantamentos florísticos realizados no interior do estado de São Paulo e 13,6% estão sendo citadas pela primeira vez para a região de Campinas. Além disso, quase 22% das espécies ocorreram em apenas um fragmento, mostrando sua importância para a conservação. A diversidade variou pouco entre as amostras e a riqueza estimada não diferiu entre os fragmentos. Muitas espécies foram abundantes em apenas um ou dois fragmentos, mas em todos houve concentração de abundância, com poucas espécies exercendo grande dominância em sua área de ocorrência. A densidade de indivíduos foi 40% menor nos fragmentos grandes e nas amostras do fragmento de 244,9ha. Entretanto, não houve correlação entre a área dos fragmentos e as densidades totais ou demais parâmetros de estrutura e abundância analisados. As análises de agrupamento mostraram que fragmentos de mesmo tamanho podem ser tão heterogêneos entre si quanto áreas distintas dentro de um mesmo fragmento, indicando que as variações observadas não estariam relacionadas ao tamanho dos fragmentos. Apenas os aspectos qualitativos mostraram distinção entre os fragmentos <100ha e o fragmento de 244,9ha. Os fragmentos <100ha apresentaram maiores porcentagens de abertura de dossel e um desequilíbrio entre a proporção de indivíduos danificados e de indivíduos jovens, indicando menores taxas de regeneração nessas áreas. Os resultados obtidos não estão de acordo com a hipótese testada, sendo que as variações observadas pareceram estar mais associadas à heterogeneidade ambiental e à ocorrência de fatores de perturbação como queimadas do que ao tamanho dos fragmentos. Entretanto, os aspectos qualitativos indicaram que a vegetação dos fragmentos <100ha pode estar sofrendo alterações que podem vir a se refletir na composição, riqueza e estrutura no futuro.

Palavras-chave: fragmentação florestal, floresta semidecídua, diversidade, riqueza, fitossociologia

FICHA CATALOGRÁFICA

Santos, Karin dos
Sa59c
Caracterização florística e estrutural de onze fragmentos de mata estacional semidecídua da área de proteção ambiental do município de Campinas-SP / Karin dos Santos.-- Campinas, SP: [s.n.], 2003.

Orientadora: Luiza Sumiko Kinoshita
Co-orientador: Flávio Antonio Maes dos Santos
Tese (Doutorado) – Universidade Estadual de Campinas .
Instituto de Biologia.

1. Biologia Vegetal. 2. Florestas – Campinas(SP). 3. Diversidade.
I. Kinoshita, Luiza Sumiko. II. Santos, Flávio Antonio Maes dos
III. Universidade Estadual de Campinas. Instituto de Biologia. IV. Título.

Variação da composição da comunidade de artrópodes das formações florestadas do extremo sul da Bahia: Disponibilidade de recursos alimentares para lagartos e anuros de serrapilheira

Moacir Santos Tinôco

Resumo

Estimativas adequadas da composição das comunidades são elementos importantes para a solução de problemas ecológicos. Metodologias distintas de avaliação empírica, contudo, podem estimar diferentemente os parâmetros de interesse. Artrópodes representam um grupo extremamente abundante e diversificado em ambientes terrestres e desempenham papéis chaves nos ecossistemas. Eles representam a principal fonte de recurso alimentar para as comunidades da herpetofauna, assim, a avaliação da composição e distribuição destes elementos em uma paisagem complexa, como é o caso deste estudo, é chave para a compreensão dos processos ecológicos na região. Este estudo buscou avaliar três aspectos principais do modelo proposto: (1) avaliar as estimativas de abundância das comunidades de artrópodes de serrapilheira em uma paisagem florestal com base em armadilhas de queda e uma análise dos artrópodes encontrados no conteúdo estomacal da herpetofauna. (2) Detectar a variação principal na composição da comunidade de artrópodes da serrapilheira de florestas em uma paisagem fragmentada no extremo sul do Estado da Bahia associando isto com as variações dos parâmetros ambientais. (3) E estudar o uso e eletividade do recurso alimentar pela herpetofauna de serrapilheira em um remanescente de Floresta Atlântica (6,069 ha). O trabalho foi conduzido na RPPN Estação Veracruz, uma reserva particular no extremo sul da Bahia, Brasil. Nós comparamos as dietas de anuros e lagartos capturados em 432 armadilhas de queda com cerca guia, distribuídas em quatro componentes da paisagem entre janeiro de 2003 e fevereiro de 2004. Nós analisamos três componentes principais da paisagem: mata de referência (M); remanescente florestal (R); e monocultura de eucalipto (E). As capturas foram baseadas em um esforço de 17.280 armadilhas de queda em 40 dias de campanha e o conteúdo estomacal presente em 523 anuros e 206 lagartos de serrapilheira capturados da mesma forma. Foram coletados animais de 12 famílias, em um total de 21 espécies de anuros e lagartos das seguintes famílias: Teiidae (4), Polychrotidae (3), Gekkonidae (1), Tropiduridae (1); Scincidae (1); Gymnophthalmidae (1), Anguidae (1) de Squamata (lagartos), e Hylidae (2); Bufonidae (1); Leptodactylidae (3); Microhilidae (2); Dendrobatidae (1) de Anura. A estimativa de artrópodes com base nas duas metodologias resultou em um total de 6.479 indivíduos capturados em armadilhas de queda e um total de 6.477 artrópodes através das análises de conteúdo estomacal, distribuídos entre 27 categorias do Phylum Arthropoda. As armadilhas de queda foram menos eficientes que a análise de conteúdo estomacal para estimar artrópodes de baixa mobilidade ou de dispersão agregada, e a segunda técnica foi menos eficiente que a primeira para estimar a abundância de animais portando defesas químicas, ou artrópodes voadores ou saltadores. Estes resultados propõem uma estimativa menos enviesada se for levada em consideração a melhor estimativa de cada técnica. Nós comparamos ambas, a composição da comunidade de artrópodes e as variáveis ambientais entre os componentes da paisagem com base em um procedimento de permutação. Então geramos um eixo de ordenação direta para as comunidades das 12 áreas utilizando o método NMDS e testando a hipótese da dependência dos principais eixos gerados (através de PCA) das variáveis ambientais utilizando um teste de regressão múltipla. Nós encontramos uma diferença significativa entre composição da comunidade e as variáveis ambientais de M e R comparados com E, mas nenhuma diferença entre os dois primeiros. Houve uma regressão significativa entre um dos eixos extraídos das variáveis ambientais (PCA1) e o eixo da ordenação da composição da comunidade (NMDS). O teste de autocorrelação espacial não encontrou associação significativa da distância entre as unidades amostrais e suas diferenças em composição. Ordens como Coleoptera, Isoptera, Acari e Hymenoptera parecem estar associadas principalmente a mata de referência, enquanto que, Isopoda, Opiliones, Araneae, Lepidoptera e Chilopoda estavam mais relacionados a monocultura do eucalipto. Entre as 27 categorias de artrópodes encontradas, 19 foram utilizadas pela herpetofauna local. A dieta foi composta principalmente por itens do Phylum Arthropoda que foram classificados em Hexapoda, Aracnida, Miriapoda e Crustacea. Formigas, cupins, grilos, aranhas e ácaros foram os itens que mais contribuíram com o universo das dietas. Foi possível identificas uma guilda de anuros e lagartos que concentraram seu consumo e eletividade em formigas. Especialmente em anuros, onde todas as espécies, menos uma, mostraram eletividade positiva por este item. Não foi possível detectar o mesmo padrão entre os lagartos, exceto por duas espécies (*Ameiva ameiva* e *Polychrus* *marmoratus*) que mostraram eletividade positiva por formigas, ainda assim, não foi possível determinar uma preferência clara por nenhuma categoria específica de artrópode. Este estudo demonstra claramente que não há uma diferença evidente na disponibilidade de recurso alimentar e eletividade pela herpetofauna entre a mata de referência (M) e os remanescentes florestais (R), mas uma clara evidência entre estes dois componentes e a monocultura de eucalipto (E). Isto indica a necessidade de um plano de manejo forte dirigido à manutenção dos remanescentes florestais na região, objetivando a manutenção da diversidade dos processos ecológicos.

Palavras-chave: sapos, lagartos, artropódes, serrapilheira, mata atlântica, eucalipto, comunidades animais

FICHA CATALOGRÁFICA

T591 Tinôco, Moacir Santos.

Variação da composição da comunidade de artrópodes nas formações florestadas do extremo sul da Bahia : disponibilidade de recursos alimentares para lagartos e anuros de serrapilheira / Moacir Santos Tinôco. - 2004.

95 f. : il.

Orientador : Prof. Dr. Pedro Luís Bernardo da Rocha.
Dissertação (mestrado) - Universidade Federal da Bahia, Instituto de Biologia, 2004.

1. Anuro. 2. Lagarto. 3. Artrópode. 4. Liteira (Entulho). 5. Diversidade biológica - conservação. 6. Mata Atlântica. 7. Eucalipto. 8. Comunidades animais. I. Rocha, Pedro Luís Bernardo da. II. Universidade Federal da Bahia. Instituto de Biologia. III. Título.

CDU - 597.8

An illustrated key to male *Actinote* from Southeastern Brazil (Lepidoptera, Nymphalidae)

***Ronaldo Bastos Francini*[1] *& Carla M. Penz*[2]**

Biota Neotropica v6 (n1) – http://www.biotaneotropica.org.br/v6n1/pt/abstract?identification-key+bn00606012006

Date Received 06/06/2005
Revised10/20/2005
Accepted 01/01/2006

[1]Universidade Católica de Santos, Av. Cons. Nébias 300, 11015-200 Santos, SP, Brazil;
email: francini@unisantos.br
[2]Department of Biological Sciences, University of New Orleans, 2000 Lakeshore Drive, New Orleans, LA 70148, USA,
email: cpenz@uno.edu. Associate professor, Programa de Pós-Graduação em Biociências, Pontifícia Universidade
Católica do Rio Grande do Sul, Av. Ipiranga 6681, 90619-900, Porto Alegre, RS, Brazil.

Abstract

Francini, R.B. and Penz, C.M. **An illustrated key to male *Actinote* from Southeastern Brazil (Lepidoptera, Nymphalidae).** *Biota Neotrop*. Jan/Abr 2006, vol. 6, no. 1 http://www.biotaneotropica.org.br/v6n1/pt/abstract?identification-key+bn00606012006. ISSN 1676-0603

In certain times of the year, *Actinote* butterflies can be vastly abundant in Southeastern Brazil, thus representing conspicuous denizens of our fauna. Their wing coloration allows for the recognition of five major patterns, which probably resulted from mimicry. Furthermore, examination of series of field-collected and reared specimens clearly demonstrates a high intra-specific variation in wing color pattern. In concert, inter-specific resemblance (mimicry) and intra-specific variation make it difficult to discriminate *Actinote* species from each other. This key aims at providing a tool for identification of male *Actinote.* To that effect, we provide diagnostic characters and illustrations of wings and male genitalia for 22 species. We hope that the clear identification of these species will lead to the discovery of species yet unrecognized in Southeastern Brazil.

Key words: *butterfly, identification, genitalia, mimicry.*

Resumo

Francini, R.B. and Penz, C.M. **Chave ilustrada para machos de *Actinote* do sudeste do Brasil (Lepidoptera, Nymphalidae).** *Biota Neotrop*. Jan/Abr 2006, vol. 6, no. 1 http://www.biotaneotropica.org.br/v6n1/pt/abstract?identification-key+bn00606012006. ISSN 1676-0603

Em certas épocas do ano, as borboletas do gênero *Actinote* podem ser muito abundantes no sudeste do Brasil, constituindo, então, elementos conspícuous da nossa fauna. Sua coloração alar permite a separação em cinco padrões básicos, provavelmente relacionados com o mimetismo. Além disso, séries de exemplares coletados no campo ou criados em laboratório demonstram claramente que existe uma grande variabilidade intra-específica na coloração alar destas borboletas. Em conjunto, a semelhança entre as espécies (mimetismo) e variação intra-específica dificultam o reconhecimento das espécies de *Actinote.* Esta chave tem como objetivo auxiliar a identificação dos machos destas borboletas e, para tanto, são apresentados caracteres diagnósticos, ilustrações das asas e genitália de 22 espécies. Esperamos que a clara identificação destas espécies possa revelar a presença de espécies ainda não reconhecidas no sudeste do Brasil.

Palavras-chave: *borboleta, identificação, genitalia, mimetismo.*

Introduction

The butterfly tribe Acraeini (Nymphalidae, Heliconiinae) currently holds the African genera *Pardopsis* Trimen, 1887, *Acraea* Fabricius, 1807 and *Bematistes* Hemming, 1935, plus the Neotropical *Actinote* Hübner, [1819], *Abananote* Potts, 1943 and *Altinote* Potts, 1943 (Ackery 1984, 1988, Penz & Djunijanti 2003, Lamas 2004). Ehrlich (1958), Van Son (1963), and Penz & Djunijanti (2003) provided several characters to define this group, including the closed hindwing cells, stalking of the forewing radial veins, morphology of dorsal forewing scales, forelegs, genitalia, and first instar larvae. Independently of the continent one happens to visit, or color pattern details, acraeines can be easily recognized in the field by their elongated wings and flight behavior - the butterfly equivalent of recognizing 'robins' or 'figs' as natural groups of organisms.

As a taxonomic unit, the generic status of *Actinote* is uncertain. In a comprehensive phylogenetic study of Acraeini, Pierre (1987) suggested that *Actinote* nests within and should be regarded a subgenenus of *Acraea*. Although Pierre's hypothesis has been recently supported with a small sample of species (Penz & Djunijanti 2003), from a practical standpoint it is unclear if *Actinote* and other Neotropical genera should be subsumed within *Acraea* (Pierre's approach) or if the speciose *Acraea* should be divided into smaller monophyletic units (*Actinote* being one of them, according to Pierre). Therefore, the generic rank of *Actinote* has been maintained here for tradition and convenience, despite the fact that these Neotropical butterflies are likely closely related to a discrete subset of African *Acraea*.

Several natural history characteristics distinguish *Actinote* from other Neotropical heliconiines. Males produce a mating plug, which they attach to the females after copulation (Ehrlich & Ehrlich 1978, Paluch et al. 2003). Eggs are always laid in clusters, and larval cycles are usually long, with some species being univoltine and spending part of the year in diapause as early instar larvae (Francini 1989, 1992 and unpublished. obs.). Adults can reach high abundances in SE Brazil in late Spring (October-November) and early Fall (March-April), but some univoltine species can be quite rare in collections because of their short adult life and limited geographic distribution (e.g., *A. zikani*; Francini 1992). While several heliconiine species prosper inside the Amazon forest, *Actinote* species often prefer open habitats where their Asteraceae host plants also thrive. In southeastern Brazil, they collectively inhabit an altitudinal range from sea level to 2400 m.

Species of *Actinote* use toxic chemical compounds and mimicry as protection against predation (e.g., Müller 1879, Brown & Benson 1974, Francini 1989, 1992). Cyanogenic glycosides and pyrrholizidine alkaloids are present in all life stages (Francini 1989, Brown & Francini 1990). Their lethargic flight, elongated abdomen and often aposematic coloration are characteristic of chemically protected butterflies (e.g., Bates 1862, Poulton 1902, Chai 1986, 1996, Srygley 1994). The 22 *Actinote* species in SE Brazil considered here are members of five different mimicry rings (Francini 1989, 1992, Brown & Francini 1990), and wing coloration for any given species is probably a result from the combined history of their phylogenetic and mimetic associations.

The dynamics of mimicry groups within *Actinote* strongly contrasts their relatives in the genus *Heliconius* Kluk, 1780. In southeastern Brazil, *Actinote* species from different mimicry groups usually fly together in the same area, and broadly overlap in adult resource use (nectaring plants, basking spots) and activity patterns. Furthermore, conspecific individuals may vary considerably in the size and color of their forewing markings both within and between sexes. At a community level, therefore, the end result potentially includes a mixed group of individuals that show a range of forewing patterns from dark-orange to white to semi-translucent in random proportions. This commonly seen *Actinote* mishmash greatly contrasts Müllerian mimicry rings of *Heliconius*, where both field observations and theory suggest that Müllerian mimics should, and do, resemble one another as closely as possible (e.g., Turner 1987). Nothing is known about how potential predators perceive and react to color variation in *Actinote*.

Although as a group *Actinote* butterflies constitute an instantly recognizable component of the butterfly fauna in Southeastern Brazil, species identification is often problematic (e.g., Hayward 1931). This difficulty is due to the interaction between two factors: some *Actinote* species share extremely similar wing patterns; and all species have a high level of intraspecific variation. Furthermore, females of several species are nearly indistinguishable from one another (D'Almeida 1935a, Francini 1989). As a result, the often-incomplete series of specimens available in early collections, abbreviated descriptions, and limited illustrations led to much confusion regarding species identification (e.g., see synonymy for *A. pyrrha* (Fabricius), below).

Here we present an illustrated key for the identification of male *Actinote* from southeastern Brazil based on 25 years of fieldwork and comparative morphology. The São Paulo region has the highest species richness for *Actinote* due to habitat diversity and overlapping species distributions. Therefore, our geographical focal point is São Paulo and surrounding states, where the 'Mata Atlântica' (Atlantic forest) vegetation ranges from open 'restinga' (sea level, shrubby vegetation neighboring the ocean), to cloud forest (2000 m). We provide synonymy, a brief diagnosis for males of each species included in the key, geographical distribution of the species, and illustrations of male genitalia.

Material and Methods

We attempted to study *Actinote* populations both in the field and in the laboratory. Because females lay eggs in clusters, sib groups are useful for evaluating intraspecific variation and for matching males and females of the same species - which gave us particularly valuable insight to variation and overlap between *A. pellenea* Hübner and *carycina* Jordan. There is a cost, however, to studying organisms that flourish in second growth or naturally open habitats. Although *Actinote carycina* larvae are common in second growth and roadsides where their Asteraceae host plants grow in abundance, their populations (and our samples) were often decimated by road clearings. Furthermore, some species are difficult to maintain in culture. For example, *Actinote morio* Oberthür is univoltine, has a long life cycle and feeds on a single Asteraceae host plant that can only be found 300 km from the laboratory. Despite these difficulties, we examined male external and internal morphology of both field-collected and laboratory reared adults to provide characters for species identifications.

Color variation in *Actinote* gave rise to the description of numerous subspecies and varieties. Although some of the described subspecies may represent legitimate divergence (see Species Accounts section), many of the names that have been proposed to define geographic races actually correspond to variation that can be found within a single population and are, thus, biologically meaningless. Here, therefore, our focus is to define and identify *Actinote* butterflies to the species level, and we defer the study of subspecific divergence to furture workers.

Our long-term experience with series of specimens demonstrates that positive identification of certain species can only be achieved through genitalic examination, which can sometimes be done without dissection even in the field using a good magnifying lens. Dissection of male genitalia followed standard methods of soaking the abdomen in 10% KOH, and permanent storage in a vial filled with glycerol. For the key, illustrations of the male right valva simply consist of an outline in dorsal, ventral, or lateral views, flattened to a uni-dimensional plane, and devoid of setae, and with the valval base positioned to the left. This was done purposefully for ease of visualization of characters, and detailed drawings of the complete male genitalia are given in the plates that accompany the species accounts. Most, but not all species, are used as examples in the illustrations of characters in the key.

For the species accounts, taxa are listed in the order that they appear in the key, which does not imply phylogenetic relationships. Because the authorities that designated each taxon name are listed in the species accounts, we do not include their names in the key or figure legends. We give the synonymy, diagnosis, geographical distribution, and brief remarks when applicable. The synonymy is as complete as possible, barring records that were dubious, unclear, or unavailable to us. The diagnosis is based on specimens from SE Brazil, and therefore may not reflect the complete color variation found across species ranges. Distributions were based on collection specimens. Each species is illustrated in a plate by pictures of the wings (dorsal) and scales (ventral hindwing, basal area), and drawings of male genitalia (dorsal, ventral and lateral views; anterior portion to the left). Further information about nomenclature, type specimen deposition, synonymy and distribution can be found in Lamas (1996, 2004).

We examined specimens in the following collections: RBF (Ronaldo Francini's personal collection, currently at the Museu de Zoologia, Universidade de São Paulo, São Paulo, Brazil), UFPR (Universidade Federal do Paraná, Curitiba, Brazil), MAPA (Museu Anchieta, Porto Alegre, Brazil), MPM (Milwaukee Public Museum, Milwaukee, USA). Most fieldwork was done in São Paulo and Rio Grande do Sul states, Brazil, but RBF also visited Paraná, Minas Gerais, Rio de Janeiro, Espírito Santo and Bahia states.

Illustrated key to male *Actinote* from southeastern Brazil based on wing pattern and genitalia

1a. Wings completely opaque and predominantly iridescent-black except for forewing yellow markings [iridescent-black mimicry group, example in Figure 1A] 3

1b. Certain wing areas translucent to some extent [black-yellow mimicry group, example in Figure1B; greasy-orange mimicry group, example in Figure 1C] 2

1c. Wings completely opaque but never iridescent-black [orange-yellow mimicry group, example in Figure 1D; red mimicry group, example in Figure 1E] 8

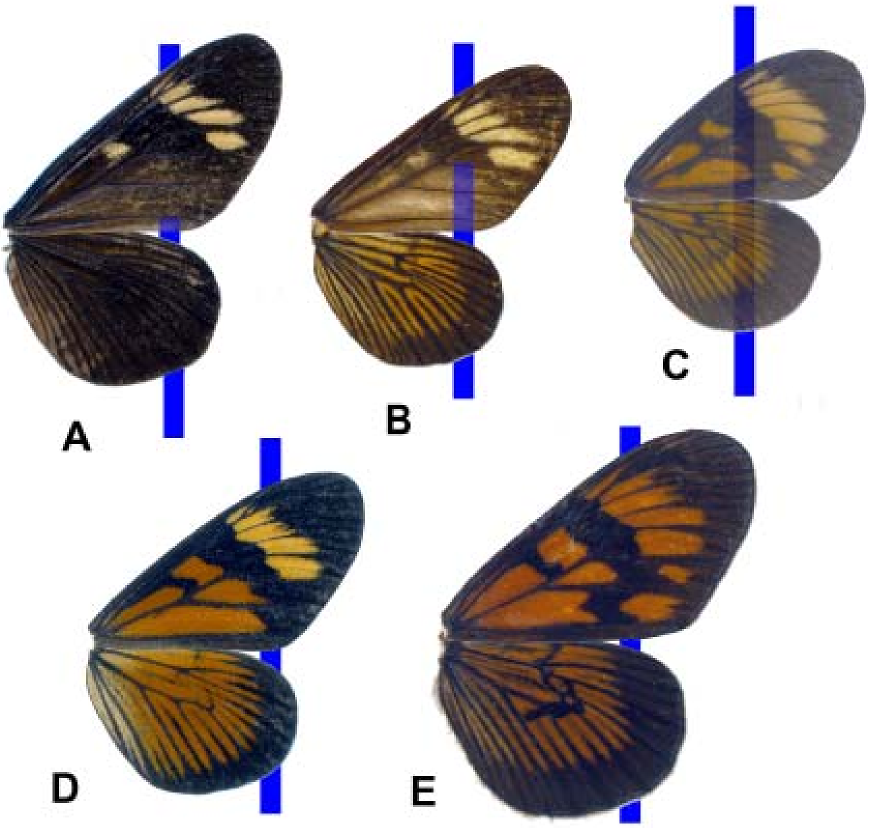


Figure 1. Vertical blue lines help to show the degree of wing transparency. (A) A. zikani; (B) A. melanisans; (C) A. canutia; (D) A. brylla; (E) A. dalmeidai.

2a. Fore- and hindwings largely translucent and with a greasy appearance 4

2b. Forewing base translucent, remainder of the wings opaque 5

3a. In ventral view, valva cylindrical; in dorsal view, base of valva narrower (Figure 2A) ……………......…….. *morio*

3b. In ventral view, valva triangular; in dorsal view, base of valva broader (Figure 2B) ………………......…….. *zikani*

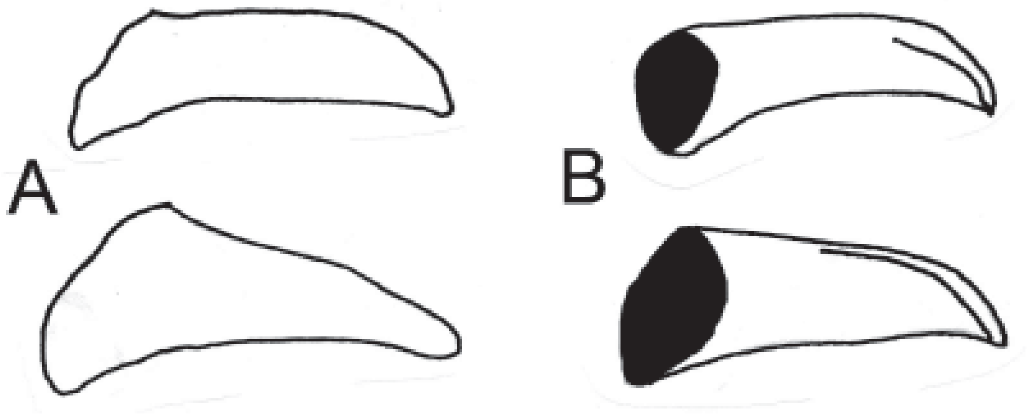


Figure 2. Dorsal and ventral views of the valva, setae ommited. (A) Actinote morio; (B) A. zikani.

4a. Hindwing comma-shaped mark well developed (indicated by the arrow in Figure 3A) ………...........…….. *mamita*

4b. Hindwing comma-shaped mark faded (Figure 3B) ………………..…………………................……………….. *canutia*

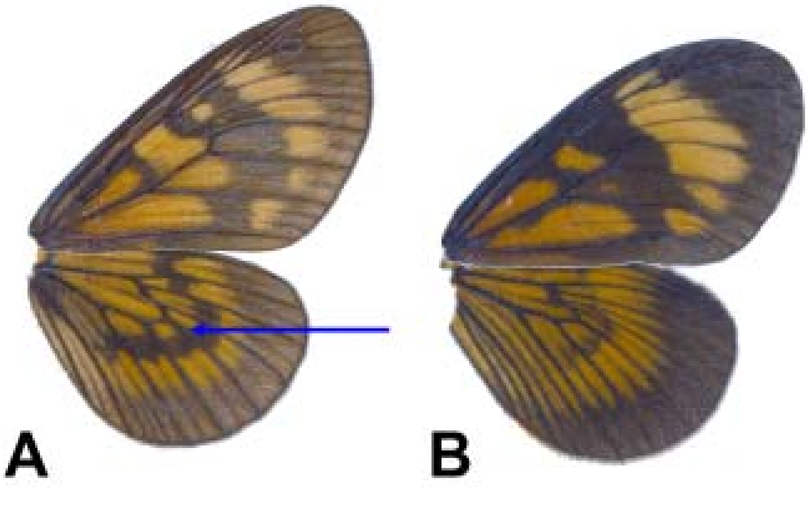


Figure 3. Fore- and hindwngs; dorsal surface. (A) A. mamita, the arrow indicates the comma-shaped mark; (B) A. canutia.

5a. Valva much longer than broad (5x longer than the maximum width), with tube-like appearance and blunt apex (Figure 4A); forewing greasy and strongly translucent at base (Figure 4B) ..………….........................…………….. *genitrix*

5b. Valva less than 3x as long as it is wide (maximum length/maximum width) ……………………...…........……… 6

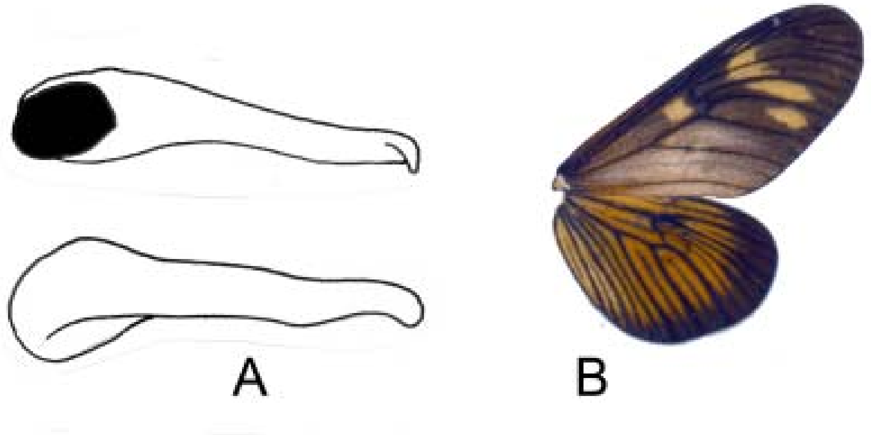


Figure 4. Actinote genitrix. (A) Dorsal and ventral views of the valva; (B) wings, dorsal surface.

6a. In ventral view, inner contour of valva bulging before apex, apex with a broad point (Figure 5A) ………………………………………………………………………………………...… *discrepans*

6b. In ventral view, inner contour of valva a simple arch, apex blunt (Figure 5B) ………….........……..……... *eberti*

6c. Valva apex pointed (example in Figure 5B) ……………………………………...............…………………………... 7

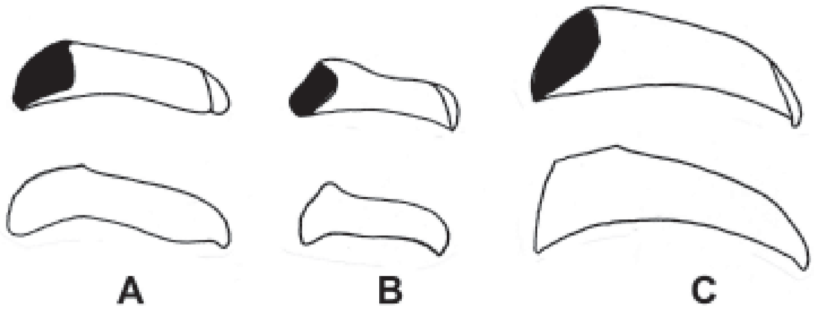


Figure 5. Dorsal (top) and ventral (bottom) views of the valva. (A) A. discrepans; (B) A. eberti; (C) A. melanisans.

7a. In ventral view, valva longer and somewhat arched (characters visible without dissection; Figure 6A) ……………………………….......................................……………………………………..…………………………….. *melanisans*

7b. In ventral view, valvae shorter, less arched, with a slight constriction before the apex and a more sharply pointed apex (characters visible without dissection; Figure 6B)………………………….…..............................……………… *rhodope*

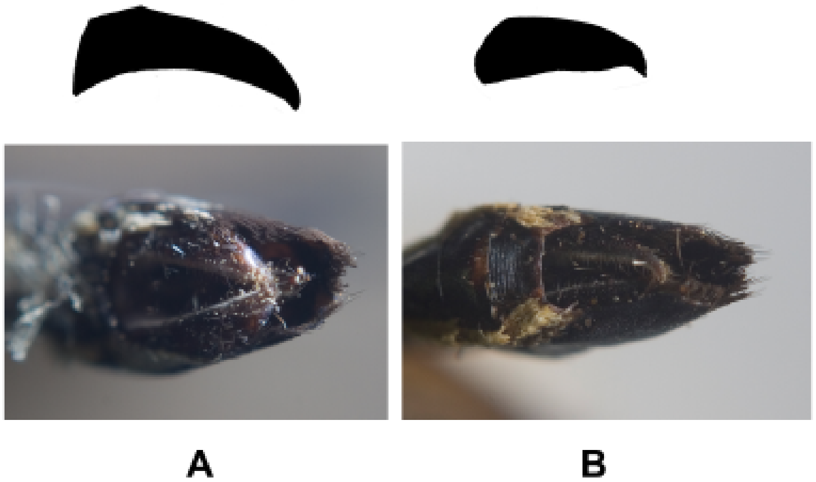


Figure 6. Ventral view of the valva and abdomen. (A) A. melanisans; (B) A. rhodope.

8a. In dorsal view, fore- and hindwing with orange stripes and spots, completely lacking yellow stripes or spots (example in Figure 7A) ………………………………………………..……………………………......................................…... 9

8b. In dorsal view, fore- and hindwing stripes and spots predominantly orange, but some yellow stripes and spots present (example in Figure 7C) ………………………………………………………………..……………....................................…. 13

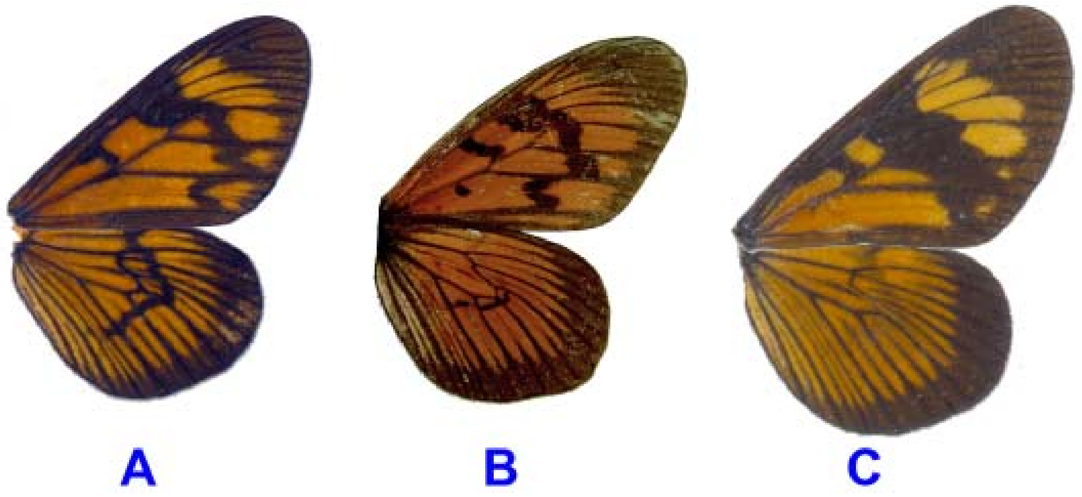


Figure 7. Dorsal view of fore- and hindwings. (A) A. surima; (B) A. catarina; (C) A. pyrrha.

9a. In dorsal view, wing background nearly black, markings dark orange, forewing stripes and spots never fused; in ventral view, valva short and with a sharply pointed apex (Figures 7A, 8A) ……………..............................…………. *surima*

9b. In dorsal view, wing background brown, markings dark orange, forewing stripes and spots often fused (common in the discocellular markings); in ventral view, valva elongated, broad at base and with a pointed apex (Figures 7B, 8B) …………………………………………………..……………..…………...………….. *catarina*

9c. In ventral view, valva apex blunt (examples in Figure 8C-F) ………………................…………………….……….. 10

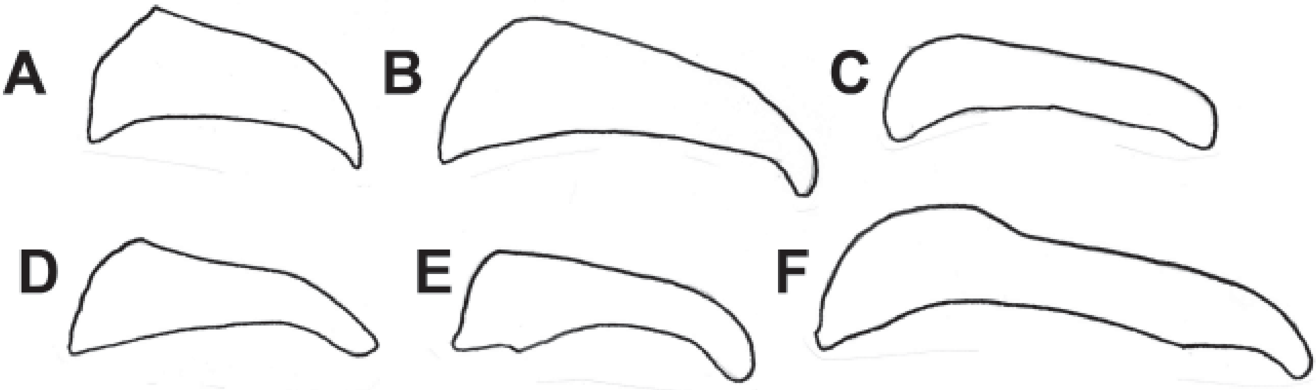


Figure 8. Ventral view of the valva. (A) A. surima; (B) A. catarina; (C) A. alalia; (D) A. bonita; (E) A. dalmeidai; (F) A. conspicua.

10a. Scales of the basal region of the hindwing with a prominent, broad mid-lobe - a pattern that differs from the typically serrate or dentate (Figure 9A) ……………………………………....………………................................………….. *alalia*

10b. Scales of the basal region of the hindwing dentate (examples in Figure 9B-C) …………........………………. 11

Figure 9. Scales of the basal region of the hindwing. (A) A. alalia; (B) A. conspicua; (C) A. bonita.

11a. Valva about 5x longer than wide (maximum length / maximum width; Figure 10A) …..............………… *conspicua*

11b. Valva 3x or less longer than wide (maximum length / maximum width; examples in Figure 10B-C) …...............… 12

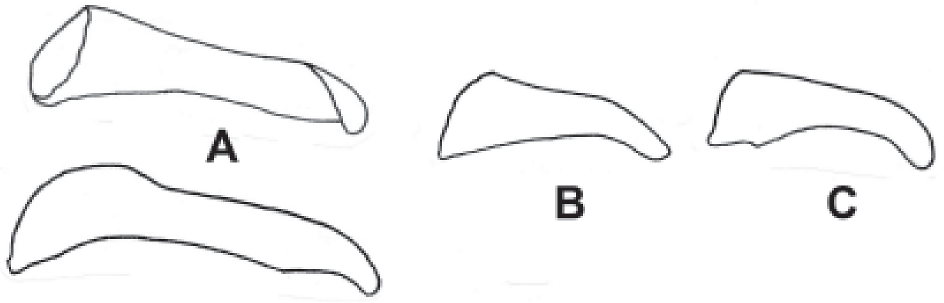


Figure 10. Valva. (A) A. conspicua, dorsal (top) and ventral (bottom) views; ventral view of (B) A. bonita; and (C) A. dalmeidai.

12a. In lateral view, valva sharply decrease in width from base to apex, apex narrower (Figure 11A) ......…… *bonita*

12b. In lateral view, valva with a slight decrease in width from base to apex, apex broader (Figure 11B) …………………………………………………………………………………………….. *dalmeidai*

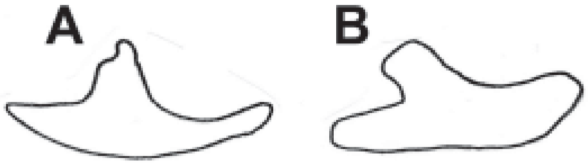


Figure 11. Lateral view of the valva; (A) A. bonita; (B) A. dalmeidai.

13a. Cell Cu2 with a thin black line across the yellow marks resembling an extra vein (blue arrow in Figure 12A); in ventral view, valvae strongly arched (Figure 12B) …………………………………….………..................................… *quadra*

13b. Cell Cu2 without a thin black line across the yellow marks (example in Figure 12C); in ventral view, valvae not strongly arched (example in Figure 12D) …………………………………………………………………..................................…... 14

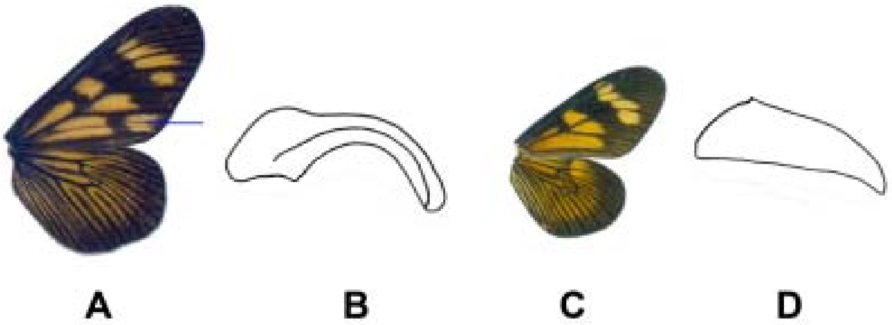


Figure 12. Dorsal view of the wings and ventral view of the valva. (A-B) A. quadra; (C-D) A. pellenea.

14a. Hindwing with reddish-orange markings on both dorsal (Figure 13A) and ventral surfaces (Figure 13B) ……………………………………………………......…………………………………....................................……… *parapheles*

14b. Hindwing without reddish-orange markings on dorsal and ventral surfaces ………………….……………… 15

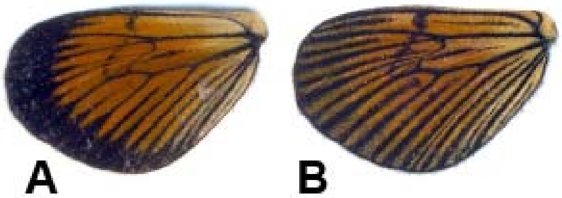


Figure 13. Dorsal (A) and ventral (B) views of the hindwing of A. parapheles.

15a. Scales of the basal region of the hindwing not dentate or serrate (examples in Figure 14A-B) ……….....……. 16

15b. Scales of the basal region of the hindwing dentate or serrate (example in Figure 14C) ……….......…………. 17

Figure 14. Scales of the basal region of the hindwing. (A) A. carycina; (B) A. pellenea; (C) A. pyrrha.

16a. Wing length generally smaller (1.8-3.0 cm, mean = 2.2 cm); basal dorsal forewing markings velvety orange, varying from darker to paler between individuals; basal dorsal forewing markings generally broad, but varying in width between individuals (Figure 15 A-B); this species is very similar to carycina ……………………………………………………………………………......................................………………….….. *pellenea*

16b. Wing length generally larger (2.2-2.9 cm, mean = 2.6 cm); dorsal background color orangish-brown; basal dorsal forewing markings more shiny than pellenea, colored orange to yellow and white, sometimes the orange basal markings with a tint of white; basal dorsal forewing markings generally narrower than pellenea, but varying in width between individuals from broad to a faint diffuse line (Figure 15 C-D); this species is very similar to pellenea; some individuals may be similar to pyrra or pratensis …….……….……... *carycina*

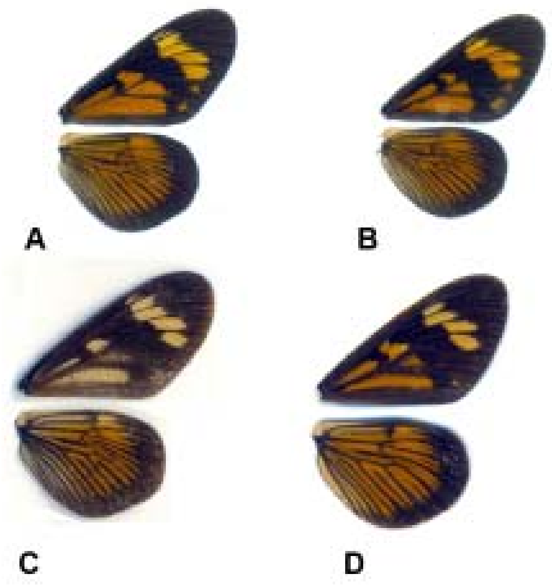


Figure 15. Dorsal (right) and ventral (left) views of wings. (A-B) A. pellenea; (C-D) A. carycina.

17a. In ventral view, valva apex blunt (blue arrow in Figure 16A) ……………………………...….......…….. *pratensis*

17b. In ventral view, valva apex more pointed (example in Figure 16B) …………………………..…...........….….…….. 18

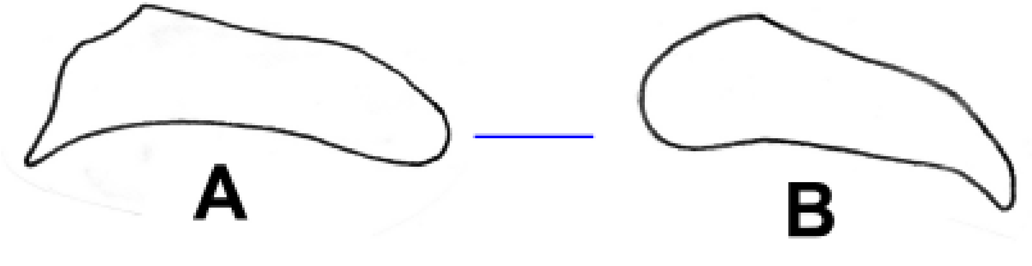


Figure 16. Ventral view of the valva. (A) A. pratensis; (B) A. brylla.

18a. In ventral view, inner and outer edges of valva nearly parallel (blue arrows in Figure 17A); dorsal forewing base markings predominantly shiny orange (Figure 16B) ……………....…………..…………………… *pyrrha*

18b. In ventral view, inner and outer edges of valva converging toward apex (blue arrows in Figure 17C); dorsal forewing base markings predominantly yellow (Figure 17D) …………………………….................................…………… *brylla*

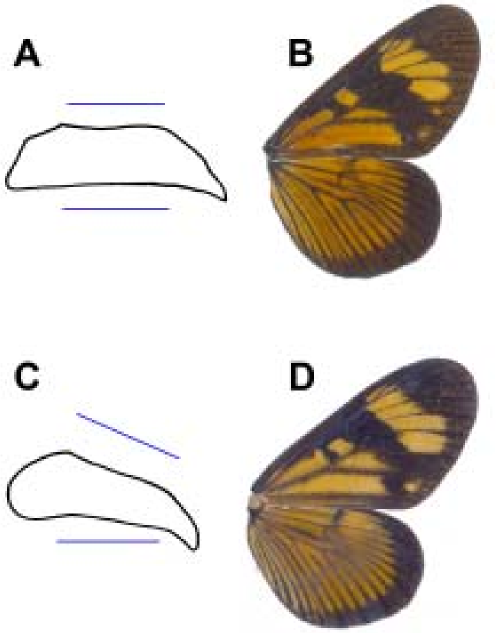


Figure 17. Ventral view of the valva and dorsal view of the wings. (A-B) A. pyrrha; (C-D) A. brylla.

Species accounts

Actinote morio Oberthür, 1917

(Plate 1)

Actinote morio Oberthür 1917:112, 123; D'Almeida 1951:5; D'Abrera 1987:444; Brown 1988:36; Francini 1989:41, 53, 198; Brown 1992:158-159; Lamas 2004:263

Actinote mario [sic] D'Abrera 1987:444

Diagnosis: Wings opaque, iridescent black; dorsal basal forewing markings faint and diffuse, dirty yellow; post medial dorsal forewing markings dirty yellow; hindwing markings dirty yellow. Valva broad, slightly flattened dorso ventrally, somewhat uniform in width and lacking constrictions or terminal indentations; apex robust, pointed. Similar to, but distinguished from *zikani* by the darker wings and the shape of the valva.

Distribution: Brazil – Rio de Janeiro, Minas Gerais, Distrito Federal. Approximate altitude range: 700-1400 m.

Remarks: Iridescent-black mimicry group. Bivoltine. Relatively rare in collections.

Actinote zikani D'Almeida, 1951

(Plate 2)

Actinote zikani D'Almeida 1951:3-5; Lamas 1973:180; Mielke & Casagrande 1986:151; Brown 1987:41; Francini 1989:41-43, 198; Fernandes, Machado & Rylands 1990:60; Brown 1991:389; Lamas 2004:264

Actinote mikani [sic] D'Almeida 1951:4

Actinote zakani [sic] Brown 1988:36

Actinote morio D'Almeida 1943:107-109

Diagnosis: Wings opaque, iridescent black; dorsal basal forewing markings faint and diffuse, dirty yellow; post medial dorsal forewing markings dirty yellow; hindwing markings dirty orange. Valva broad at the base, decreasing in width towards apex to produce a triangular shape in ventral view; apex robust, blunt. Similar to, but distinguished from *morio* by the lighter wing colors and the shape of the valva.

Distribution: Brazil – São Paulo, Rio de Janeiro. Approximate altitude range: 600-1200 m.

Remarks: Iridescent-black mimicry group. Bivoltine. Relatively rare in collections.

Actinote mamita (Burmeister, 1861)

(Plate 3)

Acrea*[sic]* mamita *Burmeister 1861:168*

Actinote mamita Lewis 1975:43, 227; Penz 1983:51-55; Penz 1985:51-53; Brown 1987:41; Brown 1988:36; Francini 1989:41, 43, 53-56, 61,63, 65, 67-71, 74-75, 77, 79, 87, 89-96, 100, 102, 107-109, 113-114, 135, 137, 140, 143, 153, 198, 199, 217, 220, 223; Brown 1992:158-159

Acraea mitama Schaus 1902:391

Actinote mamita mitama Eltringham & Jordan 1913:12; Jordan 1913b:374; Jordan & Eltringham 1916:19; Lamas 2004:263

Diagnosis: Wings greasy, translucent; all forewing markings orange; hindwing comma-mark (Fig. 3A) always conspicuous. The subspecies from southeastern Brazil, *mamita mitama* (Schaus, 1902) seems to be more orange than *mamita mamita* found in Argentina. Valva cylindrical, somewhat narrow, and strongly arched dorso-ventrally. Distinguished from *canutia* by a larger marking on forewing cell Cu1, and all forewing markings being of the same color. Genitalia similar to *canutia*, but apex of valva more delicate in dorsal view.

Distribution: Brazil – Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Rio de Janeiro, Minas Gerais; Argentina; Uruguay?; Paraguay?. Approximate altitude range: 0-1600 m.

Remarks: Greasy-orange mimicry group. Lamas (2004) listed three subspecies of mamita (*m. mamita*, *m. elena* and *m. mitama*). We did not examine specimens of *mamita elena* (from Colombia; see Lamas 2004).

Actinote canutia (Hopffer, 1874)

(Plate 4)

Acraea canutia Hopffer 1874:345-346

Actinote canutia Jordan 1913b:374; Eltringham & Jordan 1913:11; Jordan & Eltringham 1916:19; Lewis 1975:227; Smart 1976:265; Pierre 1983:72; Brown 1987:41; D'Abrera 1987:445; Brown 1988:36; Francini 1989:41, 43, 53-56, 58, 61, 63, 65, 67-71, 74-75, 77, 79, 88-96, 98, 100, 102, 107-109, 113-114, 136-138, 140, 143, 146-147, 157-159, 165, 168, 191, 193, 198-199, 216-217, 220, 223; Brown 1992:158-159; Lamas 2004:263

Acraea (*Actinote*) *canutia* Pierre 1987:27

Actinote pellenea Geyer 1832: fig. 741-742 (part.)

Diagnosis: Wings greasy, translucent; basal forewing markings darker orange than postmedial markings; hindwing comma-mark faint (Fig. 3B). Valva cylindrical, somewhat narrow, and strongly arched dorso-ventrally. Distinguished from *mamita* by having a smaller marking on forewing cell Cu1, and by the post-medial forewing markings being lighter than basal markings. Genitalia similar to *mamita*, but apex of valva more robust in dorsal view.

Distribution: Brazil – Rio Grande do Sul?, Santa Catarina, São Paulo, Rio de Janeiro, Espírito Santo, Minas Gerais. Approximate altitude range: 0-1600 m.

Remarks: Greasy-orange mimicry group.

Actinote genitrix D'Almeida, 1922

(Plate 5)

Actinote genitrix D'Almeida 1922:143-145; D'Almeida 1925:335, 346-348, 352-353; ab. *moesa* D'Almeida 1925:348; ab. *subrubicunda* D'Almeida 1925:348; D'Almeida 1935a:71, 99-100, 102-103, 105, 109-110; var. a-f D'Almeida 1935a:99-100; D'Almeida 1935b:487; Costa Lima 1936:136; D'Araujo e Silva et al. 1967:339; f. *moesa* Brown & Mielke 1968:152; Toledo 1980:87; Penz 1983:37, 40; Penz 1985:104; Mielke & Casagrande 1986:145-146, 148; ab. *moesa* Mielke & Casagrande 1986:147, 149; ab. *subrubicunda* Mielke & Casagrande 1986:147, 150; D'Abrera 1987:444; Brown 1987:41; Brown 1988:36; Francini 1989:41-43, 53, 55-56, 58, 61, 63, 65, 67-71, 74-75, 77-79, 87, 89-94, 100, 107-109, 114, 137-138, 140, 143, 157, 158-160, 165, 168, 191, 193, 198-199, 216-217, 220, 223; Brown 1992:158-159; Lamas 2004:263

Actinote genitrix moesa D'Almeida 1935a:100

Actinote genitrix subrubicunda D'Almeida 1935a:100

Actinote genetrix [sic] Ackery 1988:136

Diagnosis: Base of the forewings translucent, postmedial markings dirty white to creamy yellow. Valva very long (more than 5X longer than maximum width), broad at base and decreasing in width toward apex; straight for the most part, but with a small terminal arch. Similat to *melanisans*, *rhodope*, and *discrepans* (most often confused with *melanisans*). Forewings tend to be slightly more elongated at apex than in *melanisans*, *rhodope*, and *discrepans*. Easily distinguished from similar species by the length and shape of the valva.

Distribution: Brazil – Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Rio de Janeiro, Minas Gerais. Approximate altitude range: 600-1600 m.

Remarks: Black-yellow mimicry group.

Actinote discrepans D'Almeida, 1958

(Plate 6)

Actinote parapheles ab. *discrepans* D'Almeida 1935a:36-109; Mielke & Casagrande 1986:151

Actinote discrepans D'Almeida 1958:2-4; Penz 1983:36, 38-39; Penz 1985:104; Brown 1987:41; Brown 1988:36; Francini 1989:41, 43, 53-56, 58, 61, 63, 65, 67-71, 74-75, 77, 79, 85, 89-96, 100, 107-109, 114, 117, 136-137, 140, 143, 153, 155, 157-159, 194, 198, 217, 220, 223; Brown 1992:158-159; Lamas 2004:263

Diagnosis: Base of the forewings translucent, postmedial markings dirty white to creamy yellow. In fresh individuals, forewing discal markings often thin and sharp, resembling an exclamation point. Valva strongly arched dorso-ventrally, with a slight constriction before apex in ventral view. Similat to *genitrix*, *melanisans*, and *rhodope* (most often confused with *melanisans*), but distinguished from these species by the sharp forewing discal markings and by the length and arched shape of the valva.

Distribution: Brazil – Paraná, São Paulo, Rio de Janeiro, Minas Gerais. Approximate altitude range: 600-1600 m.

Remarks: Black-yellow mimicry group.

Actinote eberti Francini, Freitas & Penz, 2004

(Plate 7)

Actinote eberti Francini, Freitas & Penz 2004:2-5

Diagnosis: The wing color pattern of this species is intermediate between the darker *morio* and *zikani* (iridescent-black mimicry group) and the more colorful *melanisans* and *rhodope* (among other species in the black-yellow mimicry group). Wings with a greasy aspect, forewing translucent, colored areas faint but noticeable. Hindwing black margin broad, colored areas from faded orange to white. Males can be easily distinguished from similar species by the short arched valvae, broad tegumen, and small juxta.

Distrubution: Brazil – São Paulo, but possibly including Rio de Janeiro and Minas Gerais (along Serra da Mantiqueira). Approximate altitude: 1500 m.

Remarks: Possibly included in the black-yellow mimicry group. This species is only known from nine collection specimens deposited in the Universidade Federal do Paraná.

Actinote melanisans Oberthür, 1917

(Plate 8)

Actinote bubona melanisans Oberthür 1917:124

Actinote melanisans D'Almeida 1958:1-2, 6-7; Ebert 1969:35; Araujo & Valente 1981:1486; Penz 1985:104; Brown 1987:41; Brown 1988:36; Francini 1989:41, 43-44, 53-56, 58, 60, 62, 64, 67-71, 74-75, 77, 79, 84, 89-96, 99-103, 107-109, 113-114, 117, 136-138, 140, 141, 143, 146-147, 152-153, 155, 157-159, 161, 165-168, 187, 191, 193, 197-198, 215, 217, 220, 223; Lamas 2004:263

Actinote cf. *A. melanisans* Penz 1983:32-35

Actinote sp. B Penz 1983:38, 44, 45

Actinote brasiliensis var. *melanisans* D'Almeida 1925:339; ab. *fuliginosa* D'Almeida 1925:340; var. q D'Almeida 1935a:81; ab. *fuliginosa* D'Almeida 1935a:82; ab. *fuliginosa* Mielke & Casagrande 1986:147, 150

Actinote carycina D'Abrera 1987:444

Actinote hyalina Brown 1992:158-159

Actinote morio Hayward 1931:26-27; Hayward 1935:96-97; D'Almeida 1935b:488; Hayward 1951:208

Actinote pyrrha D'Almeida 1935a:71, 86-87, 109-112; var. a-f D'Almeida 1935a:87-88; D'Almeida 1958:1-2, 4-5

Actinote rhodope Biezanko & Freitas 1938:7 (part.); Biezanko & Seta 1939:5 (part.); Biezanko, Ruffinelli & Carbonell 1957:127 (part.); D'Araujo e Silva et al. 1968:340 (part.)

Actinote travassosi D'Almeida 1934:90-92

Diagnosis: Base of the forewings translucent, postmedial markings creamy yellow. Forewing discal and Cu2 markings generally faint, but discal markings may resemble those of *discrepans* in some individuals (i.e., shaped as an exclamation point). In ventral view, valva broad and somewhat arched, and with a pointed apex. Similat to *genitrix*, *discrepans*, and *rhodope*, but distinguished from these species by the broad, arched and pointed valva.

Distribution: Brazil – Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Rio de Janeiro, Minas Gerais. Approximate altitude range: 0-1600 m.

Remarks: Black-yellow mimicry group. This is the most locally common species in this mimicry group. In the plates of Volume 5 of Seitz' Macrolepidoptera of the World, an individual that closely resembles *melanisans* and *rhodope* is illustrated and named *hyalina*. This illustration does not seem to correspond to any known type specimens designated by K. Jordan. In an attempt to clear this issue, Lamas (1996) designated a female lectotype (although the illustration was said to be male; Jordan 1913b) and downranked *hyalina* to a subspecies of *A. pellenea*. This seems to have further confused the matter, and the true identity of Jordan's *hyalina* may remain forever unknown.

Actinote rhodope D'Almeida, 1923

(Plate 9)

Actinote rhodope D'Almeida 1923:231-232; f. *lynsa* D'Almeida 1923:232; D'Almeida 1925:335-336, 342-345, 352-353; var. a-c D'Almeida 1925:345-346; ab. *lynsa* D'Almeida 1925:346; ab. *tenuilimbata* D'Almeida 1931:61; D'Almeida 1935a:71, 89-93, 103-105, 109-112; var. a-f D'Almeida 1935a:89-90; D'Almeida 1935b:487; Costa Lima 1936:136; Biezanko & Freitas 1938:7 (part.); Biezanko & Seta 1939:5 (part.); Biezanko, Ruffinelli & Carbonell 1957:127; Brown & Mielke 1968:152; D'Araujo Silva et al. 1968:340; Toledo 1980:87; Penz 1985:104; Mielke & Casagrande 1986:147-148; f. *lynsa* Mielke & Casagrande 1986:147, 149; ab. *tenuilimbata* Mielke & Casagrande 1986:147, 149Brown 1987:41; Ackery 1988:136; Francini 1989:41-43, 53-56, 58, 60, 62, 64, 67-71, 74-75, 77, 78, 86, 89-96, 100, 107-108, 114, 136-138, 140, 143, 157, 158, 191, 193, 198, 217, 220, 223; Brown 1992:158-159; Lamas 2004:264

Actinote hyalina D'Almeida 1922:143, 145

Actinote rhodope fuscata D'Almeida 1935a:90, 109; Mielke & Casagrande 1986:151

Actinote rhodope lynsa D'Almeida 1935a:90, 109

Actinote rhodope tenuilimbata D'Almeida 1935a:90, 109

Actinote melanisans Ebert 1969:35 (part.)

Diagnosis: Base of the forewings translucent, postmedial markings creamy yellow. Forewing discal and Cu2 markings faint. In ventral view, valva short, somewhat broad and straight, and with a slight constriction anterior to the pointed apex. Similat to *genitrix*, *discrepans*, and *melanisans* (most often confused with *melanisans*); distinguished from these species by the shorter, straight and pointed valva.

Distribution: Brazil – Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Rio de Janeiro, Minas Gerais. Approximate altitude range: 600-1600 m.

Remarks: Black-yellow mimicry group. See also remarks for *melanisans*, above.

Actinote surima (Schaus, 1902)

(Plate 10)

Acraea surima Schaus 1902:392

Actinote surima Eltringham & Jordan 1913:13; Jordan 1913b:374; Jordan & Eltringham 1916:19; Hayward 1931:29, 169; Monte 1934:19; Hayward 1935:97; D'Almeida 1935a:94; D'Almeida 1935b:488; Biezanko & Pitoñ 1941:9; Hayward 1951:209; f. *punctata* Hayward 1951:209; Biezanko, Ruffinelli & Carbonell 1957:127; Brown & Mielke 1967:95; Brown & Mielke 1968:151; D'Araujo Silva et al. 1968:340; Ebert 1969:35; Brown & Benson 1974:218; Smart 1976:191, 265; Penz 1983:46-50; Brown 1984:158; Penz 1985:109; Almeida, Souza & Marques 1986:33; D'Abrera 1987:445; Brown 1987:41; Brown 1988:36; Francini 1989:44, 53-56, 58, 61, 74-75, 77, 79, 88-96, 100, 102, 107-109, 113-114, 136-137, 140, 143, 153, 155, 157-159, 165, 191, 193, 198-199, 217, 220, 223; Brown 1992:158-159; Paluch, Casagrande & Mielke 1999:129-140; Lamas 2004:264

Actinote surima punctata Hayward 1935:97

Acraea (*Actinote*) *surima* Pierre 1987:22

Diagnosis: For the subspecies found in SE Brazil, *surima surima*: wings opaque, all markings dark orange, hidwing comma-mark well developed. Ventral hindwing uniform in color, and paler than dorsal hindwing. Valva short and broad, slightly compressed dorsoventrally, with a pointed apex.

Distribution: Brazil – Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Rio de Janeiro, Minas Gerais, Distrito Federal, Goiás; Paraguay; Argentina. Approximate altitude range: 0-1600 m.

Remarks: Red mimicry group. Lamas (2004) listed two subspecies of *surima* (*s. surima* from Brazil and *s. perisa* from Argentina).

Actinote catarina Penz, 1996

(Plate 11)

Actinote catarina Penz & Francini 1996:311-315; Lamas 2004:263

Actinote cf. *A. alalia conspicua* Penz 1983:56

Diagnosis: In dorsal view, all forewing markings orange. Forewing orange discal markings often fused, other orange spots commonly fused. In ventral view, hindwing pale yellow with a blurry orange stain at the center. Valvae broad, compressed dorso-ventrally and slightly arched laterally; apex pointed.

Distribution: Brazil – Rio Grande do Sul, Santa Catarina, Paraná. The accurate altitude range of this species is not known. The type specimens were collected inside one of the canyons in the southern end of the Serra Geral in Rio Grande do Sul (Faxinal, located near the city of Cambará do Sul, 1200 m). We do not know how far these butterflies go down these canyons.

Remarks: Red mimicry group.

Actinote alalia (C. Felder & R. Felder, 1860)

(Plate 12)

Acraea alalia C. Felder & R. Felder 1860:105; Kirby 1871:136; Mabilde1896:64 (part.); var. Jones & Moore 1883:36 (part.)

Acraea eulalia [sic] Müller 1878a:296 (part.)

Actinote alalia Jordan & Eltringham 1916:19 (part.); D'Almeida 1935a:93 (part.); Ebert 1969:35; Lewis 1975:43, 227 (part.); Smart 1976:265 (part.); D'Abrera 1987:445; Ackery 1988:136; Lamas 2004:263

Actinote alalia alalia Eltringham & Jordan 1913:10; Jordan 1913b:374 (part.)

Acraea (*Actinote*) *alalia* Pierre 1987:22 (part.)

Diagnosis: Wings opaque, all markings dark orange. Ventral hindwing paler than dorsal, ventral hindwing medial area darker orange than basal and post-medial areas. Valva cylindrical, moderately arched laterally and dorso-ventrally; in lateral view, similar in length to tegumen+uncus; apex robust and blunt. Similar to *dalmeidai*, but can be distinguished from this species by the longer and less laterally arched valva.

Distribution: Brazil – Rio Grande do Sul?, Santa Catarina, Paraná, São Paulo, Rio de Janeiro. Approximate altitude range: 1400-2000 m.

Remarks: Red mimicry group.

Actinote conspicua Jordan, 1913

(Plate 13)

Actinote alalia conspicua Jordan 1913a:32; Jordan 1913b:374; Jordan & Eltringham 1916:18; D'Abrera 1987:445

Actinote conspicua Brown & Mielke 1968:151; Ebert 1969:35; Lamas 2004:263

Diagnosis: Large. Wings opaque, all markings dark orange. Ventral hindwing homogeneously dark orange. Valva cylindrical, long and narrow in lateral view, moderately arched dorso-ventrally; apex robust and blunt.

Distribution: Brazil – Paraná, São Paulo, Rio de Janeiro, Minas Gerais. Approximate altitude range: 1600-2000 m.

Remarks: Red mimicry group.

Actinote bonita Penz, 1996

(Plate 14)

Actinote bonita Penz & Francini 1996:311-313, 315; Lamas 2004:263

Diagnosis: Wings opaque, all markings orange. Ventral hindwing pale orange, homogeneous. Valva cylindrical; in lateral view, broad at base and decreasing in diameter toward apex; moderately arched dorso-ventrally; in ventral view, slightly bent before apex; apex blunt. Can be easily distinguished from *quadra* by the color of the ventral hindwing and less arched valva.

Distribution: Brazil – Minas Gerais, Rio de Janeiro. Approximate altitude range: 1600-2000 m.

Remarks: Red mimicry group.

Actinote dalmeidai Francini, 1996

(Plate 15)

Actinote dalmeidai Penz & Francini 1996:310-313; Lamas 2004:263

Actinote alalia D'Almeida 1935a:71, 93 (part.); Brown 1987:41; Brown 1988:36; Francini 1989:41, 43, 53-56, 58, 61, 63, 65, 67-71, 74-75, 101, 107-109, 114, 135, 194, 198, 217, 220, 223

Actinote sp. near *alalia* Brown 1992:158-159

Diagnosis: Wings opaque, all markings dark orange. Ventral hindwing paler than dorsal hindwing, ventral hindwing medial area darker orange than basal and postmedial areas. Valva cylindrical, moderately arched dorso-ventrally, strongly arched laterally; in lateral view, valva shorter than tegumen+uncus; apex robust and blunt. Similar to, but distinguished from *alalia* by the shorter and more laterally arched valva.

Distribution: Brazil – Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Rio de Janeiro, Minas Gerais. Approximate altitude range: 600-1800 m.

Remarks: Red mimicry group.

Actinote quadra (Schaus, 1902)

(Plate 16)

Acraea quadra Schaus 1902:392

Actinote quadra Jordan 1913b:373; Eltringham & Jordan 1913:13; Jordan & Eltringham 1916:18; Lewis 1975:227; Smart 1976:265; D'Abrera 1987:445; Brown 1987:41; Brown 1988:36; Francini 1989:41, 53, 135, 198; Lamas 2004:263

Acraea (*Actinote*) *quadra* Pierre 1987:22

Diagnosis: Wings opaque, all markings orange. Ventral hindwing pale yellow, homogeneous. Valva cylindrical; strongly arched laterally; apex blunt. Similar to, but easily distinguished from *bonita* by the pale yellow ventral hindwing and the strongly arched valva.

Distribution: Brazil – São Paulo, Rio de Janeiro, Minas Gerais. Approximate altitude range: 1600-2000 m.

Remarks: Orange-yellow mimicry group.

Actinote parapheles Jordan, 1913

(Plate 17)

Acraea thalia Müller 1882:263; Müller 1883b:216; Bönninghausen 1896:33

Actinote parapheles Eltringham & Jordan 1913:12; Jordan 1913a:33; Jordan 1913b:373; f. *pallescens* Jordan 1913b:373; Jordan & Eltringham 1916:18; D'Almeida 1925:335, 348-353; var. a-d D'Almeida 1925:351; var. *fumida* D'Almeida 1925:351; var. *hippea* D'Almeida 1925:354; Hayward 1931:27-28, 167-168; f. *ochreana* Hayward 1931:28, 179-180; Hayward 1935:96-97; f. *ochreana* Hayward 1935:97; D'Almeida 1935a:71, 94-99, 103-105, 109-112; Brown 1987:41; Ackery 1988:136; Brown 1988:36; Francini 1989:41-43, 53-55, 56, 58, 63, 65, 67-71, 74-75, 77, 79, 86, 89, 90-96, 98, 100-102, 107-109, 113-114, 117, 135-138, 140-141, 143, 153, 157, 158-159, 165, 168, 191, 193, 197-199, 217, 220, 223; Brown 1992:158-159; Lamas 2004:263

Acraea (*Actinote*) *parapheles* Pierre 1987:22

Actinote alalia Mabilde 1896:64

Actinote distincta D'Almeida 1922:141-142, 145

Diagnosis: Wings opaque; basal markings orange, postmedial yellow. Ventral hindwing dark orange, homogeneous. Valva cylindrical; in ventral view, long and straight; in lateral view, moderately arched dorso-ventrally; apex blunt.

Distribution: Brazil – Rio Grande do Sul?, Santa Catarina, Paraná, São Paulo, Rio de Janeiro, Minas Gerais; Argentina; Paraguay; Uruguay?. Approximate altitude range: 0-1600 m.

Remarks: Orange-yellow mimicry group.

Actinote pellenea Hübner, [1821]

(Plate 18)

Actinote pellenea Hübner 1820-1824 [1821]:18 fig. 1-4; Eltringham & Jordan 1913:12; Müller 1915:366; D'Almeida 1922:130-135, 145; f. *euterpe* D'Almeida 1922:136; D'Almeida 1925:334, 336, 352-353; var. a-f D'Almeida 1925:337; var. *euterpe* D'Almeida 1925:336; Monte 1934:19; Ronna 1934:35; D'Almeida 1935a:71-72, 74-78, 103-105, 109-112; var. a-v D'Almeida 1935a:72-73; var. *carycinoides* D'Almeida 1935a:73; D'Almeida 1935b:487; Costa Lima 1936:362 (part.); Biezanko & Freitas 1938:7; Costa Lima 1950:291; Brown & Mielke 1967:96; D'Araujo Silva et al. 1968:339; Brown & Mielke 1968:151; Brown & Benson 1974:218; Lewis 1975:43, 227; Smart 1976:265; Toledo 1980:87; Penz 1983:23-26; D'Abrera 1984:223; var. *carycinoides* Mielke & Casagrande 1986:149-150; Brown 1987:41; D'Abrera 1987:443; Ackery 1988:136; Brown 1988:36; Francini 1989:24, 26, 41-44, 53-56, 58, 60, 62, 64, 67-71, 74-75, 77, 79-80, 89-97, 100-109, 112, 114, 118-122, 124-134, 136-153, 155-159, 162-168, 173-176, 180-182, 184-185, 187-192, 194-198, 200, 2002-203, 205-212, 215, 217, 219, 220, 222-223, 225

Actinote pellenia [sic] Ehrlich & Ehrlich 1978:694

Actinote pellena [sic] Mabilde 1896:63

Acraea pellenea Kirby 1871:136; Hoppfer 1874:345 (part.); Capronnier 1874:24; Jones & Moore 1883:36, 73; Bönninghausen 1896:33; Müller 1886:424

Acraea (*Actinote*) *pellenea* Pierre 1987:22

Actinote pellenea pellenea Toledo 1980:87; Eltringham & Jordan 1913:12; Jordan 1913b:372; Jordan & Eltringham 1916:17; Brown 1984:158; Brown 1992:158-159; Lamas 2004:263-264

Actinote pellenea nordestina D'Almeida 1935a:74; Cardoso 1949:429; Mielke & Casagrande 1986:150

Actinote pellenea euterpe D'Almeida 1935a:74

Actinote anteas Monte 1934:199; D'Araujo Silva et al. 1968:339

Actinote auloeda Oberthür 1917:113-114, 123

Actinote brylla [*lorida*] Oberthür 1917:113, 123

Acraea euterpe Kirby 1871:137

Actinote thalia Pritwittz 1865:137; Joseph 1911:9-12 (part.)

Diagnosis: The SE Brazilian subspecies *pellenea pellenea* can be recognized by basal forewing markings velvety orange, varying in color from paler to darker orange but never white. Basal markings of the forewing generally broad, occupying most of the cell height. *Actinote pellenea pellenea* is very similar to *carycina* both in wing pattern and male genitalia. Nonetheless, *pellenea* and *carycina* have distinct larvae, which grants support to their status as separate species.

Distribution: Brazil – Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Rio de Janeiro, Minas Gerais, Espírito Santo, Distrito Federal, Goiás, Bahia; Paraguay; Argentina; Uruguay. Approximate altitude range: 0-1200 m.

Remarks: orange-yellow mimicry group. Lamas (2004) listed 15 described and five undescribed subspecies for *pellenea*, of which *pellenea pellenea* is the only subspecies found in Brazil. Given the remarkable color variation and nondescript genitalic morphology of this species, a reassessment of the subspecies of *pellenea* is desirable.

Actinote carycina Jordan, 1913

(Plate 19)

Actinote carycina Jordan 1913b:373; Jordan & Eltringham 1916:18; f. *calchaqui* Hayward 1931:20-22, 175-177; D'Almeida 1935a:78-79, 109-112; var. a-l D'Almeida 1935a:79-80; var. *hoffmani* D'Almeida 1935a:79-80, 109; var. *differens* D'Almeida 1935a:80, 109; f. *calchaqui* D'Almeida 1935b:487; f. *calchaqui* Hayward 1935:95, 97; Costa Lima 1936:136; Biezanko & Pitoñ 1941:9; Biezanko & Ruffinelli 1957:36; Biezanko, Ruffinelli & Carbonell 1957:127; Ebert 1969:35; Brown & Benson 1974:218; Smart 1976:265; Penz 1983:14-22; Brown 1984:158; Penz 1985:104; Francini 1985:105; Almeida, Souza & Marques 1986:33; D'Abrera 1987:444; Francini 1989:5, 12, 36, 41-44, 53-56, 58, 60, 62, 64, 68-71, 74-75, 77-79, 81, 89-97, 100-102, 107-109, 113-114, 118, 135-138, 140, 143, 146-147, 152-153, 155-159, 165, 167-168, 186-188, 190-192, 197-198, 200, 213, 215-217, 220, 223; var. *hoffmani* Mielke & Casagrande 1986:148, 150; var. *differens* Mielke & Casagrande 1986:150; Brown 1992:158-159; Paluch, Casagrande & Mielke 2001:883-896; Lamas 2004:263

Acraea (*Actinote*) *carycina* Pierre 1987:22

Actinote calchaqui Toledo 1980:88-89

Actinote pellenea Hayward 1951:207

Actinote pellenea pellenea Orfila 1964:41-48

Actinote pyrrha Biezanko & Freitas 1938:7 (part.)

Acraea thalia Müller 1876:3, 5, 8-10; Müller 1877a:214-221; Müller 1877b:218-224; Burmeister 1878:126-127; var. a-b Burmeister 1878:127; Müller 1878a:296; Müller 1878b:54-55; Burmeister 1879:194; Müller 1879:2; Müller 1879c:106-107 (part.); Gosse 1880:197 (part.); Müller 1881-82:263 (part.); Müller 1883a:415-416; Müller 1883b:216 (part.); Müller 1883c:197-201; Mabilde 1896:64 (part.)

Actinote thalia Joseph 1911:9-18 (part.); Müller 1915:186, 191-193, 195, 325, 340, 365, 366, 377, 380, 429 (part.); Monte 1934:19; D'Araujo Silva et al. 1968:339-340; Ackery 1988:136

Diagnosis: Dorsal wing background color orangish-brown, basal forewing markings vary from orange to white, and from broad to narrow. In some specimens the orange basal markings have a tint of white. Very similar to *pellenea*, but despite the variation in wing color, it can generally be distinguished from *pellenea* by the narrower forewing basal markings and slightly larger wing size (the wing size range overlaps with that of *pellenea*, however). Some individuals may also have similar wing patterns to *pratensis*, but can be distinguished from this species by the genitalia. Genitalia very similar to *pellenea*. *Actinote carycina* and *pellenea* have distinct larvae, which grants support to their status as separate species.

Distribution: Brazil – Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Minas Gerais, Rio de Janeiro. Approximate altitude range: 0-1400 m.

Remarks: orange-yellow mimicry group.

Figure 18. Variation in wing color and markings in male A. carycina from a single sib group.

Actinote pratensis Francini, Freitas & Penz, 2004

(Plate 20)

Actinote pratensis Francini, Freitas & Penz 2004:5-7

Diagnosis: Similar to *pyrrha* and *carycina*. Can be distinguished from these two and other species by the following combination of characters. Although their size range overlaps, in general male *pratensis* are larger than those of *pyrrha* and *carycina*. Basal markings of forewing orange, and those in cells Cu_1 and Cu_2 usually diffuse at the edges; sub-apical forewing markings dirty white, usually ranging from R_5 to Cu_1. PD spot absent. The dark border of hindwing is generally broader in *pratensis* than in *pyrrha*, but the ranges of variation in this character fully overlap between these two species. Male valva bowed, nearly homogeneous in width in lateral view, with blunt apex. Aedeagus shorter than the length of the genitalic capsule and comparatively thicker than those of *pyrrha* and *carycina*.

Distribution: Brazil – São Paulo, but possibly expanding to Minas Gerais (populations of *pratensis* were recorded in Águas da Prata, Rio Claro, Campinas and Jundiaí, all in São Paulo state). The altitude range for this species in unknown, but the known populations occur at ca. 600-800 m.

Remarks: Orange-yellow mimicry group.

Actinote pyrrha (Fabricius, 1775)

(Plate 21)

Papilio pyrrha Fabricius 1775:464; Goeze 1779:107; Fabricius 1781-1782:33; Fabricius 1787:16; Gmellin 1790:2252; Fabricius 1793:176; Gabriel 1927:102

Actinote pyrrha Eltringham & Jordan 1913:13 (part.); Jordan 1913b:373; Jordan & Eltringham 1916:18; Hayward 1931:25-26; Hayward 1935:96-97; f. *illimnis* Hayward 1935:96-97; D'Almeida 1935b:488; Costa Lima 1936:136; Biezanko 1938:6; Biezanko & Freitas 1938:7 (part.); Biezanko 1939:39; Biezanko & Pitoñ 1941:9; Hayward 1951:209; Biezanko, Ruffinelli & Carbonell 1957:127; D'Almeida 1958:1-3, 5; Brown & Mielke 1967:96; Brown & Mielke 1968:151; D'Araujo Silva et al. 1968:339; Ebert 1969:35; Brown & Mielke 1972:28-29 (part.); Brown & Benson 1974:218; Smart 1976:265; Penz 1983:27-31; Brown 1984:158; Penz 1985:104; D'Abrera 1987:444; Brown 1987:41; Ackery 1988:136; Brown 1988:36; Francini 1989:41, 42-43, 53-56, 58, 60, 62, 64, 67-71, 74-75, 77, 79-80, 89-97, 100-102, 107-109, 113-114, 117, 136, 137-138, 141, 143, 146-147, 153, 155, 157-159, 168, 190-192, 197-198, 214-215, 217, 220, 223

Acraea (*Actinote*) *pyrrha* Pierre 1987:22

Actinote pyrrha illimnis Hayward 1951:209

Acraea anteas Gosse 1880:197; Staudinger 1884-1888:81; var. Müller 1886:426; Bönninghausen 1896:33

Actinote anteas Costa Lima 1936:136

Actinote brasiliensis D'Almeida 1922:136-139, 145; f. *pyrrha* D'Almeida 1922:140; var. b D'Almeida 1922:140; D'Almeida 1925:334-335, 338-339, 341-342, 352, 353; var. a-c D'Almeida 1925:340; D'Almeida 1935a:71, 80, 83-86, 103, 105, 109-112; var. a-z and aa D'Almeida 1935a:80; var. *discolora* D'Almeida 1935a:81; D'Almeida 1935b:487; Costa Lima 1936:136; Biezanko & Freitas 1938:7; D'Araujo Silva et al. 1968:339; Toledo 1980:87; Mielke & Casagrande 1986:145, 148; var. *discolora* Mielke & Casagrande 1986:149, 151

Actinote bubona Oberthür 1917:117-118, 124; D'Abrera 1987:444

Actinote diaguita Toledo 1980:87-93

Acraea euterpe C. Felder 1862:475

Acraea pellenea Gosse 1880:197; Costa Lima 1950:291; f. *diaguita* Hayward 1935:95, 97; f. *diaguita* D'Almeida 1935b:488; f. *diaguita* Hayward 1951:208; f. *diaguita* Hayward 1968:350

Actinote pellenea diaguita Hayward 1931:22-23, 177-178

Acraea thalia Aurivilius 1882:47 (part.); Godart 1819-1824:240; Lucas 1835:101 (part.); Butler 1870:128 (part.); Kirby 1871:135 (part.); Capronnier 1874:24; Müller 1878a:296 (part.); Burmeister 1878:126-127 (part.); Gosse 1880:197; Müller 1883a:415; Staudinger 1884-1888:81; Haase 1893:54

Actinote thalia Weymer 1894:321; Joseph 1911:9-18

Actinote thalia pyrrha Brown 1992:158-159; Lamas 2004:264

Diagnosis: Dorsal forewing basal markings generally broad, occupying the entire height of the cells, and predominantly shiny orange. In ventral view, inner and outer edges of valva nearly parallel.

Distribution: Brazil – Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Rio de Janeiro, Minas Gerais; Paraguay; Argentina. Approximate altitude range: 0-1600 m.

Remarks: Orange-yellow mimicry group. Brown (1992) and Lamas (1996, 2004) considered *pyrrha* a subspecies of *Actinote thalia*–the type species of *Actinote* (Hemming 1967). We maintain the species status and name *pyrrha* for two reasons. First, no characters or justification have been provided to unite the types of *thalia* (a male from "Indiis" = South America, probably Surinam) and *pyrrha* (a worn female from 'Brazil'), and it is thus unclear why these two taxa were considered conspecific by Brown (1992) and Lamas (1996, 2004). Second, inasmuch as the name *pyrrha* has been traditionally used for the taxon portrayed here, we conservatively consider *Actinote pyrrha* as separate species. We note, however, that a comparative study of both adult and larval morphology is needed to confirm the taxonomic status of *pyrrha* and verify the proposed subspecific classification of *thalia*.

Actinote brylla Oberthür, 1917

(Plate 22)

Actinote brylla Oberthür 1917:116-117, 124; Lamas 2004:263

Actinote brasiliensis var. j, p, a-c D'Almeida 1935a:81; var. *jordani* D'Almeida 1935a:82, 109; var. *notabilis* D'Almeida 1935a:82, 109-110; var. *notabilis* Mielke & Casagrande 1986:151

Actinote jordani D'Almeida 1922:141, 145; D'Almeida 1958:4; Mielke & Casagrande 1986:145, 148

Actinote notabilis D'Almeida 1958:4; Brown 1988:36; Francini 1989: 41, 43, 53-56, 58, 60, 62, 64, 67-71, 74-77, 79, 83, 89-97, 100, 102-104, 106-109, 112, 114, 119-120, 123-125, 132, 134, 136-138, 140, 143, 146-147, 153, 155, 157, 159, 168, 191-192, 198, 217, 220, 223

Diagnosis: Male forewing length 2.8-3.4 cm (mean=3.1 cm). Dorsal forewing base markings predominantly yellow (predominantly orange in *pyrrha*). Hindwing comma-shaped mark always present. In ventral view, inner and outer edges of valva converging toward apex (Fig. 17C).

Distribution: Brazil – São Paulo, Rio de Janeiro, Espírito Santo, Bahia. Approximate altitude range: 0-500 m.

Remarks: Orange-yellow mimicry group. *Actinote brylla* can only be found below 500 m altitude in latitudes above 22°S (although it is possible that it exists in higher altitudes in Espírito Santo state). This species appears to be closely related to, and rarely sympatric with *pyrrha*. D'Almeida (1922a, 1935a) initially used two names for this species, later recognizing it as distinct under the name *notabilis* (D'Almeida 1958). Figures by Oberthür (1917), however, allow accurate identification of *brylla*, and were probably overlooked by D'Almeida.

Concluding remarks

All *Actinote* species of southeastern Brazil show intra-specific variation in wing color pattern so that, in some cases, there is a high degree of overlap between species. This variation can make species identification difficult, and we used sib groups to document some of the ranges of color and size of markings on the wings of several species (Fig. 15). Examples of species that overlap in both their geographical distributions and wing patterns are: (1) *melanisans*, *genitrix*, *discrepans* and *rhodope*; (2) *alalia* and *dalmeidai*; (3) *carycina*, *pellenea*, *pyrrha* and *pratensis*. All of these species, however, can be distinguished from one another by the male valva, often without dissection (e.g., Fig. 6 in the key, above). From experience, we note that having large series of specimens greatly facilitates identification.

Examination of large series of specimens indicates that, in addition to wing color variation, genital morphology can also vary in all *Actinote* species in southeastern Brazil. The parts that showed strongest variation were the saccus and tegumen+uncus, and some variation was also found in the phallobase (unpublished obs.). Variation in the valva morphology and proportions (length/width) was smaller, and this part of the male genitalia provided reliable characters for species identification.

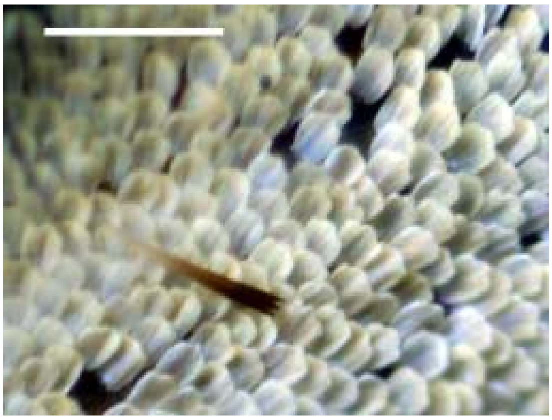
Female identification still remains a challenge for many *Actinote* species. Similarly to what was noted here for males, rearing of sib-groups and examination of large series of specimens will help our understanding of female wing pattern variation and the discovery of diagnostic characters. Furthermore, examination of the sphragis and sterigma (e.g., Penz & Francini 1996) will bring useful characters for identification of specimens in the field and collections. Future work will hopefully provide a key for female identification.

It is likely that more species of *Actinote* will be found in southeastern Brazil. Because some species are nearly indistinguishable, collections may have mixed series identified under the name of the most common species (e.g., *pyrrha* and *pratensis*). Furthermore, many areas have not been sampled systematically, where collectors might have missed the short flight period characteristic of *Actinote*. We hope that this key will be of help in the identification of *Actinote* butterflies and facilitate the finding and description of species that have gone unnoticed to us and to our predecessors.

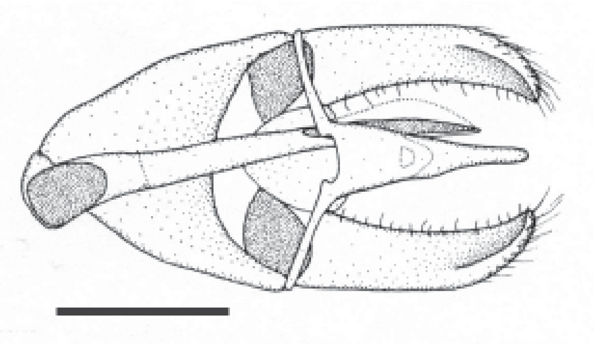
PLATE 1

Actinote morio

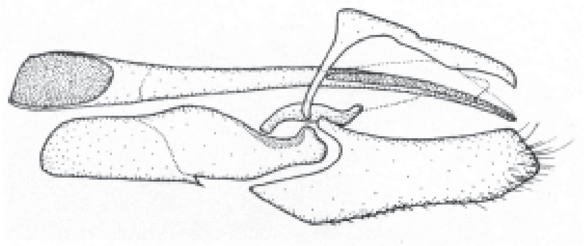
Wings in dorsal view



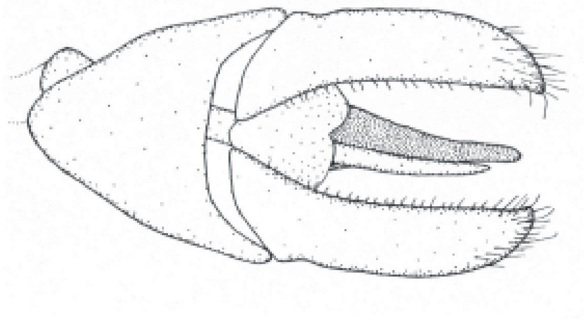
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

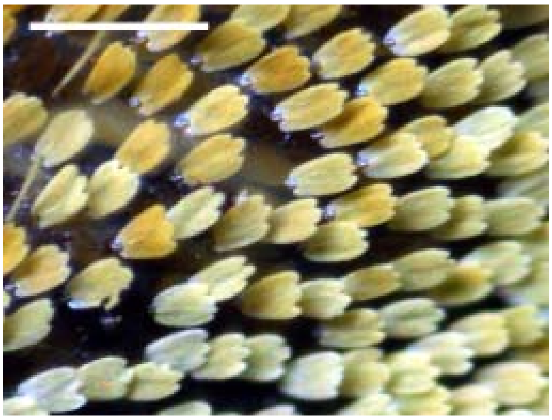


Genitalia in ventral view

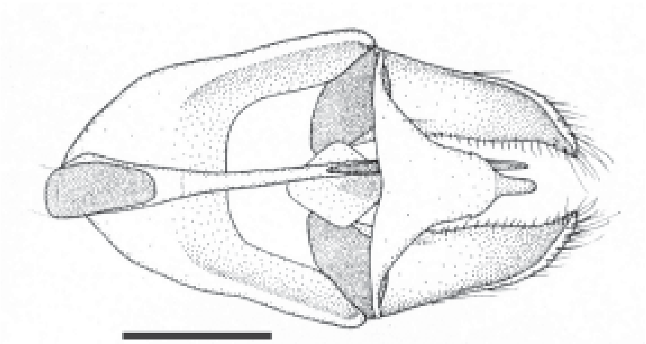
Plate 2

Actinote zikani

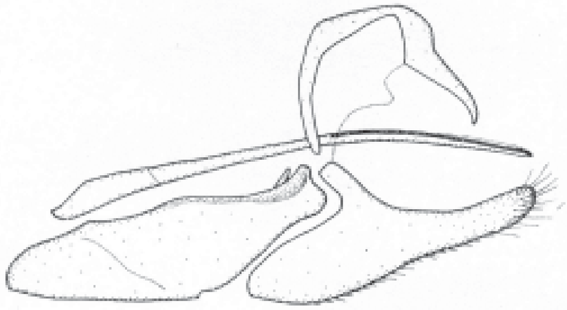
Wings in dorsal view



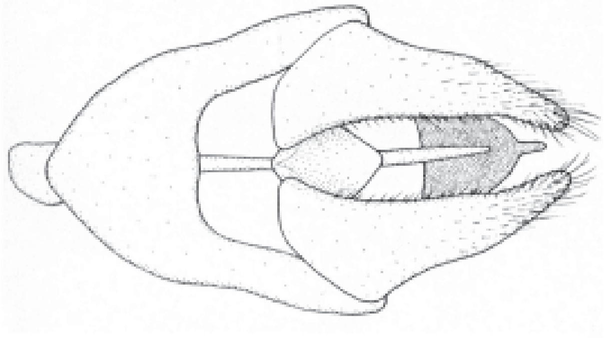
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

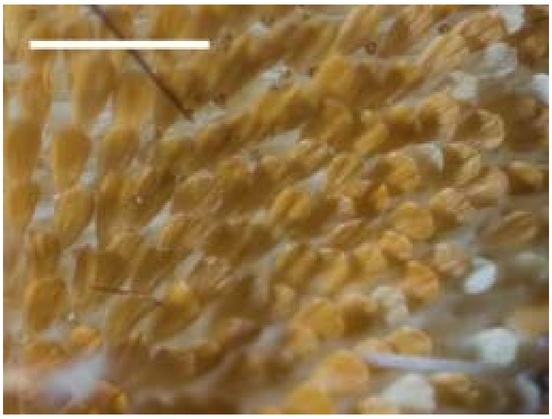


Genitalia in ventral view

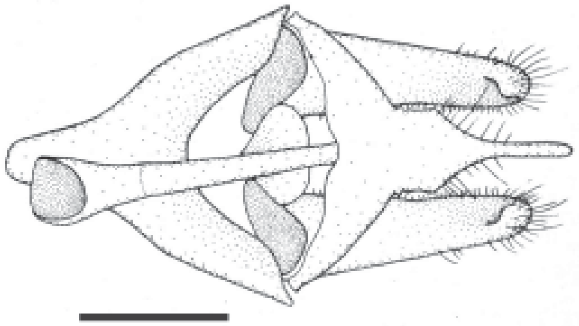
PLATE 3

Actinote mamita

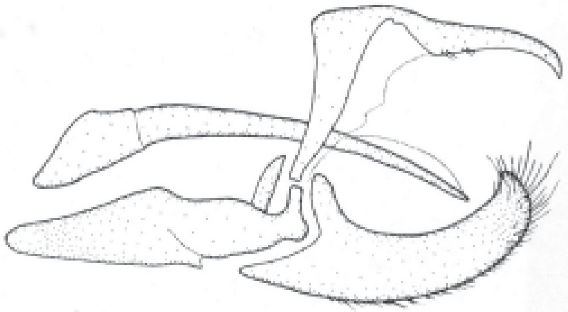
Wings in dorsal view



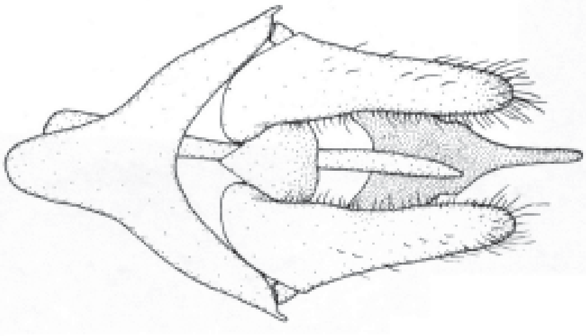
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

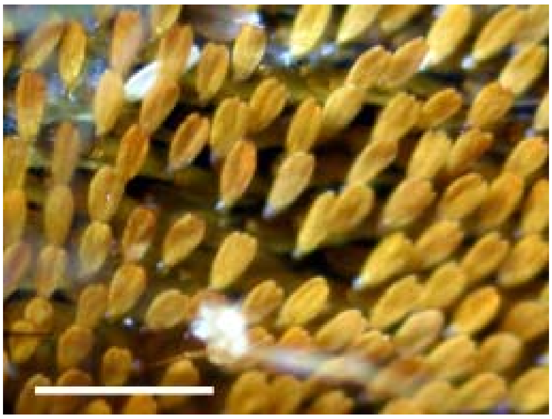


Genitalia in ventral view

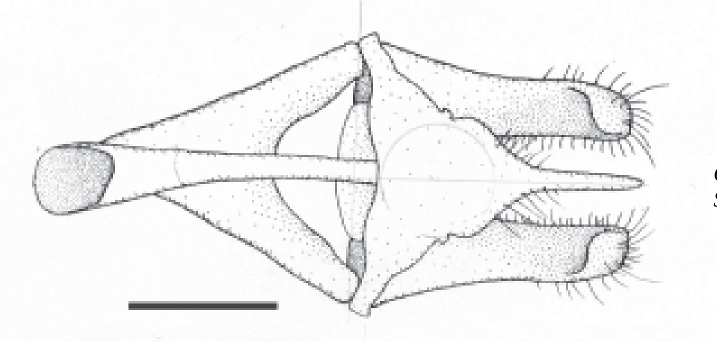
PLATE 4

Actinote canutia

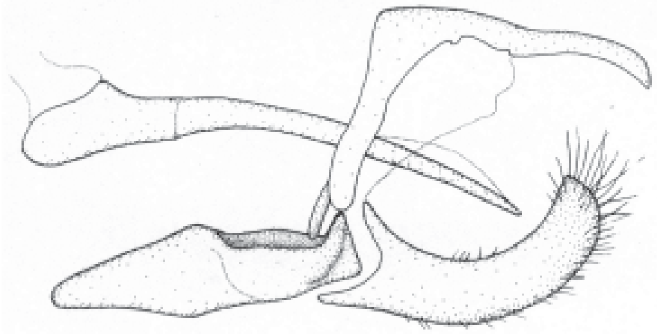
Wings in dorsal view



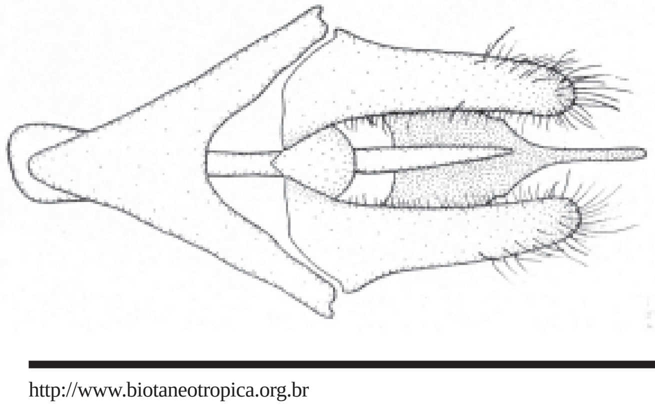
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

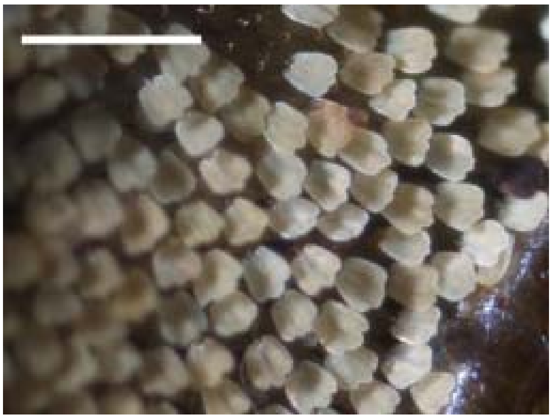


Genitalia in ventral view

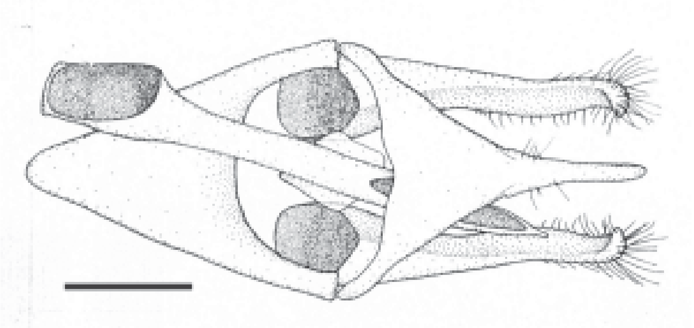
Plate 5

Actinote genitrix

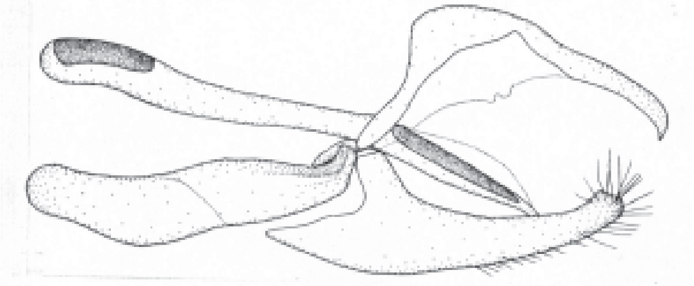
Wings in dorsal view



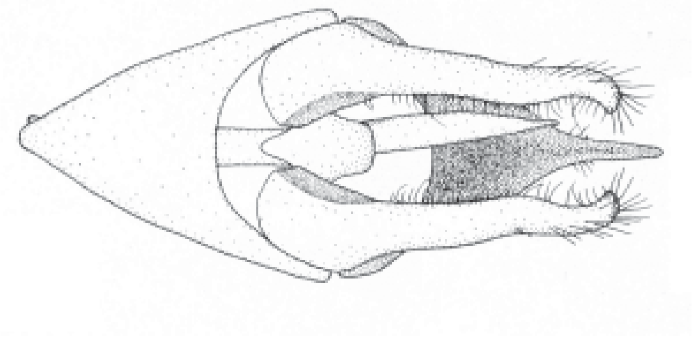
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

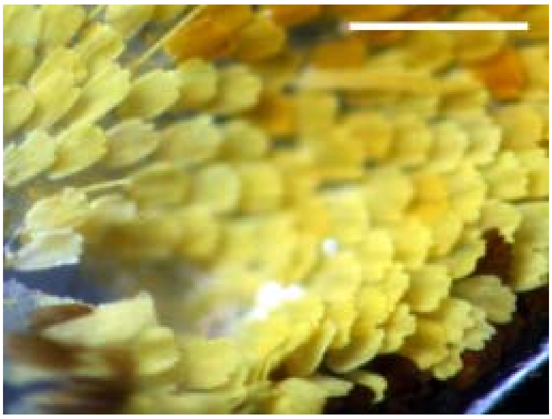


Genitalia in ventral view

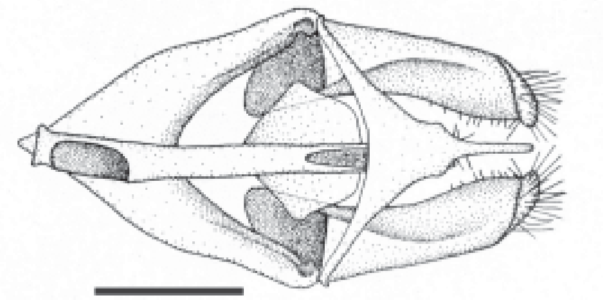
PLATE 6

Actinote discrepans

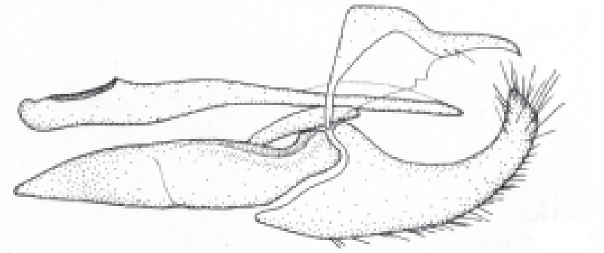
Wings in dorsal view



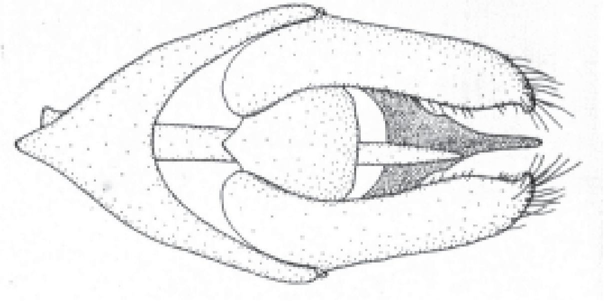
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

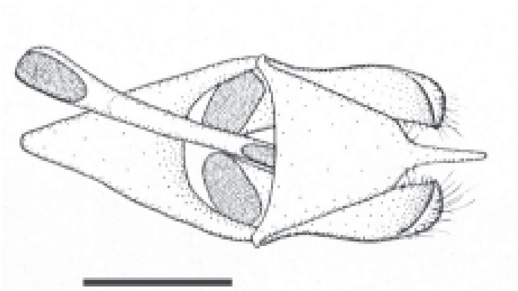


Genitalia in ventral view

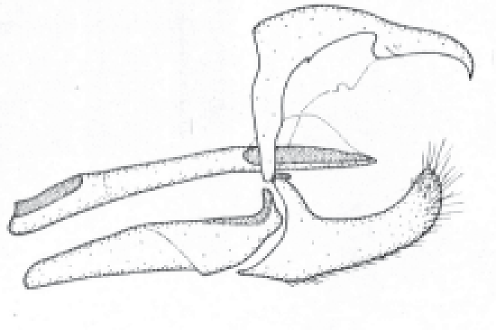
Plate 7

Actinote eberti

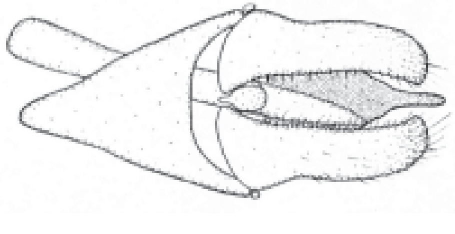
Wings in dorsal view



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

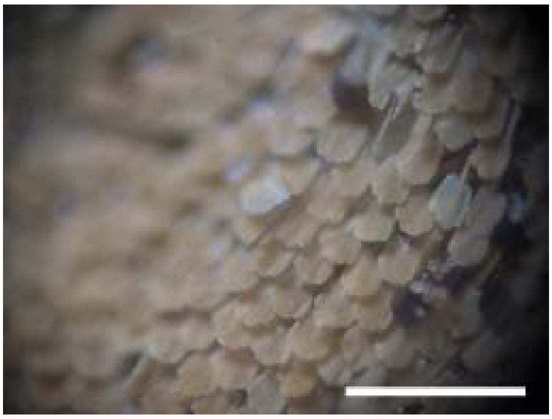


Genitalia in ventral view

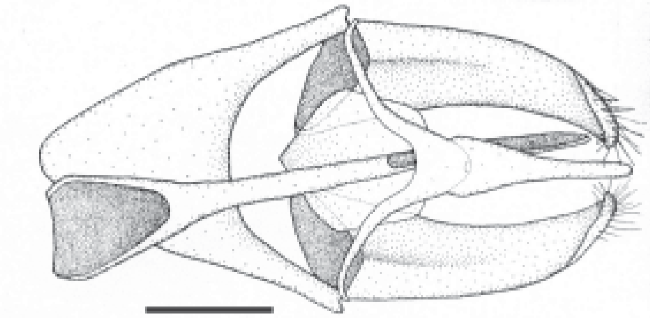
PLATE 8

Actinote melanisans

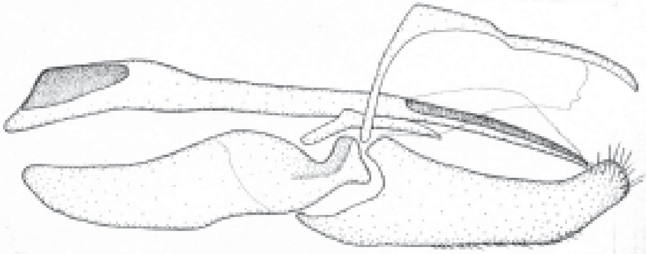
Wings in dorsal view



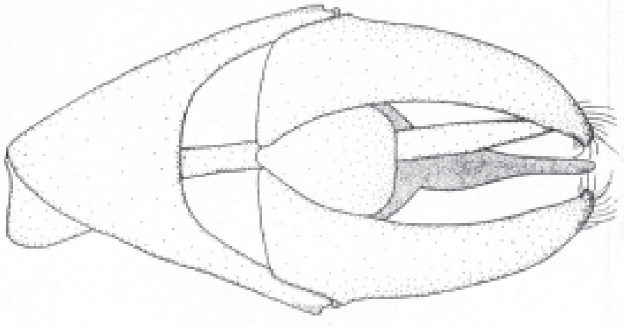
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view



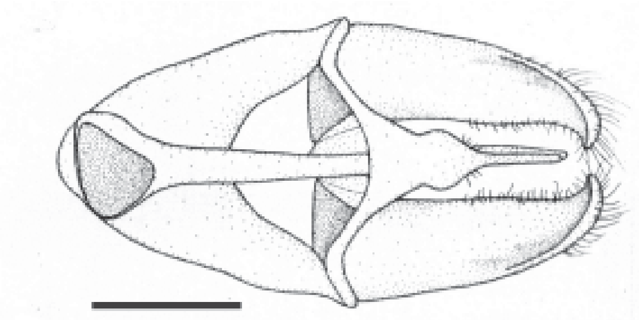
Genitalia in ventral view

PLATE 9

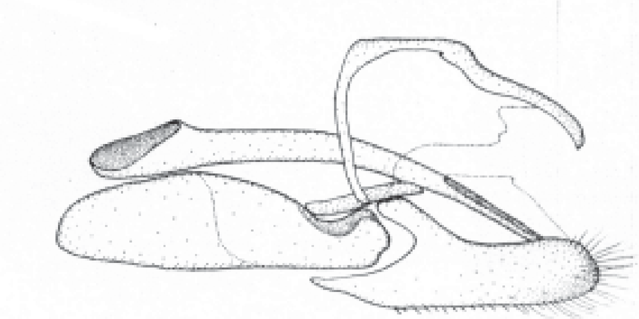
Actinote rhodope

Wings in dorsal view

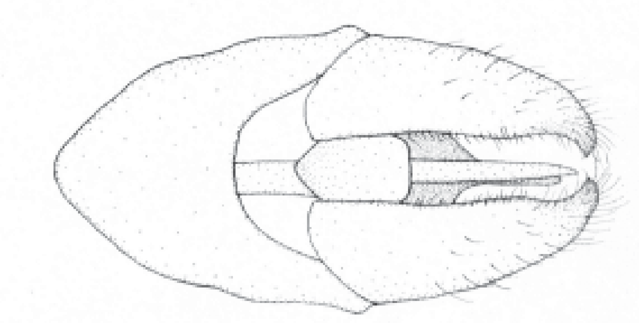
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

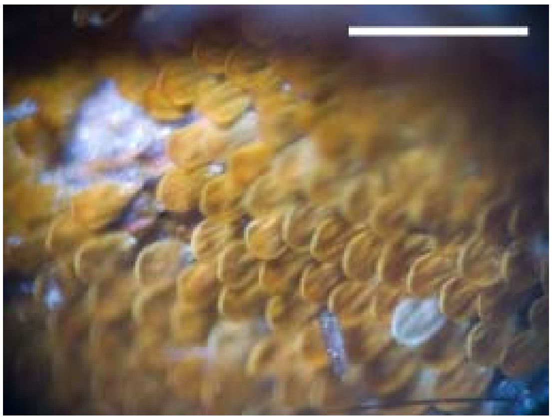


Genitalia in ventral view

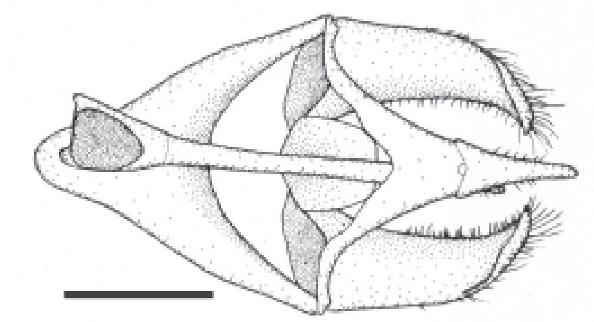
Plate 10

Actinote surima

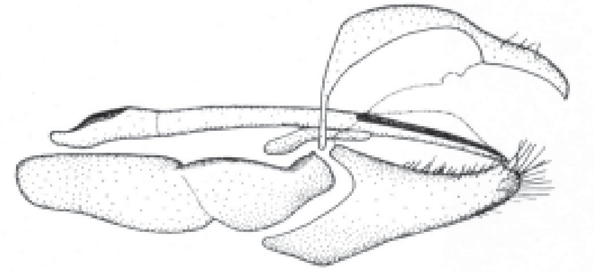
Wings in dorsal view



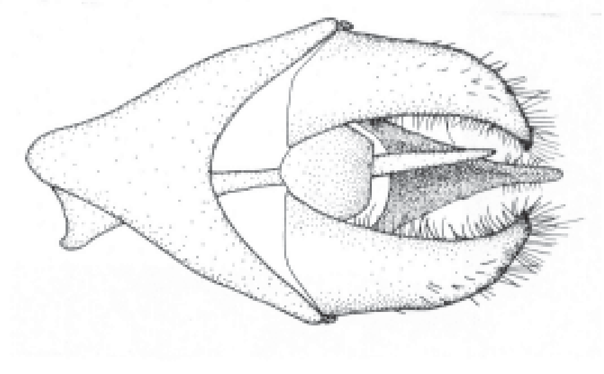
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

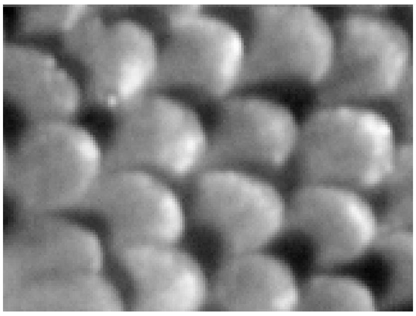


Genitalia in ventral view

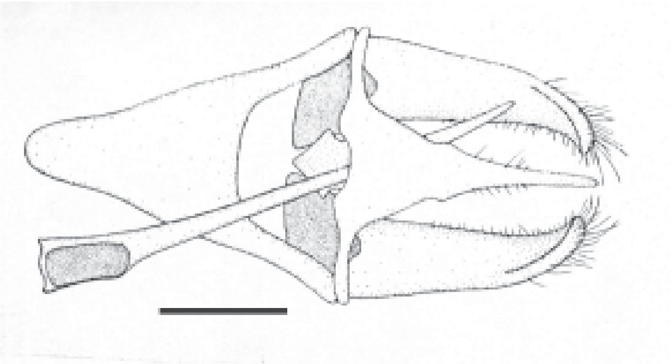
PLATE 11

Actinote catarina

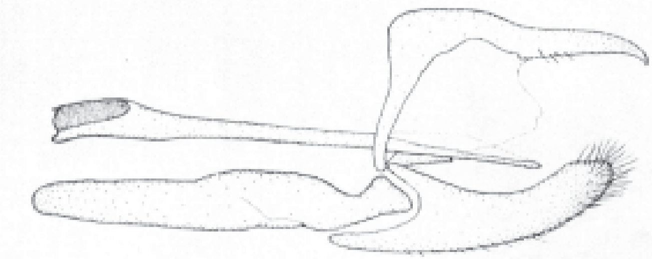
Wings in dorsal view



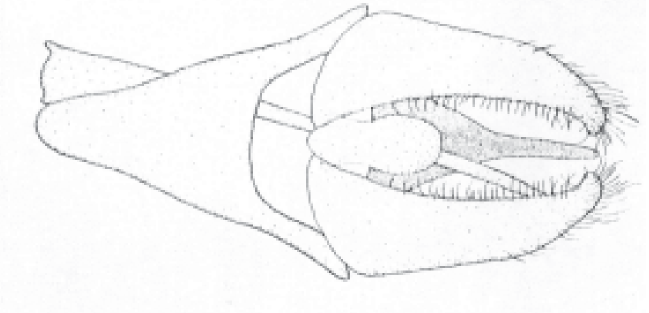
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

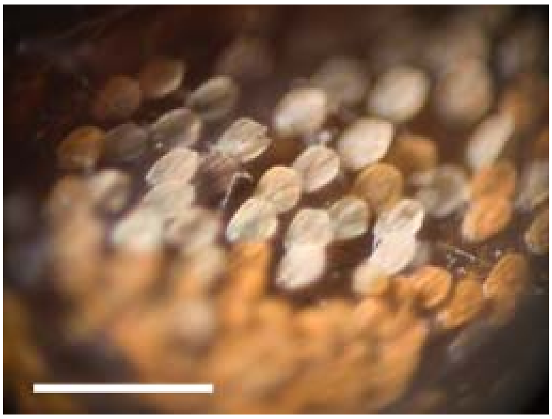


Genitalia in ventral view

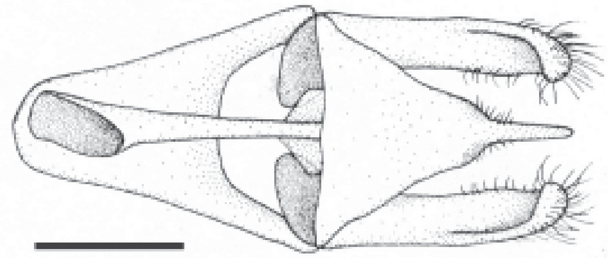
PLATE 12

Actinote alalia

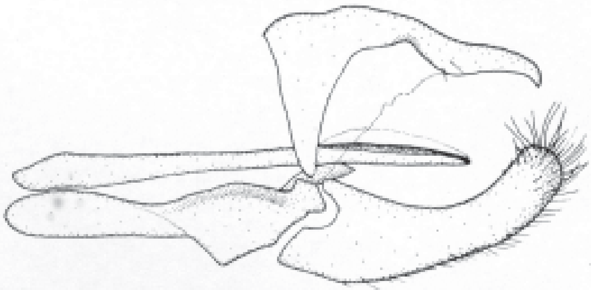
Wings in dorsal view



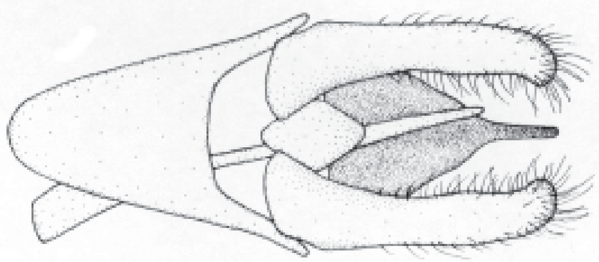
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

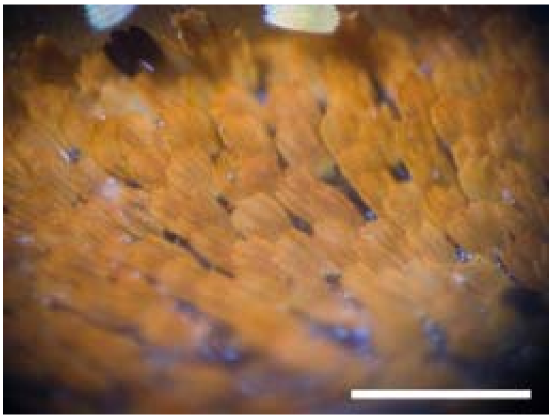


Genitalia in ventral view

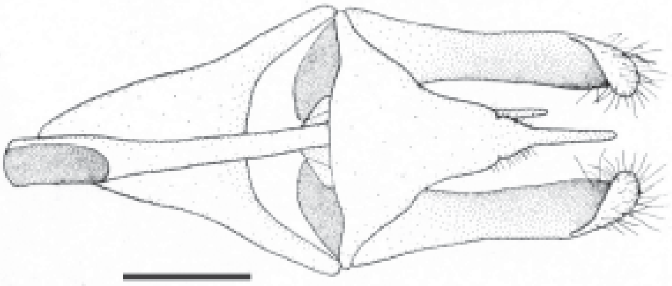
PLATE 13

Actinote conspicua

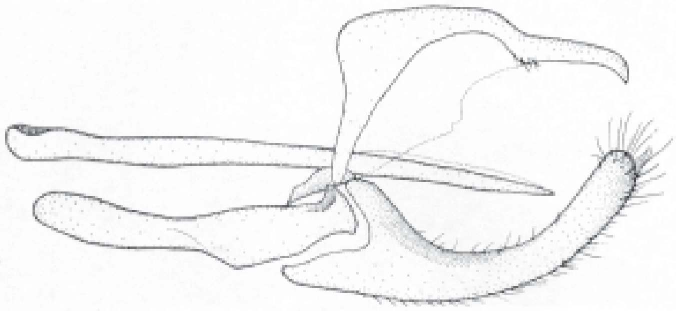
Wings in dorsal view g



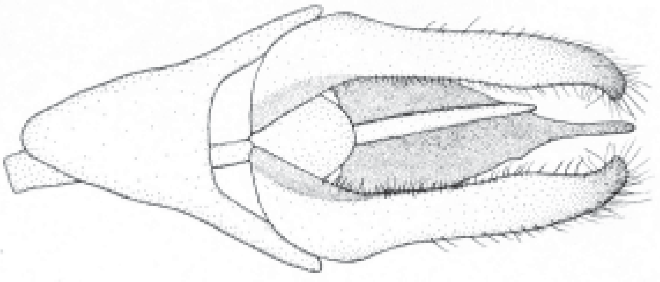
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

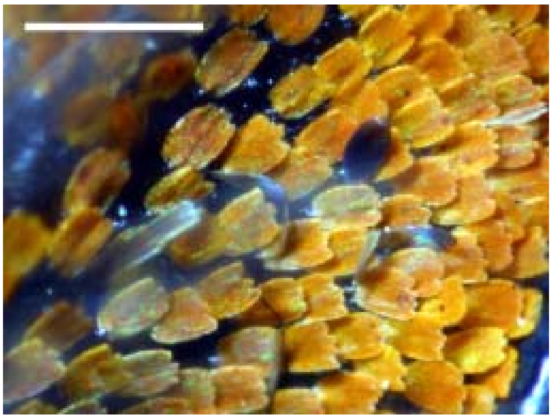


Genitalia in ventral view

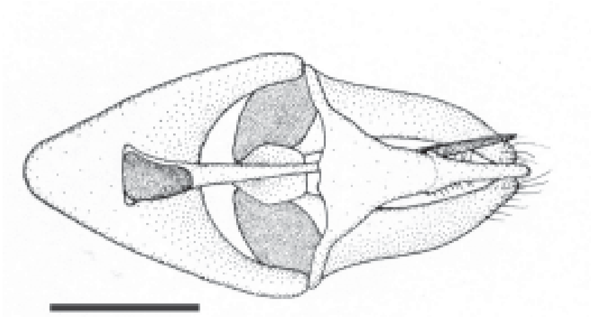
PLATE 14

Actinote bonita

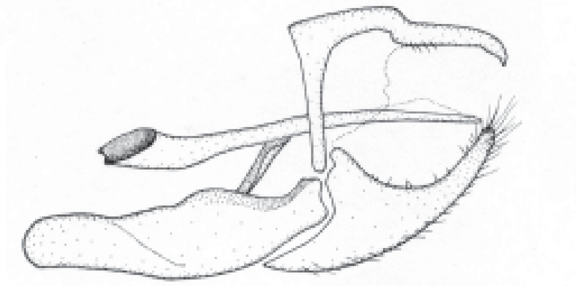
Wings in dorsal view



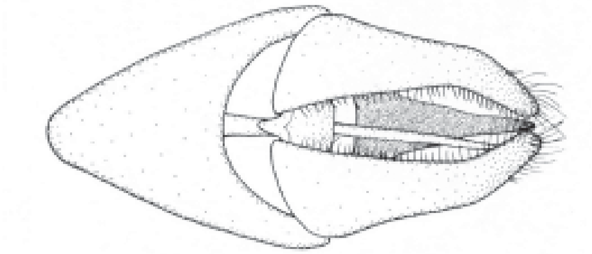
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

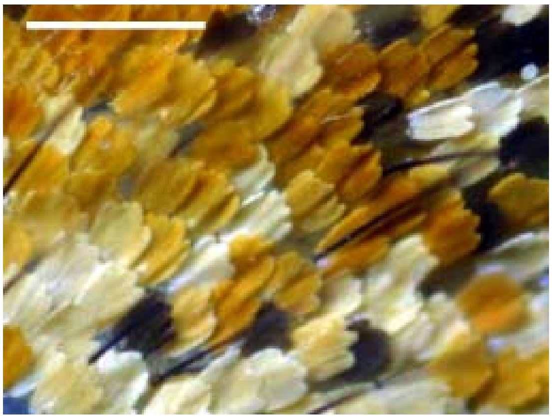


Genitalia in ventral view

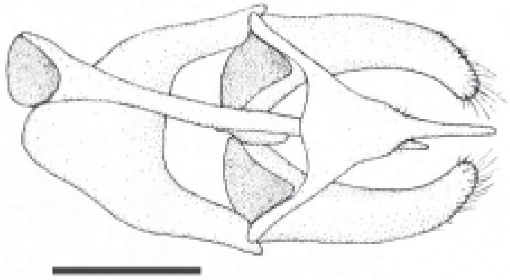
PLATE 15

Actinote dalmeidai

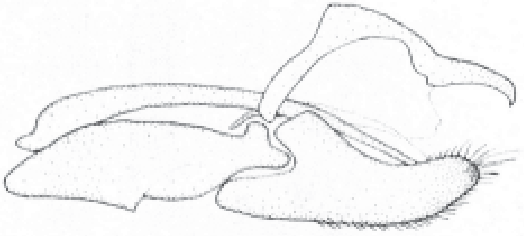
Wings in dorsal view



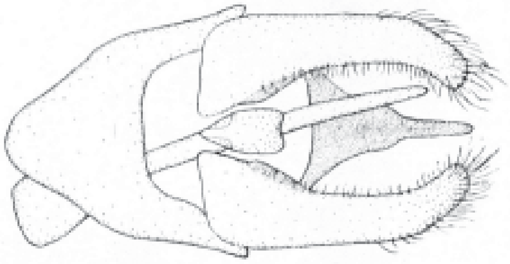
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

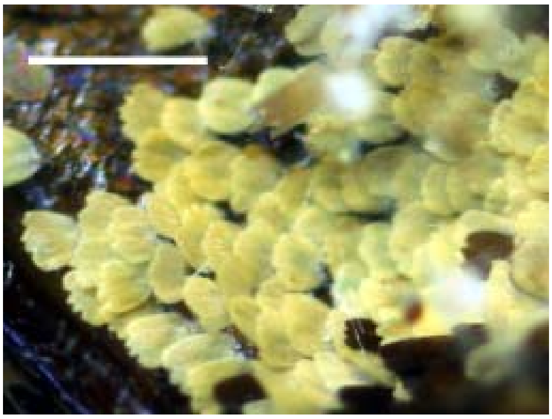


Genitalia in ventral view

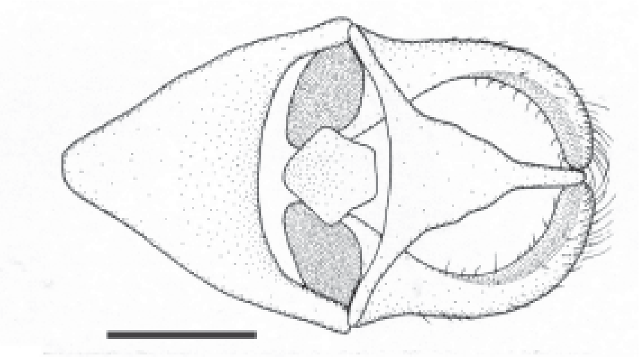
PLATE 16

Actinote quadra

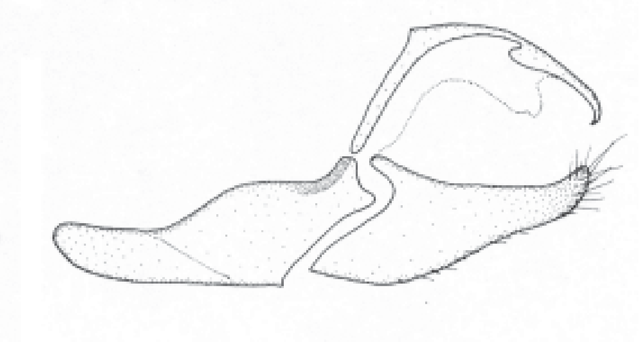
Wings in dorsal view



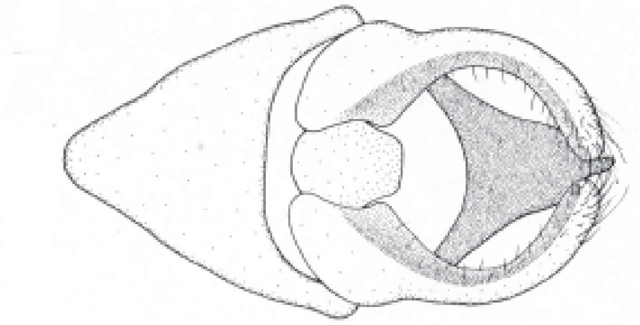
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

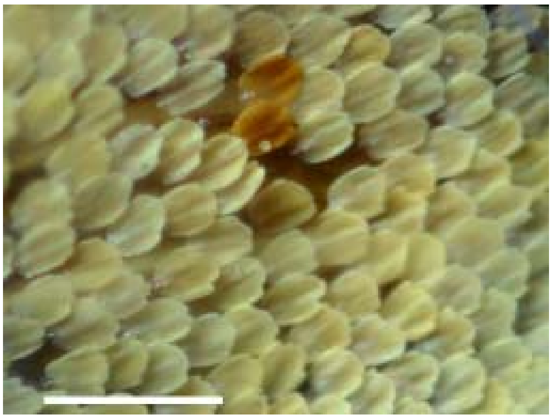


Genitalia in ventral view

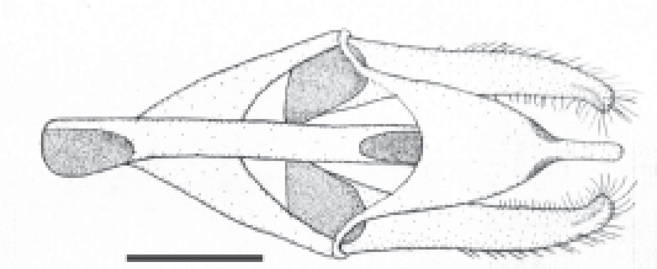
Plate 17

Actinote parapheles

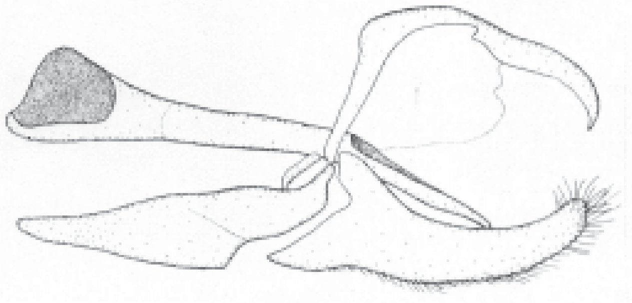
Wings in dorsal view



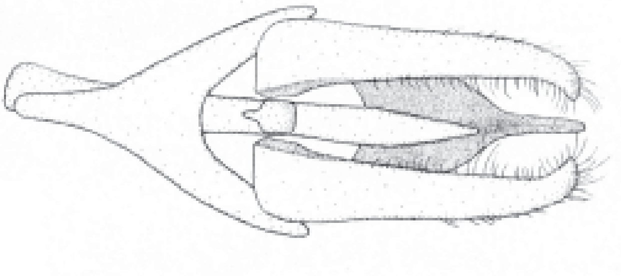
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

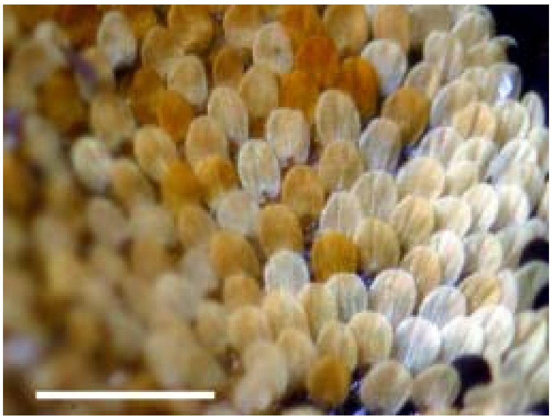


Genitalia in ventral view

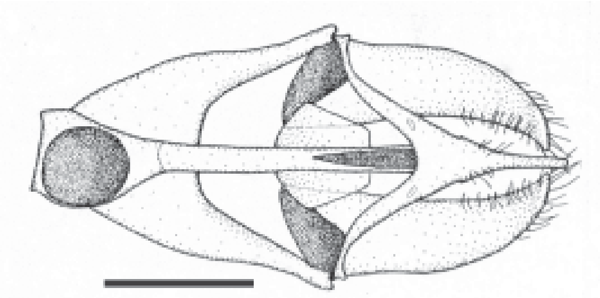
PLATE 18

Actinote pellenea

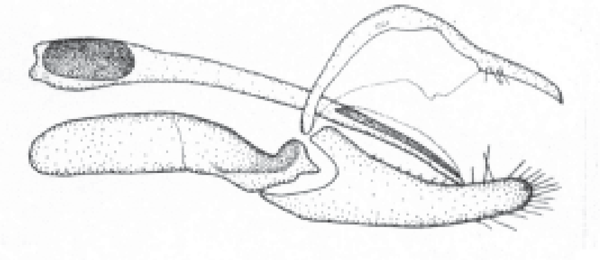
Wings in dorsal view



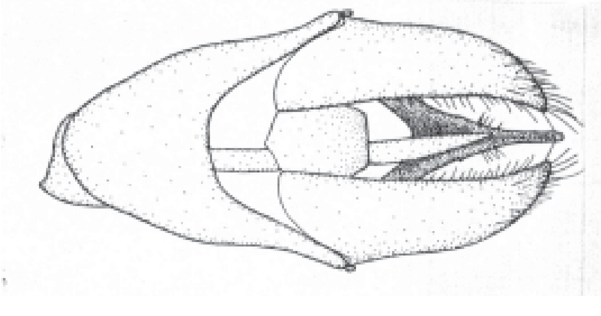
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

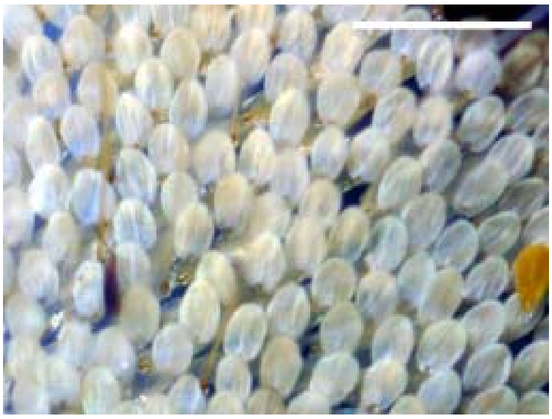


Genitalia in ventral view

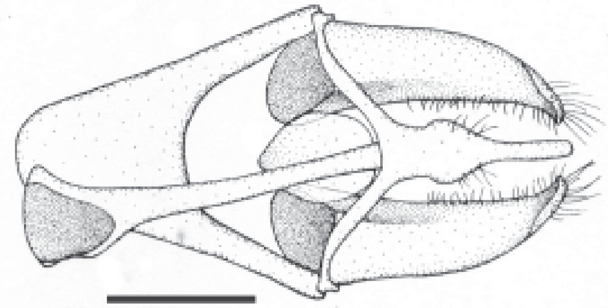
PLATE 19

Actinote carycina

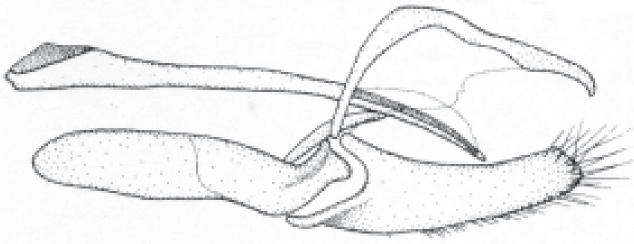
Wings in dorsal view



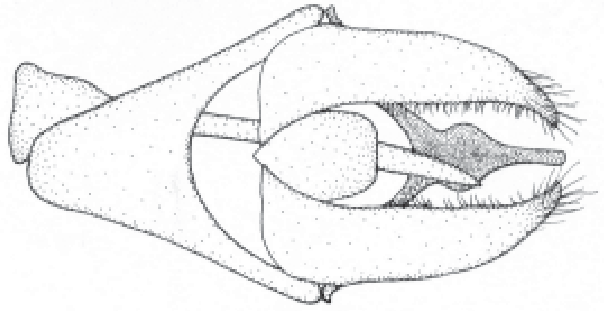
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

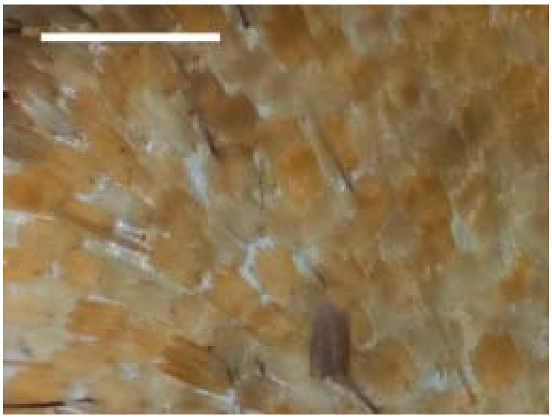


Genitalia in ventral view

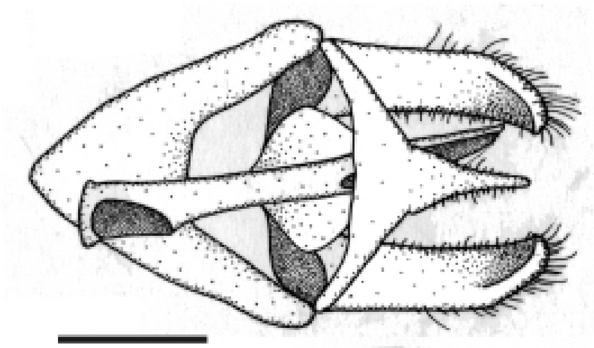
PLATE 20

Actinote pratensis

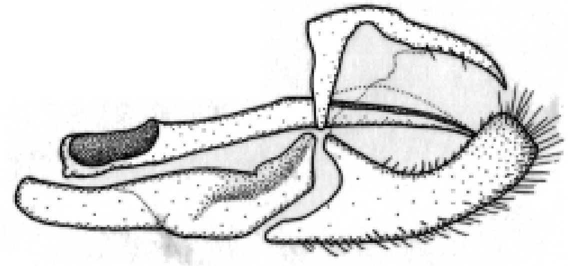
Wings in dorsal view



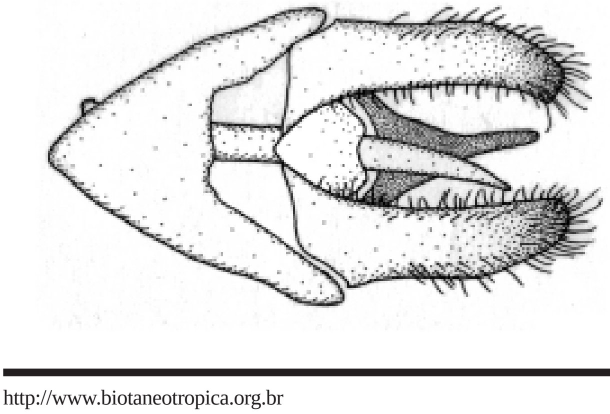
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

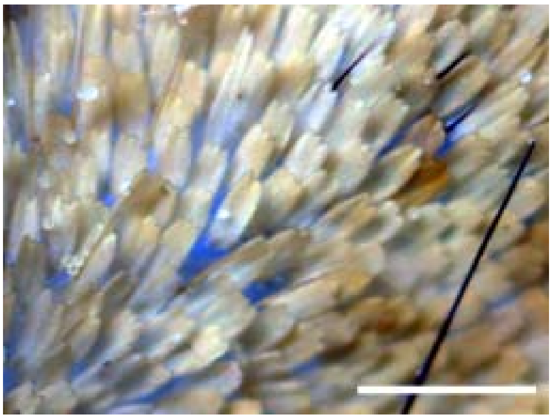


Genitalia in ventral view

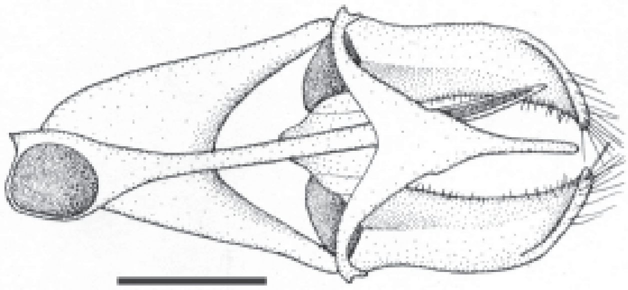
PLATE 21

Actinote pyrrha

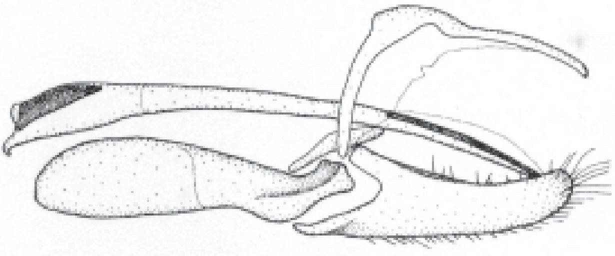
Wings in dorsal view



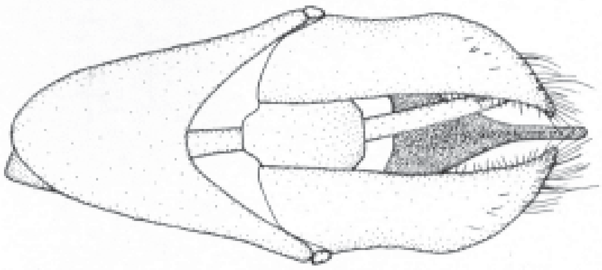
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view

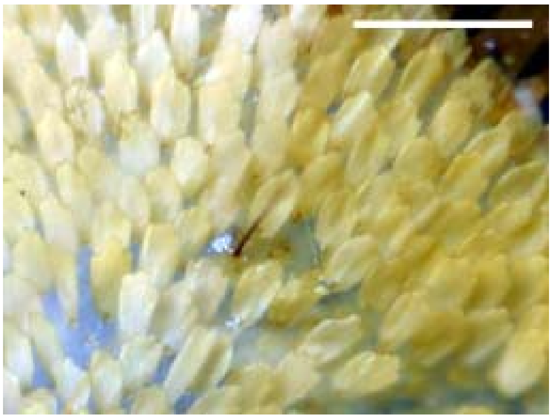


Genitalia in ventral view

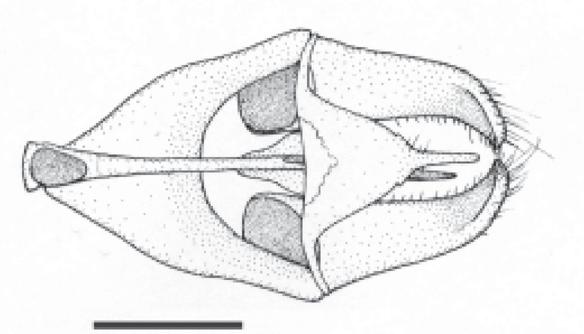
PLATE 22

Actinote brylla

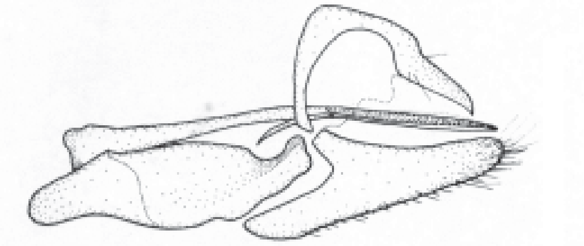
Wings in dorsal view



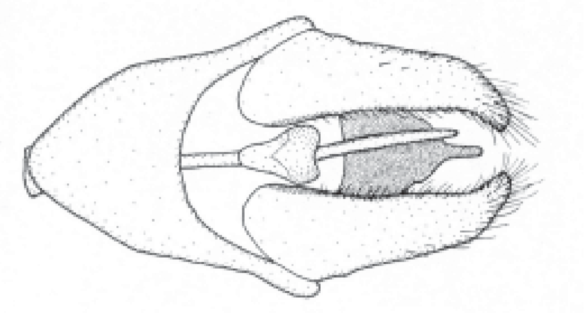
Scales of the basal area of the hindwing
Scale bar 0.1 mm



Genitalia in dorsal view
Scale bar 1 mm



Genitalia in lateral view



Genitalia in ventral view

Acknowledgments

Numerous colleagues and friends encouraged us to produce this key, and we are grateful to all. For access to collections and help in the initial development of our work, we thank Olaf Mielke and Mirna Casagrande (Universidade Federal do Paraná), Fernando Meyer (Museu Anchieta, Porto Alegre), Phil Ackery (The Natural History Museum, London), and Bob Robbins (Smithsonian Institution). Phil DeVries and Andrew Neild provided discussion and useful comments to early versions of the manuscript. Special thanks to Márlon Paluch and an anonymous reviewer for their detailed suggestions. This work was funded by FAPESP (fellowships to RBF) and the National Science Foundation (DEB 0527441, to CMP).

References

Ackery, P.R. 1984. Systematic and faunistic studies on butterflies. Symposium of the Royal Entomological Society, London, 11:9–21.

Ackery, P.R. 1988. Hostplants and classification: a review of nymphalid butterflies. Biological Journal of the Linnean Society, London, 33:95-203.

Almeida, G.S.S., C.L. Souza & E.E. Marques. 1986. Levantamento preliminar das espécies de borboletas (Rhopalocera) de ocorrência em Maringá (PR). I. Papilionoidea. Revista UNIMAR, Maringá, 8(1):29-36.

Araújo, A.M. & V.L.S. Valente. 1981. Observações sobre alguns lepidópteros e drosofilídeos do Parque do Turvo, RS. Ciência e Cultura, 33(11):1485-1490.

Aurivillius, P.O.C. 1882. Recensio critica Lepidopterorum Musei Ludovicae Ulricae quae descripsit Carolus a Linné. Kongliga Svenska Vetenskaps-Akademiens Handlingar (Ny Följd) 19(5):1-188, 1 plate, 4 figs.

Bates, H.W. 1862. Contributions to an insect fauna of the Amazon valley. Lepidoptera: Heliconiidae. Transactions of the Linnean Society, 23:495–566.

Biezanko, C.M. 1938. Dois meses de caça lepidopterológica em arredores de Porto União e União da Vitória. O Campo, Rio de Janeiro, 10(109):38-40.

Biezanko, C.M. & R.G. Freitas. 1938. Catálogo dos insetos encontrados na cidade de Pelotas e seus arredores. I. Lepidoptera. Contribuição ao conhecimento da fisiografia do Rio Grande do Sul. Boletim da Escola de Agronomia Eliseu Maciel, Pelotas, 25:1-30.

Biezanko, C.M. & J. Pitoñ. 1941. Breves apontamentos sobre alguns lepidópteros encontrados nos arredores de Itaiópolis. Boletim da Escola de Agronomia Eliseu Maciel, Pelotas, 28:1-21.

Biezanko, C.M. & A. Ruffinelli. 1957. Los lepidópteros de la colección Schweizer. Revista de la Sociedad Uruguaya de Entomologia, Montevideo, 2(1):31-53.

Biezanko, C.M., A. Ruffinelli & C.S. Carbonell. 1957. Lepidoptera del Uruguay. Lista anotada de espécies. Revista de la Facultad de Agronomia, Montevideo, 46:1-152.

Biezanko, C.M. & F.D. Seta. 1939. Catálogo dos insetos encontrados em Rio Grande e seus arredores. I. Lepidópteros. A "Universal" Echenique & Cia., Pelotas.

Bönninghausen, V. 1896. Beitrag zur Kenntnis der Lepidopteren-Fauna von Rio de Janeiro. Verhandlungen des Vereins für Naturwissenschaftliche Unterhaltung zu Hamburg, Hamburg, 9:19-41.

Brown Jr., K.S. 1987. São Paulo (Season Summary). News of the Lepidopterist's Society, l2:41.

Brown Jr., K.S. 1988. Brazil (Season Summary). News of the Lepidopterist's Society, 2:36.

Brown Jr., K.S. 1991. Conservation of Neotropical environments: Insects as indicators. In: N.M. Collins & J.A. Thomas (ed.), The conservation of insects and their habitats, pp.349-404. Academic Press, NY.

Brown Jr., K.S. 1992. Borboletas da Serra do Japi: diversidade, hábitats, recursos alimentares e variação temporal. In: L.P.C.Morellato (org.), História natural da Serra do Japi. Ecologia e preservação de uma área florestal no sudeste do Brasil. pp. 142-186. Editora da UNICAMP/ FAPESP, Campinas.

Brown Jr., K.S. & W.W. Benson. 1974. Adaptive polimorphism associated with multiple müllerian mimicry in *Heliconius numata* (Lep. Nymph.). Biotropica, 6(4):205-228.

Brown Jr., K.S. & R.B. Francini. 1990. Evolutionary strategies of chemical defense in aposematic butterflies: cyanogenesis in Asteraceae-feeding American Acraeinae. Chemoecology, 1(2):52-56.

Brown Jr., K.S. & O.H.H. Mielke. 1967. Lepidoptera of the Central Brazil plateau. I. Preliminary list of Rhopalocera: introduction, Nymphalidae, Libytheidae. Journal of the Lepidopterist's Society, 21(2):77-106.

Brown Jr., K.S. & O.H.H. Mielke. 1968. Lepidoptera of the Central Brazil plateau. III. Partial list for the Belo Horizonte area showing the character of the south-eastern "blend zone". Journal of the Lepidopterist's Society, 22(3):147-157.

Brown Jr., K.S. & O.H.H. Mielke. 1972. The Heliconians of Brazil (Lepidoptera: Nymphalidae). Part II. Introduction and general comments, with a supplementary revision of the tribe. Zoologica (New York) 57(1):1-40.

Burmeister, H.C.C. 1861. Reise durch die La Plata-Staaten, mit besonderer Rücksicht auf die physiche Beschaffenheit und den Culturzustand der Argentinischen Republik. Ausgeführt in den Jahren 1857, 1858, 1859 und 1860. H.W.Schmidt, Halle, 1:VIII + 504 pp; 2:V + 540 pp.

Burmeister, H.C.C. 1878. Description physique de la République Argentine, d'après des observations personelles et étrangeres. Lepidopteres. Paul Emile Coni, Paris et Buenos Aires, 5:VI + 524 pp.

Burmeister, H.C.C. 1879. Briefliche Mittheilungen. Stettiner Entomologische Zeitung 40(4/6):194-209.

Butler, A.G. 1870. Catalogue of diurnal Lepidoptera described by Fabricius in the collection of the British Museum. British Museum, London, V+303 pp. 3 plates.

Capronnier, J.B. 1874. Notice sur les époques d'apparition des lépidoptères diurnes du Brésil recueillis par M. C. van Volxen, dans son voyage en 1872. Annales de la Societe Entomologique de Belgique, 17:5-39, 1 plate.

Cardoso, A. 1949. Lepidópteros de Alagoas. Revista de Entomologia, Rio de Janeiro, 20(1-3):427-436.

Chai, P. 1986. Field observations and feeding experiments on the responses of rufous-tailed jacamars (Galbula ruficauda) to free-flying butterflies in a tropical rainforest. Biological Journal of the Linnean Society, 29:161-189.

Chai, P. 1996. Butterfly visual characteristics and ontogeny of responses by a specialized tropical bird. Biological Journal of the Linnean Society, 59:37-67.

Costa Lima, A.M. 1936. Terceiro catálogo dos insetos que vivem nas plantas cultivadas do Brasil. Ministério da Agricultura, Escola Nacional de Agronomia, Directoria Estatal de Produção, Rio de Janeiro, IV+460 pp.

Costa Lima, A.M. 1950. Insetos do Brasil. 6. Lepidópteros. 2a. parte, vol. 8. Escola Nacional de Agronomia, Rio de Janeiro, série didática.

D'Abrera, B. 1987. Butterflies of Neotropical Region. Part III. Brassolidae, Acraeidae and Nymphalidae (Partim). Hill House, Victoria, Australia.

D'Almeida, R.F. 1922. Mélanges lépidoptèrologiques. Etudes sur les lépidoptères du Brésil. R. Friedländler & Sohn, Berlin, 1:VIII+226 pp.

D'Almeida, R.F. 1923. Notes sur quelques Lépidoptères rhopalocères du Brésil. III. Les *Actinote* de Rio. Annales de la Société entomologique de France, Paris, 91:229-235.

D'Almeida, R.F. 1925. Quelques rectifications sur les *Actinote* de la partie orientale de l'Amérique du Sud (Lép.Rhop.). Annales de la Société entomologique de France, Paris, 94:333-354.

D'Almeida, R.F. 1931. Beiträge zur Schemetterlings-Fauna Süd-Amerikas. Entomologische Zeitschrift, 45:59-61.

D'Almeida, R.F. 1934. Zwei neue Schmetterlinge aus Brasilien. Entomologische Zeitschrift 48(12): 90-92.

D'Almeida, R.F. 1935a. Les *Actinote* de la partie orientale de l'Amérique du Sud. Annaes da Academia Brasileira de Sciências, Rio de Janeiro, 7:69-112.

D'Almeida, R.F. 1935b. Nota suplementar ao nosso artigo sobre o gênero *Actinote* Hubn. Revista de Entomologia, Rio de Janeiro, 5:486-488.

D'Almeida, R.F. 1943. Algumas observações sobre o *Actinote morio* Oberthür, 1917 (Lep. Heliconidae, Acraeinae). Papéis Avulsos do Departamento de Zoologia, São Paulo, 3(16):107-109.

D'Almeida, R.F. 1951. Uma nova espécie de *Actinote* do Sul do Brasil (Lep. Heliconiidae, Acraeinae). Arquivos do Museu Nacional, Rio de Janeiro, (42):1-5.

D'Almeida, R.F. 1958. Ligeiras notas sobre algumas *Actinote* do sudeste do Brasil (Lep. Rhop.). Boletim do Museu Nacional, Rio de Janeiro (N. S.), Zoologia, 178:1-7.

D'Araujo e Silva, A.G., C.R. Gonçalves, D.M. Galvão, A.J.L. Gonçalves, J. Gomes, M.N. Silva & L. Simoni. 1967-1968. Quarto catálogo dos insetos que vivem nas plantas do Brasil. Seus parasitas e predadores. Laboratório Central de Patologia Vegetal do Ministério da Agricultura, Rio de Janeiro. 1(1):XV+422 pp; 1(2):423-926 pp; 2(1):XXVII+622 pp; 2(2):VIII+265 pp.

Ebert, H. 1969. On the frequency of butterflies in Eastern Brazil, with a list of the butterfly fauna of Poços de Caldas, Minas Gerais. Journal of the Lepidopterist's Society, 23(suppl. 3):1-48.

Ehrlich, A.H. & P.R. Ehrlich. 1978. Reproductive strategies in the butterflies. I. Mating frequency, plugging and egg number. Journal of the Kansas Entomological Society, 51(4):666-697.

Ehrlich, P.R. 1958. The comparative morphology, phylogeny and higher classification of butterflies. Kansas University Scientific Bulletin, 39:305-370.

Eltringham, H. & K. Jordan. 1913. Nymphalidae: subfam. Acraeinae. In: H.Wagner (ed.), Lepidopterorum catalogus, 11:1-65. W. Junk, Berlin.

Fabricius, J.C. 1775. Systema Entomologiae, sistens insectorvm classes, ordines, genera, species, adiectis synonymis, locis, descriptionibvs, observationibvs. Kortii, Flensburgi et Lipsiae, I + XXX, 832 pp.

Fabricius, J.C. 1781-1782. Species Insectorvm exhibentes eorvm differentias specificas, synonyma avctorvm, loca natalia, metamorphosin adiectis observationibvs descriptionibvs. Karl E. Bohn, Hamburgi et Kilonii, 1:1-552 pp. (1781), 2:1-494 pp. (1781), appendix, pp. 494-514 (1782) and index pp. 515-517 (1782).

Fabricius, J.C. 1787. Mantissa insectorvm sistens species nvper detectas adiectis synonymis, observationibvs, descriptionibvs, emendationibvs. Christ. Gottl. Proft, Hafniae, 2:1-382.

Fabricius, J.C. 1793. Entomologia systematica emendata et aucta. Secundum classes, ordines, genera, species, adjectis synonimis, locis, observationibvs descriptionibvs. C.G.Proft, Hafniae, 3(1);VI, 488 pp.

Felder, C. 1862. Verzeichniss der von den Naturforschern der K. K. Fregate "Novara" gesammelten Macrolepidopteren. Verhandlungen der kaiserlich-königlichen zoologisch-botanischem Gesellschaft in Wien, 12:473-496.

Felder, C. & R. Felder. 1860. Lepidopterologische Fragmente. V. Wiener Entomologische Monatschrift, 4(4):97-112, 2 plates.

Fernandes, A.T., A.B.M. Machado & A.B. Rylands. 1990. Fauna brasileira ameaçada de extinção. Fundação Biodiversitas / IBAMA, Belo Horizonte.

Francini, R.B. 1985. Ecologia de populações de *Actinote* do litoral de São Paulo (Lepidoptera: Nymphalidae). Resumos do XII Congresso Brasileiro de Zoologia, Campinas, SP, pp 104-105.

Francini, R.B. 1989. Biologia e ecologia das borboletas *Actinote* (Lepidoptera: Nymphalidae) na transição sub-tropical no sudeste do Brasil. M.S. Thesis, Universidade Estadual de Campinas, Campinas, Brazil.

Francini, R.B. 1992. Ecologia de Taxocenoses de *Actinote* (Lepidoptera: Nymphalidae) em Asteraceae (Angiosperma: Magnoliatae) no Sudeste do Brasil: Subsídios para Conservação. Ph.D. Dissertation, Universidade Estadual de Campinas, Campinas, Brazil.

Francini, R.B., A.V.L. Freitas & C.M. Penz. 2004. Two new species of *Actinote* (Lepidoptera, Nymphalidae) from Southeastern Brazil. Zootaxa, 719:1-10.

Gabriel, A.G. 1927. Catalogue of the type speciemens of Lepidoptera Rhopalocera in the British Museum. III. Nymphalidae. British Museum, Oxford University Press, London, 128 pp.

Geyer, C.M. 1832. In: J. Hubner, Zuträge zur Sammlung exostischer Schmmetterlinge. J. Hübner, Augsburg, 5:1-48.

Gmelin, J.F. 1790. Caroli A. Linné Systema naturae per regna tria naturae, editio 13. Beer, Lipsiae, volume 1(5)[2225-3020].

Godart, J.B. 1819-1824. In: P.A. Latreille & J.B. Godart, Encyclopedie Methodique. Histoire naturelle. Aagasse, Paris. 9:1-828.

Goeze, J.A.E. 1779. Entomologische Beyträge zu des Ritter Linné zwölften Ausgabe des Natursystems. Weidmann, Leipzig, 3(1), XL + 390 pp.

Gosse, P.H. 1880. The butterflies of Paraguay and La Plata. Entomologist, London, 13(208):193-205, 1 plate.

Haase, E. 1893. Untersunchungen über die Mimicry auf Grundlage eines natürlichen Systema der Papilioniden. Bibliotheca Zoologica. Stuttgart, 8(11):99-161.

Hayward, K.J. 1931. Lepidópteros argentinos. Familia Nymphalidae. Revista de la Sociedad Entomológica Argentina, Buenos Aires, 4(1-3):1-199.

Hayward, K.J. 1935. Revisión de las especies argentinas del género *Actinote* (Lep. Nymphalidae). Revista de la Sociedad Entomológica Argentina, Buenos Aires, 7:93-97.

Hayward, K.J. 1951. Catálogo sinonímico de los ropalóceros argentinos excluyendo "Hesperidae". Acta Zoologica Lilloana, Tucumán, 9:85-281.

Hayward, K.J. 1968. Lista de los tipos de insectos y otros invertebrados conservados en el Instituto Miguel Lillo (tercera entrega). Acta Zoologica Lilloana, Tucumán, 22:337-352.

Hemming, F. 1967. The generic names of the butterflies and their type-species (Lepidoptera: Rhopalocera). Bulletin of the British Museum (Natural History) Entomology Supplement 9:1-509.

Hopffer, C. 1874. Neue Lepidopteren von Peru und Bolivia. Stettiner Entomologische Zeitung, 35(10-12):329-371.

Hübner, J. 1816-1826. Verzeischniss bekannter Schmettlinge. J. Hübner, Augsburg, 431 + 72 pp.

Jones, E. D. & F. Moore. 1883. Metamorphoses of Lepidoptera from S.Paulo, Brazil, in the Free Museum, Liverpool, by E. Dukinfield Jones, with nomenclature and descriptions of new forms by F. Moore, and introductory note by T.J. Moore. Proceedings of the Literary and Philosophical Society of Liverpool, 2:21-73, plates 3-6.

Jordan, K. 1913a. Diagnoses of some American Acraeinae. Entomologist, London, 46:32-33.

Jordan, K. 1913b. Acraeinae. In: A. Seitz (ed.), Gross-Schmetterlinge der Erde. Die amerikanischen Tagfalter, vol. 5, pp. 358-374, plates 81-83. Alfred Kernen, Stuttgart.

Jordan, K. & H.H. Eltringham. 1916. Lepidoptera Rhopalocera, Fam. Nymphalidae, subfam. Acraeinae. In: P. Wytsman (ed.), Genera Insectorum, 169:1-81, 2 plates. Martinus Nijhoff, La Haye.

Joseph, E.G. 1911. The collections of William John Burchell, D.C.L., in the Hope Department of the Oxford University Museum. IV. On the Lepidoptera Rhopalocera collected by W.J. Burchell in Brazil, 1825-1830. VIII. Acraeinae. Annals and Magazine of Natural History, London, 8(7):9-18.

Kirby, W.F. 1871. A synonymic catalogue of diurnal Lepidoptera. Van Voorst, London, VII + 690 pp.

Lamas, G. 1973. The type-material of Lepidoptera Rhopalocera contained in the collections of the Museu de Zoologia da Universidade de São Paulo. Papéis Avulsos de Zoologia, São Paulo, 26(13):179-185.

Lamas, G. 1996. Lista comentada de los nombres propuestos para los Acraeini neotropicales, y su material-tipo (Lepidoptera: Nymphalidae, Heliconiinae). Rrevista Peruana de Entomologia, Lima, 39:29-48.

Lamas, G. 2004. Nymphalidae. Heliconiinae, pp. 261-274. In: Lamas, G. (Ed.), Checklist: Part 4A. Hesperioidea – Papilionoidea. In: Heppner, J. B. (Ed.), Atlas of Neotropical Lepidoptera. Volume 5A. Association for Tropical Lepidoptera/Scientific Publishers, Gainesville.

Lewis, H.L. 1975. Las mariposas del mundo. Ediciones Omega, Barcelona.

Lucas, P.H.. 1835. Histoire naturelle des lépidoptères exotiques. Pauquet, Paris, IV + 156 pp., 80 plates.

Mabilde, A.P. 1896. Borboletas do Estado do Rio Grande do Sul. Guia prática para os principiantes colleccionadores de insectos contendo a descripção fiel de perto de 1000 borboletas com 280 figuras lythographadas em tamanho, formas e dezenhos conforme o natural. Estudo sobre a vida de insectos do Rio Grande do Sul e sobre a caça, classificação e conservação de uma collecção, mais ou menos regular. Typographia Gundlach & Schuldt, Porto Alegre, 240 pp., 24 plates.

Mielke, O.H.H. & M.M. Casagrande. 1986. Sobre os tipos de Lepidoptera depositados em museus brasileiros. III. Nymphalidae (Danainae, Brassolinae, Morphinae, Satyrinae Nymphalinae e Acraeinae), descritos por R.F. D'Almeida. Revista Brasileira de Entomologia, 30(1):141-152.

Monte, O. 1934. Borboletas que vivem em plantas cultivadas. Secretaria de Agricultura de Minas Gerais, Série Agrícola, 21:VIII + 221 pp.

Müller, F. 1876. Einige Worte über Leptalis. Jenaische Zeitschrift für Naturwissenschaft, 10:1-12.

Müller, F. 1877a. Notes on Brazilian entomology. Transactions of the Entomological Society of London, 1877(3):211-223.

Müller, F. 1877b. Beobachtungen an brasilianischen Schmetterlingen. III. Kosmos, Leipzig, 2:218-224.

Müller, F. 1878a. Pflanzengattungen, an denem mir bekannte Tagfalter-Raupen leben. Stettiner Entomologische Zeitung, 39:296.

Müller, F. 1878b. Ueber die Vortheile der Mimicry bei Schmetterlingen. Zoologischer Anzeiger, 1:54-55.

Müller, F. 1879. On a remarkable case of mimicry of *Eueides pavana* with *Acraea thalia*. Transactions of the Entomological Society of London, 1879(2):XX-XXIV.

Müller, F. 1882. Bemerkenswerte Fälle erworbener Aehnlichkeit bei Schmetterlingen. Kosmos, Stuttgart, 10:257-267.

Müller, F. 1883a. Der Anhang am Hinterleib der *Acraea*-Weibchen. Zoologische Anzeiger, 6:415-416.

Müller, F. 1883b. Eine Aufgabe für Lepidopterologen. Berliner Entomologische Zeitschrift, 27(2):214-216.

Müller, F. 1883c. Angebissene Flügel von *Acraea thalia*. Kosmos, Stuttgart, 13:197-201.

Müller, F. 1915. In: A. Möller (ed.) Fritz Müller: Werke, Briefe und Leben. Jena, 2 vols.

Müller, W. 1886. Südamerikanische Nymphalidenraupen. Versuch eines natürlichen Systems der Nymphaliden. Zoologische Jahrbücher. Abteilung für Systematik Geographie und Biologie der Tiere, 1:417-678, plates 12-15.

Oberthür, C. 1917. Le genre *Actinote*. Études de Lépidoptèrologie Comparée, 14:77-125, 12 plates.

Orfila, R.N. 1964. Una nueva plaga para la Argentina: “la isoca espinosa del girassol”, *Actinote pellenea pellenea* Hübner (Lep. Acraeidae). Idia, Buenos Aires, 196:41-48.

Paluch, M.; M.M. Casagrande & O.H.H. Mielke. 1999. Estágios imaturos de *Actinote surima* (Schaus) (Lepidoptera, Nymphalidae, Acraeinae) Revista Brasileira de Zoologia, Curitiba, 16(supl. 2): 129-140.

Paluch, M., M.M. Casagrande & O.H.H. Mielke. 2001. Estágios imaturos de *Actinote carycina* Jordan (Lepidoptera: Nymphalidae: Acraeinae). Revista Brasileira de Zoologia, Curitiba, 18(3):883-896.

Paluch, M., M.M. Casagrande & O.H.H. Mielke. 2003. Tampão genital de *Actinote* Hübner, como caráter taxonômico (Lepidoptera, Nymphalidae, Acraeinae). Revista Brasileira de entomologia, 47:573-580.

Penz, C.M. 1983. O gênero *Actinote* Hübner, 1819 no sul do Brasil (Lep., Nymph., Acraeinae). B.S. Thesis, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil.

Penz, C.M. 1985. Estudos sobre as espécies de *Actinote* Hübner, 1819 do Rio Grande do Sul (Lep., Nymph., Acraeinae). Resumos do XII Congresso Brasileiro de Zoologia, Campinas, p. 104.

Penz, C.M. & P. Djunijanti. 2003. Phylogenetic relationships among Heliconiinae genera based on early stage and adult morphology (Lepidoptera, Nymphalidae). Systematic Entomology, 28:451-479.

Penz, C.M. & R.B. Francini. 1996. New species of *Actinote* Hübner (Nymphalidae: Acraeinae) from Southeastern Brazil. Journal of the Lepidopterists' Society, 50:309-320.

Pierre, J. 1983. Systématique évolutive, cladistique et mimétisme chez les lépidoptères du genre *Acraea* (Nymphalidae). PhD Dissertation, University of Paris, Paris, France.

Pierre, J. 1987 Systématique cladistique chez les *Acraea* (Lepidoptera, Nymphalidae). Annales de la Société Entomologique de France (N.S.), 23(1):11-27.

Prittwitz, O. 1865. Beiträge zur Fauna des Corcovado. Stettiner Entomologische Zeitung, 26:123-143.

Ronna, E. 1934. Primeiro ensaio da catalogação dos insetos do Brasil auxiliares na luta contra as pragas. O Campo, Rio de Janeiro, 5(7):33-36.

Schaus, W. 1902. Descriptions of new American butterflies. Proceedings of the United States National Museum, 24(1262):383-460.

Smart, P. 1976. Encyclopédie des papillons. Elsevier Sequoia, Bruxelles.

Srygley, R. B. 1994. Locomotor mimicry in butterflies? The associations of positions of centres of mass among groups of mimetic, unprofitable prey. Philosophical Transactions of the Royal Society, London, B, 343:145-155.

Staudinger, O. 1884-1888. Exotische tagfalter in systematischer Reihenfolge mit Berücksichtigung neuer Arten. In: Staudinger, O. & E. Schatz, Exotische Schmetterlinge, vol 1(1): 333 pp + 1 map; vol 1(2): 100 plates. G. Lowensohn, Fürth, Bayern.

Toledo, Z.D.A. 1980. Fauna del NOA. Contribución al conocimiento de los lepidópteros argentinos. VIII. *Actinote diaguita* Hayward (Lepidoptera, Acracidae [sic]). Acta Zoologica Lilloana, 36(1):87-93.

Turner, J. R. G. 1987. The evolutionary dynamics of Batesian and Mullerian mimicry: similarities and differences. Ecological Entomology, 12:81–95.

Van Son, G. 1963. The Butterflies of the Southern Africa. Part 3: Nymphalidae: Acraeinae. Transvaal Museum, Pretoria.

Weymer, G. 1894 Exotische Lepidopteren. VII. Beitrag zur Lepidopterenfauna von Rio Grande do Sul. Stettiner Entomologische Zeitung, 55(10-12):311-333.

Title: An illustrated key to male *Actinote* from Southeastern Brazil (Lepidoptera, Nymphalidae).

Authors: Ronaldo Bastos Francini & Carla M. Penz

Biota Neotropica, Vol. 6 (number 1): 2006
http://www.biotaneotropica.org.br/v6n1/pt/abstract?identification-key+bn00606012006

Date Received 06/06/2005 - Revised10/20/2005
Accepted 01/01/2006

ISSN 1676-0611

Variabilidade genética da piramutaba Brachyplatystoma vaillantii (Siluriformes:Pimelodidae) no Sistema Estuário-Amazonas-Solimões

Kyara Formiga de Aquino

Resumo
A piramutaba (*Brachyplatystoma vaillantii*) é uma das duas mais importantes espécies comerciais de bagres na Amazônia, principalmente para o mercado de exportação. Vários autores sugerem em seus trabalhos que a espécie é composta de um único estoque que migra sazonalmente, utilizando diferentes áreas para a reprodução, alimentação/crescimento ao longo do sistema Estuário-Amazonas–Solimões (EAS). Desta forma, a piramutaba é capturada tanto pela pesca comercial artesanal, que ocorre em todo o sistema EAS, quanto pela industrial, que é praticacada somente no estuário, paralelamente à pesca artesanal. Este trabalho teve como objetivos principais estimar a variabilidade genética e verificar a existência de correlação geográfica e genética entre os indivíduos de *B. vaillantii* coletados em cinco pontos ao longo do sistema EAS, sendo as amostras obtidas em mercados das cidades de Belém, Santarém, Manaus, Tefé e Tabatinga. Foram sequenciados 942 pares de base, que correspondem a região controle do DNA mt de 100 espécimens das cinco localidades. As sequências nucleotídicas foram ulilizadas em análises de polimorfimo de DNA, filogenéticas, AMOVA e no teste de Mantel. Dentre os 100 indivíduos de *B. vaillantii* foram identificados 92 haplotipos, com 87 *singletons*. As análises filogenéticas e populacionais demonstraram que não há segregação genética entres os indivíduos de *B. vaillantii* e, de acordo com o teste Mantel, não há correlação entre a distância genética e a distância geográfica dos indivíduos de *B. vaillantii*, nas localidades de Belém, Santarém, Manaus, Tefé e Tabatinga. Isto corrobora a idéia de um único estoque pesqueiro para a espécie na Amazônia.

Palavras-chave: siluriformes, piramutaba, variabilidade genética, DNA mitocondrial, região controle

FICHA CATALOGRÁFICA

Formiga-Aquino, Kyara
Variabilidade genética da piramutaba – *Brachyplatystoma vaillantii* (Valenciennes, 1840) (Siluriformes:Pimelodidae) no Sistema Estuário-Amazonas-Solimões.
Manaus:

INPA/UFAM, 2004
XVII + 76p.

Dissertação de Mestrado
Palavras-Chave: 1.Siluriformes 2.Piramutaba 3.Variabilidade genética 4.DNA Mitocondrial 5.Região controle

Shelter availability and use by mammals and birds in an Atlantic forest area

***Beatriz de Mello Beisiegel*[1]**

Biota Neotropica v6 (n1) – http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn00206012006

Date Received 05/16/2005
Revised 10/12/2005
Accepted 01/01/2006

[1]Doctoral Student, Departamento de Psicologia Experimental, Instituto de Psicologia da Universidade de São Paulo, Brasil (http://ip.usp.br). Present address: Alameda Inhambu, 76, Vila Verde, 06670-330 Itapevi, São Paulo, Brasil (beatrizb@usp.br).

Abstract

Beisiegel, B.M. **Shelter availability and use by mammals and birds in an Atlantic Forest area**. *Biota Neotrop*. Jan/Abr 2006, vol. 6, no. 1, http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn00206012006. ISSN 1676-0611.

This paper describes the types of ground-level shelters, their availability and use by mammals and birds at Parque Estadual Carlos Botelho (PECB), an Atlantic forest area at southeastern Brazil. Eight types of shelters were found: shelters without tunnels under living trees, shelters with tunnels under living trees, shelters under mounds formed by adventitious roots, shelters under fallen trees, burrows not supported by trees or roots, riverbank shelters, stream tunnels and rock shelters. Mammal species that used shelters more frequently were *Agouti paca*, *Philander frenata*, *Lontra longicaudis*, *Metachirus nudicaudatus* and *Trinomys iheringi*. Utilization of shelter types and shelter topographic locations by these six species was roughly similar to the proportions in which shelters of different types and locations were monitored, with the exception of otters, which are semi-aquatic mammals and used mainly riverbank shelters.

Contrary to expectations, animals did not choose shelters with entrances fitted to their sizes. Shelters were used either by a single species or by different species. I hypothesize that at the PECB other factors such as microclimate inside shelters must be more important in determining shelter use than shelter external characteristics or topographic location. Some species, as coatis *Nasua nasua* and probably small didelphids and birds, enter shelters to search for invertebrates and small vertebrates.

Key words: *Shelter site, Atlantic forest, resource availability, Mammalia, Aves*

Resumo

Beisiegel, B.M. **Disponibilidade de abrigos e seu uso por mamíferos e aves em uma área de Mata Atlântica**. *Biota Neotrop*. Jan/Abr 2006, vol. 6, no. 1, http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn00206012006. ISSN 1676-0611.

Este artigo descreve os tipos de abrigos encontrados no solo, sua disponibilidade e uso por mamíferos e aves no Parque Estadual Carlos Botelho (PECB), uma área de Mata Atlântica no sudeste do Brasil. Foram encontrados oito tipos de abrigos: abrigos sem túneis sob árvores vivas, abrigos com túneis sob árvores vivas, abrigos sob raízes adventícias, abrigos sob árvores caídas, escavações não sustentadas por raízes ou árvores, abrigos em barrancos de rios, túneis formados por riachos e abrigos entre rochas. Os mamíferos que mais usaram os abrigos foram *Agouti paca*, *Philander frenata*, *Lontra longicaudis*, *Metachirus nudicaudatus* e *Trinomys iheringi*. A utilização dos tipos de abrigos e das localizações dos mesmos por estas seis espécies foi, de forma geral, proporcional à quantidade de abrigos monitorados para cada tipo e cada topografia, com a exceção das lontras, que sendo mamíferos semi-aquáticos utilizaram principalmente abrigos nos barrancos de rios.

Ao contrário do esperado, os animais não escolheram abrigos cujas entradas correspondessem a seus tamanhos corporais. Os abrigos foram usados tanto por uma só espécie quanto por várias espécies. Sugiro que no PECB fatores como microclima no interior dos abrigos usados pelas espécies devem ser mais importantes na seleção dos abrigos do que as características externas e localização dos mesmos quanto à topografia. Algumas espécies, como quatis *Nasua nasua* e provavelmente pequenos didelfídeos e aves, entram nos abrigos em busca de invertebrados e pequenos vertebrados.

Palavras-chave: *Abrigo, Mata Atlântica, disponibilidade de recursos, Mammalia, Aves*

Introduction

Shelter is an essential resource to many species of animals (McComb & Noble 1981, Ruggiero et al. 1998) and shelter availability may be a limiting factor in home range use for some species, as northern raccoons, *Procyon lotor* (Endres & Smith 1993), badgers, *Meles meles* (Doncaster & Woodrofe 1993) and red foxes, *Vulpes vulpes* (Lucherini et al. 1995) although not for others as fox squirrels, *Sciurus niger* (Robb *et al*. 1996) and otters, *Lontra longicaudis* (Pardini 1996, Pardini & Trajano 1999).

Shelter can afford protection against predators and from weather (Berner & Gysel 1967). Compared to external environment, shelter temperatures are more stable, with lower maximum and higher minimum temperatures (Berner & Gysel 1967). Shelter use by mammals and birds at Atlantic Forest areas has been subject of only a few investigations (e.g. Miles et al. 1981, Monteiro-Filho & Marcondes-Machado 1996, Pardini & Trajano 1999, Briani et al. 2001).

In the present paper I report on the types of shelters found in an Atlantic forest area, the Parque Estadual Carlos Botelho (PECB), and their use by mammals and birds. I described the animals that used the shelters, verified whether, in a short-term, each shelter was used by a single species or more than one and discussedthe hypothesis that mammal species display preferences for shelter types or shelter topographic location.

Material and Methods

Study area

The PECB is located in the state of São Paulo, southeastern Brazil, at 24°00' - 24°15' S and 47°45' - 48°10' W, and its total area is 37,793.63 ha. Three other reserves, the Parque Estadual Intervales, the Parque Estadual Turístico do Alto Ribeira and the Estação Ecológica de Xitué are contiguous to the PECB, and together they have an area of 116,836.99 ha, being one of the major Atlantic Forest remnant areas.

This study was conducted in the São Miguel Arcanjo Base of the PECB. This area is located in the Guapiara Highlands, in the Atlantic Plateau. The topography is characterized by low, parallel hills (Pfeifer et al. 1986). The altitude ranges from 700 to 839 m. A river, five big streams and hundreds of small streams form a dense drainage that belongs to the Paranapanema River drainage. The climate is type Cfb of Koeppen, described as mesothermic humid without a dry winter. There is marked seasonality in rainfall, however, with a wetter season from October to March and a drier season from April to September. Annual precipitation is 1.475 to 2.582 mm and the average precipitation in the drier month is 49 mm (Pfeifer et al. 1986, Negreiros et al. 1995). Average temperatures are 18°C to 20°C, with a minimum of 3°C and maximum of 29°C (Domingues & Silva 1988).

Vegetation is classified as Latifoliate Pluvial Tropical Forest (Domingues & Silva 1988). The study area comprised mainly primary forest, although logging occurred in many places in the past, and there are some patches of secondary forest.

The Park has a diverse and abundant fauna with at least 267 species of birds in 42 families (Figueiredo & Custódio-Filho 2003), including the jacu, *Penelope obscura*, the jacutinga, *Pipile jacutinga* and other endangered species, plus 23 species endemic to the Atlantic forest (Sick 1986). The rich mammalian fauna of the Park includes the two large South American felids, *Panthera onca* and *Puma concolor*, the two peccaries, *Tayassu tajacu* and *T. pecari*, deer (*Mazama sp*.), paca (*Agouti paca*), agouti (*Dasyprocta azarae*), bush dog (*Speothos venaticus*), crab-eating fox (*Cerdocyon thous*) and many other species of medium and large mammals (Beisiegel 1999, Beisiegel & Ades 2002, 2004).

Data collection and analysis

Most of this work was conducted from February 1997 to August 1999. The shelters were found in the course of a study on the bush dog, *Speothos venaticus*. Thus, the shelters marked had the characteristics expected for a canid shelter such as the presence of tunnels and multiple entrances (Egoscue 1962, Kilgore Jr 1969, Johnsingh 1982, Aquino & Puertas 1997). This limited the work to (1) ground level shelters; (2) shelters that had at least one entrance that was large enough to allow the passage of a bush dog (roughly 15 cm diameter). I did not attempt to identify individually the animals using the shelters, nor did I attempt to explore the shelters with devices such as periscopes or fiber-optic systems, which would allow a thorough inspection of the interior of the shelters (Moriarty & McComb 1982). Since the bush dog is a semi-aquatic species and may have a very large home range (Beisiegel 1999, Beisiegel & Ades 2004), almost all the streams that were accessible in up to half a day walking from the internal road of the park were searched, comprising an area of roughly 4,000 ha. In addition to stream vicinities, which included hillsides, hilltops were also searched because of the high shelter densities found in these areas.

Two methods were used to identify the animals that used the shelters, consisting of placing at the entrances of the shelters (1) sand plots to register tracks and (2) passive infra-red camera traps (Trail Master 500® and Trail Master camera kit®, Goodson and Associates, Inc.). Sand plots were used in 339 shelters and camera traps were used in 62 shelters. In 38 of these both methods were used, totaling 363 shelters for which I attempted identification of users.

The minimum time lapse between consecutive pictures was 2 min and for each picture the camera registered the date and time. For sand plots, I registered the dates of placement and checking of plots and the tracks found. Tracks of mammals were identified using the guide by Becker & Dalponte (1991). Whenever possible the animals were identified to species or genus, but in many instances it was just possible to identify the Family (e.g. Didelphidae) or even just Class (e.g., Mammalia, Aves) or size of the animal.

Sampling periods for sand plots (number of days from placement to last checking) ranged from one to 446 days (average = 71 days, s.d. = 62 days). During the sampling period, each sand plot was checked from one to 14 times (average = 2.5 times, s.d. = 1.9). Sampling periods for camera traps varied from one to 22 days (average = 6.7 days, s.d. = 4.7 days). However, these are just indices of the real sampling effort, since many factors affected data collection for both methods. Rain was the main problem for the use of sand plots, but sometimes the large number of tracks accumulated in a plot also prevented the identification of the user. Camera traps sometimes ran out of film or batteries, but the most frequent trouble was the false triggering of the sensors by the heath or by the raising of water levels.

The shelters were classified in types according to external and internal features and maximum height of entrances and topography were described for 91 of the shelters which users had been identified. To evaluate availability of shelters in different topographic features, strip counts of shelters were conducted along 9,362 linear meters, comprising 2,139 m of hilltops, 1,733 m of hillsides, 2,075 m of small streams (which comprised slopes and narrow valleys), 1,589 m of river plains along large streams (only large valleys), 574 m of river plains with undifferentiated alluvial deposits (which had shelter types and availability different from river plains, see below) and 1,252 m inside large streams (counting only riverbank shelters). In trails with a good visibility of the ground, all shelters in a 5-meter wide strip were counted, and in trails with dense herbaceous vegetation all shelters were counted in a 3-meter wide strip. This was due to the fact that, in sites with dense vegetation cover, a shelter would only be seen if it was very near the trail. Trails were either marked each 50 m or measured with a GPS (E-Trex, Garmin). The density of river bank shelters were estimated as the number found per km of margin and for the remaining shelters, as the number per area, calculated multiplying the length of the trails by the width of the searched strips (3 or 5 meters).

The work was performed in many steps. I began to mark the shelters that could be used by *Speothos venaticus* in February 1997, without recognizing different shelter types or topographies; sand plots were placed on shelter entrances from September 1997 and camera traps were used from June 1998 to the end of the study. Shelter types and topographic locations began to be noted on May 1998. Many shelters were monitored with sand plots before May 1998 and I did not return to many of them to note topographic location or shelter type after the monitoring period. Therefore, shelter characteristics were not noted for all shelters marked or monitored. A total of 742 shelters were marked, from which 504 could be assigned to one of the eight shelter types described below. Also from these 742 shelters, 343 were monitored with sand plots and /or camera traps, but shelter type and location were not noted for all of the monitored shelters. Of the 343 monitored shelters, type was noted for 253 shelters and topographic location was noted for 294. Both type and topography were noted for 232 of them.

Transect counts of shelters were conducted during 2001-2002. Due to the large number of marked shelters, great extension of the study area and small number of camera traps (three cameras), the shelters that were selected to be monitored were those that appeared most likely to be used by a group of *Speothos venaticus*. These shelters were the larger ones, or had most evidences of frequent use, such as entrances with clean paths leading to them, or were located near the sites where most bush dog tracks were found (Beisiegel & Ades 2004). Therefore, there was no systematic or random selection of the shelters that were monitored and the results described below can be only qualitatively interpreted.

Results

Shelter site types

Eight types of shelter sites were found (Figures 1 and 2). Most shelters (n=504) could readily be assigned to one of these eight types, based on internal characteristics, such as the presence and the size of chambers (defined as cavities with an inner diameter larger than entrance width) and of tunnels (defined as a cavity with a diameter much smaller than its observable length) and on the location of the shelter, such as under living tree, under adventitious roots of one or many trees, under fallen log, under rocks, or not under any of these, on riverbanks, and on tunnels formed by small streams. In a few cases, shelters presented characteristics of two or more types.

Shelters without tunnels under living trees (WT)

These shelters are located under or among the roots of a living tree or inside the hollow basis of a tree, and they do not form tunnels, being composed mainly by a cavity. The largest width of the shelter is observed at the entrance or a chamber with a smaller entrance. Few shelters of this type were marked because I considered them unlikely to be used by bush dogs. One shelter fitted with a camera trap had a strong animal smell and was regularly used by a didelphid (*Marmosops* sp.) and a bird (*Grallaria varia*, Passeriformes: Formicariidae). Two shelters had felid feces inside them, suggesting that they could be used as territorial marks. Many shelters of this type were located on or near hilltops and from inside them an animal could have a good view of the surroundings. I also observed a white-lipped peccary, *Tayassu pecari*, entering a shelter of this type and staying there for some minutes, during daytime. From the 504 shelters for which the type was described, 34 were WT shelters. In the strip counts one shelter of this type was found on a hilltop and three on hillsides.

Shelters with tunnels under living trees (TULT)

These were different from the WT type described above because they always were composed of at least one tunnel, which could just connect two entrances or connect different entrances and chambers, not all of which were visible from outside. They could be (a) the cavity inside the basis of a living tree, with the trunk or roots delimiting the entrances of the shelter; (b) a tunnel dug under the tree roots. Didelphids (*Philander frenata* and *Metachirus nudicaudatus*), pacas, one armadillo (*Dasypus novemcinctus*), one otter (*Lontra longicaudis*), unidentified birds, unidentified small rodents, coatis and unidentified large animals used these shelters. Of the 504 shelters, 174 were of this type. In the strip counts, eight TULT shelters were found on hilltops, seven on hillsides, six on river plains and four on small streams. These were the most frequent shelters found at hillsides and riparian habitats (Table 1).

Shelters under mounds formed by adventitious roots (UMAR)

These shelters were mainly found on two types of sites: hilltops and some river plains. These sites probably had soils less compacted when compared to the rest of the study area. This is due, in the hilltops, probably to declivity, and, in some river plains, to undifferentiated alluvial deposits (Domingues & Silva 1988) with high sand and water content. Due to this soil “softness” these sites have many trees with adventitious roots (also called prop or stilt roots), which increase the stability of the trees (Waisel, Eshel & Kafkafi 1996). These adventitious roots are normally covered by leaf-litter, which in turn harbor other trees, thus forming large mounds, with large chambers and, probably due to soil softness, large tunnels (frequently more than 50 cm diameter) inside them. These shelters can be connected by tunnels, and thus comprise an area of several square meters. They may have small (Figure 1) or very large entrances (Figure 2a). At hilltops and river plains with undifferentiated alluvial deposits they were found in a higher density than the other types of shelters (Table 1). Although these shelters were larger than the other types (Figure 1), mainly small mammals and birds used them. Of the 504 shelters, 138 were of this type. On the strip counts they were found on hilltops (61 shelters) and river plains with undifferentiated alluvial deposits (22 shelters).

Shelters under fallen trees (FT)

These were dug normally under the basis of a fallen tree. Entrances might be dug among or below roots or below the trunk. Often the fallen trunk itself had a cavity inside it, which was used as a tunnel with sometimes many entrances to it. The roots of the fallen tree could also form a shelter, similar to a WT shelter but having tunnels exiting from the inner part of the shelter. Pacas, didelphids, birds and small rodents used these shelters. Of the 504 shelters, 79 were of this type. In the systematic strip counts, one FT shelter was found on a hilltop, three on hillsides, three on river plains and four on small streams.

Burrows not located under fallen trees, tree roots or rocks (BU)

These shelters consisted in a tunnel or chamber that were dug at a slope or at the plain ground, with no supports such as roots, rocks or fallen trees. Their entrances were frequently found in groups of three close (*ca*. 1-2 m) to one another, sometimes clearly differing in age. Frequently, they were used only once or a few times. Two of these shelters were used many times: one of them was used by a pair of juruvas, *Baryphtengus ruficapillus* (Figure 2b) when it was marked in 1997 and it was still used by juruvas and also by a rodent (*Trinomys iheringi*) when a camera trap was used to monitor it one year later. These were the only animals that used this shelter. Other similar shelter was repeatedly used by a pair of juruvas, and no other animals were observed to use it. This was the only shelter type found at the internal roads and firebreaks of the park. Of the 504 shelters, 22 were of this type. In the strip counts they were found on hilltops (one shelter), hillsides (one shelter) and small streams (one shelter).

Riverbank shelters (RB)

These consisted of tunnels dug at the banks along rivers. They could have either (a) many entrances at different heights from the water level, which were used by otters, pacas and small rodents; (b) just one obvious entrance at the water level, from which often a small stream exited (Figure 2c), making it difficult to see the interior of these shelters, which were used by otters; and (c) one entrance at the water level in which the water entered, with a dry platform inside it, which were used by pacas and likely by otters, since some of them had otter tracks and feces on nearby beaches. In one shelter fitted with a camera trap, pictures of a *Chironectes minimus* and of a rodent were obtained, both of which were swimming and thus could be just passing in front of the shelter. Entrances of these three types could also belong to the same shelter. Of 504 shelters, 45 were of this type. In the systematic strips counts, nine RB shelters were found.

Stream tunnels (ST)

These shelters were formed by a partly subterraneous small streams, which opened large tunnels. Animal tracks could be found entering the tunnel in the mud of the stream (Figure 2d). The animals could use these tunnels in the dry season or use side tunnels exiting from the stream tunnels. Of the 504 shelters, eight were of this type, and two of these were used by pacas. In the systematic strip counts no shelter of this type was found.

Rock shelters (RO)

These shelters were cavities among rocks, presenting evidences of use by animals. They could have one or more entrances. This type was very rare at the PECB, although it is one of the most frequently mentioned in the literature, being reportedly used by many species (e. g. *Speothos venaticus*, Linares 1967; *Metachirus nudicaudatus*, Miles et al. 1981; *Procyon lotor,* Endres & Smith 1993; *Martes americana,* Ruggiero et al. 1998; *Lontra longicaudis*, Pardini & Trajano 1999). Of the 504 shelters, only four rock shelters with some evidence of use were found; one of them was used by a paca and the users of the others were not identified. In the systematic strip counts no shelter of this type was found.

Monitored shelters

I identified at least the size of the animals using 133 of the 363 monitored shelters. The disparity between the number of monitored shelters and the number of shelters which had their users identified is due to the problems described above, such as rain and false triggering of camera traps. Sand plots alone identified the animals using 72 shelters and camera traps alone identified the animals using (or passing in front or above) 31 shelters. Animals using eight shelters were identified by both methods and at four shelters I either saw the animal exiting from it or found signs (tracks, feces or feathers) that allowed the identification of the animals. Overall success of camera traps in identifying the users of shelters was higher than the success of the sand plot method (76% *vs.* 28%). Table 2 presents the number of shelters of each type and in each topographic location monitored. Most monitored shelters were of TULT (n = 103, or 40.6% of monitored shelters), UMAR (n= 64, or 25.2% of monitored shelters) and FT (n = 49, or 19.3% of monitored shelters) types, but it is not possible to determine whether this was due to these shelters being the most common types (see item 3.7 below) or to they having more characteristics of a shelter which could be used by bush dogs. There was less disparity among the amount of monitored shelters in the main topographic features, hilltops (n = 63, 21.3% of monitored shelters), hillsides (n = 49, 16.7% of monitored shelters), river plains (n = 68, 23.1% of monitored shelters) and small streams (n = 91, 31% of monitored shelters). Less shelters were monitored in riverbanks (n = 16, 5.4% of monitored shelters) and river plains with undifferentiated alluvial deposits (n = 7, 2.4% of monitored shelters), due to the small proportion of the study area occupied by these topographies.

Shelter use in relation to shelter type

Animals in pictures obtained by camera traps could be entering or exiting, be inside the shelters, just be in front of them or be on the tree above them (Table 3). In some of these pictures, it was not possible to know whether the animals entered the shelters after the pictures were taken, because the minimum time lapse between consecutive pictures was of two minutes. Because of this, results were divided in two types: all records and records of animals inside shelters. Both types are presented in Table 3 and on item 3.4, but the other Tables and analysis considered only the animals that entered the shelters.

Two species of birds were pictured inside the shelters and tracks registered the use of 31 different shelters by unidentified birds. Eight mammal species were identified by tracks, pictures, feces or sightings and two mammals were identified to genus level by pictures.

For animals identified to species level, *Agouti paca*, *Philander frenata*, *Nasua nasua*, *Trinomys iheringi*, *Metachirus nudicaudatus* and *Lontra longicaudis* were the species that used more shelters (Table 3). *A. paca* was the species with the highest number of used shelters and also the species which used the highest number of shelter types, using all types except WT and BU (Table 3). The percent of TULT shelters used by pacas (43% of the shelters used by the species for which the type has been recorded) was similar to the percent of TULT shelters in relation to the total number of shelters monitored (40.6%). The percents of RB (7%), ST (4%) and RO (2%) shelters used by this species were also similar to the percent of monitored shelters of these types. The percent of UMAR shelters used by pacas (9%) was much lower than the percent of monitored shelters of these type and the percent of FT shelters used by pacas (35%) was higher than that of monitored shelters of these type.

All other identified species used one to three types of shelters (Table 3). *P. frenata*, despite being the species which used the second highest number of shelters, used shelters of only two types (TULT and UMAR). *T. iheringi* may have used more shelters than the six listed in Table 3, because in some pictures appeared small rodents that resembled *T. iheringi* but could not be identified with certainty. *L. longicaudis* used three RB and one TULT shelters. *N. nasua* entered five shelters of TULT and UMAR types and was registered in front of three more shelters, being one TULT, one UMAR and one ST.

Table 1. *Shelter availability at the Parque Estadual Carlos Botelho, in number of shelters / hectare, divided by shelter types and location. For river banks, availability is given as number of shelters / linear km of stream.*

	Shelter location					
Shelter type	Hilltop	Hillside	River banks	River plain	River plain with undifferentiated alluvial deposit	Small stream
WT	0.9	3.5	0	0	0	0
TULT	7.5	8.1	0	11.3	0	3.9
UMAR	57.0	0	0	0	168.4	0
FT	0.9	3.5	0	5.7	0	3.9
BU	0.9	1.2	0	0	0	1
RB	0	0	7.2	0	0	3.9
Total	67.3	16.2	7.2	17.0	168.4	12.5

Table 2. *Number of monitored shelters for which either type, topographic location, or both, were recorded, at the Parque Estadual Carlos Botelho.*

		topography							
		ht	hs	rb	rp	rpuad	ss	not recorded	**total**
type	wt	1	3		2		3	2	**11**
	tult	9	16		31		41	6	**103**
	umar	45	4			7		8	**64**
	ft	2	9		20		14	4	**49**
	bu	1	1		1		1	2	**6**
	rb			15					**15**
	st		1		2		2		**5**
	rd						1		**1**
	not recorded	5	15	1	12		29		**62**
	total	**63**	**49**	**16**	**68**	**7**	**91**	**22**	

Table 3. *Number of shelters of each type used by mammals and birds at the Parque Estadual Carlos Botelho. Each number in this table corresponds to one shelter used by one species, higher taxonomic category, or size. The number without parenthesis in each column represent all shelters used by each species, higher taxonomic category, or size, including animals which appeared in the pictures but were just passing in front of the shelters and animals which appeared in the pictures or which tracks were found exiting, entering or inside the shelters. The number inside parenthesis indicates only the animals which appeared in the pictures or which tracks were found exiting, entering or inside the shelters. Not desc. = shelters for which type was not described.*

Family	**Species**	**Shelter type**									
		WT	**TULT**	**UMAR**	**FT**	**BU**	**RB**	**ST**	**RO**	**Not desc.**	**Total**
Momotidae	*Baryphtengus ruficapillus*					(2)					(2)
Formicariidae	*Grallaria varia*	(1)									(1)
	Batara cinerea			1							1
?	Unidentified bird		(16)	(1)	(9)		(1)	(1)		(3)	(31)
Didelphidae	*Marmosops* sp.	(1)	1								2 (1)
	Philander frenata		(7)	(6)							(13)
	Metachirus nudicaudatus		(1)	(2)	(1)					(1)	(5)
	Monodelphis cf . *americana*		1					1			2
	Monodelphis cf. *scalops*			1							1
	Chironectes minimus						1				1
	Unidentified didelphid		1	(1)	(1)						3 (2)
Agoutidae	*Agouti paca*		(20)	(4)	(16)		(3)	(2)	(1)	(6)	(52)
Echimyidae	*Trinomys iheringi*		(3)	(1)		(1)				(1)	(6)
Echimyidae?	Unidentified very large rodent		(1)								(1)
Sciuridae	*Sciurus ingrami*		2 (1)	1							3 (1)
Muridae	*Oryzomys* sp.		1								(1)
?	Unidentified small rodent		(8)	(7)	(6)		2 (1)			(3)	26 (25)
Dasypodidae	*Dasypus novemcinctus*		(1)								(1)
Mustelidae	*Lontra longicaudis*		(1)				(3)				(4)
Procyonidae	*Nasua nasua*		4 (3)	3 (2)				1			8 (5)
Tayassuidae	*Tayassu pecari*	(1)									(1)
?	Unidentified small animal (track size up to two cm)		(9)	(4)	(5)		(1)			(2)	(21)
?	Unidentified large animal (track size 4 cm or larger)		(11)	(4)	(2)		(2)			(6)	(25)

Among the types of shelters, TULT type was the one that presented the highest number of shelters used, as well as the one that was used by the highest number of species (Table 3). The only species that did not use this type of shelter were those that used only one or two shelters (*B. ruficapillus*, *G. varia*, *Marmosops* sp. and *T. pecari*). UMAR shelters, which were the larger ones, were proportionally more used by the small *Philander frenata*, small rodents and small unidentified animals. RB shelters were mainly used by pacas and otters.

Multiple and repeated users

Sixty-five shelters were used by more than one species or were used by the same species on more than one day or night. Nineteen of these were used only by one species: one (TULT) by an unidentified small bird; two (RB) by otters; ten by pacas (3 TULT, 5 FT, 1 RB, 1 of unidentified type); two (UMAR) by *P. frenata*; one (TULT) by coatis and three (1 TULT, 1 UMAR, 1 of unidentified type) by *T. iheringi*.

Thirteen shelters were used by the same species (or the same individual) on more than one night or day and were also used by other species. Six of these were used only by a pair of species (both species used the shelter more than once and no other animal used it): one WT shelter was used twice by *Marmosops sp.* and four times by *Grallaria varia*; one BU shelter was used by a pair of juruvas (*Baryphtengus ruficapillus*) and by *Trinomys iheringi*; one TULT shelter was used twice by otters and twice by *Metachirus nudicaudatus*; *M. nudicaudatus* also used one FT shelter on two of four nights in which the camera trap was used, and this shelter was also repeatedly used by *A. paca* (three nights); one UMAR shelter was used by *Philander frenata* and a small unidentified rodent and a TULT shelter was used many times by *Agouti paca* and a squirrel was pictured inside it two times. One TULT shelter was used many times by *Trinomys iheringi* and *Philander frenata* and coatis also entered it. Two TULT shelters were used repeatedly by three species and other species used them once: one of these was repeatedly used by *Philander frenata*, one unidentified mouse and one unidentified rodent, and *Agouti paca* and *Metachirus nudicaudatus* also used it. The other one was used many times by pacas, *Trinomys iheringi* and *Philander frenata*, and *M. nudicaudatus* used it once (Figure 3). This shelter was also entered by coatis and one young didelphid was pictured over its entrance. The four remaining shelters were used more than once by one species and once by another species: two TULT shelters were used repeatedly by pacas, one of them also by a bird and one of them also by a bird and a rodent; one TULT shelter was used on four nights by *Philander frenata* and once by a rodent; and one UMAR shelter was used twice by *P. frenata* and once by *M. nudicaudatus*.

Five shelters were used by one species more than once, but it was not possible to determinate the species (unidentified birds, rodents, didelphids and small animals). In these shelters, identical unidentified tracks were found repeatedly. On one ST shelter monitored by camera trap *Nasua nasua*, *Monodelphis americana* and one unidentified rodent were pictured on at least two different days each species, but none of them inside the shelter.

Fourteen shelters were used by two species, once by each one of them. Seven shelters were used by three species, once by each one of them. For the remaining six of the 65 shelters it was not possible to determine how many species entered the shelter due to differences in the definition of the tracks on the many monitoring days; on one of them, for instance, the tracks found on one day allowed only to determinate that a large animal had entered the shelter and on other day tracks of paca were found on the shelter; so it was not possible to determinate whether the large animal which tracks were found before was also a paca or not.

Shelter use in relation to topographic location

Pacas used shelters in all types of location (Table 4), including three shelters at hilltops. Percents of topographic locations of shelters used by pacas were similar to percents of shelters monitored in each topography, except for shelters in river plains, which percent were almost twice the percent of monitored shelters, and shelters in hilltops, which percent was much smaller than that of monitored shelters. *Philander frenata*, *Metachirus nudicaudatus* and *Trinomys iheringi* used shelters at hilltops, hillsides and small streams, which were among the topographies where more shelters were monitored, but did not use shelters at river plains, which also had a high number of monitored shelters. Coatis used shelters on four locations, but they were probably only foraging inside the shelters. Most shelters used by otters were on riverbanks, but this species also used one shelter in a small stream. Other species used shelters in only one location type, but they used a small number of identified shelters.

Shelter use in relation to entrance height

Contrary to expectation, animals rarely chose a shelter with entrances fitting their own size (Table 4). This was clearly evident in most pictures (Figure 4; see also Figure 2 b). As a measure of the relationship between shelter entrance size and body size of the users, I compared shoulder height (SH) of the users with maximum height of shelter entrances, for the few species for which I found the SH value. Pacas have shoulder heights of 27-32 cm (Emmons & Feer 1990), and the average entrance height of the shelters used by them was 41.5 cm. *Metachirus nudicaudatus* has a shoulder height of 11-17.5 cm (Richard-Hansen et al. 1999)

Table 4: *Characteristics and location of shelters with identified users and shoulder height of these users, at the Parque Estadual Carlos Botelho, number of shelters in each location and percent represent by this number in relation to the total number of shelters for which location was recorded for each species(in parenthesis). Locations: HT= hilltop; HS= hillside; RB = river banks; RP = River plains; RPUAD = river plains with undifferentiated alluvial deposit; SS = small stream. N = number of shelters for which height of entrances was measured. SH = Shoulder height after Emmons & Feer (1990) and Richard-Hansen* et al. *(1999).*

	Location of shelters						**Maximum height of entrances (cm)**				**SH (cm)**
	HT	HS	RB	RP	RPUAD	SS	N	range	average	s.d.	
B. ruficapillus		2 (100%)					1		30		
G. varia		1 (100%)									
Marmosops sp.		1 (100%)									
P. frenata	6 (46%)	3 (23%)				4 (31%)	10	20-200	63.9	53.9	12-24.5
M. nudicaudatus	1 (20%)	3 (60%)				1 (20%)	3	20-60	40	20	11-17.5
A. paca	3 (6%)	10 (20%)	3 (6%)	20 (40%)	2 (4%)	12 (24%)	30	16-100	41.5	19.5	27-32
T. iheringi	1 (17%)	3 (50%)				2 (33%)	3	20-200	83.3	101.2	
S. ingrami		1 (100%)					1		24		
Oryzomys sp.		1 (100%)									
D. novemcinctus		1 (100%)					1		48		17-27.5
L. longicaudis			3 (75%)			1 (25%)	4	20-60	35	15.1	
N. nasua	1 (20%)	1 (20%)			1 (20%)	2 (40%)	4	20-200	83.5	79.6	

and maximum heights of entrances of three shelters used by the species were 20, 40 and 60 cm. The only shelter used by an armadillo *Dasypus novemcinctus* (SH 17-27.5 cm, Richard-Hansen et al. 1999) had a maximum entrance height of 48 cm; SH of *Philander frenata* was not found but the values for the similar *P. opossum* are 12 to 24.5 cm (Richard-Hansen et al. 1999), while the average entrance height of its dens was 83.5 cm.

Shelter availability in relation to shelter type and topographic location

Topography was varied across the study area. Parts of the area had extended river plains, while others had streams surrounded by high, steep hillsides. The trails used to estimate shelter availability in this study were selected in order to cover the six topographies of the area but not to determine the proportion of the total study area covered by each topographic location. Therefore, the estimative of number of shelters of each type by hectare can only be applied to each topographic location, and not to the total area.

Shelter availability was similar (12.5 – 17 shelters / ha) at hillsides, river plains and small streams (Table 1). At hilltops and river plains with undifferentiated alluvial deposits, however, shelter availability was higher (*ca.* four to ten times higher). The shelters found in these sites were mostly of UMAR type. River plains with undifferentiated alluvial deposits had a very high density of shelters of this type, but this topography represented a small proportion of the study area. Therefore, the overall availability of UMAR shelters across the study area must not be much increased by this high density.

TULT was the most common shelter type in all topographies except hilltops and river plains with undifferentiated alluvial deposits. So, despite the absence of a comparative estimative of number of shelters / hectare for the entire study area, this was probably the most common shelter type. FT shelters were the second most common type found in most topographies, and BU and WT shelters were less found in all topographies. ST and RO shelters were not found in the systematic searches, thus being probably the less frequent shelter types in the study area. The availability of RB type was estimated as number of shelters / linear km of margin and is not comparable to the estimates of the other shelter types.

Discussion

This study represents a basic description of the types of shelter found, of their use by mammals and birds and of their availability in Atlantic Forest sites, providing an initial step for future studies of shelter use in this biome. Since there was no attempt to verify what kind of use by the animals was involved, animals which used shelters identified in this study could use them as nocturnal or diurnal sleeping sites, natal dens, scent-marking sites, temporary resting sites (Prestrud 1992, Larivière & Messier 1998) or food caches (Post et al. 1993), or they could be entering the shelters to forage.

Of the animals which entered the shelters, *B. ruficapillus*, *A. paca*, *L. longicaudis*, *M. nudicudatus*, *P. frenata* and *D. novemcinctus* are reported to use ground-level shelters as sleeping or resting sites (Miles et al. 1981, Carter & Encarnação 1983, Sick 1986, Beck-King & Helversen 1999, Pardini & Trajano 1999, Moraes Jr. 2004). All these species were observed to use repeatedly the same shelters in this study, except *D. novemcintus*. This species is reported to use a shelter for some time, but it can have up to five entrances (Carter & Encarnação 1983), so if the armadillo photographed entering the shelter used it more than once as a sleeping site, it could have used other entrances during the three days in which a camera trap was used in this shelter. At the Amazonian forest much more nests of *Metachirus nudicaudatus* were found on the ground level than nests of *Philander opossum,* which nested mainly 8-10 m above the ground (Miles et al.1981). The opposite result found in this study may reflect either a population density much greater for *P. frenata* than for *M. nudicaudatus* at the PECB, a real difference in the degree of arboreality between *P. frenata* and *M. nudicaudatus*, or the preferential use of less conspicuous shelters by *M. nudicaudatus* (Miles *et al*. 1981, Moraes Jr. 2004). Actually, Miles *et al.* (1981) stated that shelters of *M. nudicaudatus* were found only due to the use of spool-and-line devices, for they were perfectly concealed among leaf mounds. Other data obtained in this study may also suggest interesting subjects for future ecological studies of some species. *Philander frenata* was the main user of the very large UMAR shelters found on hilltops. These shelters had deeply caved paths entering them, suggesting long – term use; it would be valuable to follow the use of these shelters in a long-term study in order to verify whether they are used always by the same individuals or some of their progeny as it happens with other species as European badgers *Meles meles* (Doncaster & Woodrofe 1993).

Animals that appeared in pictures but were not entering, exiting or inside the shelters could be just passing in front of them, investigating them or using them as a resource. It was already mentioned that felids could use WT shelters as deposition sites for scent marks. Coatis (*Nasua nasua*) probably entered shelters to search for invertebrates and little vertebrates inside them (Beisiegel 2001), since I never observed coatis resting inside shelters in the course of a long-term study (Beisiegel & Mantovani 2006). I observed a white-lipped peccary (*Tayassu pecari*) enter a WT shelter and stay there for some minutes. The animal could either be foraging there or leaving a scent mark, although the latter is improbable since these animals scent–mark other members of the herd rather than objects of the environment (Hernandez et al. 1995). Squirrels (*Sciurus ingrami*) were sometimes photographed at shelter entrances and a squirrel was pictured twice at a shelter used by an *Agouti paca*, entering the shelter and exiting it with a big seed in its mouth (Figure 5). As both *Agouti paca* and squirrels are frugivore / granivore (Robinson & Redford 1986, Emmons & Feer 1990, Jannini 2000) the squirrel probably entered the shelter searching for seeds left by the paca. The other pictures of squirrels could be due to the same behavior or squirrels could be only passing in front of the sensor. Although *S. ingrami* use tree cavities to shelter (Monteiro-Filho & Marcondes-Machado 1996) it is likely that they use only nests located well above the ground. One small didelphid and one *Marmosops* sp. pictured outside shelters were looking to the interior of the shelter when photographed, probably searching for invertebrates. The formicariid *Grallaria varia* used the interior of a shelter on many days, but Sick (1986) states that they use perches as sleeping sites, making it unlikely that the bird used the shelter to sleep. Still, this species is frequently observed at the PECB and the constancy of use of a single shelter by (possibly) a single individual is interesting. On the other hand, the position of *Monodelphis* spp. in all the pictures suggested that their presence was not related to shelter use.

Species that used many times the same shelter seldom used it on consecutive nights. This could be misleading because most shelters had more than one entrance, but the animals might be using many shelters. In a Costa Rican forest site, two *Agouti paca* used an average of 3.5 burrows at a time (Beck-King et al. 1999). The raccoons (*Procyon lotor)* studied by Endres & Smith (1993) used an average of 27.2 to 41 shelters / year, and one female *Metachirus nudicaudatus* used four different sleeping sites on three nights (Moraes Jr. 2004). Alternation in shelter use may be a strategy of predator avoidance and of parasite control.

Simultaneous use of the same shelter by many species observed in this study is not uncommon in other regions. Northern raccoons (*Procyon lotor*), opossums (*Didelphis marsupialis*) and striped skunks (*Mephitis mephitis*) sometimes shared the same shelters in Kansas (Shirer & Fitch 1970). In general the skunks excavated the shelters and the other two species benefited from their burrows, which were also used by six other mammal species and nine species of reptiles.

Utilization of shelter types and shelter topographic locations by the six species for which more shelters were identified was roughly similar to the proportions in which shelters of these types and locations were monitored, with the one obvious exception of otters, which are aquatic mammals and used mainly riverbank shelters.

However, other interesting exceptions occurred. *Philander frenata* did not use FT shelters and *Nasua nasua* did not enter FT shelters, nor was photographed near them, although both species used the TULT and UMAR shelters and the number of FT shelters monitored was similar to the number of UMAR shelters monitored. FT shelters occurred on the same topographic locations of TULT shelters, so it would be interesting to investigate whether these species really do not enter FT shelters (and why) or this is due to a small number of identified shelters. The proportionally low use of UMAR shelters by pacas is not surprising, because most monitored shelters of this type were located at hilltops. Pacas prefer areas near water, since they are good swimmers which, when pursued, flee to the water (Pérez 1992). Due to this preference, it is surprising that pacas used three shelters at hilltops. If the choice of shelter site location by pacas is determined by availability of streams as sources of drinking water or preferred sites to forage, this data could be attributed to the large amount of streams that exist in the study area; anywhere there is one watercourse that can be quickly reached by mobile animals, such as mammals and birds. On the other hand, if the choice of shelter is determined by the possibility of using water as an escape route during an attempted predation, the use of this three hilltop shelters is difficult to understand. Also surprising was the utilization of a TULT shelter near a small stream by otters. This stream was less than one meter in width and too shallow to allow an otter to swim in most of its extension. At the study area, most streams are small and otter presence is mainly restricted to the larger ones (pers. obs.), where the animals can swim. Pardini (1996) verified that during the dry season otters increase the numbers of feces deposited at conspicuous sites at the Betari river, SP, and suggested that one explanation for this increase could be that the feces are used as scent marks and the enhancement of competition for food in the dry season causes the increase of deposition of scent marks. At the PECB, otters also increase the frequency of scent mark deposition at the drier season, including the use of some scent marking sites on very small streams on which they are not able to swim (pers. obs.). This may be due to lower food availability at the drier season, which may force the animals to expand the area where they search for food. The enhanced use of small streams on the drier season can explain one of the occasions in which otter tracks were found in this small stream shelter, in June 1998, but otter tracks were also found in it once in the wetter season (February 1998).

Other intriguing result was the absence of use of shelters on river plains by three of the species with most identified shelters: *T. iheringi*, *P. frenata* and *M. nudicaudatus*. This result is still more interesting because *T. iheringi* was frequently photographed by camera traps on river margins and *P. frenata* also uses river plains (pers. obs.). Again, it is impossible to attribute this result to an avoidance of shelters in river plains by these species or to insufficient data.

If shelter site availability was a limiting resource to mammals and birds at the PECB, it would be expected that more shelters would be used at the hilltops and river plains with undifferentiated alluvial deposits, where there is a high density of shelters. Instead, it appears that other factors determinate shelter choice.

The lack of correspondence between the body size of the animals and the size of shelters' entrances agrees with the hypothesis that other factors are more important in shelter site choice than shelter site characteristics and location. However, shelter site entrances would have to be measured to a greater depth to confirm this hypothesis. The use of shelters with the minimum entrance size possible would have the advantages of increased heat retention and exclusion of a larger variety of predatory mammals (Robb et al. 1996), and it is still possible that the animals using shelters with large entrance dimensions would work their way inside the shelter into smaller and deeper cavities than those apparent from my visual search (Shirer & Fitch 1970). Similar shelter sites may also have different internal characteristics not covered in this work, such as temperature stability and humidity (Berner & Gysel 1967).

Acknowledgements

To an anonymous FAPESP referee and to the very careful reading and suggestions of the referees for this paper; to Dr. César Ades, Dr. Maurício Barbanti, and the supports of CNPq, FAPESP (grant # 96/1217-6), Fundação O Boticário de Proteção à Natureza (grant # 0290971) and WWF (grant # CRS-080-97). IF-SP authorization to work at PECB was process SMA 41.926/96. Albert Ditchfield and Juliana Pagnozzi helped identifying small mammal pictures.

References

AQUINO, R. & PUERTAS, P. 1997. Observations of Speothos venaticus (Canidae: Carnivora) in its natural habitat in Peruvian Amazonia. Z. Saug. 62:117-118.

BECKER, M. & DALPONTE, J.C. 1991. Rastros de mamíferos silvestres brasileiros: um guia de campo. Editora Universidade de Brasília, Brasília.

BECK-KING, H. & HELVERSEN, O. 1999. Home range, population density, and food resources of *Agouti paca* (Rodentia: Agoutidae) in Costa Rica: A study using alternative methods. Biotr. 31:675-685.

BEISIEGEL, B.M. 1999. Contribuição ao estudo da história natural do cachorro do mato, *Cerdocyon thous*, e do cachorro vinagre, *Speothos venaticus*. Tese de doutorado, Universidade de São Paulo, São Paulo.

BEISIEGEL, B. 2001. Notes on the coati, *Nasua nasua* (Carnivora: Procyonidae) in an Atlantic Forest Area. Br. J. Biol. 61:689-692.

BEISIEGEL, B.M. & ADES, C. 2002. The behavior of the bush dog (*Speothos venaticus* Lund, 1842) in the field: a review. Rev. Etol. 4:17-23.

BEISIEGEL, B.M. & ADES, C. 2004. The bush dog *Speothos venaticus* (Lund, 1842) at Parque Estadual Carlos Botelho, Southeastern Brazil. Mammalia 68:65-68.

BEISIEGEL, B.M. & MANTOVANI, W. (2006). Habitat use, home range and foraging preferences of *Nasua nasua* in a pluvial tropical Atlantic forest area. J. Zool.. 269:77-87.

BERNER, A. & GYSEL, L.W. 1967. Racoon use of large tree cavities and ground burrows. J. Wildl. Mngmt. 31:706-714.

BRIANI, D.C., VIEIRA, E.M. & VIEIRA, M.V. 2001. Nests and nesting sites of Brazilian forest rodents (*Nectomys squamipes* and *Oryzomys intermedius*) as revealed by a spool-and-line device. Acta Theriol. 46:331-334.

CARTER, T. S. & ENCARNAÇÃO, C.D. (1983). Characteristics and use of burrows by four species of armadillos in Brazil. J. Mammal. 64:103-108.

DOMINGUES, E.N. & SILVA, D.A. 1988. Geomorfologia do Parque Estadual de Carlos Botelho. Bol. Téc. Inst. Flor. 42:71-105.

DONCASTER, C.P. & WOODROFFE, R.B. 1993. Den site can determine shape and size of badger territories: implications for group living. Oikos 66:88-93.

EGOSCUE, H.J. 1962. Ecology and life history of the kit fox in Toole County, Utah. Ecol. 43:481-497.

EMMONS, L.H. & FEER, F. 1990. Neotropical rainforest mammals: a field guide. The University of Chicago Press, Chicago.

ENDRES, K.M. & SMITH, W.P. 1993. Influence of age, sex, season and availability on den selection by racoons within the central basin of Tenessee. Am. Midl. Nat. 129:116-131.

FIGUEIREDO, L.F. A. & CUSTÓDIO-FILHO, A. 2003. Aves observadas em Unidades de Conservação do Estado de São Paulo por Antonio Flávio Barbosa. Bol. Centro Est. Ornit. 15:30-43.

HERNANDEZ, O.E., BARRETO, G.R. & OJASTI, J. 1995. Observations of behavioral patterns of white-lipped peccaries in the wild. Mammalia 59:146-148.

JANINNI, A.E. 2000. Dieta e densidade populacional de *Agouti paca* (Rodentia, Agoutidae) em floresta semidecídua do leste do Brasil. Tese de Doutorado, Universidade de São Paulo, São Paulo.

JOHNSINGH, A.J.T. 1982. Reproductive and social behaviour of the dhole, *Cuon alpinus* (Canidae). J. Zool. (Lond.) 198:443-463.

KILGORE, D.L., JR. 1969. An ecological study of the swift fox (*Vulpes velox*) in the Oklahoma Panhandle. Am. Midl. Nat. 81:512-534.

LARIVIÈRE, S. & MESSIER, F. 1998. Denning ecology of the striped skunk in the Canadian prairies: implications for waterfowl nest predation. J. Appl. Ecol. 35:207-213.

LINARES, O. J. 1967. El perro de monte, *Speothos venaticus* (Lund), en el norte de Venezuela (Canidae). Mem. Soc. Cienc. Natur. “La Salle”, Caracas 27:83-86.

LUCHERINI, M., LOVARI, S. & CREMA, G. 1995. Habitat use and ranging behavior of the red fox (*Vulpes vulpes*) in a Mediterranean rural area: is shelter availability a key factor? J. Zool. (Lond.) 237:577-591.

MCCOMB, W. & NOBLE, R.E. 1981. Microclimates of nest boxes and natural cavities in bottonland hardwoods. J. Wildl. Mngmt. 45: 284-289.

MILES, M.A., DE SOUZA, A.A. & POVOA, M.M. 1981. Mammal tracking and nest location in Brazilian forest with an improved spool-and-line device. J. Zool. (Lond.) 195:331-347.

MONTEIRO-FILHO, E.L.A. & MARCONDES-MACHADO, L.O. 1996. The utilization of nest boxes by small mammals. Ciênc. Cult. 48:272-274.

MORAES JR., E.A. 2004. Radio tracking of one *Metachirus nudicaudatus* (Desmarest, 1871) individual in Atlantic forest of Southeastern Brazil. Bol. Mus. Biol. Mello Leitão (N. Sér.) 17:57-64.

MORIARTY, J.J. & MCCOMB, W.C. 1982. A fiber optics system for tree cavity inspection. Wildl. Soc. Bull. 10:173-174.

NEGREIROS, O.C., CUSTODIO FILHO, A., DIAS, A.C., FRANCO, G.A.D.C., COUTO, H.T.Z., VIEIRA, M.G.L. & MOURA NETTO, B.V. 1995. Análise estrutural de um trecho de floresta pluvial tropical, Parque Estadual de Carlos Botelho, Núcleo Sete Barras (SP - Brasil). Rev. Inst. Flor. São Paulo 7:1-33.

PARDINI, R. & TRAJANO, E. 1999. Use of shelters by the neotropical river otter (*Lontra longicaudis*) in an Atlantic Forest stream, southeastern Brazil. J. Mammal. 80:600-610.

PARDINI, R. 1996. Estudo sobre a ecologia da lontra *Lontra longicaudis* no Vale do Alto Rio Ribeira, Iporanga, SP (Carnivora: Mustelidae). Dissertação de Mestrado, Universidade de São Paulo, São Paulo.

PÉREZ, E. 1992. *Agouti paca*. Mammal. Sp. 404:1-7.

PFEIFER, R.M., CARVALHO, W.A., SILVA, D.A., ROSSI, M. & MENDICINO, L.F. 1986. Levantamento semi-detalhado dos solos do Parque Estadual de Carlos Botelho. Bol. Téc. Inst. Flor. 40:75-109.

POST, D. M., REICHMAN, O. J. & WOOSTER, D. E. 1993. Characteristics and significance of the caches of eastern woodrats (*Neotoma floridana*). J. Mammal. 74:688-692.

PRESTRUD, P. 1992. Denning and home-range characteristics of breeding arctic foxes in Svalbard. *Can.* J. Zool. 70:1276-1283.

RICHARD-HANSEN, C., VIE, J.C., VIDAL, N. & KERAVEC, J. 1999. Body measurements of 40 species of mammals from French Guiana. J. Zool. (Lond.) 247:419-428.

ROBB, J.R., CRAMER, M.S., PARKER, A.R. & URBANEK, R.P. 1996. Use of tree cavities by fox squirrels and racoons in Indiana. J. Mammal. 77:1017-1027.

ROBINSON, J.G. & REDFORD, K.H. 1986. Body size, diet, and population density of neotropical forest mammals. Am. Nat. 128:665-680.

RUGGIERO, L.F., PEARSON, D.E. & HENRY, S.E. 1998. Characteristics of american marten den sites in Wyoming. J. Wildl. Mngmt. 62:663-673.

SHIRER, H.W. & FITCH, H.S. 1970. Comparison from radiotracking of movements and denning habits of the raccoon, striped skunk, and opossum in notheastern Kansas. J. Mammal. 51:491-503.

SICK, H. 1986. Ornitologia Brasileira: uma introdução. Editora Universidade de Brasília, Brasília.

WAISEL, Y., ESHEL, A. & KAFKAFI, U. 1996. Plant roots: the hidden half. 2nd Edition. Marcel Decker, Inc., New York.

Title: Shelter availability and use by mammals and birds in an Atlantic forest area

Author: Beatriz de Mello Beisiegel

Biota Neotropica, Vol. 6 (number 1): 2006
http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn00206012006

Date Received 05/16/2005 - Revised 10/12/2005
Accepted 01/01/2006

ISSN 1676-0611

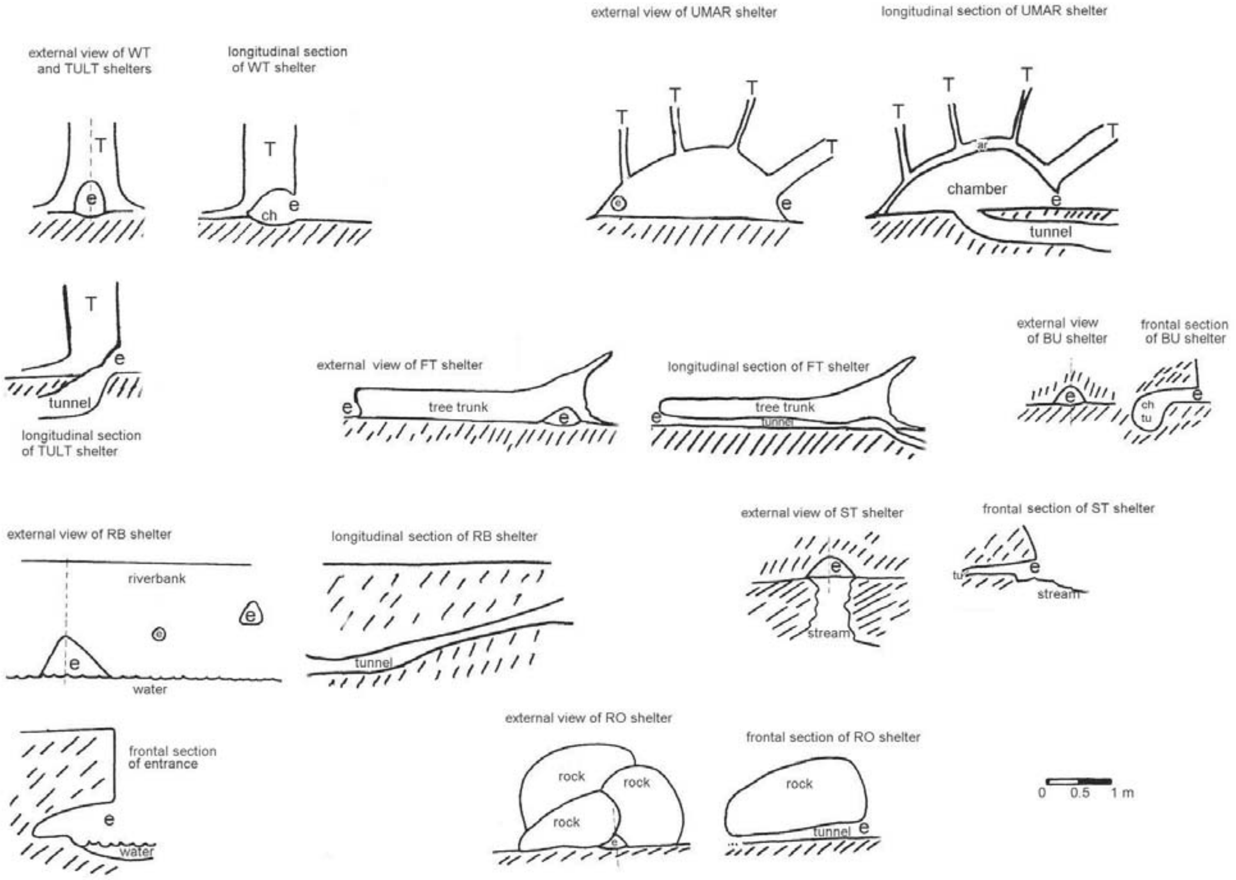


Figure 1. *Schematic representations of the external view and longitudinal (defined as a section which is parallel to plane defined by the greatest length of the structure) or frontal (defined as a section perpendicular to the longitudinal one) sections of the different types of shelters found in the Parque Estadual Carlos Botelho, an Atlantic Forest area in Southeastern Brazil. The vertical broken lines indicate the position of sections. Abbreviations are: T = tree, e = entrance, ch = chamber, tu = tunnel, ar = adventitious roots, ch/tu = chamber or tunnel; WT = shelter without tunnels under living tree; TULT = shelter with tunnels under living tree; UMAR = shelter under mound formed by adventitious roots; FT = shelters under fallen trees; BU = burrows not supported by trees or roots; RB = riverbank shelters; ST = stream tunnels and RO = rock shelters.*

Figure 2. *Pictures of different types of shelters found in the Parque Estadual Carlos Botelho (PECB), an Atlantic Forest area in South-eastern Brazil. (a) A very large entrance of a* ***Shelter under mound formed by adventitious roots*** *(UMAR) (emphasized in black), with a camera trap on the right, with a sensor located at a height of 12 cm; (b)* Baryphtengus ruficapillus *in the entrance of a* ***Burrow*** *(BU) shelter; (c) Entrance of a* ***River bank*** *(RB) shelter, used by an otter, from which a small stream exits; (d) Entrance of a* ***River bank*** *(RB) shelter with a dry platform inside it, and a rodent swimming on the right; (e)* ***Stream tunnel*** *(ST) shelter.*

Figure 3. Philander frenata *(a) and* Agouti paca *(b) using the same* ***Shelter with tunnel under a living tree*** *(TULT).*

Figure 4. Metachirus nudicaudatus *exiting a* ***Shelter under mound formed by adventitious roots*** *(UMAR). The entrance of the shelter, larger than the animal's body size, is emphasized by a red line.*

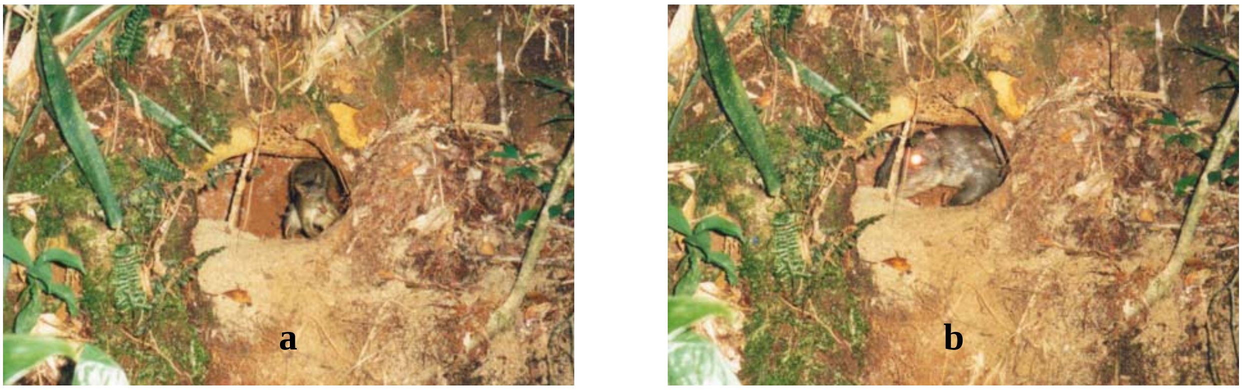


Figure 5. Sciurus ingrami *exiting a* ***Shelter with tunnel under a living tree*** *(TULT), used by a paca, with a big seed in its mouth, probably left in the shelter by the paca.*

Biometria de frutos e sementes, germinação e crescimento do angico (*Anadenanthera colubrina* (Vell.) Brenan var. *cebil* (Griseb.) Altschul) em diferentes condições de substrato e luminosidade

Ana Carolina da Cunha Rodrigue

Resumo

A maior parte da região Nordeste do Brasil é composta por dois importantes Biomas, a Caatinga e a Mata Atlântica, com características peculiares de clima e fisionomia, possuindo espécies vegetais de grande importância, muitas Fabaceae, que podem levar o Nordestino a superar melhor as dificuldades impostas tanto pela natureza quanto pelos impactos ambientais causados pelo próprio homem. Uma dessas espécies, pouco freqüente mas amplamente difundida pelo Brasil e países vizinhos, é conhecida por angico (*Anadenanthera colubrina* (Vell.) Brenan var. *cebil* (Griseb.) Altschul) – Fabaceae, Mimosoideae – que possui elevado potencial econômico sendo bastante utilizado como ornamental, medicinal, para o fornecimento de tanino, resina, madeira e mel, e devido a esse uso intenso aliado aos problemas de degradação ambiental, é considerado sob risco de extinção. Baseado nessas relevâncias apresentadas e tendo em vista os problemas de uso inadequado do solo, antropização, pobreza, entre outros ocorrentes no Nordeste, o presente trabalho objetivou desenvolver estudos comparativos, morfométricos, germinativos e de crescimento, de indivíduos procedentes de duas áreas climáticas distintas, para analisar se há diferenças morfológicas entre as populações e a variabilidade dentro delas também quando submetidas a condições de laboratório e de viveiro, com diferentes tipos de solos e luminosidades. Primeiramente frutos e sementes foram medidos e pesados e o teor de água feito em estufa a 60ºC durante 72 horas ou até que o peso fosse estabilizado. Para avaliar comparativamente a germinação, foram observados a porcentagem de germinação (%G), o tempo médio (t) e o índice de velocidade de germinação (IVG) em germinador a 30ºC ± 1 com 12 horas de luz e em viveiros com diferentes tipos de solos e luminosidades. Para avaliar o crescimento, mudas dessas duas populações foram colocadas em um arranjo Fatorial 2X5X3 estruturados em um Delineamento Inteiramente Casualizado e tiveram mensurados a altura da planta (cm), o número de folhas, diâmetro do caule (mm) e matéria seca (g). As médias dos frutos de Cruz das Almas e Tanquinho variaram, respectivamente, entre 21,64 e 17,73cm para comprimento, 1,86 e 1,70cm para largura, e 7,33 e 4,78g para massa. Para as sementes, as médias variaram entre 14,25 e 12,72mm, 13,75 e 10,20mm e 0,18 e 0,11g, respectivamente para comprimento, largura e massa procedentes de Cruz das Almas e Tanquinho. Os graus de umidade se encontraram entre 6,92 e 8,14%. Para germinação, a luminosidade mais adequada é a de 30% de luz na areia. A população de Tanquinho se mostrou mais vigorosa podendo ser explicada como estrategicamente adaptada para rapidez de estabelecimento, aproveitando as condições favoráveis ao subseqüente desenvolvimento. Com relação ao crescimento, os diferentes tipos de solos e luminosidades utilizados interferiram significativamente, causando variações consideráveis nos caracteres mensurados e as diferentes procedências também se comportaram de maneira distinta. O solo 2 sob 30% de luz favoreceu maior crescimento em altura e maior número de folhas. O solo 2 a pleno sol favoreceu maior diâmetro do caule e os tratamentos mantidos nessa luminosidade apresentaram menor peso de matéria seca. Esses comportamentos diferenciados das mudas e as variações morfofisiológicas dos indivíduos das duas populações sugerem diferenças adaptativas de uma mesma espécie a diferentes condições climáticas dos hábitats em que ocorrem, contribuindo para o sucesso ecológico e evolutivo dessa espécie.

Palavras-chave: ecofisiologia, desenvolvimento, produção, adaptação

FICHA CATALOGRÁFICA

Rodrigues, Ana Carolina da Cunha
R611b - Biometria de frutos e sementes, germinação e crescimento do angico (*Anadenanthera colubrina* (Vell.) Brenan var. *cebil* (Griseb.) Altschul) em diferentes condições de substrato e luminosidade / Ana Carolina da Cunha Rodrigues. – Feira de Santana, 2005.
92 f.

Orientador : Juan Tomás Ayala Osuna

Dissertação (Mestrado em Botânica)–
Departamento de Ciências Biológicas, Universidade Estadual de Feira de Santana, BA. , 2005

1. Fisiologia vegetal. 2. *Anadenanthera colubrina* (Vell.)Brenan var. *Cebil* (Griseb.) Altschul. I. Ayala Osuna, Juan Tomás. II. Universidade Estadual de Feira de Santana. III. Título.

CDU: 581.1

Morcegos (mammalia, chiroptera) em fragmentos florestais urbanos no município de Juiz de Fora, Minas Gerais, Sudeste do Brasil.

Ronald Souza Monteiro de Barros[1]; *Eduardo Lage Bisaggio*[2] *& Roberto Cabral Borges*[3]

Biota Neotropica v6 (n1) – http://www.biotaneotropica.org.br/v6n1/pt/abstract?inventory+bn02206012006

Recebido em 08/09/2005
Versão reformulada em 21/01/2006
Publicado em 23/02/2006

1. Programa de Pós-Graduação em Ecologia, Universidade Federal de Juiz de Fora, Campus Universitário – Martelos – 36036-900, Juiz de Fora, MG, Brasil. http://www.ufjf.edu.br/ecologia. E-mail: rsmbarros@gmail.com
2. IBAMA, ESREG, Av. Limoeiros s/n, 38971-000, Costa Marques, RO, Brasil
3. IBAMA, CGFIS/Div. de Fiscalização de Fauna, Bloco C, SCEN trecho 2, Asa Norte, 70818-900, Brasília, DF, Brasil

Abstract

Barros, R.S.M; Bisaggio, E.L. and Borges, R.C. **Bats (Mammalia, Chiroptera) in urban forest fragments in Juiz de Fora City, Minas Gerais State, southeastern Brazil.** *Biota Neotrop*. Jan/Abr 2006 vol. 6, no. 1, http://www.biotaneotropica.org.br/v6n1/pt/abstract?inventory+bn02206012006. ISSN 1676-0603

We present the results of bats' inventories carried out in three areas of urban forests (78, 9 and 2 ha) located in Juiz de Fora City. Between May 2001 and May 2002, 209 bats were captured and marked, representing seven common species in urban habitats (*Artibeus lituratus, Platyrrhinus lineatus, Anoura caudifer, Sturnira lilium, Carollia perspicillata, Myotis nigricans* and *Molossus molossus*). Only *A. lituratus* occurred in all patches, besides been the most abundant in all of them, indicating its high resistance to fragmentation. Two individuals of this species were recaptured in a different area from the one which they had been marked previously. We suggested that the studied areas have significant value for the maintenance of some bats, performing as "stepping stones", uniting populations, as well as fragments.

Key words: *Conservation, urban parks, forest fragmentation, Atlantic Forest, inventory*

Resumo

Barros, R.S.M; Bisaggio, E.L. and Borges, R.C. **Morcegos (Mammalia, Chiroptera) em fragmentos florestais urbanos no município de Juiz de Fora, Minas Gerais, Brasil**. *Biota Neotrop*. Jan/Abr 2006 vol. 6, no. 1, **http://www.biotaneotropica.org.br/v6n1/pt/abstract?inventory+bn02206012006**. ISSN 1676-0603

Apresentamos os resultados de inventários de morcegos realizados em três áreas de floresta urbana (78, 9 e 2 ha) localizadas no município de Juiz de Fora. Entre maio de 2001 e maio de 2002, 209 morcegos foram capturados e marcados, representando sete espécies comuns em habitats urbanos (*Artibeus lituratus, Platyrrhinus lineatus, Anoura caudifer, Sturnira lilium*, *Carollia perspicillata*, *Myotis nigricans* e *Molossus molossus*). Apenas *A. lituratus* foi amostrada em todas as áreas, além de ter sido a mais abundante em todas elas, indicando sua alta resistência à fragmentação. Dois indivíduos desta espécie foram recapturados em uma área diferente daquela em que haviam sido marcados anteriormente. Sugerimos que as áreas estudadas apresentam valor significativo para a manutenção de alguns quirópteros, funcionando como "trampolins ecológicos", unindo populações, bem como fragmentos.

Palavras-chave: *Conservação, parques urbanos, fragmentação florestal, Mata Atlântica, inventário.*

Introdução

A fragmentação florestal tem provocado diversos efeitos sobre os ecossistemas naturais, como a redução do tamanho de diversas populações e o desaparecimento de espécies que requerem grandes áreas para sobreviver (Bierregaard et al. 1992). De acordo com Estrada & Coates-Estrada (2001), morcegos podem ser menos vulneráveis à fragmentação do que outros mamíferos devido à sua capacidade de dispersão. Assim, embora florestas venham cedendo espaço para o avanço de cidades, diversas espécies de morcegos têm demonstrado capacidade de resistir à pressão antrópica, seja mantendo-se em fragmentos florestais localizados em perímetro urbano ou estabelecendo-se diretamente em ambientes urbanos (veja Reis et al. 1993, 2003, Sazima et al. 1994, Zortéa & Chiarello 1994, Pedro et al. 1995, Bredt & Uieda 1996, Silva et al. 1996, Félix et al. 2001, Esbérard 2003, Passos & Passamani 2003). Algumas espécies são ecologicamente flexíveis e podem utilizar vários tipos de abrigo, além de variados recursos e estratégias alimentares (Taddei 1983, Bredt et al. 1996) em diferentes tipos de habitat, incluindo parques urbanos (Zortéa & Chiarello 1994, Passos & Passamani 2003).

Morcegos são extremamente importantes nos ecossistemas florestais, atuando na polinização, na dispersão de sementes, no controle das populações de insetos (Sazima et al. 1982, Taddei 1983, Uieda & Vasconcellos-Neto 1985, Altringham 1998, Bredt et al. 1996, Garcia et al. 2000) e, conseqüentemente, na formação e manutenção destes ecossistemas (Whittaker & Jones 1994, Sipinski & Reis 1995). Além disso, alguns grupos, especificamente filostomídeos, têm sido descritos como potenciais indicadores de áreas perturbadas (Fenton et al. 1992, Medellín et al. 2000).

Estudos sobre a fauna do município de Juiz de Fora, MG, são escassos e nenhum levantamento sobre a quiropterofauna de seus remanescentes vegetais foi publicado até o momento. Considerando a importância dos morcegos na manutenção dos ecossistemas florestais, e que estes últimos vêm sendo ameaçados pela expansão urbana no referido município, estudos que venham a contribuir para o conhecimento das espécies de morcegos que ocorrem na região são de extrema importância para objetivos de conservação. Assim, nós apresentamos os resultados de inventários de morcegos em três áreas florestais localizadas na zona urbana de Juiz de Fora.

Material e Métodos

1. Áreas de estudo

O município de Juiz de Fora está situado nos limites da Floresta Estacional Semidecidual Montana (Sato 1995), na Zona da Mata de Minas Gerais. Apresenta clima tropical de altitude do tipo Cwa (mesotérmico com verão quente e chuvoso) segundo a classificação de Köppen, com temperatura média mensal em torno de 19°C e precipitação pluviométrica anual de aproximadamente 1.500 mm, sendo a estação chuvosa de outubro a abril e a estação seca de maio a setembro (Centro de Pesquisas Sociais 2001). Três áreas incluídas na matriz urbana do município foram estudadas:

Morro do Imperador (MI): 21°45’27"S, 43°22’00"W. É uma área constituída por um mosaico de fragmentos totalizando 78 ha de floresta predominantemente secundária, em decorrência do intenso desmatamento que vem ocorrendo nos últimos anos para a construção de condomínios residenciais, além de freqüentes queimadas em seus limites, embora seja um importante ponto turístico da cidade. Um inventário florístico realizado entre 2001 e 2002 identificou 172 espécies reunidas em 82 famílias (D.S. Pifano, dados não publicados). Entre estas, *Aureliana fasciculata*, *Bauhinia* spp., *Cecropia glaziovii*, *Cecropia hololeuca*, *Coffea arabica*, *Cupania oblogifolia*, *Eriotheca candolleana Eugenia dodoneaefolia*, *Eugenia cerasiflora*, *Eugenia* cf. *leptoclada*, *Ficus mexiae*, *Ficus citrifolia*, *Inga* spp., *Jacaranda micrantha*, *Myrcia* spp., *Ocotea* spp., *Pera* sp., *Piper* spp., *Piptadenia* spp., *Psidium cf. cupreum*, *Rubus rosaefolius*, *Rubus urticaefolius*, *Solanum* spp., *Syagrus romanzoffiana*, *Vismia magnoliifolia* e *Xilopia sericea*. O dossel mais alto da mata mede 25 m, embora algumas áreas já tenham se tornado capoeiras, enquanto outras se mantêm ao nível do sub-bosque.

Parque do Museu Mariano Procópio (MP): 21°44’48"S, 43°21’39"W. Parque urbano formado por volta de 1861, ocupando uma área de 9 ha localizada a menos de 800 m de MI. Entre MP e MI, a matriz constitui-se de área residencial relativamente arborizada. O parque serve como área pública de lazer, possuindo diversas trilhas, um pequeno lago artificial e uma vegetação mista de plantas exóticas e nativas como conseqüência do plantio estabelecido na época da sua implantação. Em geral, o dossel mede entre 15 e 20 m de altura. Dentre as espécies vegetais, podem ser encontradas: *Arecastrum romanzofianum*, *Artocarpus integriflora*, *Cecropia* spp., *Coffea arabica*, *Cupania oblongiflora*, *Eryobothrya japonica*, *Eugenia brasiliensis*, *Eugenia tunciflora*, *Euterpe edulis*, *Ficus elastica*, *Ficus guaranitica*, *Hymanea courbaril*, *Mangifera indica*, *Morus nigra*, *Myrcia multiflora*, *Myrcia tomentosa*, *Myrciaria jaboticaba*, *Nectandra leucantha*, *Ocotea* sp., *Persea americana*, *Piper tectonizeifolium*, *Piptadenia communis*, *Psidium guayava*, *Rollinia silvatica*, *Sapindus saponaria*, *Solanum* spp., *Syzygium jambos*, *Terminalia cattapa*, *Xylopia aromatica* e *Xylopia sericea* (M.G.S. Duarte, dados não publicados).

Mata do Hospital Santa Casa (SC): 21°46’15"S, 43°20’46"W. Pequeno fragmento florestal particular localizado na região central do município, atrás do referido hospital, com uma área de apenas 2 ha de vegetação secundária, em parte dominada por bambus. Em geral, o dossel mede em torno de 15 m. Embora esta área esteja relativamente próxima de MI (*ca* 1000 m), a matriz encontrada em suas adjacências é formada basicamente de grandes edifícios residenciais e comerciais, o que pode contribuir para seu isolamento.

2. Captura e identificação

Dez noites de captura foram realizadas em cada área entre maio de 2001 e maio de 2002. O intervalo entre as capturas em uma mesma área foi de no mínimo 20 dias, evitando-se noites de lua cheia e chuva forte. Dois pontos de amostragem foram selecionados em cada área e utilizados conjuntamente durante todas as noites de captura. Em cada ponto duas redes de neblina (2,5 x 7 m) armadas a 1m do solo eram mantidas no período entre 1800 e 0100 h. O esforço de amostragem foi calculado conforme sugerido por Straube & Bianconi (2002), multiplicando-se área e tempo totais de exposição de redes, totalizando 14700 m^2.h (4900 m^2.h em cada área).

As espécies foram identificadas no local seguindo Vizotto & Taddei (1973). Indivíduos capturados foram mantidos em sacos de pano por até uma hora, sendo posteriormente marcados com uma coleira de sonda gástrica adaptada (número 04; utilizada em procedimentos hospitalares). Este material de marcação foi utilizado por ser de baixo custo, facilmente encontrado no mercado, de rápido manuseio e já ter sido utilizado antes por um dos autores em outro estudo não publicado. Por serem transparentes transparentes, as sondas podem receber um código identificador no seu interior. Para isso, foram utilizados fios de diferentes cores, possibilitando identificar o local e o período da primeira captura. Após a marcação, os espécimes foram soltos no mesmo local. Não consideramos as recapturas em uma mesma área. No entanto, indivíduos recapturados em um segundo fragmento, ou seja, que originalmente haviam sido marcados em outro fragmento, foram considerados.

Resultados e Discussão

Duzentos e nove morcegos foram capturados, distribuídos em sete espécies e três guildas tróficas. O maior número de capturas ocorreu no parque urbano (MP), seguido de MI (Tabela 1). No parque urbano foram observadas quatro espécies da família Phyllostomidae, além de uma espécie de Vespertilionidae e uma de Molossidae, enquanto os fragmentos apresentaram três espécies de filostomídeos cada.

As espécies de quirópteros observadas neste estudo foram encontradas em perímetro urbano por diversos autores (Reis et al. 1993, Pedro et al. 1995, Bredt & Uieda 1996, Silva et al. 1996, Félix et al. 2001, Bredt et al. 2002, Esbérard 2003, Passos & Passamani 2003). Bredt & Uieda (1996) mencionam que os frugívoros *A. lituratus* e *P. lineatus*, e o nectarívoro *A. caudifer* encontram abundância de alimento e abrigo nas cidades. Já os insetívoros, são extremamente abundantes em ambientes urbanos devido às novas condições de abrigo, espaços para vôo e abundância de insetos atraídos pelas luzes (Bredt & Uieda 1996, Silva et al. 1996), e as baixas capturas deste grupo estão relacionadas com o método utilizado. De acordo com Bergallo et al. (2003), morcegos insetívoros são capazes de detectar as redes.

Embora a obtenção de um inventário representativo exija um maior esforço do número de capturas, utilização de diferentes métodos e variação dos pontos de amostragem (Bergallo et al. 2003), não descartamos a hipótese de que espécies mais sensíveis já tenham desaparecido nas áreas estudadas. Ademais, estudos devem ser empreendidos em outros fragmentos do município, principalmente nos maiores, a fim de verificar a presença de outras espécies na região.

Apenas *Artibeus lituratus* foi comum a todas as áreas amostradas, além de ter sido dominante em todas elas, representando 73% das capturas em MP, 88% em MI e 78% em SC. A espécie tem sido amplamente encontrada em ambiente urbano, sobretudo em face de um comportamento oportunista (Taddei 1983, Bredt et al. 1996, Galetti & Morellato 1994, Sazima et al. 1994, Zortéa & Chiarello 1994). Em um parque urbano de 7,7 ha em Santa Tereza (ES), Passos & Passamani (2003) observaram poucas espécies, sendo que *A. lituratus* representou 89% das capturas. Reis et al. (2003) verificaram que em fragmentos de até 10 ha, localizados no município de Londrina (PR), *A. lituratus* representou 76% das capturas, decrescendo esta taxa em fragmentos maiores da região, o que pode indicar que essa espécie é mais tolerante à fragmentação.

Entre os *A. lituratus* encontrados no parque, dois machos já haviam sido capturados e marcados em outro fragmento durante o estudo. Tais morcegos haviam sido capturados, um em maio e outro em outubro de 2001, em MI e recapturados, respectivamente, em setembro e dezembro daquele ano em MP. Estrada & Coates-Estrada (2001) mencionam que morcegos podem utilizar manchas de habitat como “trampolins ecológicos” e/ou como locais de forrageio. O uso de pequenas manchas de habitat para forrageio também foi sugerido por Schulze et al. (2000). Isto sugere que as áreas estudadas são importantes, não só para a manutenção de alguns quirópteros no município, mas também de outros fragmentos florestais que dependem das interações destes animais, mantendo assim, as populações abertas, permitindo fluxo gênico e exploração de recursos.

Contudo, morcegos vivendo em florestas nativas próximas da área urbana podem ser atraídos para a cidade em busca de alimento, principalmente espécies vegetais cultivadas (Zortéa & Chiarello 1994). Galetti & Morellato (1994) sugerem que estes animais podem introduzir espécies vegetais exóticas de jardins e áreas urbanas em habitats naturais, trazendo problemas para a conservação destes últimos. De fato, diversos frutos exóticos que ocorrem no parque são itens freqüentes na dieta de *A. lituratus* em ambientes urbanos, como *Eriobothrya japonica, Mangifera indica, Myrciaria jaboticaba, Psidium guayava, Syzygium jambos* e *Terminalia cattapa* (Galetti & Morellato 1994, Sazima et al. 1994). Futuros projetos paisagísticos e arquitetônicos nas cidades devem levar em consideração os aspectos biológicos de vegetais exóticos, a fim de preservar de forma eficiente os fragmentos florestais nos seus arredores.

Agradecimentos

Agradecemos à Rita Miranda, Maiana Pimenta, Edilena Rodrigues, Sandra Mara, Antônio de Paula, Adriana Oliveira, Giana e Neilton pelo auxílio durante os trabalhos de campo; Maria das Graças S. Duarte e Museu Mariano Procópio; Daniel S. Pifano, Fátima Salimena e Herbário da Universidade Federal de Juiz de Fora; Colégio de Aplicação João XXIII; Luiz Cláudio Alves e Marco A. Manhães; aos revisores anônimos pelas sugestões.

Referências Bibliográficas

ALTRINGHAM, J.D. 1998. Bats: biology and behavior. Oxford University Press, New York.

BERGALLO, H.G., ESBÉRARD, C.E.L., MELLO, M.A.R., LINS, V., MANGOLIN, R., MELO, G.G.S. & BAPTISTA, M. 2003. Bats species richness in Atlantic Forest: what is the minimum sampling effort? Biotropica 35(2):278-288.

BIERREGAARD, R.O.JR., LOVEJOY, T.E., KAPOS, V., SANTOS, A.A. & HUTCHINGS, R.W. 1992. The biological dynamics of tropical rainforest fragments. BioScience 42:859-866.

BREDT, A., ARAÚJO, F.A.A., CAETANO-JÚNIOR, J., RODRIGUES, M.G.R., YOSHIZAWA, M., SILVA, M.M.S., HARMANI, N.M.S., MASSUNAGA, P.N.T., BÜRER, S.P., PORTO, V.A.R. & UIEDA, W. 1996. Morcegos em áreas urbanas e rurais: manual de manejo e controle. Fundação Nacional de Saúde, Brasília.

BREDT, A. & UIEDA, W. 1996. Bats from urban and rural environments of the Distrito Federal, mid-western Brazil. Chiropt. Neotrop. 2(2):54-57

BREDT, A., UIEDA, W. & PINTO, P.P. 2002. Visitas de morcegos fitófagos a *Muntingia calabura* L. (Muntingiaceae) em Brasília, Centro-Oeste do Brasil. Rev. Bras. Zoocienc. 4(1):111-122.

CENTRO DE PESQUISAS SOCIAIS. 2001. Anuário estatístico de Juiz de Fora 2001: base de dados 2000. Juizforana, Juiz de Fora.

ESBÉRARD, C.E.L. 2003. Diversidade de morcegos em área de Mata Atlântica regenerada no sudeste do Brasil. Rev. Bras. Zoocienc. 5(2):189-204.

ESTRADA, A. & COATES-ESTRADA, R. 2001. Species composition and reproductive phenology of bats in a tropical landscape at Los Tuxtlas, México. J. Trop. Ecol. 17:672-646.

FÉLIX, J.S., REIS, N.R., LIMA, I.P., COSTA, E.F. & PERACCHI, A.L. 2001. Is the area of the Arthur Thomas park, with 82.72 ha, sufficient to maintain viable chiropteran populations? Chiropt. Neotrop. 7(1-2):129-133.

FENTON, M.B., ACHARYA, L., AUDET, D., HICKEY, M.B.C., MERRIMAN, C., OBRIST, M.K., SYME, D.M. & ADKINS, B. 1992. Phyllostomid bats (Chiroptera: Phyllostomidae) as indicators of habitat disruption in the Neotropics. Biotropica 24:440-446.

GALETTI, M. & MORELLATO, L.P.C. 1994. Diet of the large fruit-eating bat *Artibeus lituratus* in a forest fragment in Brasil. Mammalia 58(4):661-665.

GARCIA, Q.S., REZENDE, J.L.P. & AGUIAR, L.M.S. 2000. Seed dispersal by bats in a disturbed area of Southeastern Brazil. Rev. Biol. Trop. 48(1):125-128.

MEDELLÍN, R.A., EQUIHUA, M. & AMIN, M.A. 2000. Bat diversity and abundance as indicators of disturbance in netropical rainforests. Conserv. Biol. 14(6):1666-1675.

PASSOS, J.G. & PASSAMANI, M. 2003. *Artibeus lituratus* (Chiroptera, Phyllostomidae): biologia e dispersão de sementes no Parque do Museu de Biologia Prof. Mello Leitão, Santa Teresa (ES). Natureza on line 1(1):1-6.

PEDRO, W.A., GERALDES, M.P., LOPEZ, G.G. & ALHO, C.J.R. 1995. Fragmentação de habitat e a estrutura de uma taxocenose de morcegos em São Paulo (Brasil). Chiropt. Neotrop. 1(1):4-6.

REIS, N.R., BARBIERI, M.L.S, LIMA, I.P. & PERACCHI, A.L. 2003. O que é melhor para manter a riqueza de espécies de morcegos (Mammalia, Chiroptera): um fragmento florestal grande ou vários fragmentos de pequeno tamanho? Rev. Bras. Zool. 20(2):225-230.

REIS, N.R., PERACCHI, A.L. & ONUKI, M.K. 1993. Quirópteros de Londrina, Paraná, Brasil (Mammalia, Chiroptera) Rev. Bras. Zool. 10(3):371-381.

SATO, J. 1995. Mata Atlântica: direito ambiental e a legislação. Hemus, Rio de Janeiro.

SCHULZE, M.D., SEAVY, N.E. & WHITACRE, D.F. 2000. A comparison of the phyllostomid Bat assemblages in undisturbed neotropical forest and in forest fragments of a slash-and-burn farming mosaic in Petén, Guatemala. Biotropica 32(1):174-184.

SAZIMA, I., FISCHER, W.A., SAZIMA, M. & FISCHER, E.A. 1994. The fruit bat *Artibeus lituratus* as a forest and city dweller. Cienc. Cult. 46(3):164-168.

SAZIMA, M., FABIÁN, M.E. & SAZIMA, I. 1982. Polinização de *Luehea speciosa* (Tiliaceae) por *Glossophaga soricina* (Chiroptera, Phyllostomidae). Rev. Bras. Biol. 42(3):505-513.

SILVA, M.M.S., HARMANI, N.M.S., GONÇALVES, E.F.B. & UIEDA, W. 1996. Bats from the metropolitan region of São Paulo, southeastern Brazil. Chiropt. Neotrop. 2(1):39-41.

SIPINSKI, E.A. & REIS, N.R. 1995. Dados ecológicos dos quirópteros da Reserva Volta Velha, Itapoá, Santa Catarina, Brasil. Rev. Bras. Zool. 12(3):519-528.

STRAUBE, F.C. & BIANCONI, G.V. 2002. Sobre a grandeza e a unidade utilizada para estimar esforço de captura com utilização de redes-de-neblina. Chiropt. Neotrop. 8 (1-2): 150-152.

TADDEI, V.A. 1983. Morcegos: algumas considerações sistemáticas e biológicas. Bol. Téc. CATI 72:1-31.

UIEDA, W. & VASCONCELLOS-NETO, J. 1985. Dispersão de *Solanum* spp. (Solanaceae) por morcegos na região de Manaus, AM, Brasil. Rev. Bras. Zool. 2(7):449-458.

VIZOTTO, L.D. & TADDEI, V.A. 1973. Chave para determinação de quirópteros brasileiros. Edusp, São José do Rio Preto.

WHITTAKER, R.J. & JONES, S.H. 1994. The role of frugivorous bats and birds in the rebuilding of a tropical forest ecosystem, Krakatau, Indonesia. J. Biogeogr. 21:245-258.

ZORTÉA, M. & CHIARELLO, A.G. 1994. Observations on the big fruit-eating bat, *Artibeus lituratus*, in a urban reserve of south-east Brazil. Mammalia 58(4):665-670.

Título: Morcegos (Mammalia, Chiroptera) em fragmentos florestais urbanos no município de Juiz de Fora, Minas Gerais, Brasil

Autores: Ronald Souza Monteiro de Barros; Eduardo Lage Bisaggio & Roberto Cabral Borges

Biota Neotropica, Vol. 6 (número 1): 2006
http://www.biotaneotropica.org.br/v3n1/pt/abstract?article+BN00303012003

Recebido em 08/09/2005 - Revisado em 21/01/2006
Publicado em 23/02/2006

ISSN 1676-0603

Tabela 1. Espécies de morcegos e número de indivíduos capturados em três fragmentos florestais no município de Juiz de Fora, Minas Gerais, entre maio de 2001 e maio de 2002. Species of bats and number of individuals captured in three forest fragments in Juiz de Fora City, Minas Gerais State, between May 2001 and May 2002. MP – Parque do Museu Mariano Procópio; MI – Morro do Imperador; SC – Mata da Santa Casa.

Espécies registradas	Guilda trófica	MP	MI	SC	Total
Phyllostomidae					
Artibeus lituratus (Olfers, 1818)	Frugívora	80	51	32	163
Platyrrhinus lineatus (E. Geoffroy, 1810)	Frugívora	10	0	3	13
Sturnira lillium (E. Geoffroy, 1810)	Frugívora	0	0	6	6
Carollia perspicillata (Linnaeus, 1758)	Frugívora	1	1	0	2
Anoura caudifer (E. Geoffroy, 1818)	Nectarívora	5	6	0	11
Vespertilionidae					
Myotis nigricans (Schinz, 1821)	Insetívora	8	0	0	8
Molossidae					
Molossus molossus (Pallas, 1766)	Insetívora	6	0	0	6
Total		110	58	41	209

Courtship, vocalization, and tadpole description of *Epipedobates flavopictus* (Anura: Dendrobatidae) in southern Goiás, Brazil

***Ronan Caldeira Costa*[1], *Kátia Gomes Facure*[1] & *Ariovaldo Antonio Giaretta*[1]**

Biota Neotropica v6 (n1) – http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn00506012006

Date Received 06/13/2005
Revised 10/07/2005
Accepted 01/01/2006

[1]Laboratório de Taxonomia, Ecologia Comportamental e Sistemática de Anuros Neotropicais. Instituto de Biologia.
Universidade Federal de Uberlândia. CEP: 38400-902. Uberlândia - Minas Gerais. Brasil.
e-mail: ronancal@yahoo.com.br

Abstract

Epipedobates flavopictus is a diurnal, aposematic dendrobatid with a wide distribution in seasonal wet tropical regions of Brazil. We describe the daily period of vocalization, advertisement call, courtship behavior, and tadpole of *E. flavopictus* from a previously unknown population in southern Goiás and compare theses features with that of other populations. Studies were carried out in November (2004) and February (2005). We counted the number of calling males and duration of calling bouts in the morning and evening periods. The advertisement call was recorded with a digital recorder. Tadpole description was based on specimens collected in pools. Males called from well-illuminated sites such as rocky fields, rain channels, and borders of riverine forests. In November, males vocalized daily during two distinct periods, between 04:30 h and 10:00 h and between 16:30 h and 20:00 h. Morning temperature varied between 20-23ºC and humidity from 79-89%; during evening varied between 24-27ºC and 54-82%. In the middle of the day, temperature reached 36ºC and humidity 40%. During the morning, call activity was almost uninterrupted, in the evening calling bouts lasted around 9 min. In February, even with the occurrence of rainfall and temperatures similar to that of November no frog vocalized. The advertisement call is composed by a single note with 7–8 pulses with frequency ascending slightly from 3.20 to 4.05 kHz. Note duration was 144 ms, and between note intervals is 292 ms. Notes are given at a rate of 139 per minute. Upon observing the female, the male began to emit courtship call. The female approached the male and touched him laterally with her snout. The male moved forward and raised his hindquarters by stretching his hind legs. While leading the female, the male continued to give courtship and advertisement calls. The male clasped the female in axillary amplexus, and the pair entered a hole in a bank. The female deposited eggs on the surface of the soil, spreading them in groups. The egg clutches had eggs in at least two developmental stages, recently deposited and with embryos. Tadpoles were found in small, shallow rocky pools along a permanent stream, in well-illuminated sites at the forest border. The tadpole had the dorsal fin arched, not extending onto body. *E. flavopictus* appears to be unique among dendrobatids by using open areas subject to high temperatures and low humidity. Reproductive activity of the species ends before the end of the rainy season, possibly to avoid loss of tadpoles during months with unpredictable rainfall. The studied call had more notes and shorter between-call intervals than those described from other populations. The free-living tadpoles we describe differ from those of other populations by having the dorsal fin reduced.

Key words: *populational variation, Brazilian Cerrado, habitat, pattern of activity, behavior, reproduction, advertisement call*

Resumo

Epipedobates flavopictus é um dendrobatídeo diurno, aposemático que tem ampla distribuição em regiões tropicais do Brasil. Descrevemos o período diário de atividade de canto, canto de anúncio, comportamento de corte e girino de *E. flavopictus* de uma população previamente desconhecida do sul de Goiás e comparamos essas características às de outras populações. O estudo foi realizado em novembro de 2004 e fevereiro de 2005. Comparamos o número de machos em atividade de canto e a duração dos períodos de canto da manhã e da tarde. O canto foi gravado com aparelho digital. A descrição dos girinos foi feita com base em espécimes coletados em poças. Os machos vocalizavam em sítios bem iluminados tais como ambientes rupestres e borda de matas ribeirinhas. Em novembro, os machos vocalizavam diariamente em dois períodos diferentes do dia; entre 04:30 h e 10:00 h e entre 16:30 h e 20:00 h. Durante a manhã, a temperatura variou entre 20 e 23ºC e a umidade entre 79 e 89%; durante a tarde variou entre 24 e 27ºC e 54 e 82%. No meio do dia, a temperatura chegou a 36ºC e a umidade a 40%. Durante a manhã, a atividade de canto era quase ininterrupta, e a tarde os períodos de canto duravam cerca de 9 min. Em fevereiro, apesar da ocorrência de chuvas e temperatura/umidade similares as de novembro, não houve atividade de canto. O canto de anúncio é composto por uma única nota com 7-8 pulsos, com freqüência ascendente de 3,20 a 4,05 kHz. A duração da nota é de 144 ms com intervalos de 292 ms. As notas são emitidas a uma taxa de 139 notas por minuto. Uma vez visualizada a fêmea, o macho começa a emitir canto de corte. A fêmea se aproxima do macho e o toca na lateral do corpo com o focinho. O macho se move pra frente e levanta o seu quarto traseiro esticando suas pernas. Enquanto conduzindo a fêmea, o macho continuava a emitir cantos de corte e de anuncio. O macho amplexou a fêmea axilarmente, e o par entrou num buraco no barranco. A fêmea depositou os ovos na superfície do solo, espalhando-os em grupos. Uma desova examinada tinha ovos em dois estágios diferentes de desenvolvimento: recém depositados e com embriões. Os girinos foram encontrados em pequenas poças rasas em rochas ao longo de um riacho permanente, em sítios bem iluminados na borda da floresta. Os girinos tinham a nadadeira dorsal arqueada, a qual não se estendia para o corpo. Aparentemente, *E. flavopictus* é o único entre os dendrobatídeos por usar áreas abertas sujeitas a altas temperaturas e baixas umidades. A atividade reprodutiva da espécie termina antes do fim da estação chuvosa, possivelmente para evitar perda de girinos durante meses com chuvas imprevisíveis. O canto estudado tinha mais notas e intervalos de cantos mais curtos que aqueles descritos de outras populações. O girino de vida livre que descrevemos difere do de outras populações por ter a nadadeira dorsal reduzida.

Palavras-chave: *variação populacional, Cerrado brasileiro, habitat, padrão de atividade, comportamento, reprodução, canto de anúncio.*

Introduction

Epipedobates flavopictus A. Lutz, 1925 is a diurnal, aposematic (black, orange, and red) dendrobatid with a wide distribution in seasonal wet tropical regions in the Brazilian states of Minas Gerais, Goiás, Tocantins, northern Pará and northeastern Maranhão (Haddad & Martins 1994). Some interpopulational variation in adult size and color has been recognized (Haddad & Martins 1994). Haddad et al. (1988) and Haddad & Martins (1994) described the call and the tadpole, and Toledo et al. (2004) described egg clutches and parental care in populations from Minas Gerais. In spite of these previous studies, some aspects of the behavior of *E. flavopictus* remain unknown, and interpopulational differences in morphology and call parameters are only partly documented. In the present study, we describe the daily period of vocalization, the advertisement call, courtship behavior, and tadpole of *E. flavopictus* from a previously unknown population in southern Goiás.

Material and Methods

Study Site and Procedures

This work was conducted during five days in November (2004) and in three days in February (2005) at Parque Estadual da Serra de Caldas Novas (PESCAN) (17°46’8.7" S and 48°39' 39" W; ca. 800 m altitude), southern Goiás, Brazil. The PESCAN encompasses an area of 12500 ha of Cerrado Biome. The climate is AW type, according to Köppen classification, corresponding to rainy/hot humid tropical climate with rains concentrated in summer (Santos 2003). Water bodies include permanent forest streams, seasonal small (<5 liters) pools along rocky streams, and rocky rain channels. Around the administration facilities there is a stone garden with shallow (<20 cm) cement-bottomed pools.

Epipedobates flavopictus (Figure 1) was relatively common at the study site. We preliminarily determined the daily pattern of vocal activity of males of *E. flavopictus* for a 24 h period by visiting reproductive sites. Subsequently, the number of calling males was quantified along three 50 m transects of similar vegetational aspect. Site I was a rocky field (Cerrado Rupestre) (Figure 2-A); sites II and III were two segments of a rain channel (ca. 300 m apart) (Figure 2-B). Each transect was walked in the morning (between 04:00 h and 10:00 h) and evening (between 16:00 h and 20:00 h). During sampling, air temperature and relative humidity were measured each hour with a thermo-hygrometer (Hanna Instruments HI 8564). To compare the number of calling males in the morning and evening periods, we used the Wilcoxon matched pairs test (Zar 1999), performed considering the maximal number of males in each period. While sampling transects (mornings and evenings), we measures the duration of calling bouts with a stopwatch; bouts were arbitrarily considered different from one another if more than one minute elapsed between them. To check for site fidelity, males were recognized by their individual pattern of dorsal yellow spots (see Figure 18, pg. 37 in Eterovich & Sazima 2004). On February 26, 27, and 28, we visited the same transects and surrounding areas to determine the presence of calling males.

Calls of one male were recorded with a Boss 864 digital recorder coupled to a Sennheiser ME67 microphone (44000 Hz; 16 bit resolution). Sound analysis was performed with Sound Ruler software (Gridi-Papp 2003). Tadpoles were collected in pools along permanent streams where males where heard. The tadpoles were described base on specimens preserved in 5% formalin immediately after collection. Nomenclature for tadpole anatomy follows Altig & McDiarmid (1999). A sample of tadpoles was kept in laboratory until metamorphosis to confirm identification; those used for description were between stages 25 and 37 (Gosner 1960). Measurements were taken with a caliper to the nearest 0.1 mm.

Voucher specimens are housed at the frog collection of the Museu de Biodiversidade do Cerrado, at the Universidade Federal de Uberlândia. Adult AAG-UFU 2526; newly metamorphosed AAG-UFU 3157; tadpoles AAG-UFU 3151 (a lot with six tadopes).

Results

Males called from well-illuminated sites such as rocky fields, rain channels, borders of riverine forests, and at the rocky garden. In November, males vocalized daily during two distinct periods, between 04:30 h and 10:00 h and between 16:30 h and 20:00 h. During the morning, temperature varied from 20ºC to 23ºC and humidity from 79% to 89%; in the evening, temperature ranged from 24ºC to 27ºC and from 54% to 82%. In the middle of the day, when no male called (12:00 h to 15:00 h), temperature reached 36ºC and humidity 40%.

In the transects, the number of males calling during the morning (Median = 5) were not different from that calling during the evening (Median = 2) (Wilcoxon Z = -1.6; p = 0.11). During the morning, call activity was almost uninterrupted, with bouts lasting as long as 60 min and the interval between bouts were short (ca. 1 min). In the evening calls bouts lasted about 9 min (Mean = 503 s; SD = 254; N = 5 males); with intervals between bouts ranging from 10 to 20 min. In hot (Mean = 25 ºC; SD = 0.8; N = 3 days) rainy (humidity 92%) days of February no male vocalized or was saw along transects.

The advertisement call of one male was composed by a single note whit 7–8 pulses (Figure 3) that ascended slightly from 3.20 to 4.05 kHz. Note duration was 144 ms (SD = 2.8, N = 5), and between note intervals were 292 ms (SD = 5.61, N = 5). Notes were given at a rate of 139 per minute.

One complete courtship sequence that culminated in egg deposition and two partial events were observed at the rain channel (Site II), all during the morning. In the complete sequence, the female approached a calling male. Upon observing the female, the male began to emit a low, peeping courtship call (not recorded). The female approached the male and touched him laterally with her snout. The male moved forward and raised his hindquarters by stretching his hind legs, thus revealing the orange coloration on his legs. The male continued to move, usually in about 30 cm increments, stopping to raise his cloacae. The female followed him, touching his flanks when he stopped, eventually completely turning around him. The male moved 2 m from the contact point while repeating this behavior; the female was never more than 20 cm apart from him. While leading the female, the male continued to give courtship and advertisement calls. The pair reached a small hole in the bank, where the male called from the entrance. The male clasped the female in axillary amplexus, and the pair entered the hole. After about 10 min, the female began to deposit eggs on the surface of the soil, spreading the eggs in groups within a circle of ca. 10 cm diameter. It took 85 minutes from the beginning of the courtship to beginning of egg deposition.

Examination of the egg deposition site in the following afternoon revealed the presence of 20 eggs in at least two developmental stages, recently deposited and with developing embryos. Including the gelatinous capsules, the eggs with embryos measured between 4.4 and 4.7 mm in diameter (N = 4). In the two other courtships observed the pairs also were near (< 1 m) holes in the ground.

Seven tadpoles were found in two small, shallow (2 liters; 15 mm deep) rocky pools along a fast-moving permanent stream, in well-illuminated sites at the forest border. A male carrying tadpoles was seen near the pool in the stone garden. Syntopic frog species at the garden were *Physalaemus cuvieri*, *Hyla* sp. (gr. *marmorata*), *Scinax fuscovarius*, *Leptodactylus syphax*, and *L. labyrinthicus*.

Tadpole (Figure 4). Body ovoid in lateral and dorsal views. Nostril same distance from tip of snout as to eye; both nostril and eye positioned dorsolaterally. Spiracle sinistral, located equidistant at height and length of body, posterodorsally directed. Anal tube dextral, broad, without a free border. Dorsal fin arched, not extending onto body; tail tip rounded. Oral disc positioned ventrally, emarginated. Labial tooth row formula 2(2)/3(1); A-2 gap well defined and P-1 gap barely discernable; P-3 slightly shorter or same length as P-1 and P-2. Oral disc surrounded by papillae except for a broad anterior gap; papillae rounded. Papillae in a single row, although appearing alternated; some submarginal papillae laterally on disc and on posterior labium. Upper jaw sheath arc-shaped; lower jaw sheath U-shaped. Maximal observed length 29 mm (Gosner stage 41). Body 38% the total length. In life, dorsal surface silver on a gray background; translucent tail with some black mottling; translucent belly, with some silver mottling. Snout-vent length 11.1 mm at metamorphosis (N = 1).

Discussion

Among dendrobatids, choice of egg-laying sites is variable, with some species depositing eggs on the ground (Wells 1978, 1980a, 1980b, Roithmair 1994, Lima et al. 2002). Toledo et al. (2004) depicted a clutch of eggs of *Epipedobates flavopictus* in a mass; however, we found that eggs were spread in small groups. Dendrobatids are known to reproduce in primary or secondary forests (Rodriguez & Duellman 1994), even those from the Cerrado (Haddad et al. 1988, Haddad & Martins 1994). *Epipedobates flavopictus* appears to be unique among dendrobatids by using open areas subject to high temperatures and low humidity. Reproductive activity of *Epipedobates flavopictus* ends before February, prior the end of the rainy season, possibly to avoid loss of tadpoles during months with unpredictable rainfall.

Environmental variables such as humidity, temperature and photoperiod may determine anuran breeding period (Navas 1996, Navas & Bevier 2001, Hatano et al. 2002). As in other diurnal frogs, the daily calling pattern of *E. flavopictus* may be related to moderate temperatures and higher humidity (Wells 1980a, 1980b, Navas 1996, Narvaes 1997, Heying 2001, Hatano et al. 2002); although we did not measure light intensity, it seems that this factor was of secondary importance, since vocal activity occurred during full-night hours. We predict that on rainy mid-summer days the call activity may occur throughout the day. The two-phase calling period of *E. flavopictus* is similar to that described for *E. macedo* (Rodriguez & Myers 1993) and *E. parvulus* (Rodriguez & Duellman 1994). As indicated by the larger time the males spent calling and the number of observed courtship events, *E. flavopictus* is more active during the morning period.

Males of several species of dendrobatids lead females to egg-laying sites (Rodriguez & Duellman 1994, Caldwell & De Oliveira 1999, Lima et al. 2002); we observed this behavior in *E. flavopictus* as well. Among dendrobatids, multiple clutches at the same site have been reported for *E. flavopictus* (Toledo et al. 2004; present study) and for *Colostethus nidicola* (Caldwell & Lima, 2003). This association between the male and the egg laying site may be indicative of the existence of parental care in the egg phase in these species, as already recognized in other species of the family (Weygoldt 1987, Pröhl & Hödl 1999).

Good quality territories usually result in access to more females (Heying 2001) and in greater offspring survival (Pröhl & Hödl 1999). Territoriality, as evidenced by site fidelity in *E. flavopictus*, is expected in those prolonged-breeding frogs, and egg deposition usually occurs in defended areas (Wells 1977).

Geographic variation in call parameters, color pattern, and size of adults and larvae are known for several anurans (Wilczynski et al. 1992, Aresco 1996, Gascon et al. 1998). The call of *E. flavopictus* from our study area had more notes and shorter intercall intervals than those described from populations from Minas Gerais (Haddad & Martins 1994, Haddad et al. 1988). Haddad & Martins (1994) described *E. flavopictus* tadpoles based on specimens collected from a male's back and Martins & Sazima (1989) presented a photo of a late-staged tadpole. The free-living tadpoles we describe here differ from those of Haddad & Martins (1994) by having the dorsal fin reduced (not extending onto the body), a shorter P-1 gap, and, apparently, more numerous oral papillae. The specimen depicted by Martins & Sazima (1989) also showed an extended dorsal fin. A reduced dorsal fin is a feature of several *Epipedobates* species, including *E. braccatus*, *E. pictus*, and *E. hahneli* (Haddad & Martins 1994, Rodriguez & Duellman 1994).

Acknowledgements

J. Caldwell provided helpful comments on the draft. Ricardo I. Campos, Kelly C. Spena and Alexandre G. Franchim helped with the manuscript edition. Grants by CNPq (AAG) and CAPES (KGF).

References

ALTIG, R. & McDIARID, R.W. 1999. Body plan: Development and morphology. 1999. In Tadpole. The biology of anuran larvae (R.W. McDiarmid & R. Altig, eds.). The University of Chicago Press, Chicago, p.24-51.

ARESCO, M.J. 1996. *Geographic variation* in the morphology and lateral stripe of the green treefrog (*Hyla cinerea*) in the Southeastern United States. Am. Mid. Nat. 135:293-298.

CALDWELL, J.P. & DE OLIVEIRA, V.R.L. 1999. Determinants of biparental care in the spotted poison frog, *Dendrobates vanzolinii* (Anura: Dendrobatidae). Copeia 1999:565-575.

CALDWELL, J.P. & LIMA., A.P. 2003. A new Amazonian species of *Colostethus* (Anura: Dendrobatidae) with a nidicolous tadpoles. Herpetologica 59:219-234.

ETEROVICK, P.C. & SAZIMA, I. 2004. Anfíbios da Serra do Cipó - Minas Gerais - Brasil. Amphibians from the Serra do Cipó. PUC Minas, Belo Horizonte.

GASCON, C., LOUGHEED, S.C. & BOGART, J.P. 1998. Patterns of genetic population differentiation in four species of Amazonian frogs: A test of the riverine barrier hypothesis. Biotropica 30(1):104-119.

GOSNER, K.L. 1960. A simplified table for staging anuran embryos and larvae with notes on identification. Herpetologica 16:183-190.

GRIDI-PAPP, M. 2003. Sound Ruler. V0904. http://soundruler.sourceforge.net.

HADDAD, C.F.B., ANDRADE, G.V. & CARDOSO, J.A. 1988. Anfíbios do Parque Nacional da Serra da Canastra, Estado de Minas Gerais. Brasil Florestal 64:9-20.

HADDAD, C.F.B. & MARTINS, M. 1994. Four species of Brazilian poison frogs related to *Epipedobates pictus* (Dendrobatidae): taxonomy and natural history observations. Herpetologica 50:282-295.

HATANO, F.H., ROCHA, C.F.D. & VAN SLUYS, M. 2002. Environmental factors affecting calling activity of a tropical diurnal frog (*Hylodes phyllodes*: Leptodactylidae). J. Herpetol. 36(2):314-318.

HEYING, H.E. 2001. Social and reproductive behaviour in the Madagascan poison frog, *Mantella laevigata*, with comparisons to the dendrobatids. Anim. Behav. 61:567-577.

LIMA, A.P., CALDWELL, J.P. & BIAVATI, G.M. 2002. Territorial and reproductive behavior of an Amazonian dendrobatid frog, *Colostethus caeruleodactylus*. Copeia 2002:44-51.

MARTINS, M. & SAZIMA, I. 1989. Dendrobatídeos: Cores e Venenos. Ciência Hoje 9(53):34-38.

NARVAES, P. 1997. Comportamento territorial e reprodutivo de uma nova espécie de *Hylodes* (Amphibia, Anura, Leptodactylidae) da Mata Atlântica do Sudeste do Brasil. Dissertação de mestrado, Universidade de São Paulo, São Paulo.

NAVAS, C.A. 1996. The effect of temperature on the vocal activity of tropical anurans: A comparison of high and low-elevation species. J. Herpetol. 30(4):488-497.

NAVAS, C.A. & BEVIER, C.R. 2001. Thermal dependency of calling performance in the eurythermic frog *Colostethus subpunctatus*. Herpetologica 57(3):384-395.

PRÖHL, H. & HÖDL, W. 1999. Parental investiment, potential reproductive rates, and mating system in the strawberry dart-poison frog, *Dendrobates pumilio*. Behav. Ecol. Sociob. 46:215-220.

RODRIGUEZ, L.O. & DUELLMAN, W.E. 1994 Guide to the frogs of the Iquitos region, Amazonian Peru. Associoación de Ecología y Conservación, Amazon Center for Environmental Education and Research and Natural History Museum, The University of Kansas. Lawrence, Kansas.

RODRIGUEZ, L. & MYERS, C.W. 1993. A new poison frog Manu National Park, Southeastern Peru (Dendrobatidae, *Epipedobates*). Am. Mus. Nov. 3068:1-15.

ROITHMAIR, M.E. 1994. Field Studies on Reproductive-Behavior in two Dart-Poison Frog Species (*Epipedobates femoralis*, *Epipedobates trivittatus*) in Amazonian Peru. Herpetol. J. 4(3):77-85.

SANTOS, L.M. 2003. Florística e biologia reprodutiva de espécies de Melastomataceae no Parque Estadual da Serra de Caldas Novas e Parque Estadual de Pireneus, Goiás. Tese de Doutorado, Universidade Federal de Brasília, Brasília.

TOLEDO, L.F., GUIMARÃES, L.D.A., LIMA, L.P., BASTOS, R.P. & HADDAD, C.F.B. 2004. Notes on courtship, egg-laying site, and defensive behavior of *Epipedobates flavopictus* (Anura, Dendrobatidae) from two mountain ranges of central and southeastern Brazil. Phyllomedusa 3(2):145-147.

WELLS, K.D. 1977. The social behavior of anuran amphibians. Anim. Behav. 25:666-693.

WELLS, K.D. 1978. Territoriality in the green frog (*Rana clamitans*): vocalizations and agonistic behaviour. Anim. Behav. 26:1051-1063.

WELLS, K.D. 1980a. Behavioral ecology and social organization of a dendrobatid frog (*Colosthetus inguinalis*). Behav. Ecol. Sociobiol. 6:199-209.

WELLS, K.D. 1980b. Social behavior and communication of a dendrobatid frog (*Cololthetus trinitatis*). Herpetologica 36(2):189-199.

WEYGOLDT, P. 1987. Evolution of parental care in dart poison frogs (Amphibia: Anura: Dendrobatidae). Z. Zool. Syst. Evolut.-frosch. 25:51-67.

WILCZYNSKI, W., KEDDYHECTOR, A.C. & RYAN, M.J. 1992. Call Patterns and Basilar Papilla Tuning in Cricket Frogs .1. Differences among Populations and between Sexes. Brain. Behav. Evolut. 39(4):229-237.

ZAR, J. 1999. Biostatistical analysis. Prentice Hall, New Jersey.

Title: Courtship, vocalization, and tadpole description of *Epipedobates flavopictus* (Anura: Dendrobatidae) in southern Goiás, Brazil

Authors: Ronan Caldeira Costa, Kátia Gomes Facure & Ariovaldo Antonio Giaretta

Biota Neotropica, Vol. 6 (number 1): 2006
http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn00506012006

Date Received 06/13/2005 - Revised 10/07/2005
Accepted 01/01/2006

ISSN 1676-0611

Figure 1. Adult male Epipedobates flavopictus. *Municipality of Caldas Novas, Goiás, Brazil.*

Figure 2. Calling sites of E. flavopictus. *A - Rocky field (Cerrado Rupestre); B - Rain channel. Municipality of Caldas Novas, Goiás, Brazil (08/11/2004).*

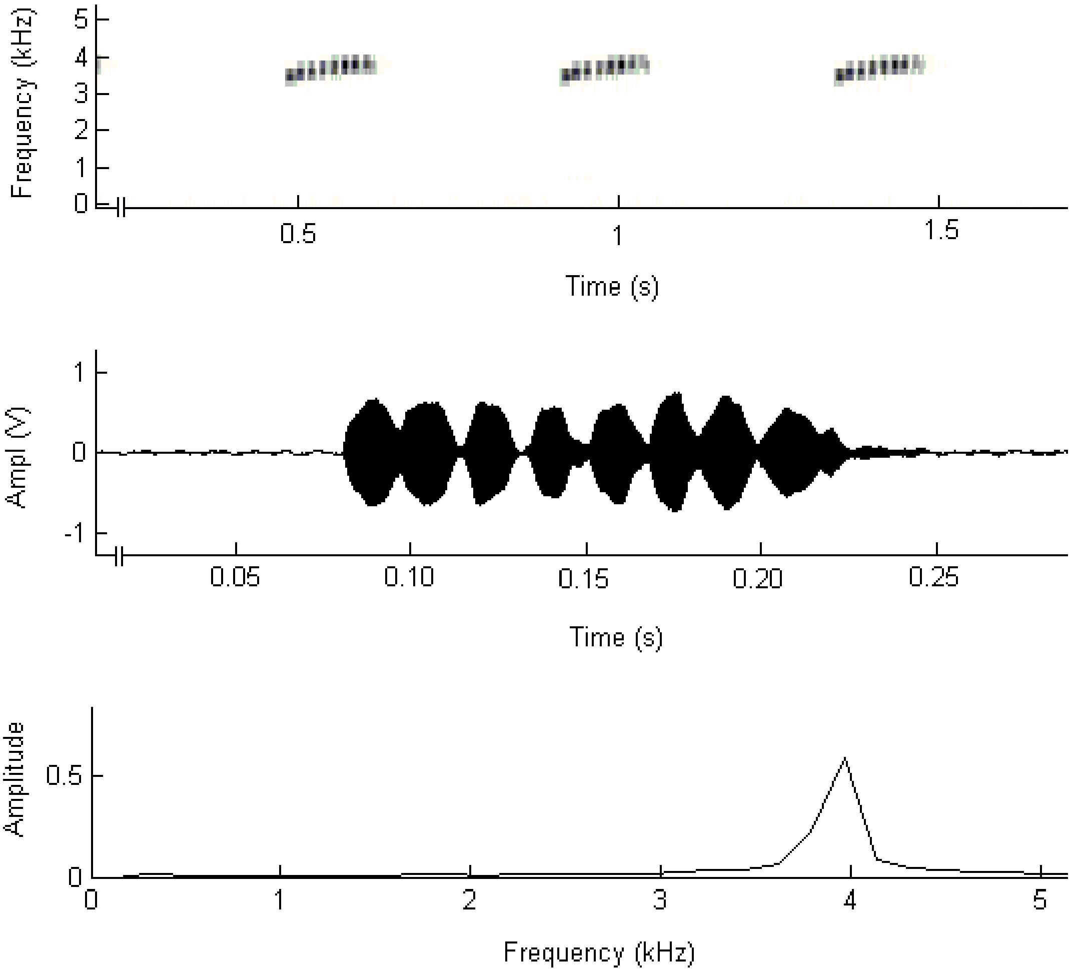


Figure 3. Advertisement call of Epipedobates flavopictus*. Above- Spectrogram, Middle- Oscilogram of a single call. Below- Power Spectrum. Call recorded in November 2004. Air temperature, 23.5ºC, water temperature, 22.7ºC. Sound file EpipedflavopAAGd. Unvouchered record. Municipality of Caldas Novas, Goiás, Brazil.*

Figure 4. Left, dorsal, and ventral views of a tadpole of Epipedobates flavopictus*. The left-sided picture shows that the dorsal fin does not extend onto the body. Gosner stage 27; 21.4 mm TL. Tadpole slightly stained with iodine. Municipality of Caldas, Novas, Goiás, Brazil.*

Review about mites (Acari) of rubber trees (*Hevea spp.*, Euphorbiaceae) in Brazil[1]

Fábio Akashi Hernandes[2] & Reinaldo José Fazzio Feres[3]

Biota Neotropica v6 (n1) – http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn00406012006

Date Received 06/15/2005

Revised 12/05/2005

Accepted 01/01/2006

[1]Part of Program BIOTA/FAPESP – Instituto Virtual da Biodiversidade, http://www.biota.org.br
[2]Programa de Pós-graduação em Biologia Animal, Bolsista CNPq (fabio_akashi@yahoo.com.br).
[3]Departamento de Zoologia e Botânica, Universidade Estadual Paulista. Rua Cristovao Colombo, 2265, Jardim Nazareth, 15054-000 São José do Rio Preto, São Paulo, Brazil (reinaldo@ibilce.unesp.br).

Abstract

Hernandes, F.A. and Feres, R.J.F. **Review about mites (Acari) of rubber trees (*Hevea* spp., Euphorbiaceae) in Brazil.** *Biota Neotrop.* Jan/Abr 2006, vol. 6, no. 1, http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn00406012006. ISSN 1676-0611

Two of the most economically important superfamilies of phytophagous mites are Tetranychoidea and Eriophyoidea, which have species represented in rubber trees in Brazil. In this paper we review the literature concerning the mite fauna registered on rubber trees in that country. The source was the information available on literature, but also data from exploratory samplings in Goianésia, State of Goiás, and from a triennial survey with monthly samplings in Cedral, State of São Paulo. Among the phytophagous mites the most important and abundant species were *Calacarus heveae* and *Tenuipalpus heveae*. Seven of the nominal species reported belong to the family Tetranychidae. *Eutetranychus banksi* and *Oligonychus gossypii* were very numerous in several crops studied, although with no evident damage to the leaves caused by the former. The richest family was Phytoseiidae (27 species). Other rich and numerous family with predatory species was Stigmaeidae (10). The study of mites associated with rubber trees was triggered after the discovery of *Calacarus heveae*, after what several works arose in order to understand the seasonal occurrence of mites on that culture, their biology, chemical control and influence of associated vegetation. Not surprisingly, most surveys were made in the State of São Paulo, which responds to up to 60% of the national latex yield. Whereas in some rubber tree crops there were made seasonal samplings, most of the surveys had only few isolated samplings.

Key words: *Biodiversity, faunistics, mites, rubber tree*

Resumo

Hernandes, F.A. and Feres, R.J.F. **Revisão sobre ácaros (Acari) de seringueiras (*Hevea* spp., Euphorbiaceae) no Brasil.** *Biota Neotrop.* Jan/Abr 2006, vol. 6, no. 1, http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn00406012006. ISSN 1676-0611

Duas das superfamílias economicamente mais importantes de ácaros fitófagos são Tetranychoidea e Eriophyoidea, que apresentam espécies presentes no cultivo de seringueira no Brasil. No presente trabalho é revisada a literatura referente à acarofauna registrada em seringueiras no Brasil. O material utilizado foi o disponível na literatura, sendo também incluídos dados de coletas exploratórias esporádicas em Goianésia, Estado de Goiás, e de levantamentos mensais durante três anos em Cedral, noroeste do Estado de São Paulo, Brasil. Entre os ácaros fitófagos, os de maior importância e que ocorreram em maior abundância foram *Calacarus heveae* e *Tenuipalpus heveae*. Sete das espécies nominais registradas pertencem à família Tetranychidae. Dentre elas, *Eutetranychus banksi* e *Oligonychus gossypii* ocorreram em grande abundância em diversos seringais estudados, a primeira delas, entretanto, sem causar dano aparente às folhas. A família com maior número de espécies (27) foi Phytoseiidae. Outra família com espécies predadoras bastante abundante foi Stigmaeidae (10). O estudo de ácaros associados à seringueira ganhou impulso após a descrição de *Calacarus heveae*, quando houve incremento dos trabalhos visando melhor compreensão da sazonalidade, biologia, controle químico e influência da vegetação vizinha e associada a seringueiras. A grande maioria das coletas realizadas em seringais paulistas é reflexo do maior número de pesquisadores e da maior produtividade que esse Estado apresenta, respondendo por mais de 60% da produção nacional de látex. Enquanto que em alguns seringais foram feitas coletas sazonais ao longo do ano, na maioria dos seringais amostrados foram feitas apenas coletas exploratórias pontuais.

Palavras-chave: *Ácaros,Biodiversidade, levantamento de fauna,seringueira*

Introduction

Two of the most economically important superfamilies of phytophagous mites are Tetranychoidea and Eriophyoidea, which have species represented in rubber trees in Brazil. Baker (1945) registered and described the first mite species, *Tenuipalpus heveae*, from that host. Since then, six other species were described from rubber trees in that country: *Calacarus heveae* Feres (1992), *Phyllocoptruta seringueirae* Feres (1998), *Shevtchenkella petiolula* Feres (1998), *Zetzellia agistzellia* Hernandes & Feres (2005), *Z. quasagistemas* Hernandes & Feres (2005) and *Tetrabdella neotropica* Hernandes & Feres (2006a). *Calacarus heveae*, considered an important pest of rubber trees, responsible for serious attacks, reaches high populations on the upper side of the leaves from February to April in the northwestern region of the State of São Paulo leading to premature fall of the leaves (Feres 1992, 2000, 2001, Feres *et al.* 2002, Vieira & Gomes 1999, Vieira *et al.* 2000).

The first paper reporting mites of rubber trees (*Hevea brasiliensis* Muell.Arg., Euphorbiaceae) listed 8 acarine species (Chiavegato 1968). The study of mites associated with that plant was triggered after the discovery of *C. heveae* (Figure 1), after what several works arose in order to understand the diversity and the seasonal occurrence of mites on that crop (Bellini *et al.* 2005a, Feres 2000, 2001a, 2001b, Feres & Nunes 2001, Feres *et al.* 2002, Zacarias & Moraes 2001, 2002, Ferla & Moraes 2002a, Hernandes & Feres 2006b), their biology (Ferla & Moraes 2003a, Pontier *et al.* 2000, Hernandes *et al.* 2006), taxonomy (Feres 1998, Hernandes & Feres 2005, Pontier & Flechtmann 1999, 2000), chemical control (Vieira & Gomes 2001), and influence of associated vegetation (Feres & Nunes 2001, Bellini *et al.* 2005b, Demite & Feres 2005). Tanzini *et al.*(1999) and Bellini *et al.*(2005a) registered epizooty of the fungus *Hirsutella thompsoni* on *C. heveae*. The aim of this work was to summarize the knowledge of mites found on rubber trees in Brazil, giving a panorama of the development of this field and pointing the main species that occur on that plant.

Material and Methods

In this paper we review the literature concerning the mite fauna registered on rubber trees in Brazil (*Hevea* spp., Euphorbiaceae), and also include data from exploratory samplings in Goianésia, State of Goiás, (15º 10’ 19’’S, 48º 57’ 11’’W) and from a triennial survey with monthly samplings conducted from January 2001 to December 2003 in Cedral (Hernandes & Feres 2006b), northwestern region of the State of São Paulo (20º 55’ 30"S, 49º 26’79"W). Once the material studied by Feres (2000) from Itiquira, State of Mato Grosso, was wrongly reffered in that article as collected in Rondonópolis, State of Mato Grosso (R.J.F. Feres, pers. comm.), the correct location is adopted in the present article.

The nomenclature of the higher taxa follows Woolley (1988), and information concerning the Museum or Institution in which most of the type specimens are deposited is given according to the legends: BMNH - British Museum (Natural History), London, UK; CNC - Canadian National Collection, Toronto, Ontario, Canada; DZSJRP - Coleção de Acari do Departamento de Zoologia e Botânica, UNESP, S.J. do Rio Preto, São Paulo, Brazil; ESALQ - Collection of Departamento de Entomologia, Fitopatologia e Zoologia Agrícola, Universidade de São Paulo/ESALQ, Piracicaba, São Paulo, Brazil; FSCA - Florida State Collection of Arthropods, Gainesville, Florida, USA; IRSN - L’Institut Royal dês Sciences Naturelles, Belgium; LE - Laboratorium voor Entomologie, Landbouwhoogeschool to Wageningen, Netherlands; MCZ - Museum of Comparative Zoology, Harvard University, Cambridge, Massachussetts, USA; NCAPPRI- National Collection of Acari Plant Protection Research Institute, Pretoria, South Africa; UC - University of California, USA; USNM – United States National Museum, Washington DC, USA.

Results and Discussion

GAMASIDA

Phytoseiidae Berlese, 1916

Amblyseius acalyphus Denmark & Muma, 1973

Amblyseius acalyphus Denmark & Muma, 1973: 243; 1989: 75; Moraes *et al.*, 1986: 6; Feres & Moraes, 1998: 125.

Registers on *Hevea*: Mato Grosso: Itiquira, Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Types: on *Acalypha* sp (Euphorbiaceae), Rio Claro, São Paulo, Brazil, deposited in ESALQ.

Amblyseius compositus Denmark & Muma, 1973

Amblyseius compositus Dermark & Muma, 1973: 240, 1989:9; Moraes & McMurtry, 1983: 134.

Registers on *Hevea*: São Paulo: Piracicaba (Vis *et al.* 2006), on *H. brasiliensis*.

Types: on *Spathodea* sp. (Bignoniaceae), Sao Paulo, Brazil, deposited in ESALQ.

Amblyseius impeltatus Denmark & Muma, 1973

Amblyseius impeltatus Denmark & Muma, 1973: 241.

Registers on *Hevea*: São Paulo: Pariquera-Açu (Zacarias & Moraes 2001, 2002), on *H. brasiliensis*.

Types: on *Theobroma* sp. (Sterculiaceae), Pariquera-Açu, São Paulo, Brazil, deposited in ESALQ.

Amblyseius neochiapensis Lofego, Moraes & McMurtry, 2000

Amblyseius neochiapensis Lofego, Moraes & McMurtry, 1999 (2000): 462.

Registers on *Hevea*: Mato Grosso: Itiquira, Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Types: on *Manihot* sp. (Euphorbiaceae), Piritiba, Bahia, Brazil, deposited in ESALQ.

Amblyseius operculatus DeLeon, 1967

Amblyseius operculatus DeLeon, 1967: 26; Denmark & Muma, 1989: 47.

Registers on *Hevea*: São Paulo: Pariquera-Açu (Zacarias & Moraes 2001, 2002), on *H. brasiliensis*.

Types: on *Cephaelis* sp. (Rubiaceae), half way to Simla and Arima, Trinidad, deposited in MCZ.

Amblyseius (*Amblyseius*) *saopaulus* Denmark & Muma, 1973

Amblyseius saopaulus Denmark & Muma, 1973: 243.

Amblyseius (*Amblyseius*) *saopaulus*; Denmark & Muma, 1989: 32.

Registers on *Hevea*: São Paulo: Pariquera-Açu (Zacarias & Moraes 2001, 2002), on *H. brasiliensis*.

Types: on *Theobroma* sp. (Sterculiaceae), Pariquera-Açu, São Paulo, Brazil, deposited in ESALQ.

Euseius alatus DeLeon, 1966

Euseius alatus DeLeon, 1966: 87.

Euseius paraguayensis; Denmark & Muma, 1970: 224 (synonym according to Moraes & McMurtry, 1983: 137).

Euseius alatus; Denmark & Muma, 1973: 262; Moraes & McMurtry, 1983: 137; Feres & Moraes, 1998: 127.

Registers on *Hevea*: São Paulo: Piracicaba (Zacarias & Moraes 2001, 2002); Mato Grosso: Itiquira, Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Types: on *Cassia bicapsularis* L. (Fabaceae), Georgetown, East Demeraka, Guiana, deposited in collection of D. DeLeon, Erwin, Tennessee, USA.

Remarks: possibly predator of *Phyllocoptruta oleivora* (Ashmead), a citrus pest (Reis *et al.* 2000).

Euseius citrifolius Denmark & Muma, 1970

Euseius citrifolius Denmark & Muma, 1970: 222; Moraes & McMurtry, 1983: 138; Moraes *et al.*, 1991: 131; Feres & Moraes, 1998: 125; Feres, 2000: 161.

Registers on *Hevea*: São Paulo: Cedral (Feres *et al.* 2002, Hernandes & Feres 2006b), Pindorama, Taquaritinga (Feres *et al.* 2002), Piracicaba (Zacarias & Moraes 2001, 2002, Vis *et al.* 2006), Olímpia (Bellini *et al.* 2005a), São José do Rio Preto (Demite & Feres 2005), Ibitinga, Macaubal, Barretos; Minas Gerais: Frutal (Feres 2000); Mato Grosso: Itiquira (Feres 2000, Ferla & Moraes 2002a), on *H. brasiliensis*.

Types: on *Citrus* sp. (Rutaceae), Asunción, Departamento Central, Paraguai, deposited in FSCA.

Remarks: this is the most frequent and numerous phytoseiid found in rubber trees in the northeastern State of São Paulo (Feres & Moraes 1998), collected on several host plants.

Euseius concordis (Chant, 1959)

Typlodromus (Amblyseius) concordis Chant, 1959: 69.

Amblyseius (Iphiseius) concordis; Muma, 1961: 288.

Amblyseius concordis; Chant & Baker, 1965: 22; Moraes & McMurtry, 1983: 138.

Euseius flechtmanni; Denmark & Muma, 1970: 223; Denmark & Muma, 1973: 261 (synonym according to Moraes *et al.*, 1982: 18).

Euseius concordis; Denmark & Muma, 1973: 264; Moraes & Oliveira, 1982: 317; Moraes & McMurtry, 1983: 138; Feres & Moraes, 1998: 127; Feres 2000: 161.

Registers on *Hevea*: São Paulo: Cedral (Feres *et al.* 2002, Hernandes & Feres 2006b), Taquaritinga (Feres *et al.* 2002); Mato Grosso: Itiquira (Feres 2000, Ferla & Moraes 2002a), Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Types: on *Citrus* sp. (Rutaceae), Concordia, Entre Rios, Argentina, deposited in USNM.

Remarks: mites of this genus are the most common predatory mites in untreated apple orchards in the State of Rio Grande do Sul, Brazil (Ferla & Moraes 2002b); the most numerous phytoseiid found in rubber trees in southern State of Mato Grosso (Ferla & Moraes 2002a).

Galendromimus (*Galendromimus*) *alveolaris* (DeLeon, 1957)

Typhlodromus alveolaris DeLeon, 1957: 141.

Typhlodromus (Typhlodromus) alveolaris; Chant, 1959: 52.

Cydnodromella alveolaris; Chant & Yoshida-Shaul, 1986: 2821; Moraes & Mesa, 1988: 80.

Galendromimus alveolaris; DeLeon, 1962: 175; DeLeon, 1967: 13; Muma, 1961: 298; Muma *et al.*, 1970: 58.

Galendromimus (Galendromimus) alveolaris; Moraes *et al.*, 1999 (2000): 255.

Registers on *Hevea*: Mato Grosso: Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Types: on *Cassia* sp. (Fabaceae), Coral Gables, Dade, Florida, USA, deposited in MCZ.

Remarks: abundant in *Mabea fistulifera* Mart. (Euphorbiaceae) in northeastern State of São Paulo (Daud & Feres 2005).

***Galendromus* (*Galendromus*) *annectens* (DeLeon, 1958)**

Typhlodromus annectens DeLeon, 1958: 75; Chant & Yoshida-Saul, 1984: 1868; Moraes & McMurtry, 1983: 142; Moraes & Mesa, 1988: 82; Moraes *et al.*, 1991: 134; Feres & Moraes, 1998: 128; Feres, 2000: 161; Feres & Nunes, 2001: 1256.

Galendromus annectens; Muma, 1961: 298; Muma, 1963: 20; Muma *et al.*, 1970: 135; Denmark & Muma, 1973: 274; Farias *et al.*, 1981: 21; Denmark, 1982: 142; Moraes *et al.*, 1982: 21; Moraes *et al.*, 1986: 186; Gondim Jr. & Moraes, 2001: 88.

Galendromus (*Galendromus*) *annectens*; Moraes *et al.*, 2004: 265.

Registers on *Hevea*: Mato Grosso: Itiquira (Feres 2000, Ferla & Moraes 2002a), Pontes e Lacerda (Ferla & Moraes 2002a); São Paulo: Olímpia (Bellini *et al.* 2005a), Cedral (Hernandes & Feres 2006b), on *H. brasiliensis*.

Types: on *Trema floridana* Britton ex Small (Ulmaceae), Coral Gables, Dade, Florida, USA, deposited in MCZ.

***Galendromus* sp.**

Registers on *Hevea*: Mato Grosso: Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Iphiseiodes zuluagai **Denmark & Muma, 1972**

Iphiseiodes zuluagai Denmark & Muma, 1972: 23.

Amblyseius zuluagai; Moraes & Mesa, 1988: 79; Moraes *et al.*, 1991: 125.

Iphiseiodes zuluagai; Aponte & McMurtry, 1995: 165; Kreiter & Moraes, 1997: 377; Feres & Moraes, 1998: 127.

Registers on *Hevea*: São Paulo: Piracicaba (Zacarias & Moraes 2001, 2002), Taquaritinga (Feres *et al.* 2002), on *H. brasiliensis*.

Types: on *Citrus sinensis* (L.) Osbeck (Rutaceae), Palmira, Valle, Colombia, deposited in FSCA.

Remarks: in Taquaritinga, São Paulo, it was collected in a crop neighbor to *Citrus* sp., where it was also present, probably moving from these cultures (Feres *et al.* 2002).

***Iphiseiodes* sp.**

Registers on *Hevea*: São Paulo: Rio Claro (Flechtmann & Arleu 1984), on *H. brasiliensis*.

Metaseiulus camelliae **(Chant & Yoshida-Shaul, 1983)**

Typhlodromus camelliae Chant & Yoshida-Shaul, 1983: 1053; Feres & Moraes, 1998: 130.

Typhlodromina camelliae; Moraes *et al.*, 1986: 236; Sato *et al.*, 1994: 437; Zacarias & Moraes, 2001: 583.

Metaseiulus camelliae; Moraes *et al.* 2004: 278.

Registers on *Hevea*: São Paulo: Olímpia (Bellini *et al*2005a), Piracicaba (Zacarias & Moraes 2002, Vis *et al.* 2006), Cedral (Hernandes & Feres 2006b), on *H. brasiliensis*.

Types: on *Camellia* sp. (Theaceae), Uruguai, intercepted in Miami, Florida, USA, deposited in CNC.

***Neoseiulus anonymus* (Chant & Baker, 1965)**

Amblyseius anonymus Chant & Baker, 1965: 21; Schicha & Elshafie, 1980: 32; McMurtry, 1983: 254.

Neoseiulus anonymus; Denmark & Muma, 1973: 27; Moraes & Mesa, 1988: 76; Moraes *et al.*, 1991: 126; Kreiter & Moraes, 1997: 378; Moraes *et al.*, 1999 (2000): 245.

Registers on *Hevea*: Mato Grosso: Itiquira, Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Types: on banana (*Musa paradisiaca* L., Musaceae), Tacamiche, La Lima, Honduras, deposited in USNM.

Remarks: one of the species commonly associated with *Mononychellus tanajoa* (Bondar) (Tetranychidae) in Northeastern Brazil (Moraes *et al.*1988).

***Neoseiulus idaeus* Denmark & Muma, 1973**

Neoseiulus idaeus Denmark & Muma, 1973: 266.

Amblyseius idaeus; Moraes & McMurtry, 1983: 134.

Registers on *Hevea*: São Paulo: Cedral (Hernandes & Feres 2006b), on *H. brasiliensis.*

Types: on *Rubus idaeus* L. (Rosaceae), Piracicaba, São Paulo, Brazil, deposited in ESALQ.

Neoseiulus tunus **(DeLeon, 1967)**

Typhlodromips tunus DeLeon, 1967: 29; Denmark & Muma, 1973: 253; Moraes *et al.*, 1986: 151.

Amblyseius tunus; McMurtry & Moraes, 1989: 181; Feres & Moraes, 1998: 126.

Neoseiulus tunus; Ferla & Moraes, 2002a: 872; Moraes *et al.*, 2004: 148.

Registers on *Hevea*: Mato Grosso: Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Types: on guava (*Psidium guajava* L., Mirtaceae), Upper Saint John's Road, Tunapuna, Trinidad, deposited in MCZ.

***Phytoscutus sexpilis* Muma, 1961**

Phytoscutus sexpilis Muma, 1961: 275; DeLeon, 1967: 17.

Typhlodromus sexpilis; Hirschmann, 1962: 17.

Amblyseius sexpilis; van der Merwe, 1968: 161.

Phytoscutus sexpilis; Muma *et al.*, 1970: 24; Yoshida-Shaul & Chant, 1997: 234.

Registers on *Hevea*: São Paulo: Olímpia (Bellini *et al.* 2005a), Pariquera-Açu (Zacarias & Moraes 2001, 2002), on *H. brasiliensis*.

Types: on grapefruit (*Citrus paradisi* MacFad., Rutaceae), Polk City, Florida, USA, deposited in USNM.

***Proprioseiopsis dominigos* (El-Benhawy, 1984)**

Amblyseius dominigos El-Benhawy, 1984: 130; McMurtry & Moraes, 1989: 185; Moraes *et al.*, 1991: 126; Feres & Moraes, 1998: 126.

Proprioseiopsis dominigos; Gondim Jr. & Moraes, 2001: 81.

Registers on *Hevea*: São Paulo: Pariquera-Açu (Zacarias & Moraes 2001, 2002), on *H. brasiliensis*.

Types: on unidentified plant, Sooretama, Espírito Santo, Brazil, deposited in CNC.

***Proprioseiopsis ovatus* (Garman, 1958)**

Amblyseiopsis ovatus Garman, 1958: 78.

Amblyseius ovatus, Moraes & McMurtry, 1983: 133; Moraes *et al.*, 1991: 127.

Typhlodromus (*Amblyseius*) *ovatus*, Chant, 1959: 90.

Proprioseiopsis ovatus, Denmark & Muma, 1973: 237.

Registers on *Hevea*: São Paulo: Piracicaba (Vis *et al.* 2006), on *H. brasiliensis*.

Types: on *Cattleya* sp. (Orchidaceae), from Equador at Brownsville, Texaz, deposited in USNM.

***Typhlodromalus feresi* Lofego, Moraes & McMurtry, 2000**

Typhlodromalus feresi Lofego, Moraes & McMurtry, (1999) 2000: 466.

Registers on *Hevea*: Mato Grosso: Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Types: on *Mabea* sp. (Euphorbiaceae) (*M. fistulifera* Mart., R.J.F. Feres, com. pess.), São José do Rio Preto, São Paulo, Brazil, deposited in ESALQ.

Typhlodromalus* aff. *horatii

Registers on *Hevea*: Mato Grosso: Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Typhlodromips amilus **DeLeon, 1967**

Typhlodromips amilus DeLeon, 1967: 28.

Registers on *Hevea*: Mato Grosso: Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Types: on Bromeliaceae, Simla, Trinidad, deposited in MCZ.

***Typhlodromips cananeiensis* Gondim Jr. & Moraes, 2001**

Typhlodromips cananeiensis Gondim Jr. & Moraes, 2001: 84.

Registers on *Hevea*: São Paulo: Cananéia (Zacarias & Moraes 2001), Pariquera-Açu (Zacarias & Moraes 2002), on *H. brasiliensis*.

Types: on *Bactris setosa* Mart. (Arecaceae), Cananéia, São Paulo, Brazil, deposited in ESALQ.

Typhlodromips* aff. *sinensis

Registers on *Hevea*: Mato Grosso: Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

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

Kampimodromus transvaalensis Nesbitt, 1951: 55.

Typhlodromus transvaalensis; Chant, 1955: 498.

Typhlodromus jackmickleyi; DeLeon, 1958: 175.

Typhlodromus pectinatus; Athias-Henriot, 1958: 179.

Neoseiulus transvaalensis; Muma, 1961: 295.

Clavidromus jackmickleyi; Muma, 1961: 296.

Clavidromus transvaalensis; Muma & Denmark, 1968: 238.

Typhlodromus (*Anthoseius*) *transvaalensis*; Chant & McMurtry, 1994: 252.

Registers on *Hevea*: Mato Grosso: Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Types: on peanut (*Arachis hypogaea* L., Fabaceae), Nylstroom, Transvaal, South Africa, deposited in CNC.

ACTINEDIDA

Acarophenacidae Cross, 1965

Unidenfified sp.

Registers on *Hevea*: São Paulo: São Jose do Rio Preto (Demite & Feres 2005) on *H. brasiliensis*. Remarks: parasites on insects; casual record on rubber trees.

Bdellidae Dugès, 1834

***Tetrabdella neotropica* Hernandes & Feres, 2006a:57**

Tetrabdella neotropica Hernandes & Feres, 2006a:57

Registers on *Hevea*: São Paulo: Cedral (Feres *et al.* 2002, Hernandes & Feres 2006b), Pindorama (Feres *et al.* 2002), Olímpia (Bellini *et al.* 2005a), Piracicaba (Vis *et al.* 2006), São Jose do Rio Preto (Demite & Feres 2005), on *H. brasiliensis*.

Remarks: Previously referred as *Spinibdella* sp. (Feres *et al.* 2002, Bellini *et al.* 2005a), and aff. *Spinibdella* (Demite & Feres 2005, Vis *et al.* 2006), this genus bears only two pairs of trichobothriae, on tarsi III and IV (Hernandes & Feres 2005b). As in *Spinibdella cronini* Baker & Balock it spins a silken cocoon around each egg (Wallace & Mahon 1972); in rubber trees it occurs mostly at the base of the leaflets, where it spins a silken cocoon, inside which it moults.

Cheyletidae Leach, 1815

Cheletomimus (*Hemicheyletia*) *wellsi* **(Baker, 1949a)**

Cheyletia wellsi Baker, 1949a: 300-301.

Paracheyletia wellsi; Volgin, 1955: 152; Muma, 1964: 245-246.

Dendrocheyla wellsi; Volgin, 1969: 211.

Hemicheyletia wellsi; Summers & Price, 1970: 18.

Cheletomimus (*Hemicheyletia*) *wellsi*; Fain *et al.* 2002: 45; Feres 2000: 162.

Registers on *Hevea*: São Paulo: Reginópolis (Feres 2000), Taquaritinga (Feres *et al.* 2002), Cedral (Hernandes & Feres 2006b), on *H. brasiliensis*.

Types: on *Citrus* sp. (Rutaceae), Philadelfia, USA, deposited in USNM.

Remarks: this predator is commonly found in leaves and fruits of *Citrus* attacked by *Phyllocoptruta oleivora* (Ashmead) (Chiavegato 1980).

***Cheletogenes* sp.**

Registers on *Hevea*: São Paulo: Olímpia (Bellini *et al.* 2005a); Goiás: Goianésia, on *H. brasiliensis*.

***Cheyletia* sp.**

Registers on *Hevea*: São Paulo: Olímpia (Bellini *et al.* 2005a); Goiás: Goianésia, on *H. brasiliensis*.

***Hemicheyletia* sp.**

Registers on *Hevea*: Pariquera-Açu (Zacarias & Moraes 2002), on *H. brasiliensis*.

Cunaxidae Thor, 1902

***Pulaeus* sp.**

Registers on *Hevea*: São Paulo: Pariquera-Açu (Zacarias & Moraes 2002), on *H. brasiliensis*.

***Pseudobonzia* sp.**

Registers on *Hevea*: Mato Grosso: Itiquira (Feres 2000, Ferla & Moraes 2002a), Pontes e Lacerda (Ferla & Moraes 2002a); São Paulo: Cedral, on *H. brasiliensis*.

***Scutopalus* sp.**

Pariquera-Açu (Zacarias & Moraes 2002), on *H. brasiliensis*.

Eriophyidae Nalepa, 1898

aff. *Acaphyllisa* sp.

Registers on *Hevea*: Mato Grosso: Itiquira (Ferla & Moraes 2002a), on *H. brasiliensis*.

Remarks: probably casual record on rubber trees; only one specimen was collected.

***Calacarus heveae* Feres, 1992**

Calacarus heveae Feres, 1992: 61; 2000: 167; 2001: 343.

Registers on *Hevea*: Amazonas: Manaus (Feres 2001a); São Paulo: Cedral (Feres *et al.* 2002, Hernandes & Feres 2006b), Pindorama, Taquaritinga (Feres *et al.* 2002), Olímpia (Bellini *et al.* 2005a), Pariquera-Açu (Zacarias & Moraes 2002), Piracicaba (Zacarias & Moraes 2002, Vis *et al.* 2006), São José do Rio Preto (Demite & Feres 2005), Américo de Campos, Barretos, José Bonifácio, Pindorama, Planalto, Macaubal, Monte Aprazível, Reginópolis; Minas Gerais: Frutal (Feres 2000); Mato Grosso: Itiquira (Feres 2000, Ferla & Moraes 2002a), Pontes e Lacerda (Ferla & Moraes 2002a); Mato Grosso do Sul: Selvíria (Feres 2000), Goiás: Goianésia, on *H. brasiliensis*.

Types: on *H. brasiliensis* (Euphorbiaceae), Planalto, São Paulo, Brazil, deposited in DZSJRP.

Remarks: serious pest of rubber trees in Brazil, this species reaches large populations on the upper side of the leaves from January to April; it leads to premature fall of leaves, preceding the natural senescence, bringing on extra budding (Feres 1992, 2000, 2001, Vieira & Gomes 1999).

aff. *Chakrabartiella* sp.

Registers on *Hevea*: Mato Grosso: Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Remarks: probably casual record on rubber trees, only four individuals were collected.

***Phyllocoptruta seringueirae* Feres, 1998**

Phyllocoptruta seringueirae Feres, 1998: 71; 2000: 168; 2001: 343.

Registers on *Hevea*: Amazonas: Manaus (Feres 2001a); São Paulo: Cedral (Feres *et al.* 2002, Hernandes & Feres 2006b), Pindorama (Feres *et al.* 2002), Olímpia (Bellini *et al.* 2005a), Buritama, Monte Aprazível, Reginópolis (Feres 2000), São José do Rio Preto (Demite & Feres 2005); Mato Grosso: Itiquira (Feres 2000, Ferla & Moraes 2002a), Pontes e Lacerda (Ferla & Moraes 2002a); Goiás: Goianésia, on *H. brasiliensis*.

Types: on *H. brasiliensis* Muell. Arg. (Euphorbiaceae), Reginópolis, São Paulo, Brazil, deposited in DZSJRP.

Remarks: registered in great abundance in rubber tree crops of Itiquira, Mato Grosso (Ferla & Moraes 2002a, R.J.F. Feres, pers. comm.).

***Shevtchenkella petiolula* Feres, 1998**

Shevtchenkella petiolula Feres, 1998: 69; 2000: 168; 2001: 343.

Registers on *Hevea*: Amazonas: Manaus (Feres 2001a); São Paulo: Cedral (Feres *et al.* 2002, Hernandes & Feres 2006b), Pindorama (Feres *et al.* 2002), Olímpia (Bellini *et al.* 2005a), Piracicaba (Vis *et al.* 2006), Buritama, Reginópolis (Feres

2000), São José do Rio Preto (Demite & Feres 2005); Mato Grosso: Itiquira (Feres 2000, Ferla & Moraes 2002a), Pontes e Lacerda (Ferla & Moraes 2002a); Mato Grosso do Sul: Selvíria (Feres 2000), on *H. brasiliensis*.

Types: on *H. brasiliensis* Muell. Arg. (Euphorbiaceae), Buritama, São Paulo, Brazil, deposited in DZSJRP.

Remarks: this species is mostly found on petioles, petiolules and flowers of rubber trees, in small number, from September to November (Feres 2000).

Eupalopsellidae Willmann, 1952

Exothorhis caudata **Summers, 1960**

Exothorhis caudata Summers, 1960: 131; Rakha & McCoy, 1985: 142.

Exothorhis citri, Meyer & Ueckermann, 1989: 10.

Exothorhis caudata, Rimando & Corpuz-Raros, 1996: 110; Swift, 1997: 39.

Registers on *Hevea*: São Paulo: Piracicaba (Vis *et al.* 2006), on *H. brasiliensis*.

Types: on *Citrus* sp. (Rutaceae), Florida, USA, deposited in UC, USA.

Remarks: Matioli *et al.*(2002) suggested this species reproduce by parthenogenesis, because no males have been registered to date. It was found associated with some citrus scale insects (*Parlatoria cinerea*, *Coccus viridis*, *Saissetia coffeae*, *Selenaspidus articulatus*, *Orthezia praelonga* and *Pinnaspis aspidistrae*)

Stigmaeidae Oudemans, 1931

Agistemus floridanus Gonzalez-Rodriguez, 1965

Agistemus floridanus Gonzalez-Rodriguez, 1965: 38; Matioli *et al.*, 2002: 103; Arruda Filho & Moraes, 2003: 52.

Registers on *Hevea*: Mato Grosso: Itiquira, Pontes e Lacerda (Ferla & Moraes 2002a); São Paulo: Olímpia (Bellini *et al.* 2005a) on *H. brasiliensis*.

Types: on *Ligustrum* sp. (Oleaceae), Orlando, Florida, USA, deposited in USNM.

Remarks: this species showed high oviposition rate when fed on *C. heveae* and *T. heveae*, serious pests of rubber trees in Brazil (Ferla & Moraes 2003a); along with Phytoseiidae, mites of this family are the most commonly found predators in rubber trees of Southeast and Middle West Brazil (Feres 2000, Ferla & Moraes 2002a).

Agistemus* aff. *floridanus

Registers on *Hevea*: Cedral (Hernandes & Feres 2006b).

Remarks: as mentioned by Buosi *et al.* (2006), there is a large range in several body measurements of this species, comprising the values reported by Matioli *et al.* (2002) for *A. brasiliensis* Matioli *et al.* (2002) and *A. floridanus* Gonzalez (1965). In that respect, it was not possible to determinate the real status of that species.

***Agistemus* sp.**

Registers on *Hevea*: São Paulo: Ibitinga, Barretos (Feres 2000), Cedral, Pindorama (Feres *et al.* 2002), Pariquera-Açu (Zacarias & Moraes 2002), Piracicaba (Zacarias & Moraes 2002, Vis *et al.* 2006); Mato Grosso: Itiquira (Feres 2000); Goiás: Goianésia, on *H. brasiliensis*; Barretos (Feres 2000) on *H. pauciflora* e *H. benthamiana*.

Remarks: species of this genus are often cited as predators of tetranychid eggs (McMurtry *et al.*1970, Oomen 1982, Inoue & Tanaka 1983 *apud* Ehara 1993) and of species of *Tenuipalpus* (Flechtmann 1975); occurs in a large variety of plants. Probably some registers of *Agistemus* males are from males of *Zetzellia agistzellia*.

***Eryngiopus* sp.**

Registers on *Hevea*: São Paulo: Piracicaba (Vis *et al.* 2006), on *H. brasiliensis*.

***Eustigmaeus* sp.**

Registers on *Hevea*: São Paulo: Piracicaba (Zacarias & Moraes 2002), on *H. brasiliensis*.

Remarks: referred as *Ledermuelleria* sp., synonym by Wood (1973:182).

***Mediolata* sp.**

Registers on *Hevea*: São Paulo: Piracicaba (Vis *et al.* 2006), on *H. brasiliensis*.

Zetzellia malvinae **Matioli, Ueckermann & Oliveira, 2002**

Zetzellia malvinae Matioli, Ueckermann & Oliveira, 2002: 111.

Registers on *Hevea*: São Paulo: Piracicaba (Vis *et al.* 2006), on *H. brasiliensis*.

Types: on *Citrus sinensis* (Rutaceae), Limeira, Sao Paulo, Brazil, deposited in ESALQ.

***Zetzellia mapuchina* Gonzalez-Rodriguez, 1965**

Zetzellia mapuchina Gonzalez-Rodriguez, 1965: 23.

Registers on *Hevea*: São Paulo: Cedral (Hernandes & Feres 2006b), on *H. brasiliensis*.

Types: on *Citrus reticulata* (Rutaceae), Argentina, intercepted in Miami, Florida, USA, deposited in USNM.

***Zetzellia agistzellia* Hernandes & Feres, 2005**

Zetzellia agistzellia Hernandes & Feres, 2005: 28.

Registers on *Hevea*: São Paulo: Cedral (Hernandes & Feres 2006b), on *H. brasiliensis*.

Remarks: This species present sexes with different patterns of organization of dorsal platelets: males resemble *Agistemus* whereas females resemble *Zetzellia*.

Zetzellia quasagistemas Hernandes & Feres, 2005

Zetzellia quasagistemas Hernandes & Feres, 2005: 37.

Registers on *Hevea*: Mato Grosso: Itiquira, Pontes e Lacerda (Ferla & Moraes 2002a); São Paulo: Ibitinga, Reginópolis (Feres 2000), Olímpia (Bellini *et al.* 2005a), Pindorama (Feres *et al.* 2002), São José do Rio Preto (Demite & Feres 2005), Cedral (Feres *et al.* 2002, Hernandes & Feres 2006b); Goiás: Goianésia, on *H. brasiliensis*.

Remarks: Previously referred as *Zetzellia* sp. (Bellini *et al.* 2005a) and *Z.* aff. *yusti* (Ferla & Moraes 2002a), this species present, as *Z. agistzellia*, some characters commonly found in males of *Agitemus*: males with setae *f1* inserted on the main plate and setae *e1* greatly reduced.

Tarsonemidae Canestrini & Fanzago, 1877

Daidalotarsonemus spp.

Registers on *Hevea*: Mato Grosso: Itiquira (Feres 2000); São Paulo: Piracicaba (Vis *et al.* 2006), on *H. brasiliensis*.

Fungitarsonemus sp.

Registers on *Hevea*: São Paulo: Pindorama (Feres *et al.* 2002), Olímpia (Bellini *et al.* 2005a), Cedral (Hernandes & Feres 2006b), on *H. brasiliensis*.

Polyphagotarsonemus latus (Banks, 1904)

Tarsonemus latus Banks, 1904: 1553.

Hemitarsonemus latus; Ewing, 1939: 54.

Neotarsonemus latus; Smiley, 1967: 137.

Polyphagotarsonemus latus; Beer & Nucifora, 1965: 38; Feres 2000: 164.

Registers on *Hevea*: Minas Gerais: Frutal (Feres 2000); São Paulo: Pindorama (Feres *et al.* 2002), Campinas (Chiavegato 1968); Mato Grosso: Itiquira, Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Types: on mango (*Mangifera* sp., Anacardiaceae), Washington DC, USA., in greenhouse, deposited at MCZ.

Remarks: cosmopolitan pest of several crops; in Campinas, it was collected in clones of rubber trees (Chiavegato 1968).

Tarsonemus confusus Ewing, 1939

Tarsonemus confusus Ewing, 1939: 26; Smiley, 1969: 221; Kaliszewski, 1993: 40.

Registers on *Hevea*: São Paulo: Olímpia (Bellini *et al.* 2005a), on *H. brasiliensis*.

Types: on *Delphinium belladonna*, (Ranunculaceae), Suitland, MD, USA, deposited in USNM.

Remarks: this species has been found in both thelytokous and sexual populations (Lindquist 1986 *apud* Wrensch & Ebbert 1993).

Tarsonemus spp.

Registers on *Hevea*: Mato Grosso: Itiquira (Feres 2000, Ferla & Moraes 2002a), Pontes e Lacerda (Ferla & Moraes 2002a); São Paulo: Cedral (Feres *et al.* 2002, Hernandes & Feres 2006b), Pindorama (Feres *et al.* 2002), Piracicaba (Vis *et al.* 2006), São José do Rio Preto (Demite & Feres 2005), Pariquera-Açu (Zacarias & Moraes 2002), on *H. brasiliensis*.

Remarks: it may be more than one species, for the material from Pontes e Lacerda was not examined; mites of this genus are usually cosmopolitans and primarily mycophagous.

Xenotarsonemus sp.

Registers on *Hevea*: São Paulo: Pariquera-Açu (Zacarias & Moraes 2002), on *Hevea brasiliensis*.

Tenuipalpidae Berlese, 1913

Brevipalpus phoenicis (Geijskes, 1939)

Tenuipalpus phoenicis Geijskes, 1939: 23.

Brevipalpus phoenicis; Sayed, 1946a: 99.

Brevipalpus yothersi; Baker, 1949b: 374.

Brevipalpus mcbridei; Baker, 1949b: 374.

Brevipalpus papayensis; Baker, 1949b: 379.

Brevipalpus phoenicis; Pritchard & Baker, 1958: 233; DeLeon, 1961: 48; Gonzalez, 1975: 82; Baker *et al.*, 1975: 18; Meyer, 1979: 87; Baker & Tuttle, 1987: 98-99; Feres 2000: 164.

Registers on *Hevea*: São Paulo: Cedral (Feres 2000, Hernandes & Feres 2006b), Ibitinga, José Bonifácio, Macaubal, Reginópolis (Feres 2000), Pindorama (Feres *et al.* 2002), Piracicaba (Vis *et al.* 2006), Rio Claro; Bahia: Itabuna (Flechtmann & Abreu 1973; Flechtmann & Arleu 1984); Mato Grosso: Itiquira, Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Types: on *Phoenix* sp. (Arecaceae), Netherlands, in greenhouse, deposited in LE.

Remarks: one of the most serious pests of citrus, bearer of leprosis virus; reponsible for leaf fall and low quality of coffee (Chagas 1973); cosmopolitan, collected from up to

100 host plants only in Central America (Childers *et al.* 2001).

***Brevipalpus* sp.**

Registers on *Hevea*: São Paulo: Pariquera-Açu (Zacarias & Moraes 2001), on *H. brasiliensis*.

***Tenuipalpus heveae* Baker, 1945**

Tenuipalpus heveae Baker, 1945: 36; Baker & Pritchard, 1953: 320; Feres, 2000: 165.

Registers on *Hevea*: São Paulo: Cedral (Feres *et al.* 2002, Hernandes & Feres 2006b), Pindorama, Taquaritinga (Feres *et al.* 2002); Barretos, Pindorama (Feres 2000), Cedral, Olímpia (Bellini *et al.* 2005a), Piracicaba (Vis *et al.* 2006), São José do Rio Preto (Demite & Feres 2005); Mato Grosso: Itiquira (Feres 2000, Ferla & Moraes 2002a), Pontes e Lacerda (Ferla & Moraes 2002a); Amazonas: Manaus (Flechtmann & Arleu 1984); Pará: Belém (Flechtmann 1979); Goiás: Goianésia, on *H. brasiliensis*; Itiquira, on *H. viridis* (Feres 2000), on *H. viridis*.

Types: on *H. brasiliensis* (Euphorbiaceae), Belterra, Pará, Brazil, deposited in USNM.

Remarks: registered in large populations mostly on the lower side of the leaves (Feres 2000, Feres *et al.* 2002, Ferla & Moraes 2002a); but also found on the upper side when in high infestation; in December 2000, it led to bronzing and severe fall of the leaves in crops from Goianésia, Goiás (J.F.C. Benesi, pers. comm.).

Tetranychidae Donnadieu, 1875

Allonychus braziliensis **(McGregor, 1950)**

Septanychus braziliensis McGregor, 1950: 318.

Allonychus braziliensis; Pritchard & Baker, 1955: 137.

Registers on *Hevea*: São Paulo: Campinas (Chiavegato 1968), on *H. brasiliensis*.

Types: on quince (*Cydonia* sp., Rosaceae), Viçosa, Minas Gerais, Brazil, deposited in USNM.

Remarks: possibly casual record, on clones of rubber trees (Chiavegato 1968).

***Atrichoproctus uncinatus* Flechtmann, 1967**

Atrichoproctus uncinatus Flechtmann, 1967: 39 *apud* Flechtmann & Baker, 1970: 157; Flechtmann & Baker, 1975: 116; Feres, 2000: 166.

Registers on *Hevea*: Mato Grosso: Itiquira, on *H. benthamiana* (Feres 2000).

Types: on *Rhododendron indicum* (L.) Sweet, (Ericaceae), *Desmodium* sp. (Fabaceae) and *Quercus* sp. (Fagaceae), Piracicaba and Matão, São Paulo, Brazil, deposited in ESALQ.

Remarks: green colored species, occurs mostly on the upper side of the leaves.

***Eutetranychus banksi* (McGregor, 1914)**

Tetranychus banksi McGregor, 1914: 358.

Neotetranycus banksi; (McGregor) Banks, 1917: 177.

Anychus banksi; (McGregor) McGregor, 1919: 644.

Eutetranychus banksi; (McGregor) McGregor, 1950: 141.

Tetranychus rusti; McGregor, 1917: 582.

Anychus rusti; (McGregor) McGregor, 1919: 645.

Eutetranychus rusti; (McGregor) McGregor, 1950: 669; synonym according to Pritchard & Baker (1955).

Anychus clarki; McGregor, 1935: 161.

Eutetranychus clarki; (McGregor) McGregor, 1950: 270; synonym according to Pritchard & Baker (1955).

Anychus orientalis; Klein, 1936: 3.

Anychus ? latus; Hirst, 1923: 991.

Anychus latus; Sayed, 1946c: 125.

Anychus africanus; Tucker, 1926: 5.

Anychus verganii; Blanchard, 1940: 24; synonym according to Pritchard & Baker (1955).

Anychus ricini; Rahman & Sapra, 1940: 194.

Eutetranychus mexicanus; McGregor, 1950: 27; synonym according to Pritchard & Baker (1955).

Eutetranychus banksi; McGregor, 1914: 268; Pritchard & Baker, 1955: 115; Flechtmann & Baker, 1970: 156; Flechtmann & Baker, 1975: 112; Feres 2000: 165.

Registers on *Hevea*: São Paulo: Campinas (Chiavegato 1968), Cedral (Feres *et al.* 2002, Hernandes & Feres 2006b), Pindorama, Taquaritinga (Feres *et al.* 2002), Olímpia (Bellini *et al.* 2005a), Pariquera-Açu (Zacarias & Moraes 2002), Piracicaba (Zacarias & Moraes 2002, Vis *et al.* 2006), São José do Rio Preto (Demite & Feres 2005), Bálsamo, Ibitinga, Macaubal, Pindorama; Minas Gerais: Frutal (Feres 2000); Mato Grosso: Itiquira (Ferla & Moraes 2002a), on *H. brasiliensis*.

Types: on castor bean (*Ricinus communis* L., Euphorbiaceae) and *Stizolobium* sp. (Fabaceae), Orlando, Florida, USA, deposited in USNM.

Remarks: collected from many hosts all around the world (Bolland *et al.*1998); pest of citrus in USA.; registered in great abundance in rubber trees in Brazil, although with no evident damage to the leaves; in Campinas, it was collected in yards of clones of rubber trees (Chiavegato 1968).

***Mixonychus* sp.**

Registers on *Hevea*: São Paulo: Piracicaba (Vis *et al.* 2006), on *H. brasiliensis*.

***Mononychellus* sp.**

Registers on *Hevea*: Mato Grosso: Itiquira, Pontes e Lacerda

(Ferla & Moraes 2002a), on *H. brasiliensis*.

Oligonychus coffeae (Nietner, 1861)

Acarus coffeae Nietner, 1861: 19.

Tetranychus bioculatus; Wood-Mason, 1884: 1.

Paratetranychus bioculatus; Baker & Pritchard, 1953: 213.

Oligonychus merwei; Tucker, 1926: 6.

Paratetranychus terminalis; Sayed, 1946b: 94.

Oligonychus coffeae; Pritchard & Baker, 1955: 315; Baker & Pritchard, 1960: 505; Meyer & Rodrigues, 1965: 12; Rodrigues, 1968: 220; Gutierrez, 1968: 446; Meyer, 1974: 251; Meyer, 1987: 146; Feres 2000: 166;

Registers on *Hevea*: Mato Grosso: Itiquira, Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*; Itiquira, on *H. guianensis* and *H. viridis* (Feres 2000).

Types: on *Coffea arabica* L. (Rubiaceae), Sri Lanka (Ceylon), institution of deposition of types not found.

Remarks: considered the most serious pest of tea in several countries (Flechtmann & Arleu 1984); on rubber trees, however, it has not been observed great damages.

Oligonychus gossypii (Zacher, 1921)

Paratetranychus gossypii Zacher, 1921: 183; Hirst, 1926: 832; André, 1933: 306.

Oligonychus gossypii; Pritchard & Baker, 1955: 359; Baker & Pritchard, 1960: 508; Baker & Pritchard, 1962(1963): 327; Flechtmann, 1967: 23, 31; Meyer, 1974: 263; Meyer, 1987: 152; Feres, 2000: 166.

Registers on *Hevea*: São Paulo: Cedral (Feres *et al.* 2002, (Hernandes & Feres 2006b), Ibitinga, Barretos (Feres 2000), Piracicaba (Zacarias & Moraes 2002, Vis *et al.* 2006); Mato Grosso: Itiquira (Feres 2000, Ferla & Moraes 2002a), Pontes e Lacerda (Ferla & Moraes 2002a); Espírito Santo: Viana (Flechtmann & Arleu 1984); Acre: Rio Branco (Flechtmann 1989; Fazolin & Pereira 1989); Amazonas: Manaus (Fazolin & Pereira 1989), on *H. brasiliensis*; Itiquria, Mato Grosso (Feres 2000), on *H. rigidifolia* and *H. viridis*.

Types: on cotton (*Gossypium herbaceum* L., Malvaceae), Togo, Africa, probably deposited in Zacher's collection..

Remarks: registered in great abundance in crops of the States of Pará and Amazonas, leading to intense bronzing and premature fall of the leaves (Fazolin & Pereira 1989, Flechtmann 1989); reported on many plants in West Africa and Central America, as cotton, cassava, bean and papaya (Pritchard & Baker 1955).

Tetranychus mexicanus (McGregor, 1950)

Septanychus mexicanus McGregor, 1950: 323.

Tetranychus mexicanus; Pritchard & Baker, 1955: 411; Flechtmann, 1967: 21, 29; Chiavegato, 1968: 67; Flechtmann & Baker, 1970: 162; Flechtmann & Baker, 1975: 120; Feres, 2000: 167.

Registers on *Hevea*: Mato Grosso: Itiquira (Feres 2000, Ferla & Moraes 2002a), Pontes e Lacerda (Ferla & Moraes 2002a); São Paulo: Campinas (Chiavegato 1968), on *H. brasiliensis*; Itiquira, on *H. benthamiana* and *H. pauciflora* (Feres 2000).

Types: on *Citrus* (Rutaceae), Mexico, intercepted in Laredo, Texas, USA, deposited in USNM.

Remarks: species of broad geographical distribution, collected from many host plants; in rubber trees it occurs mostly on the lower side of the leaves, where it produces considerable amounts of silk; in Campinas, it was collected in yards of clones of rubber trees (Chiavegato 1968).

Tetranychus urticae Koch, 1836

Tetranychus urticae Koch, 1836: 10.

Acarus telarius Linnaeus; 1758: 616.

Tetranychus telarius (L.); Dugès, 1834: 15; synonymy according to Smith & Baker (1968).

Acarus sambuci Schrank, 1781: 521.

Tetranychus sambuci (Schrank); Koch, 1842: 37.

Epitetranychus sambuci (Schrank); Oudemans, 1931a: 194; synonymy according to Pritchard & Baker (1955).

Tetranychus dugesii; Cano & Alcacio, 1886: 197; synonymy according to Estebanes & Baker (1968).

Acarus textor; Fourcroy, 1785: 530.

Tetranychus textor (Fourcroy); Oudemans, 1929: 276; synonymy according to Pritchard & Baker (1955).

Tetranychus russeolus; Koch, 1838: 15; synonymy according to Pritchard & Baker (1955).

Tetranychus viburni; Koch, 1838: 17.

Schizotetranychus viburni; (Koch) Oudemans, 1937: 1061; synonymy according to Pritchard & Baker (1955).

Tetranychus fervidus; Koch, 1842: 21; synonymy according to Pritchard & Baker (1955).

Acarus cucumeris; Boisduval, 1867: 84.

Tetranychus cucumeris; (Boisduval) Murray, 1877: 102; synonymy according to Pritchard & Baker (1955).

Acarus rosarum; Boisduval, 1867: 84.

Tetranychus rosarum; (Boisduval) Murray, 1877: 102; synonymy according to Pritchard & Baker (1955).

Acarus cinnabarinus; Boisduval, 1867: 88

Tetranychus cinnabarinus; (Boisduval) Boudreaux, 1956; synonymy according to Dupont (1979).

Acarus haematodes; Boisduval, 1867: 88.

Tetranychus telarius haematodes; (Boisduval) Murray, 1877: 101; synonymy according to Smith & Baker (1968).

Acarus ferrugineus; Boisduval, 1867: 90.

Tetranychus ferrugineus; (Boisduval) Murray, 1877: 103; synonymy according to Pritchard & Baker (1955).

Acarus vitis; Boisduval, 1867: 92.

Tetranychus vitis; (Boisduval) Murray, 1877: 103; synonymy according to Pritchard & Baker (1955).

Distigmatus pilosus; Donnadieu, 1875: 118; synonymy according to Pritchard & Baker (1955).

Tetranychus major; Donnadieu, 1875: 120; synonymy according to Pritchard & Baker (1955).

Tetranychus piger; Donnadieu, 1875: 121; synonymy according to Pritchard & Baker (1955).

Tetranychus minor; Donnadieu, 1875: 121; synonymy according to Pritchard & Baker (1955).

Tetranychus longitarsus; Donnadieu, 1875: 122; synonymy according to Pritchard & Baker (1955).

Tetranychus plumistoma; Donnadieu, 1875: 122; synonymy according to Pritchard & Baker (1955).

Tetranychus fici; Murray, 1877: 107; synonymy according to Pritchard & Baker (1955).

Tetranychus eriostemi; Murray, 1877: 109; synonymy according to Pritchard & Baker (1955).

Tetranychus inaequalis; Targioni Tozzetti, 1878: 251; synonymy according to Pritchard & Baker (1955).

Tetranychus bimaculatus; Harvey, 1892: 133; synonymy according to Pritchard & Baker (1955).

Tetranychus altheae; von Hanstein, 1901: 74.

Epitetranychus altheae; (von Hanstein) Zacher, 1916: 23; synonymy according to Pritchard & Baker (1955).

Epitetranychus hamatus; Zacher, 1916: 25; synonymy according to Pritchard & Baker (1955).

Epitetranychus aequans; Zacher, 1916: 25; synonymy according to Pritchard & Baker (1955).

Epitetranychus alceae; Oudemans, 1928b: 290; synonymy according to Pritchard & Baker (1955).

Tetranychus reinwardtiae; Oudemans, 1930b: 170;

Epitetranychus reinwardtiae; (Oudemans) Oudemans, 1931a 194; synonymy according to Pritchard & Baker (1955).

Epitetranychus caldarii; Oudemans, 1931a: 194.

Tetranychus caldarii; (Oudemans) Geijskes, 1939: 40; synonymy according to Pritchard & Baker (1955).

Tetranychus fragariae; Oudemans, 1931a: 226; synonymy according to Pritchard & Baker (1955).

Tetranychus fransseni; Oudemans, 1931b: 227; synonymy according to Pritchard & Baker (1955).

Tetranychus aspidistrae; Oudemans, 1931c: 258; synonymy according to Pritchard & Baker (1955).

Tetranychus choisyae; Oudemans, 1931d: 274; synonymy according to Pritchard & Baker (1955).

Tetranychus stellariae; Oudemans, 1931d: 275; synonymy according to Pritchard & Baker (1955).

Tetranychus violae; Oudemans, 1931d: 277; synonymy according to Pritchard & Baker (1955).

Tetranychus manihoti; Oudemans, 1931d: 289; synonymy according to Pritchard & Baker (1955).

Eotetranychus inexpectatus; Andre, 1933: 131; synonymy according to Pritchard & Baker (1955).

Tetranychus dahliae; Oudemans, 1937: 1022; synonymy according to Pritchard & Baker (1955).

Eotetranychus scabrisetus; Ugarov & Nikolskii, 1937: 33; synonymy according to Pritchard & Baker (1955).

Eotetranychus cucurbitacearum; Sayed, 1946a: 90; synonymy according to Pritchard & Baker, 1955).

Tetranychus multisetis; McGregor, 1950: 294; synonymy according to Pritchard & Baker (1955).

Tetranychus arabicus; Attiah, 1967; synonymy according to Meyer (1987).

Tetranychus aduncus; Flechtmann, 1967: 20; synonymy according to Flechtmann & Baker (1970).

Tetranychus ricinus; Saba, 1973: 63; synonymy according to Meyer (1987).

Registers on *Hevea*: São Paulo: Olímpia (Bellini *et al. 2*005a), on *H. brasiliensis*.

Types: on nettle (*Fleurya aestuans* L., Urticaceae), Regensburg, Germany, type specimens probably lost .

Remarks: this is one of the most serious tetranychid pests; attacks cotton (*Gossypium herbaceum* L.), *Manihot* sp. (Euphorbiaceae) and bean (*Phaseolus vulgaris* L., Fabaceae) (Prichard & Baker 1955); registered on 912 host plants (Bolland *et al.*1998); in rubber trees, however, it was found in low number (Bellini *et al. 2*005a).

Tetranychus sp.

Registers on *Hevea*: São Paulo: São Jose do Rio Preto (Demite & Feres 2005), on *H. brasiliensis*.

Remarks: Bolland *et al.*(1998, pg 141) wrongly mentioned *H. brasiliensis* as host for the species *Paraponychus corderoi* (Baker & Pritchard, 1962) (C.H.W. Flechtmann, personal communication).

Tydeidae Kramer, 1877

Afrotydeus kenyensis (Baker, 1970)

Tydeus (*Afrotydeus*) *kenyensis* Baker, 1970: 165.

Tydeus kenyensis; Feres, 2000: 163.

Afrotydeus kenyensis; André, 1980: 106.

Registers on *Hevea*: São Paulo: Macaubal; Mato Grosso: Itiquira (Feres 2000), on *H. brasiliensis*.

Types: on coffee (*Coffea arabica* L., Rubiaceae), Kenya, deposited in BMNH.

***Homeopronematus* sp.**

Registers on *Hevea*: São Paulo: Olímpia (Bellini *et al.* 2005a), São Jose do Rio Preto (Demite & Feres 2005), Cedral (Hernandes & Feres 2006b); Goiás: Goianésia, on *H. brasiliensis*.

***Lorryia formosa* Cooreman, 1958**

Lorryia formosa Cooreman, 1958: 6; Baker, 1968a: 995.

Registers on *Hevea*: São Paulo: Cedral (Feres *et al.* 2002, (Hernandes & Feres 2006b), Olímpia (Bellini *et al.* 2005a), Pariquera-Açu (Zacarias & Moraes 2002), São Jose do Rio Preto (Demite & Feres 2005), Ibitinga; Mato Grosso: Itiquira (Feres 2000, Ferla & Moraes 2002a), Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Types: on *Citrus* sp. (Rutacea), Rhab, Morocco, deposited in IRSN.

Remarks: once considered harmful to citrus crops (Smirnoff 1957); collected from many host plants (Flechtmann 1973); exhibited reproduction by thelytoky when reared on rubber tree leaves, which is possibly the first case of thelytoky in Tydeoidea (Hernandes *et al.* 2006); collected in large population at the base of the leaves.

***Lorryia* spp.**

Registers on *Hevea*: São Paulo: Cedral (Hernandes & Feres 2006b), Olímpia (Bellini *et al.* 2005a), Pariquera-Açu (Zacarias & Moraes 2002), Piracicaba (Zacarias & Moraes 2002, Vis *et al.* 2006), Rio Claro (Flechtmann & Arleu 1984); Mato Grosso: Itiquira, Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Remarks: it may be more than one species; specimens from Rio Claro, Itiquira and Pontes e Lacerda were not examined.

***Melissotydeus* sp.**

Registers on *Hevea*: São Paulo: Olímpia (Bellini *et al.* 2005a), on *H. brasiliensis*.

***Neolorryia boycei* (Baker, 1944)**

Retetydeus boycei Baker, 1944: 78.

Lorryia boycei; Baker, 1968a: 1004; Feres, 2000: 163.

Neolorryia boycei; André, 1980: 127; Kazmierski, 1998: 350.

Registers on *Hevea*: São Paulo: Reginópolis (Feres 2000), on *H. brasiliensis*.

Types: on moss, Laguna de Zempoala, Morelos, Mexico, deposited in USNM.

***Neolorryia* sp.**

Registers on *Hevea*: São Paulo: Piracicaba (Vis *et al.* 2006), on *H. brasiliensis*.

***Parapronematus acaciae* Baker, 1965**

Parapronematus acaciae Baker, 1965: 116.

Registers on *Hevea*: São Paulo: Pariquera-Açu (Zacarias & Moraes 2002), Piracicaba (Zacarias & Moraes 2002, Vis *et al.* 2006), on *H. brasiliensis*.

Types: on *Acacia* sp. leaf (Fabaceae), Leopoldville, Belgian Congo, deposited in USNM.

***Parapronematus* spp.**

Registers on *Hevea*: São Paulo: José Bonifácio, Macaubal, Barretos (Feres 2000), Olímpia (Bellini *et al.* 2005a); Mato Grosso: Itiquira, Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*.

Remarks: it may be more than one species; specimens from Pontes e Lacerda were not examined.

***Pausia* sp.**

Registers on *Hevea*: São Paulo: Piracicaba (Vis *et al.* 2006), on *H. brasiliensis*.

***Pretydeus curiosa* (Ueckermann & Smith-Meyer, 1979)**

Lorryia curiosa Ueckermann & Smith-Meyer, 1979: 44.

Pretydeus curiosa; André, 1980: 143-144.

Registers on *Hevea*: São Paulo: Pariquera-Açu (Zacarias & Moraes 2002), on *H. brasiliensis*.

Types: on *Maytenus nemorosa* (Eckl. Zeyh.) Marais (Celastraceae), Matubatuba (Zululand), deposited in NCAPPRI.

***Pretydeus* sp.**

Registers on *Hevea*: São Paulo: Pariquera-Açu (Zacarias & Moraes 2002), Piracicaba (Vis *et al.* 2006), on *H. brasiliensis*.

***Pronematus ubiquitus* (McGregor, 1932)**

Tydeus ubiquitus McGregor, 1932: 62.

Pronematus ubiquitus; Thor, 1933: 46; Baker, 1939: 273; Baker, 1946: 255; Meyer & Rodriguez, 1966: 19; Baker, 1968b: 1093.

Registers on *Hevea*: São Paulo: Piracicaba (Vis *et al.* 2006), on *H. brasiliensis*.

Types: on *Citrus* sp. foliage (Rutaceae) , Linsay, California, USA, deposited in USNM.

***Pronematus* spp.**

Registers on *Hevea*: São Paulo: Cedral (Feres *et al.* 2002, Hernandes & Feres 2006b), Pindorama, Taquaritinga (Feres *et al.* 2002), Ibitinga, Macaubal, Pindorama, Reginópolis (Feres 2000), Olímpia (Bellini *et al.* 2005a), Piracicaba

(Zacarias & Moraes 2002, Vis *et al.* 2006), São Jose do Rio Preto (Demite & Feres 2005); Mato Grosso: Itiquira, Pontes e Lacerda (Ferla & Moraes 2002a), on *H. brasiliensis*; Itiquira (Feres 2000), on *H. benthamiana*.

Remarks: *Pronematus ubiquitus* was reported as predator of eriophyids (Baker & Wharton 1952); it may be more than one species; specimens from Itiquira and Pontes e Lacerda were not examined.

Pseudolorryia cf. *nicaraguensis*

Registers on *Hevea*: São Paulo: Piracicaba (Vis *et al.* 2006), on *H. brasiliensis*.

Triophtydeus spp.

Registers on *Hevea*: São Paulo: Piracicaba (Vis *et al.* 2006), Cedral, on *H. brasiliensis*.

Tydeus (*Tydeus*) *californicus* (Banks, 1904)

Tetranychoides californicus Banks, 1904: 54.

Tydeus californicus; Baker & Wharton, 1952: 192; Fleschner & Arakawa, 1953: 1092.

Tydeus (*Tydeus*) *californicus*; Baker, 1970: 174.

Registers on *Hevea*: São Paulo: Pariquera-Açu (Zacarias & Moraes 2002), on *H. brasiliensis*.

Types: on orange leaves (*Citrus* sp, Rutaceae), Watsonville, California, U.S.A., institution of deposition not found.

Tydeus (*Tydeus*) *costensis* Baker, 1970

Tydeus (*Tydeus*) *costensis* Baker, 1970: 174.

Registers on *Hevea*: São Paulo: Pariquera-Açu (Zacarias & Moraes 2002), on *H. brasiliensis*.

Types: on *Datura* sp. leaf (Solanacea), Birris, near Cartago, Costa Rica, deposited in USNM.

Tydeus sp.

Registers on *Hevea*: São Paulo: Monte Aprazível (Feres 2000); Campinas (Chiavegato 1968), on *H. brasiliensis*.

Remarks: in Campinas, it was collected in clones of rubber trees (Chiavegato 1968).

ACARIDIDA

Acaridae Ewing & Nesbitt, 1954

Caloglyphus sp.

Registers on *Hevea*: São Paulo: São Jose do Rio Preto (Demite & Feres 2005), on *H. brasiliensis*.

Neotropacarus sp.

Registers on *Hevea:* Mato Grosso: Itiquira (Ferla & Moraes 2002a); São Paulo: Piracicaba (Zacarias & Moraes 2002, Vis *et al.* 2006), Pariquera-Açu (Zacarias & Moraes 2002), on *H. brasiliensis*.

Tyrophagus putrescentiae (Schrank, 1781)

Acarus putrescentiae Schrank, 1781: 521.

Tyrophagus putrescentiae; Oudemans, 1924: 250; Feres 2000: 169.

Registers on *Hevea*: São Paulo: Barretos, Buritama, Pindorama, Reginópolis; Mato Grosso: Itiquira (Feres 2000), Goiás: Goianésia, on *H. brasiliensis*.

Types: institution of deposition, host and locality types not found.

Remarks: pest of culture medium, insect food in laboratories and stored food (Flechtmann 1986).

Tyrophagus sp.

Registers on *Hevea*: Mato Grosso: Itiquira (Ferla & Moraes 2002a), on *H. brasiliensis*.

Histiostomatidae Hughs, 1976

Unidentified species.

Registers on *Hevea*: São Paulo: Barretos, Buritama (Feres 2000), on *H. brasiliensis*.

Remarks: several species are found in wet environments, like exudations of wounded trees (Flechtmann 1975); only hypopus were collected.

Winterschmidtiidae Oudemans, 1923

Czenspinskia sp.

Registers on *Hevea*: São Paulo: Olímpia (Bellini *et al.* 2005a), Pariquera-Açu, Piracicaba (Zacarias & Moraes 2002), São Jose do Rio Preto (Demite & Feres 2005), Cedral (Hernandes & Feres 2006b), on *H. brasiliensis*.

Oulenzia sp.

Registers on *Hevea*: São Paulo: Cedral (Feres *et al.* 2002, Hernandes & Feres 2006b), Pariquera-Açu (Zacarias & Moraes 2002), Pindorama (Feres *et al.* 2002), Olímpia (Bellini *et al.* 2005a), Piracicaba (Vis *et al.* 2006), São Jose do Rio Preto (Demite & Feres 2005), Ibitinga; Mato Grosso: Itiquira (Feres 2000, Ferla & Moraes 2002a), on *H. brasiliensis*.

Remarks: *O. arboricola* (Oudemans) was described from *Hevea* leaves in Sumatra; specimens were also collected on jute, in India; reported as phytophagous (Baker & Wharton 1952).

ORIBATIDA

Oribatulidae Thor, 1929

***Spinoppia* sp.**

Registers on *Hevea*: São Paulo: Piracicaba (Vis *et al.* 2006), on *H. brasiliensis*.

Oripodidae Jacot, 1925

***Pirnodus* sp.**

Registers on *Hevea*: São Paulo: Piracicaba (Vis *et al.* 2006), on *H. brasiliensis*.

Unidentified spp.

Registers on *Hevea*: São José do Rio Preto (Demite & Feres 2005), Piracicaba (Vis *et al.* 2006).

Fifty four nominal species and about 50 unidentified species of mites were reported on rubber trees in Brazil. *Calacarus heveae* and *Tenuipalpus heveae* are economically important pests of that culture, reaching great populations at the end of the rainy season and beginning of the dry season. *Phyllocoptruta seringueirae*, being found in large populations in the State of Mato Grosso and São Paulo (Ferla & Moraes 2002a, Bellini *et al.* 2005a, R.J.F. Feres, pers. comm.), is another eriophyid mite that deserves attention.

Seven of the nominal species of mites reported in rubber trees in Brazil belong to Tetranychidae, which comprises agricultural pests for several crops. *Eutetranychus banksi* was registered in great abundance in several rubber tree crops, although no evident damage to the leaves has been noticed.

The family with greatest number of species was Phytoseiidae (2~~5~~7), with preponderantly predatory species (McMurtry & Croft 1997). Zacarias & Moraes (2001) reported nine phytoseiid species on rubber trees in the southern region of the State of São Paulo, suggesting they could be helping to maintain low the population levels of some mite pests. *Euseius citrifolius* was the phytoseiid most commonly found on rubber trees of São Paulo State.

Stigmaeidae is another family with very abundant predatory species, with at least ten species reported to date. Ferla & Moraes (2003b) observed high oviposition rate of *Agistemus floridanus* fed on *C. heveae* and *T. heveae*. However, due to the explosive populational increase and high abundance of these phytophagous in natural conditions, it is highly unlikely that *A. floridanus* can reduce significantly their population.

This work lists 31 sampling points in many States of Brazil (Figure 2). In most rubber tree plantations studied there were only a few isolated samplings (Baker 1945, Chiavegato 1968, Flechtmann & Arleu 1984, Fazolin & Pereira 1989, Flechtmann 1989, Vieira & Gomes 1999, Feres 2000, 2001), but as soon as a harmful pest as *C. heveae* was discovered, several works arose in order to understand the seasonal occurrence of mites on that culture. In some rubber tree plantations of the State of São Paulo the authors conducted samplings every season of the year (Feres *et al.* 2002). A few studies in the States of São Paulo and Mato Grosso conducted monthly samplings for a year of analysis (Bellini *et al.* 2005, Ferla & Moraes 2002). The study conducted in Cedral (Hernandes & Feres 2006b), northwestern region of the State of São Paulo, represents the first long term study of mites of rubber trees, considering three years of monthly samplings, and provides many information concerning the seasonal occurrence of mites.

Not surprisingly, most surveys of mites in rubber trees in Brazil were made in the São Paulo State (Figure 2), which responds to up to 60% of the national latex yield (Gonçalves *et al.* 2001). That disparity in relation to the number of studies conducted in other Brazilian States also reflects the greater number of researchers working on mites in that state.

Acknowledgements

To agricultural engineer José F.C. Benesi (APABOR, S.J. Rio Preto, São Paulo, Brazil), for collecting and sending the material from Goianésia, Goiás; M.Sc. Rodrigo Damasco Daud (UNESP, S.J. do Rio Preto, São Paulo, Brazil), for the assistance in identification of the material from Goianésia; Prof. Dr. Carlos H.W. Flechtmann (ESALQ-USP, Piracicaba, São Paulo, Brazil), Prof. Dr. Carlos Amadeu L. Oliveira (UNESP, Jaboticabal, São Paulo, Brazil), for valuable suggestions on the manuscript; to Dr. Antônio Carlos Lofego (IB-USP), Ronald Ochoa, Debra D. Creel and Barry O'Connor (USNM – Beltsville, Maryland, USA) for the valuable information concearning many holotype specimens. This work was partially supported by the State of São Paulo Research Foundation (FAPESP) within the BIOTA/FAPESP- Virtual Institute of Biodiversity Program (www.biota.org.br)- Proc. nº 98/7099-0 and the National Council for Scientific and Technological Development (CNPq)- Proc. nº 134081/2003-0.

References

ANDRÉ, H.M. 1980. A generic revision of the family Tydeidae (Acari: Actinedida). IV-Generic descriptions, keys and conclusions. Bull. Ann. Soc. R. Belge Ent. 116:103-107.

ANDRÉ, M. 1933. Note sur "l'Araigneé rouge" dês serres du Muséum. Bull. Mus, Natl. Hist. Nat. Paris (ser.2). 5:302-308.

APONTE, O. & McMURTRY, J.A. 1995. Revision of genus *Iphiseiodes* DeLeon (Acari: Phytoseiidae). Int. J. Acarol. 21:165-183.

ARRUDA FILHO, G.P.de & MORAES, G.J.de. 2003. Stigmaeidae mites (Acari: Raphgnathoidea) from Arecaceae of the Atlantic Forest in São Paulo State, Brazil. Neotrop. Entomol. 32:49-57.

ATTIAH, H.H. 1967c. Revision on the *Tetranychus telarius c*omplex in the U.A.R. with description of new species (Acarina: Tetranychidae). Bull. Soc. Entomol. Egypte. 51(7):7-10.

ATHIAS-HENRIOT, C. 1958. Contribution à la Connaissance du genre *Typhlodromus* Scheuten (Acariens, Parasitiformes, Phytoseiidae). Description de deux espèces nouvelles d'Algèrie et clé dês espèces du groupe *finlandicus*. Rev. Pathol. Veg. Entomol. Agric. 37:179-186.

BAKER, E.W. 1939. The fig mite, *Eriophyes ficus* Cotte, and other mites of the fig tree, *Ficus carica* Linn. Calif. Dep. Agr. 28 (4):266-275.

BAKER, E.W. 1944. Tideidos Mexicanos (Acari, Tydeidae). Rev. Soc. Mex. Hist. Nat. 5:73-81.

BAKER, E.W. 1945. Mites of the genus *Tenuipalpus* (Acarina: Trichadenidae). Proc. Entomol. Soc. Wash., 47:333-344.

BAKER, E.W. 1946. Some Tydeidae from the fig tree (*Ficus carica* L.). Anales Escuela Nac. Cienc. Biol. Mex. 4(2-3):255-261.

BAKER, E.W. 1949a. A review of the mites of the family Cheyletidae in the United States National Museum. Proc. U.S. Natl. Mus. 99:267-320.

BAKER, E.W. 1949b. The genus *Brevipalpus* (Acarina:Pseudoleptidae). Am. Midl. Nat. 42:350-402.

BAKER, E.W. 1965. A review of the genera of the family Tydeidae (Acarina). *In* Advances of Acarology. 2:95-120. Cornell Univ. Press, Ithaca.

BAKER, E.W. 1968a. The genus *Lorryia.* Ann. Entomol. Soc. Am. 61:986-1008.

BAKER, E.W. 1968b. The genus *Pronematus.* Ann. Entomol. Soc. Am. 61:1091-1097.

BAKER, E.W. 1970. The genus *Tydeus*: Subgenera and species groups with descriptions of new species (Acarina:Tydeidae). Ann. Entomol. Soc. Am. 63:163-177.

BAKER, E.W. & PRITCHARD, A.E. 1953. A review of the false spider mite genus *Tenuipalpus* Donnadieu (Acarina: Phytoptipalpidae). Ann. Entomol. Soc. Am. 46:317-336.

BAKER, E.W. & PRITCHARD, A.E. 1960. The tetranychoid mites of Africa. Hilgardia. 29:455-574.

BAKER, E.W. & PRITCHARD, A.E. 1962 (1963). Arañas rojas de America Central. Revta. Soc. Hist. Nat. 23:309-340.

BAKER, E.W. & TUTTLE, D.M. 1987. The false spider mites of Mexico (Tenuipalpidae: Acari). Tech. Bull. / U.S. Dep. Agric. 1706:1-237.

BAKER, E.W., TUTTLE, D.M. & ABBATIELLO, M.J. 1975. The false spider mites of northwestern and north central Mexico (Acarina:Tenuipalpidae). Smith. Contrib. Zool. 194:1-23.

BAKER, E.W. & WHARTON, G.W. 1952. An introduction to acarology. The McMillan CO, New York.

BANKS, N. 1904. Class III, Arachnida, Order I, Acarina, four new species of injurious mites. Jour. N.Y. Entomol. Soc. 12:53-56.

BANKS, N. 1917. New mites, mostly economic (Arach., Acar.). Ent. News. 28:193-199.

BEER, R.E. & NUCIFORA, A. 1965. Revisione dei generi della famiglia Tarsonemidae (Acarina). Boll. Zool. Agric. Bachic. Ser. 2. 7:19-43.

BELLINI, M.R., MORAES, G.J. de & FERES, R.J.F. 2005a. Ácaros (Acari) de dois sistemas comuns de cultivo de seringueira no noroeste do Estado de São Paulo. Neotrop. Entomol. 34:475-484.

BELLINI, M.R., MORAES, G.J. de & R.J.F. FERES. 2005b. Plantas de ocorrência espontânea como substrato alternativo para fitoseídeos (Acari: Phytoseiidae) em cultivos de seringueira (*Hevea brasiliensis* Muell. Arg., Euphorbiaceae). Rev. Bras. Zool. 22(1):35-42.

BLANCHARD, E. 1940. Tres acaros daninos para los cultivos argentinos. Rev. Fac. Agron. La Plata (ter epoca) 24: 11-18.

BOISDUVAL, A. 1867. Essay sur L'entomologie horticole. Paris.

BOLLAND, H.R., GUTIERREZ, J. & FLECHTMANN, C.H.W. 1998. World catalog of the spider mite family (Acari: Tetranychidae). Brill, Leiden.

BOUDREAUX, H.B. 1956. New species of Tetranychid mites. Pan. Pac. Ent. 30:181-186.

BUOSI, R., FERES, R.J.F., OLIVEIRA, A.R., LOFEGO, A.C. & HERNANDES, F.A. 2006. Ácaros plantícolas (Acari) da "Estação Ecológica de Paulo de Faria", Estado de São Paulo, Brasil. Biota Neotropica 6:(no prelo)

CANO, Y. & ALCACIO, D. 1886. Una nueva especie de Arana Mexicana, *Tetranychus dugesii*. Naturaleza. 7: 197-200.

CHAGAS, C.M. 1973. Associação do ácaro *Brevipalpus phoenicis* (Geijskes) à mancha anular do cafeeiro. Biológico. 39:229-232.

CHANT, D.A. 1955. Notes on the mites of the genus *Typhlodromus* Scheuten, 1857 (Acarina: Laelaptidae), with descriptions of the males of some species and the female of a new species. Can. Entomol. 87:496-503.

CHANT, D.A. 1959. Phytoseiid mites (Acarina: Phytoseiidae). Part I. Bionomics of seven species in southeastern England. Part II. A taxonomic review of the family Phytoseiidae, with descriptions of thirty-eight new species. Can. Entomol. Suppl. 12:166p.

CHANT, D.A. & BAKER, E.W. 1965. The Phytoseiidae (Acarina) of Central America. Mem. Entomol. Soc. Canada. 41: 1-56.

CHANT, D.A. & McMURTRY, J.A. 1994. A review of the subfamilies Phytoseiinae and Typhlodrominae (Acari: Phytoseiidae). Int. J. Acarol. 20:223-310.

CHANT, D.A. & YOSHIDA-SHAUL, E. 1983. A world review of five similar species groups in the genus *Typhlodromus* Scheuten. Part II. The *conspicuus* and *cornus* groups (Acarina:Phytoseiidae). Can. J. Zool. 61:1041-1057.

CHANT, D.A. & YOSHIDA-SHAUL, E. 1984. A world review of the *occidentalis* species group in the genus *Typhlodromus* Scheuten (Acarina: Phytoseiidae). Can. J. Zool. 62:1860-1871.

CHANT, D.A. & YOSHIDA-SHAUL, E. 1986. A new subfamily, Cydnodromellinae, in the family Phytoseiidae (Acarina: Gamasina). Can. J. Zool. 64:2811-2823.

CHIAVEGATO, LG. 1968. Contribuição para o conhecimento de alguns ácaros que ocorrem na seringueira (*Hevea brasiliensis* Muell. Arg.). I Reunião Anual Soc. Bras. Entomol. p. 67.

CHIAVEGATO, LG. 1980. Ácaros da cultura dos citros, p.469-501. *In*: Rodriguez, O. & F.C.P. Viégas (Ed.). Citricultura Brasileira. Fundação Cargill. Campinas. p.1-739.

CHILDERS, C.C., KITAJIMA, E.W., WELBOURN, W.C., RIVERA, C. & OCHOA, R. 2001. *Brevipalpus* mites on citrus and their status as vectors of citrus leprosis. Manejo Integr. Plagas. 60:66-70.

COOREMAN, J. 1958. Notes et observations sur les Acariens. VII- *Photia graeca* n.sp. (Acaridia, Canestriniidae) et *Lorryia formosa* n. sp. (Stomatostigmata, Tydeydae). Bull. Inst. R. Sci. Nat. Belg. Sci. Entomol. 34:1-10.

DAUD, R.D. & FERES, R.J.F. 2005. Diversidade e flutuação populacional de ácaros (Acari) em *Mabea fistulifera* Mart. (Euphorbiaceae) de dois fragmentos de mata estacional semidecídua em São José do Rio Preto, São Paulo, Brasil. Neotrop. Entomol. 34 (2):191-201.

DELEON, D. 1957. Three new *Typhlodromus* from southern Florida (Acarina: Phytoseiidae). Fla. Entomol. 40:141-144.

DELEON, D. 1958. Four new *Typhlodromus* from southern Florida (Acarina: Phytoseiidae). Fla. Entomol. 41:73-76.

DELEON, D. 1961. The genus *Brevipalpus* in Mexico. Part II (Acarina:Tenuipalpidae). Fla. Entomol. 44:41-52.

DELEON, D. 1962. Twenty-three new Phytoseiidae, mostly from southeastern United States (Acarina: Phytoseiidae). Fla. Entomol. 45:11-27.

DELEON, D. 1966. Phytoseiidae of British Guyana with keys to species (Acarina: Mesostigmata). Studies the Fauna of Suriname and other Guyanas, 8: 81-102.

DELEON, D. 1967. Some mites of the Caribbean Area. Part I. Acarina on plants in Trinidad, West Indies. Allen Press Inc., Lawrence.

DEMITE, P.R. & FERES, R.J.F. 2005. Influência de vegetacão vizinha na distribuicão de acaros em seringal (*Hevea brasiliensis* Muell. Arg., Euphorbiaceae) em São Jose do Rio Preto, SP. Neotrop. Entomol. 34(5):829-836.

DENMARK, H. A. 1982. Revision of *Galendromus* Muma, 1961 (Acarina: Phytoseiidae). Int. J. Acarol. 8:133-167.

DENMARK, H.A. & MUMA, M.H. 1970. Some phytoseiid mites of Paraguay (Phytoseiidae: Acarina). Fla. Entomol. 53:219-227.

DENMARK, H.A. & MUMA, M.H. 1972. Some Phytoseiidae of the Colombia (Acarina : Phytoseiidae). Fla. Entomol. 55:19-29.

DENMARK, H.A. & MUMA, M.H. 1973. Phytoseiid mites of Brazil (Acarina: Phytoseiidae). Rev. Bras. Biol. 33:235-276.

DENMARK, H.A. & MUMA, M.H. 1989. A revision of the genus *Amblyseius* Berlese, 1914 (Acari: Phytoseiidae). Occ. Pap. Florida St. Coll. Arthropods 4:1-149.

DONNADIEU, A.L. 1875. Recherches pour servir à l'historie dês Tétranyques. Ann. Soc. Lyon. 12:1-134.

DUGES, A. 1834. Recherches sur l'orde des Acariesn em general at le famille des Trombidies in particular. An. Sci. Nat. Paris (ser. 2) 1:5-46.

DUPONT, L.M. 1979. On gene flow between *Tetranychus urticae* Koch, 1836 and *Tetranychus cinnabarinus* (Boisduval) Boudreaux, 1956 (Acari: Tetranychidae): synonomy between the two species. Entomol. Exp.Appl. 25:297-303.

EHARA, S. 1993. Two new species of the genus *Agistemus* Summers from Malasya (Acari, Stigmaeidae). Jour. Acarol. Soc. Jpn. 2:79-82.

EL-BENHAWY, E.M. 1984. Description of some Phytoseiidae mites from Brazil (Acarina: Phytoseiidae). Acarologia 25:125-144.

ESTEBANES, & BAKER, E.W. 1968. Aranas rojas de Mexico (Acarina: Tetranychidae). Ann. Esc. Nac. Mex. 15:61-133.

EWING, H. E. 1939. A revision of the mites of the subfamily Tarsoneminae of North America, the West Indies and Hawaiian Islands. Tech. Bull. / U.S. Dep. Agric. (653):1-63.

FAIN, A., BOCHKOV, A.V. & CORPUZ-RARUS, L.A. 2002. A revision of the *Hemicheyletia* generic group (Acari: Cheyletidae). Bull. Inst. Roy. Sci. Nat. 72:27-66.

FARIAS, A.R., FLECHTMANN, C.H.W., MORAES, G.J. de & McMURTRY, J.A. 1981. Predadores do ácaro verde da mandioca, no nordeste do Brasil. Pesqui. Agropecu. Bras. 16:313-317.

FAZOLIN, M. & PEREIRA, L.V. 1989. Ocorrência de *Oligonychus gossypii* (Zacher 1921) (Acari:Tetranychidae) em seringueiras cultivadas. An. Soc. Entomol. Bras. 18:199-202.

FERES, R.J.F. 1992. A new species of *Calacarus* Keifer (Acari, Eriophyidae, Phyllocoptinae) from *Hevea brasiliensis* Muell. Arg. (Euphorbiaceae) from Brazil. Int. J. Acarol. 18:61-65.

FERES, R.J.F. 1998. Two new Phyllocoptinae mite (Acari: Eriophyidae) from *Hevea brasiliensis* Muell. Arg. (Euphorbiaceae) from Brazil. Int. J. Acarol. 24:69-74.

FERES, R.J.F. 2000. Levantamento e observações naturalísticas da acarofauna (Acari, Arachnida) de seringueiras cultivadas (*Hevea* spp., Euphorbiaceae) no Brasil. Rev. Bras. Zool. 17: 157-173.

FERES, R.J.F. 2001a. Primeiro registro de ácaros eriofiídeos (Acari, Eriophyidae) em seringueiras (*Hevea brasiliensis* Muell. Arg., Euphorbiaceae) da Floresta Amazônica, Brasil. Rev. Bras. Zool. 18:343 – 345.

FERES, R.J.F. 2001b. Ácaros eriofiídeos (Acari, Eriophyidae) em seringueira (*Hevea brasiliensis* Muell. Arg., Euphorbiaceae) no Brasil, p.31-36, *In* Sa, L.A.N. & Moraes, G.J. (orgs). Ácaros de importância quarentenária. Embrapa Meio Ambiente, Jaguariúna.

FERES, R.J.F. & MORAES, G.J. de. 1998. Phytoseiid mites (Acari: Phytoseiidae) from wood areas in the State of São Paulo, Brazil. Syst. Appl. Acarol. 3:125-132.

FERES, R.J.F. & NUNES, M.A. 2001. Ácaros (Acari, Arachnida) associados a euforbiáceas nativas em áreas de cultivo de seringueiras (*Hevea brasiliensis* Muell. Arg., Euphorbiaceae) na região noroeste do Estado de São Paulo, Brasil. Rev. Bras. Zool. 18:1253-1264.

FERES, R.J.F., ROSSA-FERES, D. de C., DAUD, R.D. & SANTOS, R.S. 2002. Diversidade de ácaros (Acari, Arachnida) em seringueiras (*Hevea brasiliensis* Muell. Arg., Euphorbiaceae) na região noroeste do Estado de São Paulo, Brasil. Rev. Bras. Zool. 19:137-144.

FERLA, N.J. & MORAES, G.J. de. 2002a. Ácaros (Arachnida, Acari) da seringueira (*Hevea brasiliensis* Muell. Arg.) no Estado do Mato Grosso, Brasil. Rev. Bras. Zool. 19:867-888.

FERLA, N.J. & MORAES, G.J. de. 2002b. Ácaros predadores (Acari) em plantas nativas e cultivadas do Estado do Rio Grande do Sul, Brasil. Rev. Bras. Zool. 19:1011-1031.

FERLA, N.J. & MORAES, G.J. de. 2003a. Ciclo biológico de *Calacarus heveae* Feres, 1992 (Acari, Eriophyidae). Rev. Bras. Entomol. 47:399-402.

FERLA, N.J. & MORAES, G.J. de. 2003b. Oviposição dos ácaros predadores *Agistemus floridanus* Gonzalez, *Euseius concordis* (Chant) e *Neoseiulus anonymus* (Chant & Baker) (Acari) em resposta a diferentes tipos de alimentos. Rev. Bras. Zool. 20:153-155.

FLECHTMANN, C.H.W. 1967. Contribuição para o conhecimento dos ácaros de plantas de algumas regiões do estado de São Paulo. Tese de Doutoramento, ESALQ-USP, Piracicaba. p.1-47.

FLECHTMANN, C.H.W. 1973. *Lorryia formosa* Cooreman, 1958 – Um ácaro dos citros pouco conhecido no Brasil. Cienc. Cult. 25:1179-1181.

FLECHTMANN, C.H.W. 1975. Elementos de Acarologia. Livraria Nobel S.A, São Paulo.

FLECHTMANN, C.H.W. 1979. *Tuckerella ornata* (Tucker), um ácaro novo para o Brasil e outros Tetranychoidea (Acari) do Estado do Pará. Na. Esc. Sup. Agric. "Luiz de Queiroz", Piracicaba. 36:615-620.

FLECHTMANN, C.H.W. 1986. Ácaros em produtos armazenados e na poeira domiciliary. FEALQ, Piracicaba.

FLECHTMANN, C.H.W. 1989. Seringueira (*Hevea* sp.) um novo hospedeiro para *Oligonychus gossypii* (Zacher, 1921) (Acari: Tetranychidae). Bol. Mus. Emílio Goeldi, Ser. Zool. 5: 27-128.

FLECHTMANN, C.H.W. & ABREU, J.M. 1973. Ácaros fitófagos do Estado da Bahia, Brasil. Cienc. Cult. 25:244-251.

FLECHTMANN, C.H.W. & ARLEU, R.J. 1984. *Oligonychus coffeae* (Nietner, 1981), um ácaro tetraniquídeo da seringueira (*Hevea brasiliensis*) novo para o Brasil e observações sobre outros ácaros desta planta. Ecossistema 9:123-125.

FLECHTMANN, C.H.W. & BAKER, E.W. 1970. A preliminary report on the Tetranychidae (Acarina) of Brazil. Ann. Entomol. Soc. Am. 63:156-163.

FLECHTMANN, C.H.W. & BAKER, E.W. 1975. A report on the Tetranychidae (Acari) of Brazil. Rev. Bras. Entomol. 19:111-122.

FLESCHNER, C.A. & ARAKAWA, K.Y. 1953. The mite *Tydeus californicus* on citrus and avocado leaves. J. Econ. Entomol. 45(6):1092

FOURCROY, A.F. de. 1785. Entomolgia Parisiensis, 1:1-231; 2:233-544.

GARMAN, P. 1958. New species belonging to the genera *Amblyseius* and *Amblyseiopsis* with keys to *Amblyseius*, *Amblyseiopsis* and *Phytoseiulus*. Ann. Ent. Soc. Am. 51:69-79.

GEIJSKES, D.C. 1939. Beitraege zur Kenntnis der europeaischen Spinnmilben (Acari, Tetranychidae), mit besonderer Beruecksichtigung der niederlaendischen Arten. Meded. Landbouwhoogesch. Wagening. 42:1-68.

GONÇALVES, P.S., BATAGLIA, O.C., ORTOLANI, A.A. & FONSECA. F.S. 2001. Manual de heveicultura para o Estado de São Paulo. Boletim Técnico IAC. 189. Campinas.

GONDIM Jr., M.G.C. & MORAES, G.J. de. 2001. Phytoseiid mites (Acari: Phytoseiidae) associated with palm trees (Arecaceae) in Brazil. Syst. Appl. Acarol. 6:65-94.

GONZALEZ-RODRIGUEZ, H. 1965. A taxonomic study of the genera *Mediolata*, *Zetzellia* and *Agistemus* (Acarina: Stigmaeidae). Univ. Calif. Public. Entomol. 41:1-64.

GONZALEZ-RODRIGUEZ, H. 1975. Revision of the *Brevipalpus phoenicis* "complex", with descriptions of new species from Chile and Thailand (Acarina, Tenuipalpidae). Acarologia 17:82-91.

GUTIERREZ, J. 1968. Tetranychidae nouveaux de Madagascar (Quatrième note). Acarologia. 10:1-28.

HANSTEIN, R.V. 1901. Beitrage zur Kenntnis der Gattung Tetranychus Duf. Zts. Wiss. Zool. 70:58-108.

HARVEY, F.L. 1892. The two-spotted mite. Ann. Rept. Maine Agric. Exp. Sta. 133-144.

HERNANDES, F.A. & R.J.F. FERES. 2005a. Two new species of *Zetzellia* Oudemans (Acari: Stigmaeidae) that threaten the concept of genera: disgeneric marriage? Zootaxa. 1048:27–44.

HERNANDES, F.A. & R.J.F. FERES. 2006a. *Tetrabdella neotropic*a (Acari: Bdellidae), new genus and species from Brazil. Zootaxa. 1135:57-68.

HERNANDES, F.A. & R.J.F. FERES. 2006b. Diversidade e sazonalidade de ácaros (Acari) em seringal (*Hevea brasiliensis* Muell. Arg.) na regiao Noroeste do Estado de São Paulo. Neotrop. Entomol. 35 (in press).

HERNANDES, F.A., FERES, R.J.F. & NOMURA, F. 2006. Biological cycle of *Lorryia formosa* Cooreman, 1958 (Acari: Tydeidae) in rubber tree leaves. Exp. Appl. Acarol. (in press)

HIRSCHMANN, W. 1962. Gangsystematik der Parasitiformes. Acarol. Schrift. Verg. Milb., Hirschmann-Verlag, Furth/Bay. 5:1-80.

HIRST, S. 1923. On some new or little-known species of Acari. Proc. Zool. Soc. Lond. 1923:971-1000.

HIRST, S. 1926. Descriptions of new mites including four new species of "red spider". Proc. Zool. Soc. London. 1926:825-841.

KALISZEWSKI, M. 1993. Key to Paleartic females of the genus *Tarsonemus*. Wydawnictwo Naukowe Uniwersytet Im. Adama Mickiewica w Poznaniu, Poznan, Seria Zoologia 14:1-204.

KAZMIERSKI, A. 1998. Tydeidae of the world: generic relationships, new and redescribed taxa and keys to all species. A revision of the subfamilies Pretydeinae and Tydeinae (Acari: Actinedida: Tydeidae) - part 4. Acta Zool. Cracov. 41:283-455.

KLEIN, H.Z. 1936. Contributions to the knowledge of the red spiders in Palestine. Bull. Agr. Sta. Rehoroth. 21:1-63.

KOCH, C.L. 1836. Deutsche Crustacea, Myriapoda, Arachnida. Fasc. 1.

KOCH, C.L. 1838. Deutsche Crustacea, Myriapoda, Arachnida. Fasc. 17.

KOCH, C.L. 1842. Uebersicht des Arachnidensystems, 3:1-131, Nurnberg, Germany.

KREITER, S. & MORAES, G.J. de. 1997. Phytoseiid mites (Acari: Phytoseiidae) from Guadeloupe and Martinique. Fla. Entomol. 80:376-382.

LINNAEUS, C. 1758. Systema Naturae, Ed. X. (Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus I. Editio decima, reformata.) Holmiae. Systema Nat. ed. 10 i-ii + 1-824.

LOFEGO, A.C., MORAES, G.J. de & McMURTRY, J.A. 2000. Three new species of phytoseiid mites (Acari: Phytoseiidae) from Brazil. An. Soc. Entomol. Bras. 29:461-467.

MATIOLI, A.L., UECKERMANN, E.A. & OLIVEIRA, C.A.L. de. 2002. Some Stigmaeid and Eupalopsellid mites from citrus orchards in Brazil (Acari: Stigmaeidae and Eupalopsellidae). Int. J. Acarol. 28:99-120.

McGREGOR, E.A. 1914. Four new tetranychids. Ann. Entomol. Soc. Am. 7: 354-364.

McGREGOR, E.A. 1917. Descriptions of seven new species of red spiders. Proc. U.S. Natl. Mus. 51:581-590.

McGREGOR, E.A. 1919. The red spiders of America and a few European species likely to be introduced. Proc. U.S. Nat. Mus. 56: 641-679.

McGREGOR, E.A. 1932. The ubiquitous mite, a new species on citrus. Proc. Entomol. Soc. Wash. 34:60-63.

McGREGOR, E.A. 1935. The Texas citrus mite, a new species. Proc. Ent. Soc. Wash. 37:161-165.

McGREGOR, E.A. 1950. Mites of the family Tetranychidae. Am. Midl. Nat. 44:257-420.

McMURTRY, J.A. 1983. Phytoseiidae mites from Guatemala, with descriptions of two new species and redefinitions of the genera *Euseius*, *Typhloseiopsis*, and *Typhlodromus occidentalis* species group (Acari: Mesostigmata). Int. J. Acarol. 25:249-272.

McMURTRY J.A. & MORAES, G.J. de. 1989. Some phytoseiid mites from Peru with descriptions of four new species (Acari: Phytoseiidae). Int. J. Acarol. 15:179-188.

McMURTRY, J.A. & CROFT, B.A. 1997. Life-styles of phytoseiid mites and their roles in biological control. Annu. Rev. Entomol. 42:291-321.

McMURTRY, J.A. & HUFFAKER, C.B. & DRIE, Van De. 1970. Ecology of tetranychid mites and their natural enemies: a review. 1. Tetranychid enemies: their biological characters and the impact of spray practices. Hilgardia. 40:331-390.

MEYER, M.K.P.S. 1974. A revision of the Tetranychidae of Africa (Acari) with a key to the genera of the world. Entomology Mem. Dep. agric. tech. Serv. Repub. S. Afr. 36:1-291.

MEYER, M.K.P.S. 1979. The Tenuipalpidae (Acari) of Africa with keys to the world fauna. Entomology Mem. Dep. agric. tech. Serv. Repub. S. Afr. 50:1-135.

MEYER, M.K.P.S. 1987. African Tetranychidae (Acari: Prostigmata), with reference to the world genera. Entomology Mem. Dep. Agric. Wat. Supply Repub. S. Afr. 69:1-175.

MEYER, M.K.P.S. & RODRIGUES, M. da C. 1965. Acari associated with cotton in Southern Africa (with reference to other plants). Garcia Orta. Ser. Zool. 13:195-226.

MEYER, M.K.P.S. & UECKERMANN, E.A. 1989. African Raphgnathoidea (Acari: Prostigmata). Tech. Commun./ Dep. Agric. Water Supply, Repub. S. Afr. 74:1-58.

MORAES, G.J. de, ALENCAR, J.A. & WENZEL NETO, F. 1988. Exploitations for natural enemies of the cassava green mite in Brazil. *In*: Proc. Symp. Int. Soc. Trop. Root Crops 8th: 351-353.

MORAES, G.J. de, DENMARK, H.A. & GUERRERO, J.M. 1982. Phytoseiid mites of Colombia (Acarina: Phytoseiidae). Int. J. Acarol. 8:15-22.

MORAES, G.J de, KREITER, S. & LOFEGO, A.C. 1999 (2000). Plant mites (Acari) of the French Antilles. 3. Phytoseiidae (Gamasida). Acarologia 40:237-264.

MORAES, G.J. de & McMURTRY, J.A. 1983. Phytoseiid mites (Acarina) of northeastern Brazil with descriptions of four new species. Int. J. Acarol. 9:131-148.

MORAES, G.J. de, McMURTRY, J.A. & DENMARK, H.A. 1986. A catalog of the mite family Phytoseiidade. References to taxonomy, synonymy, distribution and habitat. EMBRAPA-DDT, Brasília.

MORAES, G.J. de, McMURTRY, J.A. & DENMARK, H.A. 2004. A revised catalog of the mite family Phytoseiidae. Zootaxa. 434: 1-494.

MORAES, G.J. de, & MESA, N.C. 1988. Mites of the family Phytoseiidae (Acari) in Colombia, with descriptions of three new species. Int. J. Acarol. 14:71-88.

MORAES, G.J. de, MESA, N.C. & BRAUN, A. 1991. Some phytoseiid mites of Latin America (Acari: Phytoseiidae). Int. J. Acarol. 17:117-139.

MORAES, G.J. de & OLIVEIRA, J.V. 1982. Phytoseiid mites of coastal Pernambuco in northeastern Brazil. Acarologia 23:315-318.

MUMA, M.H. 1961. Subfamilies, genera, and species of Phytoseiidae (Acarina: Mesostigmata). Bull. Florida St. Mus. Biol. Sci. 5:267-302.

MUMA, M.H. 1963. The genus *Galendromus* Muma, 1961 (Acarina: Phytoseiidae). Fla. Entomol. 1:15-41.

MUMA, M.H. 1964. Cheyletidae (Acarina: Trombidiformes) associated with citrus in Florida. Fla. Entomol. 47:239-253.

MUMA, M.H. & DENMARK, H.A. 1968. Some generic descriptions and name changes in the family Phytoseiidae (Acarina: Mesostigmata). Fla. Entomol. 51:229-240

MUMA, M.H., DENMARK, H.A. & DELEON, D. 1970. Phytoseiidade of the Florida. Arthropods of Florida and neighboring land areas, 6. Florida Department of Agriculture and Consume Services, Division of Plant Industry, Gainesville.

MURRAY, A. 1877. Economic Entomology, Aptera. Chapman & Hall. London.

NESBITT, J. 1951. A taxonomic study of the Phytoseiinae (Family Laelapidae) Predaceous upon Tetranychidae of economic importance. Zool. Verhandei. 12:1-64.

NIETNER, J. 1861. Observations on the enemies of the coffee tree in Ceylon. Ceylon, 31 p.

OOMEN, P.A. 1982. Studies on population dynamics of the scarlet mite, *Brevipalpus phoenicis*, a pest of tea in Indonesia. Medelingen Landbouwhogeschool. 82:1-88.

OUDEMANS, A.C. 1924. Acarologische Aanteekeningen. 74. Entomol. Ber. Amst. 6:249-260.

OUDEMANS, A.C. 1928. Acarologische Aanteekeningen. 89. Entomol. Ber. Amst. 7:285-293.

OUDEMANS, A.C. 1929. Acarologische Aanteekeningen. 98. Entomol. Ber. Amst. 7:476-485.

OUDEMANS, A.C. 1930. Acarologische Aanteekeningen. 105. Entomol. Ber. Amst. 8:157-172.

OUDEMANS, A.C. 1931a. Acarologische Aanteekeningen. 106. Entomol. Ber. Amst. 8:189-204.

OUDEMANS, A.C. 1931b. Acarologische Aanteekeningen. 107. Entomol. Ber. Amst. 8:221-236.

OUDEMANS, A.C. 1931c. Acarologische Aanteekeningen. 108. Entomol. Ber. Amst. 8:251-263.

OUDEMANS, A.C. 1931d. Acarologische Aanteekeningen. 109. Entomol. Ber. Amst. 8:272-280.

OUDEMANS, A.C. 1937. Kritisch Historich Overzicht der Acarologie. 3 C. 1:1-1348.

PONTIER, K.J; FLECHTMANN, C.H.W. 1999. Description of male *Tenuipalpus heveae* Baker, 1945 (Acari, Prostigmata, Tenuipalpidae). Int. J. Acarol. 25(4):293-296.

PONTIER, K.J; FLECHTMANN, C.H.W. 2000. Description of the immature stages of *Tenuipalpus heveae* Baker, 1945 (Acari, Prostigmata, Tenuipalpidae). Syst. Appl. Acarol. 5:77-81.

PONTIER, K.J.B., MORAES, G.J. de & KREITER, S. 2000. Biology of *Tenuipalpus heveae* (Acari, Tenuipalpidae) on rubber tree leaves. Acarologia. 41:423-427.

PRITCHARD, A.E. & BAKER, E.W. 1955. A revision of the spider mite family Tetranychidae. Pacific Coast Entomological Society. Memoirs series vol.2, San Francisco.

PRITCHARD, A.E. & BAKER, E.W. 1958. The false spider mites (Acarina: Tenuipalpidae). Univ. Calif. Publ. Entomol. 14:175-274.

RAHAMAN, K.A. & SAPRA, A.N. 1940. Mites of the family Tetranychidae from Lyallpur with descriptions of four new species. Proc. Ind. Acad. Sci. (ser. B). 11:177-196.

RAKHA, M.A. & McCOY, 1984. Eupalopsellid mites on Florida citrus, with a description of *Exothorhis caudata* Summers development stages (Eupalopsellidae: Raphnathoidea). Fla. Entomol. 68(1):141-144.

REIS, P.R., CHIAVEGATO, L.G., ALVES, E.B. & SOUZA, E.O. 2000. Ácaros da família Phytoseiidae associados aos citros no município de Lavras, sul de Minas Gerais. An. Soc. Entomol. Brasil. 29:95-104.

RIMANDO, L.C. & CORPUZ-RAROS, L.A. 1996. Some Philipine Raphgnathoidea (Acari) – I. Genera *Paraeupalopsellus* and *Exothorhis* (Eupalopsellidae). Phil. Entomol. 10(2):97-117.

RODRIGUES, M. Da C. 1968. Acarina de Moçambique - Catálogo das espécies relacionadas com a agricultura. Agron. Moçamb. 2:215-256.

SABA, F. 1973. Les acariens nuisibles aux plantes cultivees au Moroc. Al Awamia. 49(3):69-97.

SATO, M.E., RAGA, A., CERÁVOLO, L.C., ROSSI, A.C. & POTENZA, M.R. 1994. Ácaros predadores em pomar cítrico de Presidente Prudente, Estado de São Paulo. An. Soc. Entomol. Bras. 23:435-441.

SAYED, M.T. 1946a. Description of *Tenuipalpus granati* nov. spec. and *Brevipalpus pyri* nov. spec. 1er Ent. Bull. Soc. Fouad. 1er 30:99-104.

SAYED, M.T. 1946b. Contribution to the knowledge of the Acarina of Egypt: V-Five new species of Tetranychidae. Bull. Soc. Fouad. Ier Ent. 30:79-97.

SAYED, M.T. 1946c. The genus *Anychus* McGregor in Egypt and the Sudan. Bull. Soc. Fouad. Ier Ent. 30:143-148.

SCHICHA, E. & ELSHAFIE, M. 1980. Four new species of phytoseiid mites from Austrália, and three species from América redescribed (Acari: Phytoseiidae). Jour. Aust. Entomol. Soc. 19:27-36.

SCHRANK, F. von de P. 1781. Enumeratio Insectorum Austriae Indigenorum. Ausgutae Vindelicorum. Augsburg.

SMILEY, R. L. 1969. Further studies on the Tarsonemidae, II (Acarina). Proc. Entomol. Soc. Wash. 71:218-229.

SMILEY, R.L. 1967. Some Tarsonemidae of the Republic of the Congo (Acarina). Proc. Entomol. Soc. Wash. 66:145-150.

SMIRNOFF, W.A. 1957. An undescribed species of *Lorryia* (Acarina, Tydeidae) causing injury to citrus trees in Morocco. J. Econ. Entomol. 50:36-362.

SMITH, F.F. & BAKER, E.W. 1968. Names of the two-spotted spider mite and the carmine spider mite to be redesigned. Co-op. Econ. Insect. Rep. USDA. 18:1-1080.

SUMMERS, F.F. 1960. *Eupalopsis* and eupalopsellid mites (Acarina: Stigmaeidae, Eupalopsellidae). Fla. Entomol. 43:119-138.

SUMMERS, F.M. & D.W. PRICE. 1970. Revision of the family Cheyletidae. Univ. Calif. Publ. Entomol. 61:1-153.

SWIFT, S.F. 1997. First records of mites in the family Eupalopsellidae (Acari: Prostigmata: Raphignathoidea) in the Hawaiian Islands. Bishop Mu.Occ.Pap. 49:39-41.

TANZINI, M.R.; ALVES, S.B.; TAMAI, M.A.; MORAES, G.J. de; FERLA, N.J. 1999. An epizootic of *Calacarus heveae* (Acari: Eriophyidae) caused by *Hirsutella thompsonii* on rubber trees. Exp. Appl. Acarol. 24: 141-144.

TARGIONI TOZZETTI, A. 1878. Relazione intorno ai lavori della Stazione di Entomologia agraria di Firenze per l’anno 1876. Acaridei. Ann. Agr. 1:242-275.

THOR, S. 1933. Acarina Tydeidae, Ereynetidae. Tierreich. 60:1-82.

TUCKER, R.W.E. 1926. Some South Africa mites. Mainly Tetranychidae and Eriophyidae. Union S. Africa Dept. Agr. Div. Ent. Mem. 5:3-15.

UECKERMANN, E.A. & SMITH-MEYER, M.K.P. 1979. African Tydeidae (Acari). I. The genus *Lorryia* Oudemans, 1925. Phytophylactica. 11:43-50.

UGAROV, A.A. & NIKOLSKII, V.V. 1937. Systematic study of spider mites from Central Asia [in Russian]. Tr. Sredne-Aziat. Stn. Zashch. Rast. 2: 26-64.

VAN der MERWE, G.G. 1968. A taxonomic study of the family Phytoseiidae (Acari) in South Africa with contributions to the biology of two species. S. Afr. Dep. Agric. Tec. Serv. Entomol. Mem. 18:1-198.

VIEIRA, M.R.; FABRI, E.G.; OLIVEIRA, E.A. 2000. Sintomatologia do ataque de *Calacarus heveae* em seringueira (*Hevea brasiliensis*). Rev. Agric. 75(3):405-414.

VIEIRA, M.R. & GOMES, E.C. 1999. Sintomas, desfolhamento e controle de *Calacarus heveae* Feres, 1992 (Acari, Eriophyidae) em seringueira (*Hevea brasiliensis* Muell. Arg.). Cult. Agron. 8:39–52.

VIEIRA, M.R. & GOMES, E.C. 2001. Avaliação de acaricidas no controle de *Calacarus heveae* Feres, 1992 (Acari: Eriophyidae) em seringueira através de contagem em campo. Cult. Agron. 10:145-158.

VIS, R.D., MORAES, G.J.de & BELLINI, M.R. 2006. Mites (Acari) of rubber trees (*Hevea brasiliensis*, Euphorbiaceae) in Piracicaba, State of São Paulo, Brazil. Neotrop. Entomol. 35: 112-120.

VOLGIN, V.I. 1955. *In* Paulovskii, E.N. Acarina of rodents of the USSR fauna. Akad. Nauk SSSR, Zool. Inst. Opredelitelipo faune. 59:1-459.

VOLGIN, V.I. 1969. Acarina of the family Cheyletidae of the World. Akad. Nauk. SSSR Zool. Inst. Opredelitelipo faune. 59:1-495.

WALLACE, M.M.H. & MAHON, J.A. 1972. The taxonomy and biology of Australian Bdellidae (Acari). 1, Subfamilies Bdellinae, Spinibdellinae and Cytinae. Acarologia 14:544-580.

WOOD, TG. 1973. Revision of Stigmaeidae (Acari: Prostigmata) in the Berlese collection. Acarologia 15:76-95.

WOOD-MASON, J. 1884. Report on the tea-mite and tea-bug of Assam. Taylor & Francis Pub. London.

WOOLLEY, T.A. 1988. Acarology: mites and human welfare. Library of Congress cataloging in Publication. Fort Collins, Colorado.

WRENSCH, D.L. & EBBERT, M.A. 1993. Evolution and diversity of sex ratios in insects and mites. Chapman & Hall. New York.

YOSHIDA-SHAUL, E. & CHANT, D.A. 1997. A world review of the genus *Phytoscutus* Muma (Phytoseiidae: Acari). Acarologia. 38:219-238.

ZACARIAS, M.S. & MORAES, G.J. de. 2001. Phytoseiid mites (Acari) associated with rubber trees and other euphorbiaceous plants in southeastern Brazil. Neotrop. Entomol. 30:579-586.

ZACARIAS, M.S. & MORAES, G.J. de. 2002. Mite diversity (Arthropoda: Acari) on euphobiaceous plants in three localities in the State of São Paulo. Biota Neotropica. 2:1-12.

ZACHER, F. 1916. Zur Kenntnis der Spinnmilben. Mitt. Kais. Biol. Anst. Land-Forst. 16:19-25.

ZACHER, F. 1921. Neue und wenig bekannte Spinnmilben. Ztschr. Ang. Entomol. 7:181-187.

Title: Review about mites (Acari) of rubber trees (*Hevea spp.*, Euphorbiaceae) in Brazil

Authors: Fábio Akashi Hernandes & Reinaldo José Fazzio Feres

Biota Neotropica, Vol. 6 (number 1): 2006
http://www.biotaneotropica.org.br/v6n1/pt/abstract?article+bn00406012006

Date Received 06/15/2005 - Revised 12/05/2005
Accepted 01/01/2006

ISSN 1676-0611

INDEXES

Species and families of mites found in rubber trees in Brazil:

(current synonyms in bold)

Acaridae
Acarus cinnabarinus
Acarus coffeae
Acarus putrescentiae
Acarus telarius
Aff. *Acaphyllisa* sp.
Aff. *Aceria* sp.
Aff. *Chakrabartiella* sp.
Afrotydeus kenyensis
Agistemus floridanus
Agistemus aff. *floridanus*
Agistemus sp.
Allonychus braziliensis
Amblyseiopsis ovatus
Amblyseius* (*Amblyseius*) *saopaulus
Amblyseius (Iphiseius) concordis
Amblyseius acalyphus
Amblyseius anonymus
Amblyseius compositus
Amblyseius concordis
Amblyseius domingos
Amblyseius idaeus
Amblyseius impeltatus
Amblyseius neochiapensis
Amblyseius operculatus
Amblyseius ovatus
Amblyseius saopaulus
Amblyseius sexpilis
Amblyseius tunus
Amblyseius zuluagai
Anychus africanus
Anychus latus
Anychus ? *latus*
Anychus banksi
Anychus clarki
Anychus orientalis
Anychus ricini
Anychus rusti
Anychus verganii
Atrichoproctus uncinatus
Bdellidae
Brevipalpus mcbridei
Brevipalpus papayensis
Brevipalpus phoenicis
Brevipalpus yothersi
Brevipalpus sp.
Calacarus heveae
Caloglyphus sp.
Cheletogenes sp.
Cheletomimus* (*Hemicheyletia*) *wellsi
Cheyletia wellsi
Cheyletia sp.
Cheyletidae
Clavidromus jackmickleyi
Clavidromus transvaalensis
Cunaxidae
Cydnodromella alveolaris
Czenspinskia sp.
Daidalotarsonemus sp.
Dendrocheyla wellsi
Eriophyidae
Eryngiopus sp.
Euseius alatus
Euseius citrifolius
Euseius concordis
Euseius flechtmanni
Euseius paraguayensis
Eutigmaeus sp.
Eutetranychus banksi
Eutetranychus clarki
Eutetranychus mexicanus
Eutetranychus rusti
Exothorhis caudata
Fungitarsonemus sp.
Galendromimus* (*Galendromimus*) *alveolaris
Galendromimus alveolaris
Galendromus* (*Galendromus*) *annectens
Galendromus annectens
Galendromus sp.
Hemicheyletia sp.
Hemicheyletia wellsi
Hemitarsonemus latus
Histiostomatidae
Homeopronematus sp.
Iphiseiodes sp.
Iphiseiodes zuluagai
Kampimodromus transvaalensis
Ledermuelleria sp.
Lorryia boyce
Lorryia curiosa
Lorryia formosa
Lorryia spp.
Mediolata sp.
Melissotydeus sp.
Metaseiulus camelliae
Mixonychus sp.
Mononychellus sp.
Neolorryia boycei
Neolorryia sp.
Neoseiulus anonymus
Neoseiulus idaeus
Neoseiulus transvaalensis
Neoseiulus tunus
Neotarsonemus latus
Neotetranycus banksi
Neotropacarus sp.
Oligonychus coffeae
Oligonychus gossypii
Oligonychus merwei
Oribatida
Oribatulidae
Oripodidae
Oulenzia sp.
Paracheyletia wellsi
Parapronematus acaciae
Parapronematus spp.
Paratetranychus bioculatus
Paratetranychus gossypii
Paratetranychus terminalis
Pausia sp.
Phyllocoptruta seringueirae
Phytoscutus sexpilis
Phytoseiidae
Pirnodus sp.
Polyphagotarsonemus latus
Pretydeus curiosa
Pretydeus sp.
Pronematus spp.
Pronematus ubiquitus
Proprioseiopsis domingos
Proprioseiopsis ovatus
Pseudobonzia sp.
Pseudolorryia cf. *nicaraguensis*
Pulaeus sp.
Retetydeus boycei
Scutopalus sp.

Septanychus braziliensis
Septanychus mexicanus
Shevtchenkella petiolula
Spinoppia sp.
Stigmaeidae
Tarsonemidae
Tarsonemus confusus
Tarsonemus latus
Tarsonemus spp.
Tenuipalpidae
Tenuipalpus heveae
Tenuipalpus phoenicis
Tetrabdella neotropica
Tetranychidae
Tetranychoides californicus
Tetranychus aduncus
Tetranychus banksi
Tetranychus bioculatus
Tetranychus mexicanus
Tetranychus rusti
Tetranychus sp.
Tetranychus telarius
Tetranychus urticae
Triophtydeus sp.
Tydeidae
Tydeus (*Afrotydeus*) *kenyensis*
Tydeus* (*Tydeus*) *californicus
Tydeus californicus
Tydeus* (*Tydeus*) *costensis
Tydeus sp.
Tydeus ubiquitus
Typhlodromalus aff. *horatii*
Typhlodromalus feresi
Typhlodromina camelliae
Typhlodromips aff. *sinensis*
Typhlodromips amilus
Typhlodromips cananeiensis
Typhlodromips tunus
Typhlodromus (*Amblyseius*) *ovatus*
Typhlodromus* (*Anthoseius*) *transvaalensis
Typhlodromus (*Typhlodromus*) *alveolaris*
Typhlodromus alveolaris
Typhlodromus annectens
Typhlodromus camelliae
Typhlodromus jackmickleyi
Typhlodromus pectinatus
Typhlodromus sexpilis
Typhlodromus transvaalensis
Typlodromus (Amblyseius) concordis
Tyrophagus putrescentiae
Tyrophagus sp.
Xenotarsonemus sp.
Winterschmidtiidae
Zetzellia aff. *yusti*
Zetzellia agistzellia
Zetzellia malvinae
Zetzellia mapuchina
Zetzellia quasagistemas
Zetzellia spp.

Host types of mites found in rubber trees in Brazil:

Acacia sp. (Fabaceae)
Acalypha sp. (Euphorbiaceae)
Arachis hypogaea – peanut (Fabaceae)
Bactris setosa (Arecaceae)
Bromeliaceae.
Camellia sp. (Theaceae)
Cassia bicapsularis (Fabaceae)
Cassia sp. (Fabaceae)
Cattleya sp. (Orchidaceae)
Cephaelis sp. (Rubiaceae)
Citrus paradisi – grapefruit (Rutaceae).
Citrus sinensis (Rutaceae)
Citrus sp. – (Rutaceae)
Coffea arabica – coffee (Rubiaceae)
Cydonia sp. – quince (Rosaceae)
Datura sp. (Solanaceae)
Delphinium belladonna (Ranunculaceae)
Desmodium sp. (Fabaceae)
Fleurya aestuans - nettle (Urticaceae)
Gossypium herbaceum – cotton (Malvaceae)
Hevea brasiliensis (Euphorbiaceae)
Ligustrum sp. (Oleaceae)
Mabea fistulifera (Euphorbiaceae)
Mangifera sp. - mango (Anacardiaceae)
Manihot sp. (Euphorbiaceae)
Maytenus nemorosa (Celastraceae)
Mucuna sp.(Fabaceae)
Musa paradisíaca – banana (Musaceae)
Phoenix sp. (Arecaceae)
Psidium guajava – guava (Mirtaceae)
Quercus sp. (Fagaceae)
Rhododendron indicum - (Ericaceae)
Ricinus communis – castor bean (Euphorbiaceae)
Rubus idaeus L. (Rosaceae)
Spathodea sp. (Bignoniaceae)
Theobroma sp. (Sterculiaceae)
Trema floridana (Ulmaceae)

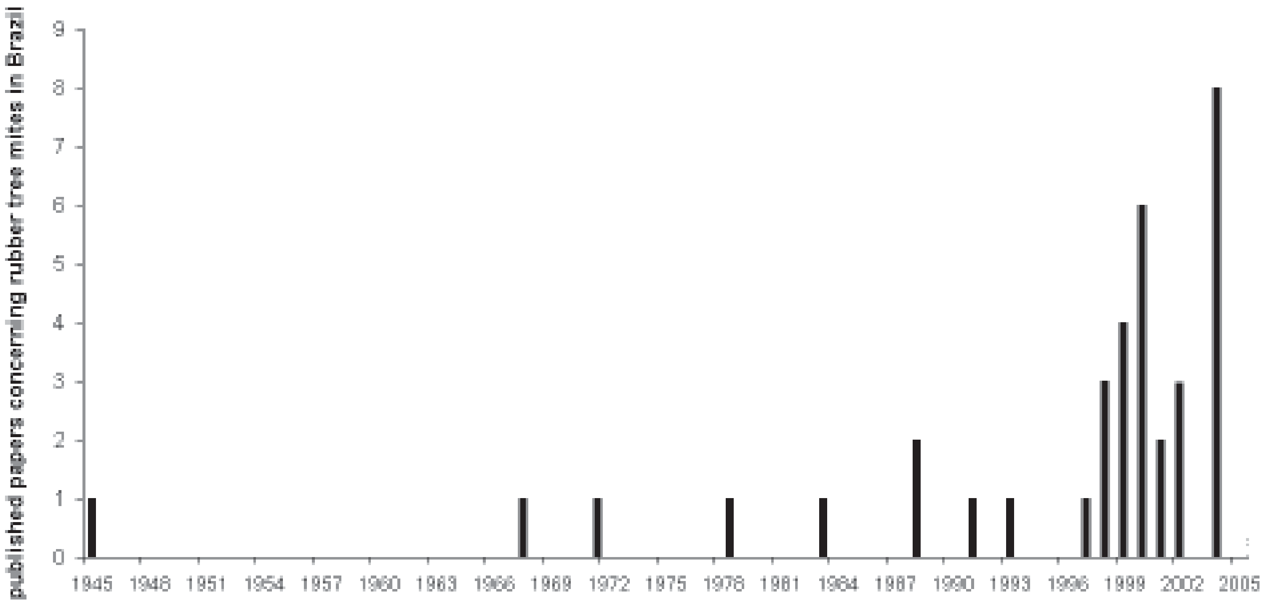


Figure 1. *Number of published papers concerning mites on rubber trees in Brazil.*

Figure 2. *Brazilian states sampled for rubber tree mites (in green); in parenthesis, the number of sites sampled in each state.*

Avaliação experimental da ocorrência de competição contemporânea entre espécies endêmicas de lagartos das dunas do médio São Francisco, Bahia

Alexander Silveira Gomes

Resumo

A existência de competição interespecífica está associada à sobreposição no uso de recursos por espécies e à redução na disponibilidade de recurso para uma espécie pelo uso de recursos ou a apropriação antecipada por uma outra. Interações competitivas podem produzir um padrão de uso diferencial de recursos pelas espécies envolvidas, como aquele previamente detectado entre *Tropidurus psammonastes* (Tropiduridae) e *Eurolophosaurus divaricatus* (Tropiduridae) e *Cnemidophorus* sp n (Teiidae), espécies endêmicas de lagartos das dunas de Ibiraba, Bahia. Para testar as hipóteses de que a presença de *T. psammonastes* reduz a densidade local das outras duas espécies (o que indicaria existência de competição contemporânea forte) e o padrão de uso de micro-hábitat das mesmas (o que indicaria existência de competição contemporânea, embora fraca), realizei um experimento de campo com duração de 76 dias durante um período do ano em que o potencial para interações competitivas é alto (i.e., entre o final de seca e início das chuvas). Manipulei a densidade de *T. psammonastes* pela remoção de seus indivíduos de quatro unidades amostrais experimentais, avaliando o efeito sobre as outras duas espécies em comparação a quatro unidades amostrais não alteradas. Na situação controle, o padrão de uso de micro-hábitat das espécies foi o mesmo descrito em um estudo realizado entre 1995 e 1996 na mesma área. As situações controle e experimental foram comparadas através de testes de randomização (MRPP) com base nos dados totais e da última metade do experimento. Não detectei diferença significativa das densidades entre as unidades amostrais controle e experimentais para nenhuma das duas espécies, indicando que, caso estivesse ocorrendo competição, ela não foi suficientemente forte para gerar efeitos de curto prazo. Não detectei diferenças dos padrões de uso multivariado de micro-hábitat pelas espécies entre controle e experimento. Como as disponibilidades de micro-hábitat não variaram entre tratamentos, esse resultado indica que não fui capaz de detectar mesmo interações competitivas fracas entre *T. psammonastes* e as demais espécies. Um estudo anterior refutou a hipótese de que o padrão diferencial de uso de recursos por essas espécies pode ser explicado por inércia filogenética. O presente estudo corroborou o padrão de uso de micro-hábitat descrito anteriormente para as espécies, sugerindo que ele não é estocástico, e refutou a hipótese de que o padrão deriva de competição contemporânea. Desse modo, esse conjunto de evidências sugere que o padrão observado pode derivar de interações ecológicas competitivas passadas, o que, embora não testável, é plausível visto que as espécies envolvidas são endêmicas das dunas, apresentando distribuição geográfica restrita.

Palavras-chave: competição interespecífica, lagartos, manipulação de densidade, caatinga

FICHA CATALOGRÁFICA:

G633 Gomes, Alexander Silveira.
Avaliação experimental da ocorrência de competição contemporânea entre espécies endêmicas de lagartos das dunas do Médio São Francisco, BA /

Alexander Silveira Gomes. - 2005.
29 f. ; il.

Orientador: Prof. Dr. Pedro Luís Bernardo da Rocha.

Dissertação (mestrado) - Universidade Federal da Bahia, Instituto de Biologia,
2005.

1. Lagarto - Competição (Biologia) - São Francisco, Rio - Bahia. 2. Lagarto - Comportamento. 3. Caatinga – População biológica. 4. Comunidades animais

Pesquisa ecológica. 5. Monitoramento biológico. I. Rocha, Pedro Luís

Bernardo da. II. Universidade Federal da Bahia. Instituto de Biologia. III. Título.
CDD - 591.7
CDU - 591.5

Turtles of the Tiputini Biodiversity Station with remarks on the diversity and distribution of the Testudines from Ecuador

Diego F. Cisneros-Heredia[1]

Biota Neotropica v6 (n1) –http://www.biotaneotropica.org.br/v6n1/pt/abstract?inventory+bn00906012006

Date Received 05/23/2005 - Revised 10/18/2005 - Accepted 01/01/2006

[1]College of Biological and Environmental Sciences, Universidad San Francisco de Quito, Casilla Postal 17-12-841 Quito, Ecuador. E-mail: diegofrancisco_cisneros@yahoo.com

Abstract

Cisneros-Heredia, D.F. **Turtles of the Tiputini Biodiversity Station with remarks on the diversity and distribution of the Testudines from Ecuador**. *Biota Neotrop*. Jan/Abr 2006, vol. 6, no. 1 http://www.biotaneotropica.org.br/v6n1/pt/abstract?inventory+bn00906012006. ISSN 1676-0611

Ten species of Testudines, from four different families: Chelidae, Kinosternidae, Podocnemididae, and Testudinidae, are reported from the Tiputini Biodiversity Station (Universidad San Francisco de Quito), northeastern Amazonian Ecuador; including the second report from Ecuador of *Batrachemys heliostemma*. These ten species are sympatric but not completely syntopic, thus I comment on their diversity and habitat preferences patterns. The general distribution of some turtles from Amazonian Ecuador is discussed, providing additional records and distribution maps for *Chelus fimbriatus*, *Platemys platycephala*, *Batrachemys heliostemma*, *Batrachemys raniceps*, *Mesoclemmys gibba*, *Phrynops geoffroanus*, *Kinosternon scorpioides*, and *Geochelone denticulata*. The presence of *Peltocephalus dumerilianus* in Amazonian Ecuador is confirmed; based on re-examination of specimens previously reported by Dr. Gustavo Orcés in 1949. The total Ecuadorian richness of Testudines species includes 31 living taxa, and I provide an annotated list of the turtles and tortoises of mainland and insular Ecuador. Much information is still needed in order to understand the ecological relationships of the Testudines from Ecuador and future research should focus on long-term studies designed to answer several questions about their biology and ecology. Several threats are currently jeopardizing the long-term conservation of turtle populations in Ecuador, and we must increase our knowledge on these amazing animals in order to protect and preserve them.

Key words: *Reptilia, Testudines, Chelidae, Kinosternidae, Podocnemididae, Testudinidae, Chelus fimbriatus, Platemys platycephala, Batrachemys heliostemma, Batrachemys raniceps, Mesoclemmys gibba, Phrynops geoffroanus, Kinosternon scorpioides, Geochelone denticulata, Podocnemis expansa, Podocnemis unifilis, Peltocephalus dumerilianus, diversity, habitat preferences, distribution, checklist, Amazonia, Ecuador*

Resumen

Cisneros-Heredia, D.F. **Las Tortugas de la Estación de Biodiversidad Tiputini con notas sobre la distribución de alginos Testudines de Ecuador.** *Biota Neotrop*. Jan/Abr 2006, vol. 6, no. 1http://www.biotaneotropica.org.br/v6n1/pt/abstract?inventory+bn00906012006. ISSN 1676-0611

Diez especies de Testudines, de cuatro familias diferentes: Chelidae, Kinosternidae, Podocnemididae, y Testudinidae, son reportadas de la Estación de Biodiversidad Tiputini (Universidad San Francisco de Quito), en la Amazonía Nororiental de Ecuador; incluyendo el segundo reporte para Ecuador de *Batrachemys heliostemma*. Estas diez especies son simpátricas pero no completamente sintópicas, por lo que comento sobre sus patrones de diversidad y preferencias de hábitat. La distribución general de algunas especies de tortugas de la Amazonía de Ecuador es discutida, proveyendo registros adicionales y mapas de distribución para *Chelus fimbriatus*, *Platemys platycephala*, *Batrachemys heliostemma*, *Batrachemys raniceps, Mesoclemmys gibba*, *Phrynops geoffroanus*, *Kinosternon scorpioides*, y *Geochelone denticulata*. La presencia de *Peltocephalus dumerilianus* en la Amazonía de Ecuador es confirmada; basada en la reexaminación de especímenes previamente reportados por el Dr. Gustavo Orcés en 1949. La riqueza total de especies de tortugas en Ecuador incluye 31 taxa vivientes; proveo una lista anotada de las especies de tortugas de Ecuador continental e insular. Mucha información es aún requerida para poder comprender las relaciones ecológicas de los Testudines de Ecuador e investigaciones futuras deberían enfocarse en estudios a largo plazo diseñados para responder a varias preguntas sobre su biología y ecología. Algunos peligros amenazan la conservación a largo plazo de las poblaciones de tortugas de Ecuador y debemos incrementar nuestro conocimiento sobre estos sorprendentes animales para poder protegerlos y conservarlos.

Palabras-clave:*Reptilia, Testudines, Chelidae, Kinosternidae, Podocnemididae, Testudinidae, Chelus fimbriatus, Platemys platycephala, Batrachemys heliostemma, Batrachemys raniceps, Mesoclemmys gibba, Phrynops geoffroanus, Kinosternon scorpioides, Geochelone denticulata, Podocnemis expansa, Podocnemis unifilis, Peltocephalus dumerilianus, diversidad, preferencias de hábitat, distribución, lista, Amazonia, Ecuador*

Introduction

Thirty taxa of living Testudines have been recognized for Ecuador (Miyata 1982, Pritchard & Trebbau 1984, Almendáriz 1991, Coloma et al. 2000-2004); four species are marine turtles, 11 taxa correspond to the endemic giant tortoises of the Galapagos Archipelago (McFarland et al. 1974), and 15 species occur in mainland Ecuador. Five mainland taxa are restricted to the Pacific lowlands of Ecuador, including one member of the family Kinosternidae (*Kinosternon leucostomum* Duméril & Bibron) and all Ecuadorian members of the families Chelydridae (1 sp.: *Chelydra serpentina* [Linnaeus]) and Geoemydidae (3 spp.: *Rhinoclemmys annulata* [Gray], *R. melanosterna* [Gray], and *R. nasuta* [Boulenger]). The greatest diversity of Testudines in mainland Ecuador occurs in the Amazonian lowlands; unfortunately little information is available on most turtles from mainland Ecuador, and although most Amazonian taxa are conceived as widespread, little data exists on its distribution and ecology. The objective of this paper is to make an initial approach oT the testudines diversity in Ecuador, with some remarks on the distribution of the Testudines from Amazonian Ecuador, compiling every record from Amazonian Ecuador, presenting some specific data on the diversity and habitat preferences of the turtles and tortoise from the Tiputini Biodiversity Station; and an annotated list of the turtles and tortoises of mainland and insular Ecuador.

Materials and Methods

Field work was done at the Tiputini Biodiversity Station, (TBS - 00°37’05" S, 76°10’19" W, 190 – 270 m a.s.l.), a research station located in the province of Orellana, Republic of Ecuador, ca. 280 km ESE from Quito; in the northern bank of the Tiputini River, part of the Napo and Amazonas Rivers Basins. TBS was established in 1995 by the Universidad San Francisco de Quito (Ecuador), in cooperation with Boston University (USA), as a center of education, research and conservation. TBS is adjacent to the Yasuní National Park and it is part of the Yasuní Biosphere Reserve.

TBS preserves a tract of 650 hectares which mostly includes primary Terra Firme forest (Lowland Evergreen Forest), but there is a rather narrow belt of flooded vegetation of Varzea (Lowland Evergreen Forest flooded by white-waters) and Igapó (Lowland Evergreen Forest flooded by black-waters) towards the river, streams, and around an small oxbow lake. Along the Tiputini River, several beaches are uncovered during the dry season, but all are short, never greater than 100 m.

Herpetological work at TBS was conducted between 1997 and 2001, with 11 human/months. Turtles were surveyed by day and night with through encounters technique (Heyer et al. 1994), especially on the wetlands (swamps, rivulets, streams, oxbow lake, and river). Some specimens were examined and later released to confirm their identities. Individuals not captured (especially those observed while basking over logs in the lake and river) were examined using 10x42 Swarovski binoculars in order to determine its identification. Additional specimens of Ecuadorian Testudines were examined from the collection of the Fundación Herpetológica G. Orcés, Quito (FHGO).

Results and Discussion

The family Chelidae is represented at TBS by six species, including *Chelus fimbriatus* (Schneider), *Platemys platycephala* (Schneider), *Batrachemys heliostemma* McCord, Ouni & Lamar, *Batrachemys raniceps* (Gray), *Mesoclemmys gibba* (Schweigger), and *Phrynops geoffroanus* (Schweigger). The last four species correspond to the commonly named “toadhead” turtles, all previously classified under the genus *Phrynops* until the recent re-evaluation by McCord et al. (2001).

Batrachemys heliostemma was recorded twice at TBS; one juvenile was observed in August 1999 and a second juvenile was found on February 2001, both at a shallow swamp located behind the oxbow lake of TBS by day. Both individuals showed the yellow facial marks characteristic of the species. The second individual was caught, examined and released; it had a carapace length of 121 mm, maximum plastral length of 100 mm, and carapace width of 92 mm. The habitat where both individuals were observed coincides with descriptions provided by McCord et al. (2001) for Peruvian populations, and supports their hypothesis about the apparent preference of *B. heliostemma* for high non-flooded areas. *Batrachemys heliostemma* is a recently described species known from the upper Amazon Basin with records in Venezuela, Colombia, Ecuador, Brazil, and Peru (McCord et al. 2001). This species was known in Amazonian Ecuador from only one locality, “Mariam” in the province of Sucumbíos, Ecuador, collected in October 1983 (McCord et al. 2001). TBS is the second locality for the species in Ecuador, and the westernmost record of the species (Figure 1).

Batrachemys raniceps was recorded twice at TBS, both on the border of the small drainage connecting the oxbow lake and the Tiputini River by day (both examined and later released). One individual of *Mesoclemmys gibba* was found at TBS while walking ca. 10 m away from the Tiputini River, on an ephemeral marsh created by a recent flooding; it released a strong-smelling musk when captured (later released). *Phrynops geoffroanus* was the most common toadhead turtle recorded at TBS; several individuals were observed basking over logs partially submerged at the mouth of a small affluent of the Tiputini River, and along the river itself. In the oxbow lake, at least two individuals were seen partially

Figure 1. Known records of *__Batrachemys heliostemma__* *(squares) and* *__Batrachemys raniceps__* *(circles) in the Republic of Ecuador. TBS = Tiputini Biodiversity Station, closed symbols = material studied, open symbols = literature records (see text), numbers correspond to the following provinces in Amazonian Ecuador: 1 = Sucumbíos, 2 = Napo, 3 = Orellana, 4 = Pastaza, 5 = Morona-Santiago, 6 = Zamora-Chinchipe.*

Figure 2. Known records of <u>Chelus fimbriatus</u> (squares) and <u>Kinosternon scorpioides</u> (circles) in the Republic of Ecuador. For symbols equivalence see Figure 1.

Figure 3. Known records of *Mesoclemmys gibba* *(circles) in the Republic of Ecuador. For symbols equivalence see Figure 1.*

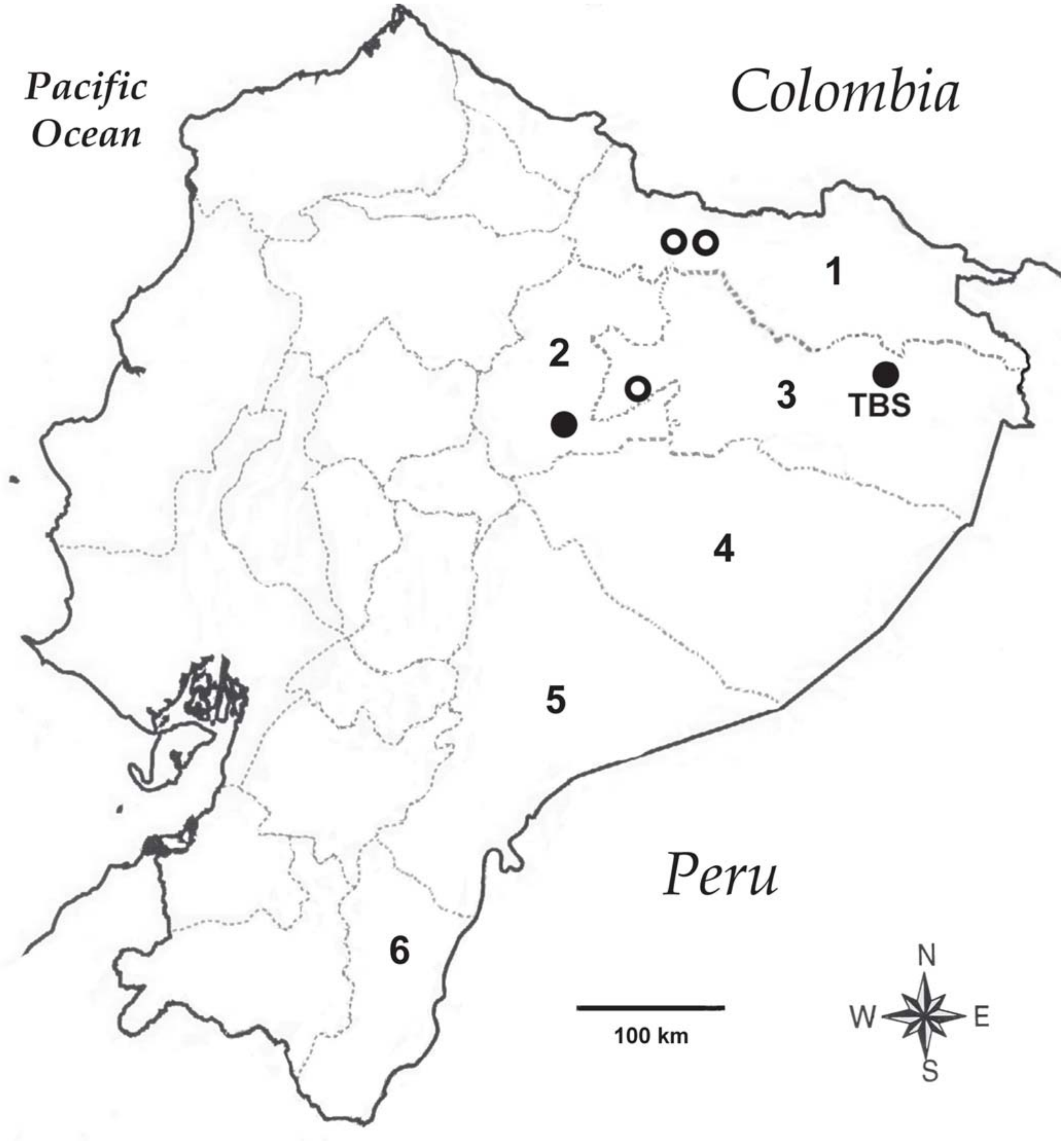


Figure 4. Known records of Phrynops geoffroanus (circles) in the Republic of Ecuador. For symbols equivalence see Figure 1.

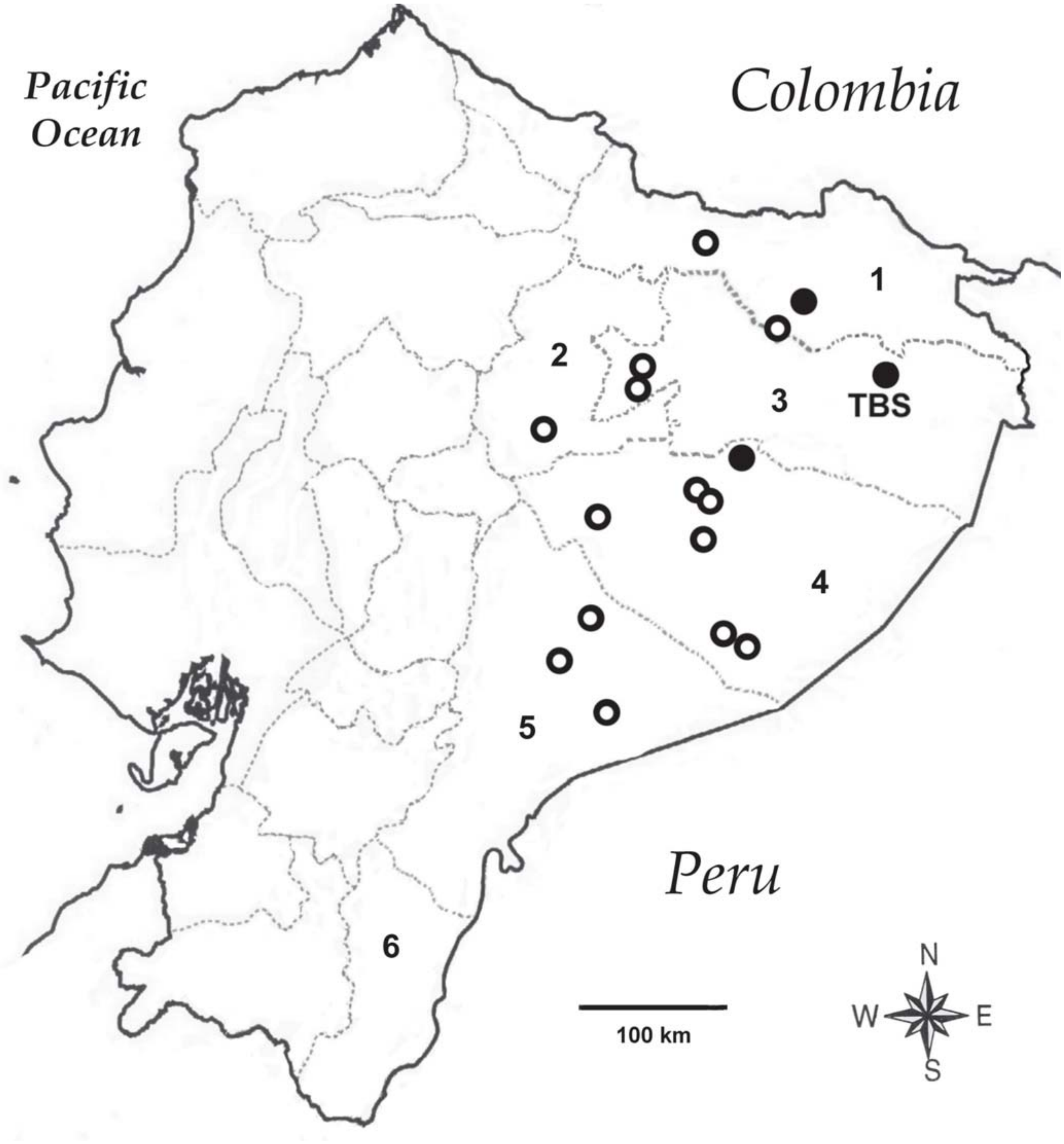


Figure 5. Known records of *<u>Platemys platycephala</u>* *(circles) in the Republic of Ecuador. For symbols equivalence see Figure 1.*

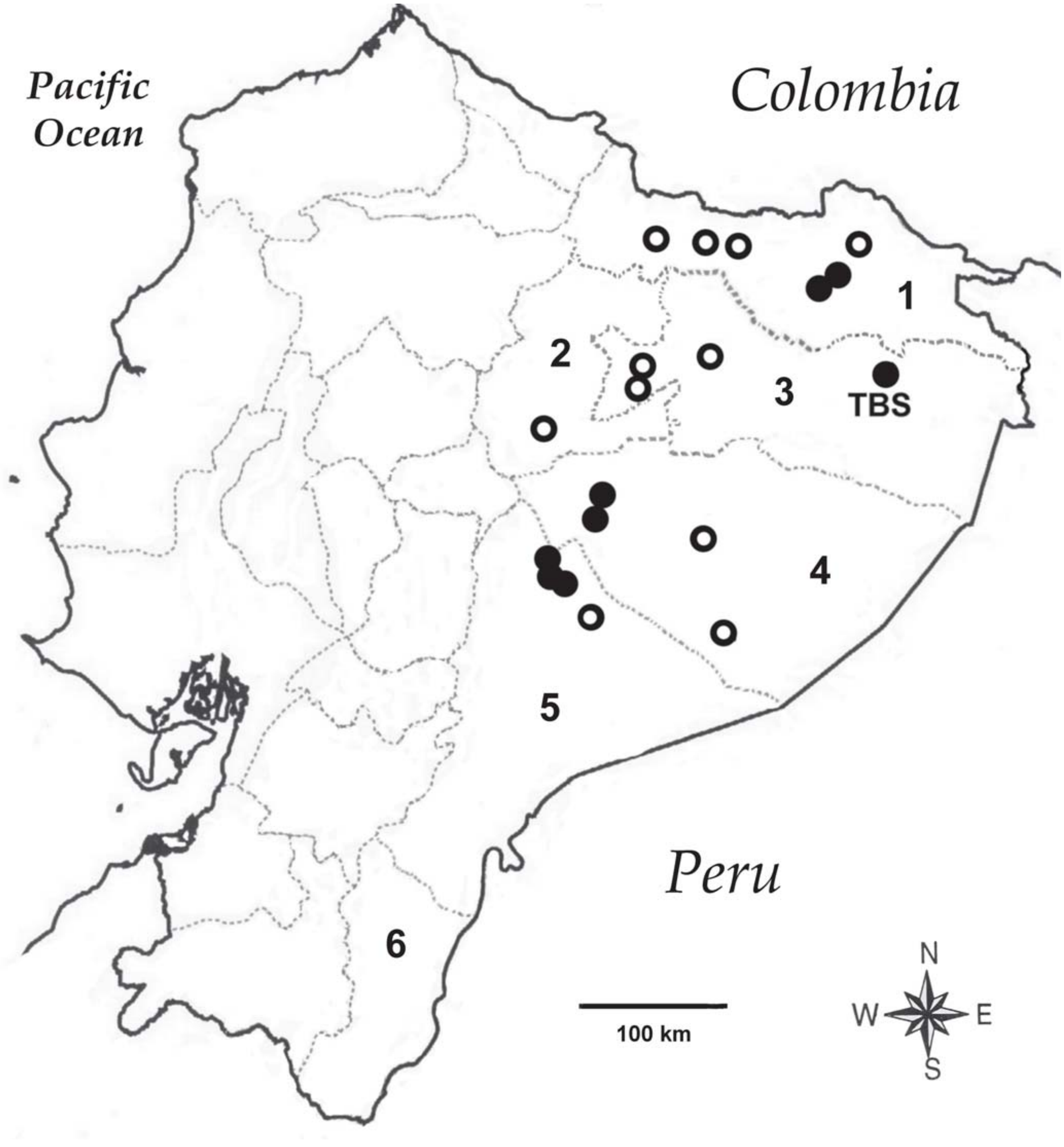


Figure 6. Known records of *<u>Geochelone denticulata</u>* *(circles) in the Republic of Ecuador. For symbols equivalence see Figure 1.*

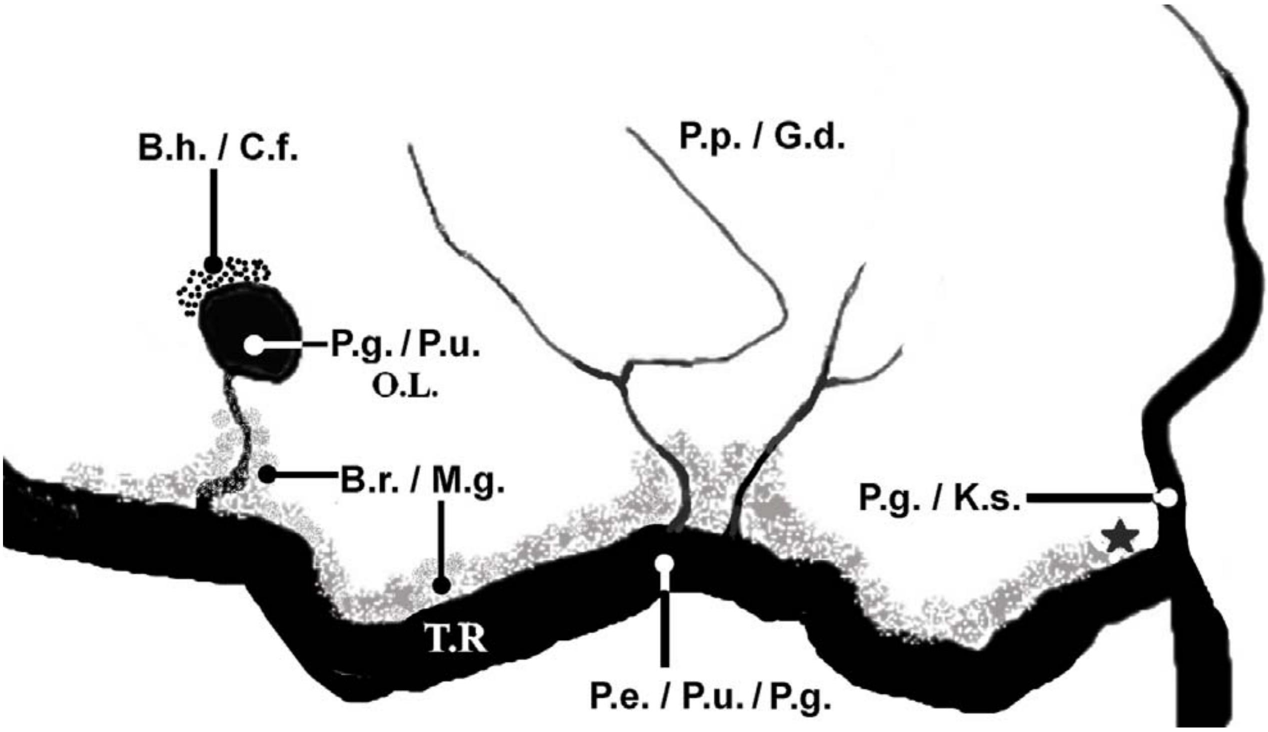


Figure 7. Schematic map of a section of the Tiputini River (T.R.) at the Tiputini Biodiversity Station (station laboratory = star), province of Orellana, Ecuador; indicating habitat preferences by ten chelonian species. O.L. = oxbow lake; dotted area next to oxbow lake = non-seasonally flooded shallow swamp; gray shadow areas = seasonally flooded forest. B.h. = Batrachemys heliostemma: B.r. = Batrachemys raniceps, C.f. = Chelus fimbratus, G.d. = Geochelone denticulata, K.s. = Kinosternon scorpioides, M.g. = Mesoclemmys gibba, P.g. = Phrynops gibbus, P.p, = Platemys platycephala, P.e. = Podocnemis expansa, P.u. = Podocnemis unifilis.

immersed in a marsh area on the border of the lake, and at least three were usually observed while basking over logs partially submerged. One individual of *P. geoffroanus* released a strong-smelling musk when captured (later released).

Platemys platycephala was recorded in five occasions, always walking in non-flooded and seasonally flooded forest by day. At non-flooded forest, it was usually near shallow streams. One individual was found in 09 August 1999 during day among the leaf-litter near to a small rivulet in primary non-flooded forest; it was examined and released, having a carapace length of 117 mm, maximum plastral length of 109 mm, carapace width of 80 mm, head length of 41 mm, and weight of 139.5 g. Individuals observed coincides well with the description of the subspecies *Platemys platycephala melanonota* by Ernst (1983). *Chelus fimbriatus* was observed once at TBS during late afternoon on August 2000, moving in a shallow swamp located behind the oxbow lake of TBS.

Few localities for members of the family Chelidae in Ecuador have been mentioned in the literature, so in addition to the TBS records, I report herein some new localities. One specimen of *Batrachemys raniceps* was collected at Shushufindi (00º12’43" S, 76º39’29" W, 220 m), province of Sucumbíos, by J.-M. Touzet on 02 October 1996 (FHGO 1481). *Batrachemys raniceps* was first reported in Ecuador by Miyata (1982) without mentioning a locality, and I could not locate additional published records for the species in Ecuador; thus the species is apparently reported in Ecuador just from the provinces of Sucumbíos and Orellana (Figure 1). Two specimens of *Chelus fimbratus* were collected at Laguna Grande, Cuyabeno Reserve (00º05’ S,76º10’ W, 220 m), province of Sucumbíos, by F. Campos on 25 December 1989 (FHGO 206) and 25 February 1990 (FHGO 207). *Chelus fimbriatus* was reported by Orcés (1949) from localities in the province of Zamora-Chinchipe and Sucumbíos; by Duellman (1978) from the province of Sucumbíos, and Iverson (1992) plotted a locality in the province of Pastaza; therefore the distribution of *C. fimbratus* apparently comprises the entire Amazonian Ecuador, with confirmed records from the provinces of Sucumbíos, Orellana, Pastaza, and Zamora-Chinchipe (Figure 2). One specimen of *Mesoclemmys gibba* was collected at Shushufindi (00º12’43" S, 76º39’29" W, 220 m), province of Sucumbíos, by J.-M. Touzet on 20 September 1987 (FHGO-live 037), and one individual was observed at the Laguna Grande, Cuyabeno Reserve (00º05’ S,76º10’ W, 220 m), province of Sucumbíos, by the author on August 2000. *Messoclemys gibba* has been reported from the province of Sucumbíos (Duellman 1978, Pritchard & Trebbau 1984), from the province of Orellana and Pastaza (Pritchard & Trebbau 1984, Iverson 1992), and more recently from the province of Napo (Deforce et al. 2004). Therefore, *Messoclemys gibba* has confirmed records in northern Amazonian Ecuador, in the provinces of Napo, Sucumbíos, Orellana and Pastaza (Figure 3). One specimen of *Phrynops geoffroanus* was collected at the Hollín River (Hollín-Loreto road), near Tena (ca. 00º41’ S, 77º40’ W), province of Napo, by M. Mamallacta on 15 July 1998 (FHGO-live 2188). Orcés (1949) cited this species as “*P. hilari*” from the province of Napo (localities also mentioned by Pritchard & Trebbau 1984), and was reported from the province of Sucumbíos by Duellman (1978) and Pritchard & Trebbau (1984). Thus, *Phrynopus geoffroanus* has been recorded in Ecuador from the provinces of Napo, Sucumbíos, and Orellana (Figure 4). The absence of records of *M. gibba* and *P. geoffroanus* in southern Amazonian Ecuador could reflect the paucity of surveys in these area rather than real absence or rarity. One specimen of *Platemys platycephala* was collected at San Pablo de Kantesiaya (00º15’00" S, 76º25’30" W, 240 m), province of Sucumbíos, by J.-M. Touzet on 01 February 1987 (FHGO-live 122), and another was collected at the Shiripuno River (sector Ñoneno) (01º05’ S, 76º50’ W), province of Pastaza, by J.-M. Touzet on 30 August 1997 (FHGO 2261). *Platemys platycephala* was reported by Orcés (1949) from the province of Orellana and Pastaza, Duellman (1978) reported the species from the province of Sucumbíos, and Pritchard & Trebbau (1984) mentioned records from the provinces of Orellana, Napo, Sucumbíos, Pastaza, and Morona-Santiago (Pritchard & Trebbau [1984] cited the locality of Macuma (=Makuma) in the province of Zamora-Chinchipe, however it is located in the province of Morona-Santiago). Almendáriz (1987) reported the species from the province of Pastaza and Iverson (1992) and Ernst (1983) plotted several localities, especially in southeastern Ecuador. *Platemys platycephala* has the widest reported distribution in eastern Ecuador, with confirmed records at every Amazonian province: Napo, Sucumbíos, Orellana, Pastaza, Morona-Santiago and Zamora-Chinchipe (Figure 5).

The family Kinosternidae is represented at TBS by one species, *Kinosternon scorpioides* (Linnaeus). One *K. scorpioides* was observed among the border vegetation at the drainage of a rivulet, tributary of the Tiputini River, and a second turtle was captured (late released) while walking amidst leaf-litter on the margin of the same rivulet. Orcés (1949) reported the species from the province of Orellana, and Duellman (1978) and Pritchard & Trebbau (1984) from the province of Sucumbíos. *Kinosternon scorpioides* has confirmed records along northern Amazonian Ecuador, in the provinces of Sucumbíos and Orellana (Figure 2).

Two species of the family Podocnemididae occur at TBS, *Podocnemis expansa* (Schweigger) and *P. unifilis* Troschel. *Podocnemis expansa* was the rarest among them, with just two direct observations of two big-size adults basking on a partially submerged tree at the Tiputini River, near the beach, plus the observation of at least two nests along the beaches of the Tiputini River on August 1999. The carapace of an adult *P. expansa* (kept at the laboratory of the station) had a length of 780 mm and was obtained ca. 1995 near TBS. *Podocnemis unifilis* was the most observed turtle along the Tiputini River and at the oxbow lake. Groups up to 12 adult or juvenile individuals were frequently observed basking over partially submerged logs or along vegetation near the border of the river or lake. Several nests were observed at the beaches of the Tiputini River. On one occasion, up to four nests were attacked at the same beach by a couple of Black Caracaras (*Daptrius ater*) and by a Tegu Lizard (*Tupinambis teguixin*). Eggs of *P. unifilis* (and probably *P. expansa*) were extracted occasionally from nests by native inhabitants, even though this practice is illicit in that section of the Tiputini River.

The only tortoise at TBS is *Geochelone denticulata* (Linnaeus). This tortoise was rather common, especially at non-flooded primary forest, but also at flooded primary forest (during low flood periods). Five to eight individual records were obtained each year between 1997 and 2001. Individuals were found walking usually during early and late afternoon. Most tortoises had ticks on the carapace. Five individuals found in year 2000 (January, April and August) were measured, showing a mean carapace length of 410.8 ± 75.0 mm (range 475.0 – 310.0 mm), mean carapace width of 327.5 ± 85.4 mm (range 380.0 – 200.0 mm), and maximum plastral length of 287.7 ± 55.5 mm (range 336.0 – 227.0 mm). Orcés (1949) reported this species from the provinces of Sucumbíos, Orellana, and Pastaza; Duellman (1978) reported it from the province of Sucumbíos; Pritchard & Trebbau (1984) reported *G. denticulata* from the provinces of Sucumbíos and Morona-Santiago; and Almendáriz (1987) reported it from the province of Pastaza. I have observed this species at several localities near Tarapoa (ca. 00º08’ S, 76º24’ W, ca. 300 m), province of Sucumbíos, near Puyo (ca. 01º28’ S, 77º59’ W, ca. 950 m), province of Pastaza, and on the Macas-Puyo road (ca. 02º19’ S, 78º07’ W), province of

Morona-Santiago. Thus, *Geochelone denticulata* has been reported from almost every province in Amazonian Ecuador (Napo, Sucumbíos, Orellana, Pastaza and Morona-Santiago) except for the province of Zamora-Chinchipe (Figure 6).

Although two species of the genus *Podocnemis* (*P. unifilis* and *P. expansa*) are usually regarded as the only members of the family Podocnemididae in Ecuador, Orcés (1949) reported *Peltocephalus dumerilianus* (Schweigger) from Ecuador based on five specimens from the province of Pastaza, and one juvenile with uncertain locality. The identity of those specimens has never been confirmed, nor the specimens examined again; and just Iverson (1992) and Iverson & Vogt (2002) accepted those records. Miyata (1982), Almendáriz (1991) and Coloma et al. (2000-2004) did not included *P. dumerilianus* in their lists of Ecuadorian reptiles. Two out of six specimens reported by Orcés (1949) were located at the collection of the Colegio Mejia, Quito; they correspond well with *P. dumerilianus* and confirmed the presence of this species in the Republic of Ecuador, with records at least in the province of Pastaza. Medem (1960) reported *P. dumerilianus* from the Apaya lagoon, near Puerto Leguizamo, on the Putumayo River, not far from the border of Colombia with Ecuador (ca. 20 km); therefore, *P. dumerilianus* could also exist in the wetlands of eastern Sucumbíos, Ecuador. The Ecuadorian richness of Chelonian species increases to 31 living taxa with the recognition of *Peltocephalus dumerilianus*, with 11 species distributed in the Amazonian lowlands. As several nomenclatural and systematic changes have occurred affecting the classification of Ecuadorian turtles and tortoises, I present an annotated list of the turtles and tortoises from mainland and insular Ecuador in Appendix 1.

The total chelonian diversity at the Tiputini Biodiversity Station comprises ten species, from four different families: Chelidae, Kinosternidae, Podocnemididae, and Testudinidae. Data presented herein suggest that although most chelonians at TBS are sympatric, they are not completely syntopic; this case is especially evident in the four toadhead turtles, supporting hypotheses presented by McCord et al. (2001) on habitat preferences. The shallow swamps in non-flooded areas (behind oxbow lake) were occupied in syntopy by *Batrachemys heliostemma* and *Chelus fimbriatus*. Small drainages and ephemeral marshes in flooded areas were the habitat of *Batrachemys raniceps* and *Mesoclemmys gibba*. Non-flooded and seasonally flooded forests, including hill areas far from the Tiputini River, were inhabited by *Platemys platycephala* and *Geochelone denticulata*. Open waters of the oxbow lake were inhabited by *Phrynopus geoffroanus* and *Podocnemis unifilis*, while at small drainages *P. geoffroanus* was in syntopy with *Kinosternon scorpioides*; and at the river with both members of the family Podocnemididae, *Podocnemis expansa* and *P. unifilis. Podocnemis expansa* is an exclusive inhabitant of the river (Figure 7).

However, much information is still needed in order to understand the ecological relationships of these sympatric Testudines. Little information is available on the life cycles of the Amazonian species, including egg deposition sites, nesting periods, environmental requirements for successful egg development, predation effects over nests, emergence period of neonates, behavior of neonates, ontogenic changes in habitat, microhabitat and time use patterns, movement patterns, maturity time for males and females, sex ratio, survivorship and longevity (Gibbons 1990, Burke et al. 2000). Future research at TBS and other research stations along Amazonian Ecuador should focused on long-term studies designed to answer these biological and ecological questions.

Several threats are currently jeopardizing the long-term conservation of turtle populations along the planet. Habitat alteration, pollution, human exploitation, diseases and introduced species are causal factors for the declines of several turtles (Burke et al. 2000). *Podocnemis expansa* is an explicit case of the fragility of the turtle populations in Amazonian Ecuador. The extreme and uncontrolled overexploitation of this giant river turtle has reduced its numbers to the point that its long-term survivorship is uncertain. Several conservation efforts, including sustainable harvesting, protection and management of nests, have been established in Ecuador for the economically-relevant species of the genus *Podocnemis*, but research and conservation efforts focused on every turtle taxon must be established in Ecuador. We must increase our knowledge on these amazing animals in order to protect and preserve them.

Acknowledgments

I am grateful to the staff of the Tiputini Biodiversity Station, Universidad San Francisco de Quito, especially to David Romo, Consuelo Barriga de Romo, Kelly Swing, Mayer Rodríguez and Franklin Narváez, for their continuous support during my field work; and to Jean-Marc Touzet and Ana María Velasco for allowing access to material and information at the FHGO. I thank Ana Almendáriz, John Iverson, Stephen Karl, the Savanna River Ecology Laboratory, the Charles Darwin Foundation, and the Department of Vertebrate Zoology, Smithsonian Institution, for providing useful literature or access to their libraries. I am extremely grateful to María Elena Heredia and Laura Heredia for their continuous moral and financial support. Field work was partially financed by the Tiputini Biodiversity Station, Universidad San Francisco de Quito, lab work by the Universidad San Francisco de Quito, and work at the Smithsonian Institution by the 2002 Research Training Program, National Museum of Natural History and Smithsonian's Women Committee.

References

ALMENDÁRIZ, A. 1987. Contribución al conocimiento de la herpetofauna centroriental Ecuatoriana. Revista Politécnica Quito XII (4):77-133.

ALMENDARIZ, A. 1991. Anfibios y reptiles. In Lista de Vertebrados de Ecuador (R. Barriga, A. Almendáriz & L. Albuja, eds.). Revista Politécnica XVI (3):89-162.

ALMENDARIZ, A. & CARR, J. L. 1992. Amphibians and Reptile List; January-February Trip. In Status of Forest Remnants in the Cordillera de la Costa and Adjacent Areas of Southwestern Ecuador (T. A. Parker III & J. L. Carr, eds.). Conservation International, RAP Working Paper 2, p.128-130.

BOUR, R. 1980. Essai sur la taxonomie des Testudinidae actuels (Reptilia, Chelonii). Bull. Mus. Nat. Hist. Nat. 4(2):541-546.

BOWEN, B. W. & KARL, S. A. 1997. Population Genetics, Phylogeography, and Molecular Evolution. In The Biology of Sea Turtles (Lutz, P. L. & Musick, J. A., eds.). CRC Press, Boca Raton, p.29-50.

BOWEN, B. W. & KARL, S. A. 1999. In War, Truth is the First Casualty. Conservation Biology 13(5):1013-1016.

BOWEN, B. W. & KARL, S. A. 2000. Meeting Report: Taxonomic Status of the East Pacific Green Turtle (*Chelonia agassizii*). Marine Turtle Newsletter 89:20-22.

BURKE, V. J., LOVICH, J. E. & GIBBONS, J. W. 2000. Conservation of Freshwater Turtles. In Turtle Conservation (M. Klemens, ed.). Smithsonian Institution Press, Washington, D.C., p.156-179.

CACCONE, A., GENTILE, G., GIBBS, J.P., FRITTS, T.H., SNELL, H.L., BETTS, J. & POWELL, J.R. 2002. Phylogeography and history of Giant Galápagos Tortoises. Evolution 56(10): 2052–2066.

CACCONE, A., GIBBS, J.P., KETMAIER, V., SUATONI, V. & POWELL, J.R. 1999. Origin and evolutionary relationships of giant Galápagos tortoises. PNAS 96(23): 13223-13228.

CARR, J. L. & ALMENDÁRIZ, A. 1989. Contribución al Conocimiento de la Distribución Geográfica de los Quelonios del Ecuador Continental. Revista Politécnica XIV (2):75-103.

COLOMA, L. A., QUIGUANGO, A. & RON, S. 2000-2004. Reptiles de Ecuador: lista de especies y distribución. Crocodylia, Serpentes y Testudines. [on line]. Ver. 1.1. (25 May 2000). Museo de Zoología, Pontificia Universidad Católica del Ecuador, Quito, http://www.puce.edu.ec/Zoologia/repecua.htm (Last accessed on 22 May 2005).

DEFORCE, E. A., DEFORCE, C. D. & LIDERMAN, P. V. 2004. *Phrynops gibbus* (Gibba Turtle). Trap-happy Behavior. Herpetological Review 35(1):55-56.

DIAMOND, A. W. 1976. Breeding biology and conservation of Hawksbill turtles, *Eretmochelys imbricata* L., on Cousin Island, Seychelles. Biological Conservation 9(3):199-215.

DUELLMAN, W. E. 1978. The Biology of an Equatorial Herpetofauna in Amazonian Ecuador. University of Kansas, Miscellaneous Publication 65, p.1-352.

DUTTON, P. H., DAVIS, S. K., GUERRA, T. & OWENS, D. 1996. Molecular Phylogeny for Marine Turtles Based on Sequences of the ND4-Leucine tRNA and Control Regions of Mitochondrial DNA. Molecular Phylogenetics and Evolution 5(3):511-521.

ERNST, C. H. 1983. Geographic Variation in the Neotropical Turtle, *Platemys platycephala*. Journal of Herpetology 17 (4): 345-355.

GIBBONS, J. W. 1990. Recommendations for future research on freshwater turtles: What are the Questions. In Life History and Ecology of the Slider Turtle. (Gibbons, J. W., ed.). Smithsonian Institution Press, Washington, D.C., p. 311-317.

HEYER, W. R., DONNELLY, M. A., MCDIARMID R. W., HAYEK, L. A. C. & FOSTER, M. S. 1994. Measuring and Monitoring Biological Diversity – Standard Methods for Amphibians. Smithsonian Institution Press, Washington, D.C.

IVERSON, J. B. 1992. A revised Checklist with Distribution Maps of the Turtles of the World. Richmond (Privately printed).

IVERSON, J. B. & VOGT, R. C. 2002. *Peltocephalus*, *P. dumerilianus*. Catalogue of American Amphibians and Reptiles 744: 1-4.

KARL, S. A. & BOWEN, B. W. 1999. Evolutionary Significant Units versus Geopolitical Taxonomy: Molecular Systematics of an Endangered Sea Turtle (genus *Chelonia*). Conservation Biology 13 (5): 990-999.

MCCORD, W. P., OUNI, M. J. & LAMAR, W. W. 2001. A Taxonomic Reevaluation of *Phrynops* (Testudines: Chelidae) with the description of two new genera and a new species of *Batrachemys*. Revista de Biología Tropical, San José; 49 (2): 715-764.

MCFARLAND, C. G., VILLA, J. & TORO, B. 1974. The Galápagos Giant tortoises (*Geochelone elephantopus*) Part I: Status of the Surviving Populations. Biological Conservation 6 (2): 118-133.

MEDEM, F. 1960. Datos Zoo-geográficos y ecológicos sobre los Crocodylia y Testudinata de los ríos Amazonas, Putumayo y Caquetá. Caldasia VIII (38): 341-351.

MEYLAN, P. A. 1996. Skeletal morphology and relationships of the Early Cretaceous side-necked turtle, *Araripemys barretoi* (Testudines: Pelomedusoides: Araripemydidae), from the Santana Formation of Brazil. Journal of Vertebrate Paleontology 16 (1):20-33.

MIYATA, K. 1982. A Check List of the Amphibians and Reptiles of Ecuador with a Bibliography of Ecuadorian Herpetology. Smithsonian Herpetological Information Service 54: 1-69.

OKAYAMA, T., DIAZ-FERNANDEZ, R., BABA, Y., HALIM, M., ABE, O., AZENO, N. & KOIKE, H. (1999). Genetic diversity of the Hawksbill Turtle in the Indo-Pacific and Caribbean regions. Chelonian Conservation and Biology 3 (2): 362-367.

ORCÉS V., G. 1949. Los Testudinata Ecuatorianos que se conservan en las colecciones de Quito, Ecuador. Boletín de Informaciones Científicas Nacionales III (20/21): 13-22.

PHILLIPS, C. A., DIMMICK, W. W. & CARR, J. L. 1996. Conservation Genetics of the Common Snapping Turtle (*Chelydra serpentina*). Conservation Biology 10 (2): 397-405.

PRITCHARD, P. C. H. 1980. *Dermochelys coriacea*. Catalogue of American Amphibians and Reptiles 238: 1-4.

PRITCHARD, P.C.H. 1996. The Galapagos Tortoises. Nomenclatural and Survival Status. Chelonian Research Foundation in association with Conservation International and Chelonia Institute.

PRITCHARD, P. C. H. 1999. Status of the Black Turtle. Conservation Biology 13 (5): 1000.

PRITCHARD, P. C. H. & TREBBAU, P. 1984. The Turtle of Venezuela. Society for the Study of Amphibians and Reptiles, Contributions to Herpetology, No. 2.

RUSSELLO, M.A., GLABERMAN, S., GIBBS, J.P., MARQUEZ, C., POWELL, J.R. & CACCONE, A. 2005. A cryptic taxon of Galáapagos tortoise in conservation peril. Biology Letters (2005) 1: 287-290.

SITES, JR., J. W. & K. A. CRANDALL. 1997. Testing Species Boundaries in Biodiversity Studies. Conservation Biology 11 (6): 1289-1297.

SPINKS, P. Q., SHAFFER, H. B., IVERSON, J. B. & MCCORD, W. P. 2004. Phylogenetic hypotheses for the turtle family Geoemydidae. Molecular Phylogenetics and Evolution 32 (1): 164–182.

WALKER, D., MOLER, P. E., BUHLMANN, K. A. & AVISE, J. C. 1998. Phylogeographic uniformity in mitochondrial DNA of the snapping turtle (*Chelydra serpentina*). Animal Conservation 1998 (1): 55-60.

YASUKAWA, Y., HIRAYAMA, R. & HIKIDA, T. 2001. Phylogenetic relationships of geoemydine turtles (Reptilia: Bataguridae). Current Herpetology 20: 105–133.

Title: Turtles of the Tiputini Biodiversity Station with remarks on the diversity and distribution of the Testudines from Ecuador.

Author: Diego F. Cisneros-Heredia

Biota Neotropica, Vol. 6 (number 1): 2006
http://www.biotaneotropica.org.br/v6n1/pt/abstract?inventory+bn00906012006

Date Received 05/23/2005 - Revised 10/18/2005
Accepted 01/01/2006

ISSN 1676-0611

APPENDIX 1.

Annotated Checklist of the living Testudines (turtles and tortoises) from mainland and insular Ecuador.

FAMILY CHELIDAE

Notes: All species of toad-head turtles were included in the genus *Phrynops* until the revision of McCord et al. (2001) whom resurrected the genera *Batrachemys*, *Mesoclemmys* and *Rhinemys* from its synonymy.

1. *Batrachemys heliostemma* McCord, Ouni & Lamar, 2001

Distribution in Ecuador: Eastern Tropical (Amazonia). Provinces of Sucumbíos and Orellana.

2. *Batrachemys raniceps* (Gray, 1855)

Distribution in Ecuador: Eastern Tropical (Amazonia). Provinces of Sucumbíos and Orellana.

Notes: Previously under the synonymy of Batrachemys (Phrynops) nasuta.

3. *Chelus fimbriatus* (Schneider, 1783)

Distribution in Ecuador: Eastern Tropical (Amazonia). Provinces of Sucumbíos, Orellana, Pastaza, and Zamora-Chinchipe.

4. *Mesoclemmys gibba* (Schweigger, 1812)

Distribution in Ecuador: Eastern Tropical (Amazonia). Provinces of Napo, Sucumbíos, Orellana and Pastaza.

5. *Platemys platycephala* (Schneider, 1792)

Distribution in Ecuador: Eastern Tropical (Amazonia). Provinces of Napo, Sucumbíos, Orellana, Pastaza, Morona-Santiago, and Zamora-Chinchipe.

Notes: Ecuadorian populations are assigned to the subspecies *Platemys platycephala melanonota* Ernst.

6. *Phrynops geoffroanus* (Schweigger, 1812)

Distribution in Ecuador: Eastern Tropical (Amazonia). Provinces of Napo, Sucumbíos, and Orellana.

FAMILY CHELONIIDAE

7. *Chelonia mydas* Bocourt, 1868

Distribution in Ecuador: Pacific coast of Ecuador (including surrounding islands) and Galápagos Archipelago.

Notes: The Ecuadorian populations have been assigned to the subspecies *Chelonia mydas agassizii* Bocourt 1868, which is considered by some authors (eg. Pritchard 1999) as a species, different from *mydas*: *Chelonia agassizii*. However, there is still much controversy regarding the real differentiation of populations assigned to the taxon *agassizii* from those assigned to *mydas*, and its real taxonomic status (see Bowen & Karl 1997, 1999, Karl & Bowen 1999, Pritchard 1999, Bowen & Karl 2000). As the black turtle *agassizii* is considered "unique in some respect and is likely to be an emerging evolutionary lineage" (Bowen & Karl 2000), I herein maintained the subspecific status (as *Chelonia mydas agassizii*) for the East Pacific populations (including Ecuador), pending further studies.

8. *Eretmochelys imbricata* (Linnaeus, 1766)

Distribution in Ecuador**:** Pacific coast of Ecuador (including surrounding islands) and Galápagos Archipelago.

Notes: The name *Eretmochelys imbricata bissa* (Rüppell) (with *squamata* Agassiz as a synonym) has been assigned by several authors to the Indo-Pacific populations, including the Ecuadorian (see Pritchard and Trebbau 1984). The intra-specific variation of *Eretmochelys imbricata* is still insufficiently known, and the subspecific status has been questioned by some authors (see Diamond 1976). Okayama et al. (1999) found that the distribution of the mtDNA haplotype diversity is consistent with the fundamental division between the Atlantic and Pacific populations, but also found significant lineage segregation within the Indo-Pacific stock (Okayama et al., 1999). The subspecies division is herein maintained until more studies provide a more complete understanding of the species variation and systematics.

9. *Lepidochelys olivacea* (Eschscholtz, 1829)

Distribution in Ecuador: Pacific coast of Ecuador (including surrounding islands) and Galápagos Archipelago.

FAMILY CHELYDRIDAE

10. *Chelydra serpentina* (Linnaeus, 1758)

Distribution in Ecuador: Western Tropical. Provinces of Esmeraldas, Manabí, Guayas, Los Ríos, Pichincha.

Notes: Ecuadorian populations are assigned to the subspecies *C. s. acutirostris* Peters. However, the taxonomic status of the different names under *Chelydra serpentina* is still controversial. Currently four subspecies are recognized for *C. serpentina*: *C. s. serpentina*, *C. s. acutirostris*, *C. s. osceola*, and *C. s. rossignonii*. The North American taxa (nominal subspecies and *osceola*) have been considered either as synonyms or as subspecies but further studies are needed (Phillips et al. 1996, Walker et al. 1998, Sites & Crandall 1997). Much controversy still exists on the status of the Central and South American populations; Phillips et al. (1996) suggested specific status for both taxa (*acutirostris* and *rossignonii*) based on patterns of geographic variation in isozyme and mitochondrial DNA restriction fragment pattern data; but Sites & Crandall (1997) presented an alternative interpretation of their data and concluded that species status may not be guaranteed for Central and South American taxa, but that the Ecuadorian population may deserve species status if the fixation of a unique allele at two nuclear isozyme loci (M-Icdh and S-Icdh) is showed to be present with more extensive sampling; however additional studies have not been performed yet and the subspecies status is maintained for the Ecuadorian population.

Several specimens of *Chelydra serpentina* have been found in places outside its previously reported distribution range (ej. Los Frailes, Machalilla National Park, province of Manabí – FHGO 713; La Maná, province of Cotopaxi – not preserved). However, the validity of these records is uncertain because they could correspond to animals transported by illegal traffic, rather than a real extension in the distribution range of the species (ej., *Geochelone denticulata* reported by Orcés [1949] from western Ecuador). Illegal traffic of turtles in Ecuador has involved several thousands of freshwater turtles and tortoises over the years. The extensive commerce towards the biggest cities (ej., Quito and Guayaquil) was stopped (or at least minimized) in the late-90's through a public campaign to stop wildlife traffic; however, several dozens are still captured for the pet markets in small-medium towns. Illegal traffic involves almost any mainland species, but the most common-captured species are: *Geochelone denticulata*, *Chelydra serpentina*, *Kinosternon leucostomum*, and *Rhinoclemmys* spp. Further, thousands of specimens of Trachemys spp. are exported into Ecuador for the legal pet market, and several of those turtles are released into Ecuadorian wetlands when people are unable to care them. It is unknown if there is any population of *Trachemys* spp. established in Ecuador and the consequences on the native wildlife.

FAMILY DERMOCHELYIDAE

11. *Dermochelys coriacea* (Vandelli, 1761)

Distribution in Ecuador: Pacific coast of Ecuador (including surrounding islands) and Galápagos Archipelago.

Notes: Some authors recognized two subspecies inside *Dermochelys coriacea*, the nominal and *schlegelii* (Garman) (with *augusta* [Philippi] as a synonym); with the nominal subspecies for the Atlantic populations and *schlegelii* assigned to the Indo-Pacific populations. Although differences between Eastern Pacific and Atlantic populations have been mentioned (Pritchard and Trebbau 1984), low genetic variation was showed in analyses of mtDNA sequence divergence between Pacific and Atlantic populations (Dutton et al. 1996); and currently *Dermochelys coriacea* is recognized as monotypic, without subspecific divisions (Pritchard 1980, Pritchard and Trebbau 1984).

FAMILY GEOEMYDIDAE

Notes**:** The family Geoemydidae (with Bataguridae as a junior synonym) was previously considered a subfamily inside Emydidae, however currently both are considered as separate families; with Emydidae as the sister group of a Geoemydidae/Testudinidae clade (Spinks et al. 2004).

12. *Rhinoclemmys annulata* (Gray, 1860)

Distribution in Ecuador: Western Tropical. Provinces of Esmeraldas, Manabí, Guayas, Los Ríos, Imbabura, Pichincha.

Notes**:** This species was separated into the resurrected genus *Chelopus* by Yasukawa et al. (2001), however recent analysis strongly suggest that the genus *Rhinoclemmys* (including *annulata*) is monophyletic and the recognition of the genus *Chelopus* is not justified (Spinks et al. 2004).

13. *Rhinoclemmys melanosterna* (Gray, 1861)

Distribution in Ecuador: Northwestern Tropical. Province of Esmeraldas.

Notes: Records of *Rhinoclemmys melanosterna* (ej. Puerto Cayo-Puerto Nuevo road, Manabí – FHGO 1335, Manta-Eloy Alfaro road, Manabí – FHGO 1478) and *R. nasuta* (record from the Machalilla National Park reported by Almendáriz & Carr 1992) from outside their currently known distribution ranges must be evaluated carefully, as they can be product of artificial introductions rather than reflect the real distribution of the species (see notes under *Chelydra serpentina*).

14. *Rhinoclemmys nasuta* (Boulenger, 1902)

Distribution in Ecuador: Northwestern Tropical. Provinces of Esmeraldas and Pichincha.

Notes: See notes under *Rhinoclemmys melanosterna*.

FAMILY KINOSTERNIDAE

15. *Kinosternon leucostomum* Duméril & Bibron, 1851

Distribution in Ecuador: Western Ecuador. Provinces of Esmeraldas, Guayas, Los Ríos, Pichincha, and Cañar.

Notes: Ecuadorian population is assigned to the subspecies *Kinosternon leucostomum postinguinale*_(Cope). Records of *Kinosternon leucostomum* from outside its currently known distribution range must be evaluated carefully, as they can be product or artificial introductions rather than reflect the real distribution of the species (see notes under *Chelydra serpentina*).

16. *Kinosternon scorpioides* (Linnaeus, 1766)

Distribution in Ecuador: Eastern Tropical (Amazonia). Provinces of Sucumbíos and Orellana.

Notes: Ecuadorian populations are assigned to the subspecies *Kinosternon scorpioides scorpioides* (Linnaeus).

FAMILY PODOCNEMIDIDAE

Notes: The family Podocnemididae was previously considered a subfamily inside Pelomedusidae, but currently the Malagasy and American species are in the family Podocnemididae and just the African species in the family Pelomedusidae (see Meylan 1996)

17. *Podocnemis expansa* (Schweigger, 1812)

Distribution in Ecuador: Eastern Tropical (Amazonia). Provinces of Sucumbíos, Napo, Orellana, and Pastaza.

Notes: Ecuadorian populations are critically endangered and on the brink of extinction.

18. *Podocnemis unifilis* Troschel, 1848

Distribution in Ecuador: Eastern Tropical (Amazonia). Provinces of Sucumbíos, Napo, Orellana, Pastaza and Morona-Santiago.

19. *Peltocephalus dumerilianus* (Schweigger, 1812)

Distribution in Ecuador: Eastern Tropical (Amazonia). Province of Pastaza.

Notes: First reported from Ecuador by Orcés (1949).

FAMILIA TESTUDINIDAE

Notes: All Ecuadorian species of the family Testudinidae are members of the subgenus Chelonoidis, which has been accorded generic status by some authors (ej. Bour 1980). The taxonomic arrangement of the Galapagos tortoises is not completely settled:

(1) Some authors relegate all Galapagos tortoise taxa as subspecies of a single species, usually named *G. nigra* or *G. elephantopus*.

(2) The populations from southern Isla Isabela (Darwin and Alcedo Volcanoes, Cerro Azul, Sierra Negra) are problematic. Pritchard (1996) suggested that the four southern Isla Isabela taxa do not warrant separate status. Caccone et al. (1999) found that those populations lack genetic differentiation; but latter, Caccone et al. (2002) found that *microphyes* (Volcan Darwin) and *vandenburghi* (Volcan Alcedo) are genetically distinct, and deserve separation; but they can not refute the suggestion that the two southern most subspecies are not genetically distinct.

(3) It was recently recognized that the Isla San Cruz populations, formerly recognized as the single taxon *nigrita* (with *porteri* as a synonym), include three distinct lineages, with at least one deserving its recognition as a new and endangered taxon (Russello et al. 2005).

20. *Geochelone abingdonii* (Günther, 1877)

Distribution in Ecuador: Galápagos Archipelago, Isla Pinta.

Notes: Only survivor (Lonesome George) lives at the Charles Darwin Research Station.

21. *Geochelone becki* (Rothschild, 1901)

Distribution in Ecuador: Galápagos Archipelago, Isla Isabela (Wolf volcano).

22. *Geochelone chathamensis* (Van Denburgh, 1907)

Distribution in Ecuador: Galápagos Archipelago, Isla San Cristobal.

23. *Geochelone darwini* (Van Denburgh, 1907)

Distribution in Ecuador: Galápagos Archipelago, Isla San Salvador.

24. *Geochelone denticulata* (Linnaeus, 1766)

Distribution in Ecuador: Eastern Tropical (Amazonia). Provinces of Sucumbíos, Napo, Orellana, Pastaza and Morona-Santiago.

Notes: Records from Western Ecuador are certainly specimens transported by illegal traffic (Carr & Almendáriz 1989, also see notes under *Chelydra serpentina*).

It has been suggested that *Geochelone carbonaria* (Spix) could occur in Ecuador (Vanzolini in Miyata 1982, P. Salvador pers. comm.), however no voucher specimens are known.

25. *Geochelone ephippium* (Günther, 1875)

Distribution in Ecuador: Galápagos Archipelago, Isla Pinzón.

26. *Geochelone guntheri* (Baur, 1890)

Distribution in Ecuador: Galápagos Archipelago, Isla Isabela (Sierra Negra).

27. *Geochelone hoodensis* (Van Denburgh, 1907)

Distribution in Ecuador: Galápagos Archipelago, Isla Española.

28. *Geochelone microphyes* (Günther, 1875)

Distribution in Ecuador: Galápagos Archipelago, Isla Isabela (Darwin volcano).

29. *Geochelone nigrita* (Duméril & Bibron, 1835)

Distribution in Ecuador: Galápagos Archipelago, Isla Santa Cruz.

30. *Geochelone vandenburghi* (DeSola, 1930)

Distribution in Ecuador: Galápagos Archipelago, Isla Isabela (Alcedo volcano).

31. *Geochelone vicina* (Günther, 1875)

Distribution in Ecuador: Galápagos Archipelago, Isla Isabela (Cerro Azul).