Acarologia

A quarterly journal of acarology, since 1959
Publishing on all aspects of the Acari

All information:

<http://www1.montpellier.inra.fr/CBGP/acarologia/>
acarologia-contact@supagro.fr

**Acarologia is proudly non-profit,
with no page charges and free open access**

Please help us maintain this system by
encouraging your institutes to subscribe to the print version of the journal
and by sending us your high quality research on the Acari.

Subscriptions: Year 2023 (Volume 63): 450 €

<http://www1.montpellier.inra.fr/CBGP/acarologia/subscribe.php>

Previous volumes (2010-2021): 250 € / year (4 issues)

Acarologia, CBGP, CS 30016, 34988 MONTFERRIER-sur-LEZ Cedex, France

ISSN 0044-586X (print), ISSN 2107-7207 (electronic)

The digitalization of Acarologia papers prior to 2000 was supported by Agropolis Fondation under the reference ID 1500-024 through the « Investissements d'avenir » programme (Labex Agro: ANR-10-LABX-0001-01)

Supporting agricultural research
for sustainable development

**Acarologia is under free license and distributed under the terms of the
Creative Commons-BY**

Mite fauna (Acari) associated with the poultry industry in different laying hen management systems in Southern Brazil: a species key

Tamara Bianca Horn^a, Juliana Granich^a, Júlia Horn Körbes^a, Guilherme Liberato Da Silva^{a,b}, Noeli Juarez Ferla^{a,c}

^a Laboratório de Acarologia, Tecnovates, UNIVATES – Centro Universitário. Lajeado, Rio Grande do Sul State, Brazil.

^b Departamento de Microbiologia, Imunologia e Parasitologia, Universidade Federal do Rio Grande do Sul. Porto Alegre, Rio Grande do Sul State, Brazil.

^c CNPq Researcher.

ABSTRACT

This study is based on results from a large project on the mite diversity in commercial laying hen systems in Brazil. It aims to identify potential biocontrol agents amongst mites present in poultry farms, with a focus on one feather mite pest *Megninia ginglymura*. A secondary goal is to provide an operational identification tool to help the development of biological control in poultry farms. Sampling was conducted from August 2013 to August 2014, with 43 sampling events, in three different laying hen management systems. We used traps, laying hen feathers, and abandoned wild bird nests to collect the mites. A total of 38,862 mites belonging to 23 families and 39 species were found, including 17 species exclusively found in traps, six in wild bird nests, and one in feathers. The most abundant and frequent ectoparasitic species was *M. ginglymura* (76.3%; observed in all management systems). Amongst other mites, Tydeidae showed the highest richness with five species (*Brachytydeus argentinensis* (Baker, 1970), *Brachytydeus australensis* (Baker, 1970), *Brachytydeus obnoxia* (Kuznetzov and Zapletina, 1972), *Brachytydeus oregonensis* (Baker, 1970), and *Brachytydeus tuttlei* (Baker, 1965)), followed by Cheyletidae with four species (*Chelacheles bipanus* Summers and Price, 1970, *Cheyletus eruditus* (Schrank, 1781), *Cheyletus malaccensis* (Oudemans, 1903), and *Cheletomimus (Hemicheyletia) wellsi* (Baker, 1949)). Potential predatory species for biological control were *C. malaccensis* (9.4%), *Typhlodromus transvaalensis* (Nesbitt, 1951) (0.8%), *Blattisocius keegani* (Fox, 1947) (0.7%), and *Blattisocius dentriticus* (Berlese, 1918) (0.4%). A dichotomous key is provided to identify 48 species dwelling in Brazilian layer farms.

Received 17 February 2017

Accepted 16 August 2017

Published 30 January 2018

Corresponding author

Tamara Bianca Horn:
tamarahorn83@hotmail.com

Academic editor

Lise Roy

DOI

10.24349/acarologia/20184233

© Copyright
Horn T.B. et al.

Distributed under

Creative Commons CC-BY 4.0

Keywords Aviculture; Ectoparasite, *Megninia ginglymura*, *Cheyletus malaccensis*, *Tuiciglyphus setosus*

Zoobank <http://zoobank.org/3AEF355B-46C9-46F3-943C-415B5245094A>

Introduction

The diversity of mites in poultry farms is wide and revealed different life habits as parasitic, predatory, detritivorous mites (Brady 1970). However, only a few species present economic or sanitary importance as the hematophagous mites *Ornithonyssus bursa* (Berlese, 1888), *Ornithonyssus sylviae* (Canestrini; Fanzago, 1877) (Macronyssidae) and *Dermanyssus gallinae* (De Geer, 1778) (Dermanyssidae) (Faccini 1987) or the feather mite *Megninia ginglymura* (Mégnin, 1877). Others may act as potential predatory mites.

How to cite this article Horn T.B. et al. (2018), Mite fauna (Acari) associated with the poultry industry in different laying hen management systems in Southern Brazil: a species key. *Acarologia* 58(1): 140-158; DOI 10.24349/acarologia/20184233

The repeated use of acaricides at high concentrations to control infestations could lead firstly to the development of acaricide-resistant and more importantly to the accumulation of acaricides in chickens' organs and also in eggs. Various synthetic chemical pesticides, for example carbaryl and permethrin, can accumulate in different levels in organs/tissues, skin, fat and muscle (Marangi *et al.* 2012).

Alternative controls, which replace the use of chemical pesticides, are important to increase the quality of the products, of the environment, of workers' health, and of rural animal welfare. Biological control using *Strongylopsalis mathurinii* (Ribeiro, 1931) (Dermaptera: Labiidae) has been successful in controlling *D. gallinae* in the poultry industry of the state of São Paulo (Guimarães *et al.* 1992). Lesna *et al.* (2009) investigated potential predators for the biological control of *D. gallinae* among predatory mites, and found two genuine predators: *Gaeolaelaps aculeifer* (Canestrini, 1883) (Laelapidae) and *Androlaelaps casalis* (Berlese, 1887) (Laelapidae); they also highlighted *Cheyletus eruditus* (Schränk, 1781) (Cheyletidae), *Zerconopsis remiger* (Kramer, 1876) (Ascidae), and *Blattisocius keegani* (Fox, 1947) (Blattisociidae), which may act as predators. In another investigation, they observed that *A. casalis* and *Stratiolaelaps scimitus* (Womersley, 1956) (Laelapidae) were capable of feeding and reproducing on *D. gallinae* (Lesna *et al.* 2012). Toldi *et al.* (2014) studied the biology of *Cheyletus malaccensis* (Oudemans, 1903) (Cheyletidae) feeding on *D. gallinae* under laboratory conditions. This predatory mite showed no preference for any prey phase, feeding on all stages, and was considered by these authors as a potential natural enemy of *D. gallinae*.

The biological control of *M. ginglymura* was poorly investigated and needs further studies. *Blattisocius dentriticus* (Berlese, 1918) (Blattisociidae) feeding on *M. ginglymura* under laboratory conditions showed lower values of life-table parameters than *Tyrophagus putrescentiae* (Schränk, 1781) (Acaridae) (Silva *et al.* 2016a). These two prey species were also tested as food for the predator *C. malaccensis*, and *M. ginglymura* was considered the best food item as it achieved better life-table results ($Ro = 135.6$; $T = 41.6$; $\lambda = 1.13$; $rm = 0.12$) than *T. putrescentiae* (Granich *et al.* 2016).

This study, which complements the study by Horn *et al.* (2016), provides additional data aiming to identify the most promising biocontrol agent species, with a focus on the feather mite *M. ginglymura*, and to provide a key to species derived from poultry farms in the South of Brazil.

Materials and methods

This study was conducted in different commercial laying hen systems between August 2013 and August 2014, in Lajeado County, Vale do Taquari, state of Rio Grande do Sul, Brazil. Six poultry houses were sampled with their characteristics as reported in Horn *et al.* (2016).

Two additional methods of sampling mites associated to poultry farms were proposed in this study as complementary to trap data by Horn *et al.* (2016): laying hen feathers and wild bird nests. For feather mites evaluations, ten laying hens were evaluated for each laying hen house. Five feathers per laying hen were collected, totaling 50 feathers per sample in each laying hen house. The feathers were placed individually in a plastic container with 70% alcohol during a minimum of 24 hours before the screening. The plastic containers were taken to the laboratory in paper box with styrofoam inside. The screening was performed by filtering the alcohol in qualitative filter paper of diameter 12.5 cm and weight of 80 g/m². This method primarily checks actual health and economic mite species. In addition, potential predatory mites captured in the feathers may indicate a possible predation relationship due to foraging for food.

The wild bird nests abandoned were found in the lateral roof side of the laying hens houses were also evaluated for the presence of mites. The species birds identified were *Columbina picui* (Temminck, 1813), *C. talpacoti* (Temminck, 1810) (Columbidae), *Turdus* sp. (Turdidae) and *Zenaidura macroura* (Des Murs, 1847) (Columbidae). The bird nests were stored in individual

plastic bags and in laboratory, they were exposed in Berlese funnel for five to seven days and mites stored in plastic container with 70% alcohol. This sampling method can highlight a possible migration relationship between acarofauna of wild birds and confined laying hens as well as help identify potential predators for biological control (Lesna *et al.* 2009).

All mites were collected with a fine-tipped paintbrush and mounted with Hoyer's medium on microscope slides (Walter and Krantz 2009). The slides were kept for up to 10 days at 50-60 °C to dry the medium, to extend the legs and for diaphanization of the specimens.

Identifications

The identification of specimens to the species level was done using a phase contrast light microscope and identifications keys. Voucher specimens were stored at the reference Collection of the Natural Sciences Museum of the UNIVATES University Center (ZAUMCN), Lajeado, Rio Grande do Sul, Brazil.

Results

A total of 38,862 mites belonging to 23 families and 39 species were found. Most mites were collected from feathers (73.1%), followed by traps (25.7%) and bird nests (1.2%). The family with the highest richness was Tydeidae, with five species (*Brachytydeus argentinensis* (Baker, 1970), *Brachytydeus australensis* (Baker, 1970), *Brachytydeus obnoxia* (Kuznetsov and Zapletina, 1972), *Brachytydeus oregonensis* (Baker, 1970), and *Brachytydeus tuttlei* (Baker, 1965)), followed by Cheyletidae with four species (*Chelacheles bipanus* Summers and Price, 1970, *C. eruditus*, *C. malaccensis*, and *Cheletomimus (Hemicheyletia) wellsi* (Baker, 1949)), and Acaridae with three species (*Aleuroglyphus ovatus* (Troupeau, 1878), *Thyreophagus entomophagus* (Laboulbène, 1852), and *T. putrescentiae*) (Figure 1). However, *M. ginglymura* had the highest abundance, with 76.3% of the total number of mites. This species was observed on laying hens of all systems evaluated; it was recorded both in traps (13.3% of the total) and feathers (99.7% of the total). The second most abundant species was *C. malaccensis* (9.4%) and the third one was *Tucciglyphus setosus* Horn and Klimov, 2017 (8.6%), both found on laying hens of all systems evaluated and in all sampling methods. *Cheyletus malaccensis* and *T. setosus* represent 35.1% and 32.7% of the total number of mites associated to traps, respectively. Aside from these species, *B. dentriticus*, *B. keegani*, *C. (Hemicheyletia) wellsi*, *Tetranychus* sp., *Typhlodromus transvaalensis* (Nesbitt, 1951) (Phytoseiidae), and *T. putrescentiae* were present in bird nests, feathers, and traps (Figure 1).

Brachytydeus oregonensis, *Raphignathus* sp., and *Tarsonemus granarius* Lindquist, 1972 (Tarsonemidae) were associated to traps and bird nests. *M. ginglymura*, *A. ovatus*, *Macrocheles muscaedomesticae* (Scopoli, 1772) (Macrochelidae), and *Rubroscirrus nidorum* (Ferla and Rocha, 2012) (Cunaxidae) were present in feathers and traps.

Seventeen species were exclusively found in traps and a single species exclusively found on feathers, *Dermatophagoides farinae* (Hughes, 1961) (Pyroglyphidae). In bird nests, six exclusively species were found and three of them belong to the genus *Brachytydeus* (*B. argentinensis*, *B. australensis* and *B. obnoxia*). Furthermore, *A. casalis* and Oribatid mites were collected from bird nests. Also in abandoned bird nests, the most representative species were *C. malaccensis* (30.1%), *B. keegani* (19%), and *B. dentriticus* (11.7%). *Androlaelaps casalis* and *O. bursa* were only recorded using this sampling method. In feathers, there was a high dominance of *M. ginglymura* (99.7%) and all other species occurred in low numbers. The most representative species in traps were *C. malaccensis* (35.1%), *T. setosus* (32.7%), and *M. ginglymura* (13.3%).

Mite species and the laying hen systems where they were collected from are listed in Appendix, along with sampling month and year and comments on their known habits and habitats. The number of recorded specimens is shown in parentheses.

BIRD NESTS (BN)		TRAP (T)	
<i>Androlaelaps casalis</i> (0.6) <i>Brachytydeus argentinensis</i> (0.8) <i>Brachytydeus australensis</i> (8.1) <i>Brachytydeus obnoxia</i> (0.2) <i>Ornithonyssus bursa</i> (1.3) <i>Oribatida</i> (0.2)		<i>Brachytydeus tuttlei</i> (4.5) <i>Brevipalpus phoenicis</i> (0.01) <i>Carpoglyphus lactis</i> (0.01) <i>Chelacheles bipanus</i> (0.06) <i>Cheyletus eruditus</i> (0.2) <i>Chortoglyphus arcuatus</i> (0.9) <i>Ctenoglyphus</i> sp. nov. (0.2) <i>Epidermoptidae</i> (0.03) <i>Fuscuropoda</i> sp. (0.03) <i>Hypoaspis lubrica</i> (0.01) <i>Glycyphagus destructor</i> (1.2) <i>Molotroglyphus</i> sp. (0.02) <i>Paraneognathus wangae</i> (0.06) <i>Proctolaelaps pomorum</i> (0.01) <i>Storchia pacificus</i> (0.01) <i>Suidasia pontifica</i> (0.03) <i>Thyreophagus entomophagus</i> (0.5)	
<i>Brachytydeus oregonensis</i> (BN: 1.0; T: 1.5) <i>Raphignathus</i> sp. (BN: 0.8; T: 0.02) <i>Tarsonemus granarius</i> (BN: 9.4; T: 0.01)		<i>Blattisocius dentriticus</i> (BN: 11.7; F: 0.01; T: 0.9) <i>Blattisocius keegani</i> (BN: 19; F: 0.02; T: 1.8) <i>Cheletomimus (Hemichyletia) wellsi</i> (BN: 5.4; F: 0.01; T: 2.1) <i>Cheyletus malaccensis</i> (BN: 30.1; F: 0.03; T: 35.1) <i>Tetranychus</i> sp. (BN: 0.2; F: 0.01; T: 0.04) <i>Tuccioglyphus setosus</i> (BN: 9.6; F: 0.1; T: 32.7) <i>Typhlodromus transvaalensis</i> (BN: 0.8; F: 0.02; T: 3.0) <i>Tyrophagus putrescentiae</i> (BN: 0.6; F: 0.08; T: 0.6)	
<i>Dermatophagoides farinae</i> (0.01)		FEATHER (F)	
		<i>Aleuroglyphus ovatus</i> (F: 0.01; T: 0.1) <i>Macrocheles muscaedomesticae</i> (F: 0.01; T: 0.08) <i>Megninia ginglymura</i> (F: 99.7; T: 13.3) <i>Rubroscirus nidorum</i> (F: 0.04; T: 0.9)	

Figure 1 Mite fauna and their relative abundances (%) (parentheses) in bird nests (BN), feathers (F) and traps (T) between August 2013 and August 2014, in Lajeado County, Rio Grande do Sul, Brazil.

Key to genera and species (excluding Oribatida) present in poultry farms in Rio Grande do Sul, Brazil^{*, **}

* the species mentioned in Silva *et al.* (2013) and Faleiro *et al.* (2015) were included in the key (these authors misidentified: *Diamesoglyphus* sp. as *Ctenoglyphus* sp. and *Tuccioglyphus setosus* as *Pyroglyphus* sp. The identification of the specimens were reviewed by the authors and it was concluded that in fact specimens of each of the two species respectively belong to a single (Horn *et al.* 2017).

** the identification of the species was performed according to Colloff 2009; Fain 1965; Fain and Yan 1997; Fain *et al.* 2002; Ferla and Rocha 2012; Gaud *et al.* 1985; Hughes 1976; Krantz and Walter 2009; Oconnor 1982; Silva *et al.* 2016b; and Zhang *et al.* 1999.

- With 1-4 pairs of dorsolateral or ventrolateral stigmata posterior to coxae II; coxae of legs free, usually movable; tarsi of legs II-IV with peripodomeric fissure associated with slit organs; tarsus of leg I with dense dorsal cluster of solenidiform setae subdistally. **Superorder Parasitiformes**.....2
- Without visible stigmata posterior to coxae II; coxae I-IV fused to podosomal body wall so that the first completely free leg segment is the trochanter; ; tarsi of legs II-IV without fissure and slit organs; tarsus of leg I with sparse pairings of dorsal setae distally and subdistally. **Superorder Acariformes**.....15
- Gnathosoma usually narrow and elongate such that the hypostomal and subcapitular setae are aligned in a more or less longitudinal row; idiosoma tortoise-shape, usually oval in outline; pedofossae present; epigynial shield without setae **UROPODIDAE**.....*Fuscuropoda* sp.

- Gnathosoma with another shape; second subcapitular setae (hypostomal seta *h2*) usually laterad of setae *h3* and not in a linear arrangement with other subcapitular setae; idiosoma without tortoise-shape; pedofossae absent; epigynial shield usually with at least one pair of setae *Dermanyssidae*.....3
- 3. Peritremes looped proximally, joining the stigma posteriorly
..... **MACROCHELIDAE**.....*Macrocheles muscaedomesticae* (Scopoli, 1772)
— Peritremes not looped4
- 4. Deutonymphs and adults with less than 20 pairs of dorsal shield setae
..... **PHYTOSEIIDAE**.....5
— Deutonymphs and adults with more than 20 pairs of dorsal shield setae 6
- 5. Podonotal region of dorsal shield with four pairs of lateral setae (*j3*, *z2*, *z4* and *s4*)
..... *Amblyseius herbicolus* (Chant, 1959)
— Podonotal region of dorsal shield (anterior to *R1*) with five or six pairs of lateral setae (*j3*, *z2*, *z4* and *s4* present; *z3* and/or *s6* present) *Typhlodromus transvaalensis* (Nesbitt, 1951)
- 6. Female sternal shield with one or typically two pairs of setae (sternal setae 1-2); corniculi often divided distally or entire; Femur II with 10 setae, including 4 dorsals
..... **AMEROSEIIDAE**.....*Kleemannia plumigera* (Oudemans, 1930)
— Female with zero to typically three sternal setae on the sternal shield; corniculi rarely divided distally; Femur II with 10-11 setae, including 5 dorsals7
- 7. Female with epigynial shield truncate or weakly convex posteriorly and either narrowly separated from or abutting a ventrianal shield or widely separated from an anal shield that is round or oval but usually not inversely subtriangular 8
— Female with epigynial shield broadly or narrowly rounded posteriorly, usually widely separated from inversely subtriangular anal shield or epigynial shield expanded into a genitoventral or genitoventrianal shield 11
- 8. Female with epigynial shield gently rounded posteriorly and usually with an oval or elliptical anal shield bearing only the 3 anal setae (or rarely expanded to capture the nearest pair of opisthogastric setae); fixed cheliceral digit with *pilus dentilis* modified to a hyaline flap
..... **MELICHARIDAE**.....*Proctolaelaps pomorum* (Oudemans, 1929)
— Female with epigynial shield usually truncate posteriorly and usually with a ventrianal shield bearing 2-7 of the opisthogastric setae in addition to the anal setae
..... **BLATTISOCIDAE**.....9
- 9. Peritreme extending as far forward as coxae I; both digits of the chelicerae equally well-developed*Blattisocius dentriticus* (Berlese, 1918)
— Peritreme is very short, not extending beyond coxae II; fixed digit of the chelicerae considerably shorter than the movable 10
- 10. Peritreme reaching to about the posterior margin of coxae II; fixed digit of the chelicerae very short, without teeth; the movable digit has three teeth
..... *Blattisocius tarsalis* (Berlese, 1918)
— Peritreme short, barely reaching the middle of coxae III; fixed digit of chelicerae with minute teeth and about two-thirds the length of the movable digit; the movable digit has one or two teeth *Blattisocius keegani* (Fox, 1947)
- 11. Chelicerae of female whip-like, styliform; corniculi membranous, indistinct
..... **DERMANYSSIDAE**.....*Dermanyssus gallinae* (De Geer, 1778)

— Chelicerae variously produced but not styliform; corniculi variously developed 12

12. Chelicerae elongate, edentate; corniculi membranous, usually lobate; palptrochanter often with a raised medioventral keel; with a large anterior nonsetigerous spur on leg coxae II; genu IV typically with two ventral setae

. **MACRONYSSIDAE** *Ornithonyssus bursa* (Berlese, 1888)

— Chelicerae various, dentate or edentate; corniculi strongly sclerotized or membranous, horn-like, barbed or lobate; palptrochanter without raised medioventral keel; generally with more than one large nonsetigerous coxal spur; genu IV typically with one ventral setae

. **LAELAPIDAE** 13

13. Sternal shield of female broader than long; digits of male chelicerae edentate; *pilus dentilis* long and slender *Androlaelaps casalis* (Berlese, 1887)

— Sternal shield of female usually longer than broad; digits of male chelicerae dentate; *pilus dentilis* short and setiform 14

14. Genital shield of female large; pre-endopodal plates well-defined and connected by narrow strip; tectum with a smooth anterior margin

. *Hypoaspis lubrica* Voigts and Oudemans, 1904

— Genital shield of female small; pre-endopodal plates indistinct; tectum with a denticulate margin *Gaeolaelaps aculeifer* (Canestrini, 1883)

15. Chelicerae rarely chelate, fixed digit often regressed and movable digit usually a hook, knife, needle or stylet-like structure; cheliceral bases sometimes fused medially; palpi simple or modified into a thumb-claw process, sometimes reduced; subcapitulum without rutella; ambulacral of at least legs II and III usually with 2 lateral claws and with or rarely without a median empodium that may be padlike or rayed and often armed with tenent hairs, or occasionally claw- or sucker-like; opisthosoma lacking paired lateral glands; opisthosomatic setal row *c* usually with 2 pairs of setae (*cl-c2*), rarely with 3 pairs or hypertrichous; tracheal system with 1 pair of stigmata opening between bases of chelicerae or on anterior prodorsum usually present and sometimes associated with peritremes dorsally on the cheliceral bases or on the anterior margin of prodorsum **Suborder Prostigmata** 16

— Chelicerae typically chelate, usually dentate, rarely attenuate or stylet-like; cheliceral bases always separated; palpi simple, never with thumb-claw process; subcapitulum usually with rutella or pseudorutella; ambulacral of legs I-IV usually with 1 or 3 claws, bidactyl condition rare, empodium clawlike or sucker-like, never pad-like, rarely rayed; opisthosomata usually with pair of lateral glands (these are absent in more primitive taxa); opisthosomatic setal row *c* usually with 3-4 pairs of setae or hypertrichous; tracheal system absent or, when present, arising from bases of legs or as brachytracheae (relatively short tubes) on various parts of the legs or idiosoma; stigmata and peritremes never present between cheliceral bases or on prodorsum

. **Suborder Astigmata** 36

16. Pretarsal empodium of legs II and III membranous, nude; adult females with anterolateral prodorsal stigmata openings **TARSONEMIDAE** 17

— Pretarsal empodium of legs II and III claw-like, split distally, pad-like, rayed; juveniles and adults with stigmata openings at base of gnathosoma, on gnathosoma or absent 18

17. Female with sejugal apodeme not emarginated; pharynx short, resembling a horse shoes; setae *c1* and *c2* with similar lengths *Tarsonemus granarius* Lindquist, 1972

— Female with sejugal apodeme emarginated symmetrically in the middle region; pharynx elongated, similar to bowling bottles; setae *c2* longer than *c1* *Tarsonemus confusus* Ewing, 1939

18. With 1-2 pairs of variously shaped prodorsal trichobothria	19
— Without prodorsal trichobothria	25
19. Leg trichobothria absent	20
— Trichobothria present on at least tibia leg IV, tibia I or tarsus leg I	
..... CUNAXIDAE <i>Rubroscirus nidorum</i> Ferla and Rocha, 2012	
20. Pretarsus leg I with vestigial claws or without any claws or with apotele I absent	
..... IOLINIDAE <i>Parapronematus</i> sp.	
— Pretarsus leg I with paired claws and/or apotele I present	TYDEIDAE21
21. Cheliceral stylets distinctly shorter than palpal tarsus	22
— Cheliceral stylets not shorter than palpal tarsus	24
22. Empodial hooks (<i>om</i>) present	<i>Brachytydeus tuttlei</i> (Baker, 1965)
— Empodial hooks (<i>om</i>) absent	23
23. Body elongated; ventral striae between metasternal setae lying longitudinally; dorsal setae slender and relatively long: setae <i>fl</i> distinctly longer than $\frac{1}{2}$ distance <i>fl-hl</i> ; bothridial setae (<i>bo</i>) slightly serrate; solenidion ωI long: not shorter than the width of tarsus I	<i>Brachytydeus oregonensis</i> (Baker, 1970)
— Body broadened; ventral striae between metasternal setae lying transversely; dorsal setae lanceolate, short: setae <i>fl</i> about as long as $\frac{1}{2}$ section <i>fl-hl</i> ; bothridial setae (<i>bo</i>) smooth; solenidion ωI short: shorter than $\frac{1}{2}$ width of tarsus I	<i>Brachytydeus obnoxia</i> (Kuznetsov and Zapletina, 1972)
24. Stiletos as long as palpal tarsus	<i>Brachytydeus australensis</i> (Baker, 1970)
— Stiletos distinctly longer than palpal tarsus	<i>Brachytydeus argentinensis</i> (Baker, 1970)
25. Pretarsal claws well developed or reduced but always with tenent hairs	26
— Pretarsal claws lacking tenent hairs	27
26. Tarsi I-II without peg-shaped or bulbous solenidia and with 1-2 long, slender, tapered solenidia usually closely associated with a short or minute seta to form duplex sets	TETRANYCHYDAE <i>Tetranychus</i> sp.
— Tarsi I-II with distal, peg-shaped or bulbous solenidia and with no solenidia closely associated with a seta to form duplex sets	
..... TENUIPALPIDAE <i>Brevipalpus phoenicis</i> (Geijskes, 1939)	
27. Palptarsus with 1 or 2 comb-like setae; stylophore fused to subcapitulum; base of moveable digit contained within the stylophore capsule	CHEYLETIDAE28
— Palptarsus without comb-like setae; cheliceral bases variously fused to each other, never completely fused to subcapitulum; base of movable digit located at the tip of the cheliceral base, not within stylophore	33
28. Eyes absent	29
— One pair of prodorsal eyes present	31
29. Dorsal idiosomal setae short and fanshaped	<i>Eucheyletia reticulata</i> Cunliffe, 1962
— Dorsal idiosomal setae slender to narrowly-spatulate, never fanshaped	30
30. Omega in tarsus I distinctly swollen basally; usually with one tooth at the basis of pedipalpal claw; femur IV with 1 seta	<i>Cheyletus malaccensis</i> (Oudemans, 1903)

- Omega on tarsus I narrows very gradually without swelling; usually with more than one tooth at the basis of pedipalpal claw; femur IV with 2 setae *Cheyletus eruditus* (Schränk, 1781)
- 31. Body fusiform; coxal fields II and III separated by about body width *Chelacheles bipanus* Summers and Price, 1970
- Body ovoid; coxal field II and III separated by less than body width 32
- 32. Dorsum with two sclerites *Cheletomorpha lepidopterorum* (Shaw, 1794)
- Dorsum with three sclerites *Cheletomimus (Hemicheyletia) wellsi* (Baker, 1949)
- 33. Peritremes and stigma absent **STIGMAEIDAE** *Storchia pacificus* (Summers, 1964)
- Peritremes associated with cheliceral bases or on anterior margin of prodorsum 34
- 34. Peritremes at anterior margin of prodorsum *Raphignathus* sp.
- Peritremes on dorsal surface of stylophore 35
- 35. Peritremes emerging anteriorly, posteriorly to cheliceral condyle; peritremes arising medially on stylophores *Molothrognathus* sp.
- Peritremes confined in W-shaped; stylophore elongated and tapered *Paraneognathus wangae* Fan and Li, 1995
- 36. Body cuticle usually at least partially striated; pretarsi often enlarged, with ambulacral stalk and disk well developed, empodial claws usually reduced or incorporated into ambulacral disk as central sclerites 45
- Body cuticle smooth or striated; pretarsi variously formed, sometimes enlarged; empodial claws variously formed or absent 37
- 37. Prodorsum with lamellar (*le*) setae absent; pretarsi with long, thin condylophores or fused or absent; dorsal setae may be elongate, but never heavily barbed **CARPOGLYPHIDAE** *Carpoglyphus lactis* (Linnaeus, 1767)
- Prodorsum with lamellae (*le*) setae present, or if absent, then pretarsi with short condylophores or dorsal setae long and heavily barbed 38
- 38. Ventral subcapitulum with a prominent pattern of external transverse and oblique ridges **GLYCYPHAGIDAE** 39
- Ventral subcapitulum without external ridges 40
- 39. Tibia I-II with 1 ventral setae; dorsal body setae often strongly modified (flattened and pectinate, bipectinate or foliate) *Diamesoglyphus* sp.*
- Tibia I-II with 2 ventral setae; dorsal body setae densely pectinate *Glyciphagus destructor* (Schränk, 1781)
- 40. Discrete coxal apodemes III and sometimes IV absent; discrete propodosomal sclerites absent **CHORTOGLYPHIDAE** *Chortoglyphus arcuatus* (Troupeau, 1879)
- Discrete coxal apodemes III and IV present, projecting obliquely from bases of trochanters; propodosomal sclerites usually present 41
- 41. Tarsi with both tectal setae filiform, similar in length **SUIDASIIDAE** *Suidasia pontifica* Oudemans, 1905
- Tarsi with tectal setae asymmetrical **ACARIDAE** 42

42. External vertical setae *ve* arising the anterior angles of the dorsal propodosomal shield at the same level as *vi* or slightly posterior 43
 — Seta *ve* rudimentary or absent or when present arising near the middle of the lateral edge of the propodosomal shield 44
43. Genu I with solenidion σ'' no more than three times longer than σ' ; ventral apex of tarsi with proral (*p*, *q*) and unguinal (*u*, *v*) setae usually in the form of short, stout spines, occasionally one or both pairs strongly reduced or absent; male without modifications of leg I
 Aleuroglyphus ovatus (Troupeau, 1878)
 — Genu I with solenidion σ'' at least three times longer than σ' ; ventral apex of tarsi with proral (*p*, *q*) and unguinal (*u*, *v*) setae thin, not short, stout spines; male with leg I enlarged and bearing a ventral apophysis on femur *Tyrophagus putrescentiae* (Schrank, 1781)
44. Tarsi I-II with setae *ft'* (*ba*) absent or if present on tarsus I, then filiform
 Thyreophagus entomophagus (Laboulbène, 1852)
 — Tarsi I-II with setae *ft'* (*ba*) in the form of a spine directly adjacent to solenidion $\omega 1$
 Rhyzoglyphus callae Oudemans, 1924
45. Genu III with solenidion σ absent **EPIDERMOPTIDAE**
 — Genu III with solenidion σ present 46
46. Vertical setae (*vi*) absent; tarsus I with solenidion $\omega 1$ inserted subcapically, very near solenidion $\omega 3$. House dust mites. Nests of rodents and birds
 PYROGLYPHIDAE 47
 — Vertical setae (*vi*) present; tarsus I with solenidion $\omega 1$ inserted basally. Ectoparasites of avian orders; feather mites **ANALGIDAE** *Megninia ginglymura* (Mégnin, 1877)
47. Setae *si* and *se* equal or subequal. Setae *se* distinctly shorter than $\frac{1}{2}$ of body width
 Tucciglyphus setosus Horn and Klimov, 2017
 — Setae *si* and *se* unequal. Setae *se* longer than $\frac{1}{2}$ of body width
 Dermatophagoides farinae Hughes, 1961

Discussion

Commercial egg production is an important economic activity in Vale do Taquari and in the state of Rio Grande do Sul. In this context, improving the efficiency and sustainability of pest control practices is a major challenge. The development of biological control against pest mites might be of help and requires to know all associated mites, their frequency, damages caused by them (Silva *et al.* 2013) and possible natural enemies. Among food habits of mites, the huge diversity can be emphasized: there are detritivorous, predatory (Horn *et al.* 2016), parasitic, hematophagous and omnivorous mites, not to mention feather mites (which are more detritivorous-microbivorous, but live as parasites on birds' body). This study provides the first dichotomous key that helps to identify the main species associated with poultry farms in Southern Brazil. It includes all food habits and might assist acarologists as well as farm technicians (agronomists, agricultural technicians, veterinarians, and zoo-technicians) to better understand pest problems and contribute to improve control. It includes species with health and economic importance such as feather mites, hematophagous mites and stored food mites as well as potential predatory mites.

The biological control of mite pests by natural predators can help reduce high infestations, preventing ectoparasites from becoming a health and economic problem, and is essential to knowing which laying hens and wild birds are carriers of the pest mites into poultry houses

(Silva *et al.* 2013). *Megninia ginglymura* stood out as a sanitary species associated with all environments and managements evaluated. Currently used synthetic acaricides have limitations, such as unfeasible eradication and presence of residues in eggs (Lesna *et al.* 2009). The biological control of *M. ginglymura* by the predators *C. malaccensis* (Granich *et al.* 2016) and *B. dentriticus* (Silva *et al.* 2016a) under laboratory conditions showed higher values of life-table parameters when *C. malaccensis* was evaluated as natural enemy of *M. ginglymura* ($R_0 = 135.6$; $T = 41.6$; $\lambda = 1.13$; $rm = 0.12$). No *M. ginglymura* specimen was recorded in abandoned bird nests in this study, thus corroborating the findings of Silva *et al.* (2013). This absence of *M. ginglymura* from any of the abandoned wild bird nests under test might be considered a very important piece of information in elucidating the relationship between wild birds in this region and mite fauna of laying hen houses. However, this information must be considered with caution as this mite species feeds on the body of the host, and nests should be evaluated soon after abandonment so that *M. ginglymura* could be captured. *Ornithonyssus bursa* was recorded only in abandoned bird nests and no specimens were recorded inside laying hen houses. However, several predators and other mites belonged to the same species as those collected in laying hen houses (feathers and traps) and abandoned bird nests, which leads us to conclude that there may be a transit of mite fauna in commercial poultry farms, corroborating the results obtained by Silva *et al.* 2013.

Among the recorded mite fauna, eight species were captured with all three methods for sampling mites; five of which were considered as having predatory habits (*B. dendriticus*, *B. keegani*, *C. (Hemicheyletia) wellsi*, *C. malaccensis* and *T. transvaalensis*), two were generalists (*T. setosus* and *T. putrescentiae*) and the presence of *Tetranychus* sp. in laying hen houses is yet to be elucidated due to the fact that this genus is largely known as a phytophagous genus (Bolland *et al.* 1998).

Predatory mite strategies to control feather mites are different from other economic pests as *D. gallinae* can remain outside the host and be captured by them over this period. For *M. ginglymura* to be effectively controlled by predatory mites, these must be able to have foraging activity directly on the bird-host body. Moreover, requirement is related to physical constraints: the predatory mite must survive to high temperature of the body of the host. The fact that predatory mites were captured in feathers might suggest that they were able to live in the host and endure the average body temperature of laying hens (41.5 – 42.5°C). The presence of several predatory mite species on feathers strongly suggests that they are not unable to forage on host, which makes biological control against *M. ginglymura* promising.

Predatory species associated with feathers were observed at very low relative densities (Figure 1). It is worth noting that some of Cheyletids developed parasitic habits throughout evolution (some *Cheyletiella* spp.). This suggests that this group (which comprises mostly predatory mites) is intrinsically more adapted to on-bird life than other predatory mites such as soil/litter mites, and therefore, represents a promising candidate to control of *M. ginglymura*.

The predator *Raphignathus* sp. and the generalists *B. oregonensis* and *T. granarius* were concomitant in abandoned bird nests and traps. *Brachytydeus oregonensis* was misidentified as *Lorryia* sp. and observed in hen nests (Silva *et al.* 2013).

Inside hen houses, *A. ovatus*, *M. muscaedomesticae*, *M. ginglymura*, and *R. nidorum* were common (species present in feathers and traps). Most predatory species were associated to hen nests and traps; *B. dentriticus*, *B. keegani*, *C. eruditus*, *C. malaccensis*, *Cheletomorpha lepidopterorum* (Shaw, 1794) (Cheyletidae), and *T. transvaalensis* (Silva *et al.* 2013; Faleiro *et al.* 2015). A total of 17 species were captured exclusively in traps, with the most recurrent species being *B. tuttlei*, *G. destructor*, and *C. arcuatus*. Species exclusively found in abandoned bird nests were *A. casalis*, *B. argentinensis*, *B. australensis*, *B. obnoxia*, *O. bursa* and the soil-mite group Oribatida. *Androlaelaps casalis* is a generalist predator that is capable of feeding and reproducing on *D. gallinae* (Lesna *et al.* 2012). This provides a valuable overview of mite species present in poultry farm buildings, and thus a basis for subsequent studies dedicated to improve biocontrol in such contexts. The next step is choosing the natural enemies' candidates amongst present predatory mites, in order to initiate the development of a pest management

method without pesticides to control ectoparasites. Preliminary studies at laboratory level indicate potential for biological control of *M. ginglymura* by natural enemies in poultry systems. New investigative stage should be the application of this knowledge to the practical level in poultry farms.

References

- Ack A. 2004 — Manual de doenças das aves — Cascavel, Coluna do Saber. 222pp.
- Baker E.W. 1949 — A review of the mites of the family Cheyletidae in the United States National Museum — Proceedings of the United States National Museum, 99: 267-320.
- Baker E.W. 1970 — The genus *Tydeus*: subgenera and species groups with descriptions of new species (Acarina: Tydeidae) — Annals of the Entomological Society of America, 63: 163-177. doi:10.1093/aesa/63.1.163
- Brady J. 1970 — The mites of poultry litter: observations on the bionomics of common species, with a species list for England and Wales — Journal of Applied Ecology, 7(2): 331-348. doi:10.2307/2401384
- Bolland H.R., Gutierrez J., Fletchmann C.H.W. 1998 — World catalogue of the spider mite family (Acari: Tetranychidae) — Koninklijke Brill NV, Leiden. 392pp.
- Cebolla R., Pekar S., Hubert J. 2009 — Prey range of the predatory mite *Cheyletus malaccensis* (Acari: Cheyletidae) and its efficacy in the control of seven stored-products pests — Biological Control, 50: 1-6. doi:10.1016/j.biocontrol.2009.03.008
- Chiavegato L.G. 1980 — Ácaros da cultura dos citros — In: Rodriguez, O. and Viégas, F.C.P. (eds.) *Citricultura brasileira*. Campinas, Fundação Cargill. pp. 469-501.
- Collins D.A. 2012 — A review on the factors affecting mite growth in stored grain commodities — Experimental and Applied Acarology, 56: 191-208. doi:10.1007/s10493-012-9512-6
- Colloff M.J. 2009 — Dust mites — Collingwood, Australia, CSIRO Publishing and Dordrecht Springer. 592pp.
- De Leon D. 1962 — Three new genera and seven new species of cheyletids (Acarina: Cheyletidae) — The Florida Entomologist, 45: 129-137. doi:10.2307/3492563
- Dönel G., Doğan S. 2011 — A new species of *Raphignathus* Dugés and a newly discovered male of *R. fani* Doğan and Ayyıldız from Turkey — International Journal of Acarology, 37: 27-33. doi:10.1080/01647954.2010.531765
- Dosse G. 1967 — Schadmilben des libanons und ihre pradatoren — Zeitschrift für Angewandte Entomologie, 59: 16-48. doi:10.1111/j.1439-0418.1967.tb03837.x
- Duck L., Kaufman G., Palevsky E., Berdicevsky I. 2001 — Mites in fungal — Micoses, 44: 390-394. doi:10.1046/j.1439-0507.2001.00684.x
- Faccini J.L.H. 1987 Ácaros hematófagos: parasitos de aves de postura (*Gallus gallu*) no Brasil. Diversificação, biologia e controle — Arquivo Fluminense Medicina Veterinária, 2: 29-31.
- Fain A. 1965 Les acariens nidoles et detriticoles de la famille Pyroglyphidae Cunliffe (Sarcoptiformes) — Revue Zoologique et de Botanique Africaines, 52: 257-286.
- Fain A., Bochkov A.V., Corpuz-rarus L.A. 2002 — A revision of the *Hemicheyletia* generic group (Acari: Cheyletidae) — Bulletin De L'institut Royal Des Sciences Naturelles de Belgique, 72: 27-66.
- Fain Q.H., Yan C. 1997 — The genus *Storchia*, with the description of a new species (Acari: Prostigmata: Stigmaeidae) — Systematic and Applied Acarology, 2: 161-166. doi:10.11158/saa.2.1.22
- Faleiro D., Toldi M., Silva G.L., Ferla N.J. 2015 — The ectoparasites *Dermanyssus gallinae* and *Megninia ginglymura*: bioecology and natural enemies in commercial egg-laying hens — Systematic and Applied Acarology, 20(8): 861-874. doi:10.11158/saa.20.8.3
- Fenilli R., Flechtmann C.H.W. 1990 — Ácaros do pinheiro-do-Paraná em Lages, Santa Catarina — Anais da ESALQ, 47: 243-250. doi:10.1590/S0071-12761990000100015
- Ferla N.J., Johann L., Klock C., Majolo F., Botton M. 2011 — Phytoseiid mites (Acari: Phytoseiidae) from vineyards in Rio Grande do Sul State, Brasil — Zootaxa, 2976: 15-31.
- Ferla N.J., Moraes G.J. 2002 — Ácaros (Arachnida, Acari) da seringueira (*Hevea brasiliensis* Muell. Arg.) no Estado do Mato Grosso, Brasil — Revista Brasileira de Zoologia, 19(3): 867-888. doi:10.1590/S0101-81752002000300025
- Ferla N.J., Rocha M.S. 2012 — A new species of *Rubroscirus* from Brazil (Acari: Bdelloidea: Cunaxidae) — Systematic and Applied Acarology, 17(4): 435-440.
- Fernandez-Caldas E., Fox R.W., Bucholtz G.A., Trudeau W.L., Ledford D.K., Lockey R.F. 1990 — House dust mite allergy in Florida. Mite survey in households of mite-sensitive individuals in Tampa, Florida — Allergy Proceedings, 11: 263-267. doi:10.2500/108854190778879710
- Flechtmann C.H.W. 1968 — Notas sobre ácaros de produtos armazenados — Solo, 60: 63-65.
- Flechtmann C.H.W., Castelo F.F.P. 1982 — On some insects and mites associated with dried and salted fish in Brazil — Acta Amazonica, 12: 489-490. doi:10.1590/1809-43921982122489
- Franz J.T., Masuch G., Musken H., Bergmann K.C. 1997 — Mite fauna of German farms — Allergy, 52: 1233-1237. doi:10.1111/j.1398-9995.1997.tb02529.x
- Gaud J., Atyeo W.T., Barré N. 1985 — Les acariens du genre *Megninia* (Analgidae) parasites de *Gallus gallus* — Acarologia, 26(2): 171-182.
- Granich J., Horn T.B., Körbes J.H., Toldi M., Silva G.L., Ferla N.J. 2017 — Development of *Cheyletus malaccensis* (Acari: Cheyletidae) feeding on mite species found in commercial poultry systems: *Megninia ginglymura* (Acari: Analgidae) and *Tyrophagus putrescentiae* (Acari: Acaridae) — Systematic and Applied Acarology, 21(12): 1604-1613. doi:10.11158/saa.21.12.2

- Gerson U., Smiley R.L. 1990 — Acarine biocontrol agents: an illustrated key and manual — London: British Library Cataloguing in Publication Data. 174pp.
- Gerson U., Smiley R.L., Ochoa R. 2003 — Mites (Acari) for pest control — Malden: Blackwell Science. 540pp.
- Guimarães J.H., Tucci E.C., Gomes J.P.C. 1992 — Dermaptera (Insecta) associados a aviários industriais no Estado de São Paulo e sua importância como agentes de controle biológico de pragas avícolas — Revista Brasileira de Entomologia, 36(3): 527-534.
- Horn T.B., Körbes J.H., Granich J., Senter M., Ferla N.J. 2016 — Influence of laying hen systems on the mite fauna (Acari) community of commercial poultry farms in southern Brazil — Parasitology Research, 115(1): 355-366. doi:10.1007/s00436-015-4756-9
- Horn T.B., Ferla J.J., Körbes J.H., Granich J., Oconnor B., Klimov P., Ferla N.J. 2017 — Two new genera of pyroglyphid mites, *Tuccioglyphus* and *Marioglyphus*, with a key to genera of the World (Acari: Pyroglyphidae) — Zootaxa, 4244(3): 301-320. doi:10.11646/zootaxa.4244.3.1
- Hughes A.M. 1976 — The mites of stored food and houses — London, Her Majesty's Stationery Office, 9, 400pp.
- Iglesias-Souto J., Sánchez-Machín I., Iraola V., Poza P., González R., Matheu V. 2009 — Oral mite anaphylaxis by *Thyreophagus entomophagus* in a child: a case report — Clinical and Molecular Allergy, 7: 10. doi:10.1186/1476-7961-7-10
- Krantz G.W., Walter D.E. 2009 — A manual of Acarology — Lubbock, Texas Tech University Press. 807pp.
- Lesna I., Sabelis M.W., Van Niekerk T.G.C.M., Komdeur J. 2012 — Laboratory tests for controlling poultry red mites (*Dermanyssus gallinae*) with predatory mites in small 'laying hen' cages — Experimental and Applied Acarology, 58(4): 371-383. doi:10.1007/s10493-012-9596-z
- Lesna I., Wolfs P., Faraji F., Roy L., Komdeur J., Sabelis M.W. 2009 — Candidate predators for biological control of the poultry red mite *Dermanyssus gallinae* — Experimental and Applied Acarology, 48(1-2): 63-80. doi:10.1007/s10493-009-9239-1
- Livshitz I.Z., Kuznetsov N.N., Zapletina V.P. 1972 — New species of the family Tydeidae (Acariformes) from Crimea and Azerbaijan — Zoologicheskii Zhurnal, 51: 1578-1580.
- Marangi M., Morelli V., Pati S., Camarda A., Cafiero M.A., Giangaspero A. 2012 — Acaricide residues in laying hens naturally infested by red mite *Dermanyssus gallinae* — PLoS ONE 7(2): e31795. doi:10.1371/journal.pone.0031795
- Maurer V., Hertzberg H. 2001 — Ökologische legehennenhaltung. Was tun gegen die kleinen Vampire? — DGS Magazin, 40, 49-52.
- Mohamed A. 2013 — Biological aspects and life table parameters of predator gamasid ascid mite, *Blattisocius dentriticus* (Berlese) (Acari: Gamasida: Ascidae) — Egyptian Academic Journal of Biological Sciences, 6(2): 97-105.
- O'Connor B.M. 1982 — Acari: Astigmata — In: Parker, S.B. (ed.) — Synopsis and Classification of Living Organisms. New York, McGraw Hill. pp. 146-169.
- Oliveira C.B., Tonin A.A., Monteiro S.G. 2012 — Parasitismo do ácaro *Ornithonyssus bursa* em humanos no Sul do Brasil — Acta Scientiae Veterinariae, 40(4): 1091.
- Reichert M.B., Silva G.L., Rocha M.S., Johann L., Ferla N.J. 2014 — Mite fauna (Acari) in soybean agroecosystem in the northwestern region of Rio Grande do Sul State, Brazil — Systematic and Applied Acarology, 19(2): 123-136. doi:10.11158/saa.19.2.2.
- Schulz S., Fuhlendorff J., Steidle J.L.M., Collatz J., Franz J.T. 2004 — Identification and biosynthesis of an aggregation pheromone of the storage mite *Chortoglyphus arcuatus* — ChemBioChem, 5: 1500-1507. doi:10.1002/cbic.200400110
- Silva G.L., Ferla N.J., Toldi M., Faleiro D.C.C. 2013 — Mite fauna (Acari) associated to commercial laying hens and bird nests in Vale do Taquari, Rio Grande do Sul, Brazil — Biotemas, 26(4): 253-262. doi:10.5007/2175-7925.2013v26n4p253
- Silva G.L., Metzelthin M.H., Silva O.S., Ferla N.J. 2016b — Catalogue of the mite family Tydeidae (Acari: Prostigmata) with the World Key to the Species. — Zootaxa, 4135(1): 001-068. doi:10.11646/zootaxa.4135.1.1
- Silva G.L., Radaelli T.F.S., Esswein I.Z., Ferla N.J., Silva O.S. 2016a — Comparison of biological development of *Blattisocius dentriticus* (Blattisociidae) fed on *Tyrophagus putrescentiae* (Acaridae) and *Megninia ginglymura* (Analgidae) — Int. J. Acarol. 42(8): 405-411. doi:10.1080/01647954.2016.1210674
- Silva L.C., Silva D.E., Horn T.B., Ferla N.J. 2015 — Primeiro registro de *Paraneognathus wangae* (Acari: Caligonellidae) no Brasil. In: VI Simpósio Brasileiro de Acarologia — São José do Rio Preto, UNESP. Available from: <http://www.sibac.net.br/cd/resumos-por-area.html>. 23 May 2016.
- Sinha R.N., Wallace H.A.H., Chebib F.S. 1969a — Principal-component analysis of interrelations among fungi, mites and insects in grain bulk ecosystems — Ecology, 50: 536-547.
- Sinha R.N., Wallace H.A.H., Chebib F.S. 1969b — Canonical correlation between groups of acarine, fungal and environmental variables in bulk grain ecosystems — Researches on Population Ecology, 11: 92-104. doi:10.1007/BF02514513
- Soares N.M., Tucci E.C., Guastalli E.A.I., Yajima H. 2008 — Controle da infestação por *Ornithonyssus sylviarum* (Canestrini e Fanzago, 1877) (Acari: Macronyssidae) em poedeiras comerciais utilizando extrato de *Azadirachta indica* — Revista Brasileira de Parasitologia Veterinária, 17(4): 175-178. doi:10.1590/S1984-29612008000400001
- Summers F.M. 1964 — Three uncommon genera of the mite family Stigmaeidae (Acarina) — Proceedings of the Entomological Society of Washington, 66: 184-192.
- Summers F.M., Price D.W. 1970 — Review of the mite family Cheyletidae — University California Publications Entomology, 61: 1-153.

- Summers F.M., Schlinger E.I. 1955 — Mites of the family Caligonellidae (Acarina) — *Hilgardia*, 23: 539-561. doi:10.3733/hilg.v23n12p539
- Toldi M., Silva G.L., Faleiro D., Ferla N.J. 2014 — Life history of the predatory mite *Cheyletus malaccensis* (Acari: Cheyletidae) feeding on poultry red mite *Dermanyssus gallinae* (Acari: Dermanyssidae) at different temperatures — In: XIVth Int. Congress of Acarology. Kyoto, ICA. CD-room.
- Tucci E.C., Guastali E.A.L., Rebouças M.M., Mendes M.C., Gama N.M.S.Q. 2005 — Infestação por *Megninia* spp. em criação industrial de aves produtoras de ovos para consumo — *Arquivos do Instituto de Biologia*, 72(1): 121-124.
- Tucci E.C., Guimarães J.H. 1998 — Biologia de *Dermanyssus gallinae* (De Geer, 1778) (Acari Dermanyssidae) — *Revista Brasileira de Parasitologia Veterinária*, 7(1): 27-30.
- Walter D.E., Krantz G.W. 2009 — Collecting, rearing, and preparing specimens. In: Krantz, G.W. and Walter, D.E. (eds.) *A manual of Acarology* — Lubbock, Texas Tech University Press. pp. 83-96.
- Zhang Z-Q. 1963 — *Mites of greenhouses: identification, biology and control* — Cambridge, Cabi Publishing. 244pp.
- Zhang Z-Q. 1999 — *Key to Tarsonemidae of New Zealand* — Auckland, Final report to MAF Science Policy. 35pp.

Appendix: Mite species and collection data and information on the known habits and habitats. The number of recorded specimens is shown in parentheses.

Suborder Astigmata

Acaridae Ewing and Nesbitt, 1954

Aleuroglyphus ovatus (Troupeau, 1878)

Tyroglyphus ovatus Troupeau, 1878

Locality of the specimens examined: **Feather:** S2: VI-2014(1); FR: VII-2014(1). **Trap:** A2: V-2014(2), VI-2014(1); SI: IV-2014(1), V-2014(2), VI-2014(5); FR: VI-2014(2).

Comments: Species from the genus *Aleuroglyphus* are reported as stored food mites. *Aleuroglyphus ovatus* are common in bran, wheat, chicken meal, dried fish products, flour, and pollards, where it can multiply to form large colonies. It has also been found in laying hen houses (Hughes 1976).

Thyreophagus entomophagus (Laboulbène, 1852)

Acarus entomophagus Laboulbène, 1852

Locality of the specimens examined: **Trap:** A1: X-2013(2), XI-2013(2), VII-2014(2), VIII-2014(44); A2: X-2013(1); A3: IX-2013(1); SI: IX-2013(2).

Comments: It is a storage mite usually reported in farms (Franz *et al.* 1997), but not in household dust (Fernandez-Caldas *et al.* 1990). Sensitivity to mite species might cause occupational respiratory disorders in farmers. However, it does not inhabit urban houses often nor it causes symptoms by ingestion, although Iglesias-Souto *et al.* (2009) reported a child suffering from anaphylaxis caused by the ingestion of flour contaminated with *T. entomophagus*.

Tyrophagus putrescentiae (Schrank, 1781)

Acarus putrescentiae Schrank, 1781:552.

Locality of the specimens examined: **Feather:** A1: VII-2014(1); A2: X-2013(1); A3: I-2014(2), VI-2014(1), VII-2014(5); SI: IX-2013(2), X-2013(2), XI-2013(1), III-2014(1), V-2014(1); S2: X-2013(1), XI-2013(1); FR: II-2014(2), V-2014(1), VI-2014(1). **Trap:** A1: I-2013(1), VII-2014(5), VIII-2014(2); A2: IX-2013(3), III-2014(2), VII-2014(1); A3: IX-2013(4), V-2014(4), VI-2014(28); SI: IX-2013(1), I-2014(1), VI-2014(4); S2: IX-2013(1), X-2013(1), XI-2013(4). **Bird nest:** *Columbina picui*: XI-2014(3).

Comments: It is commonly associated with stored foods with high content of grease and protein such as flour, wheat, soy, cheese, rye bread, milk powder, various seeds, and as a cosmopolitan mite it is a pest of fungal cultures. High infestations cause deterioration in the quality and hygiene of the product and can accelerate deterioration (Duek *et al.* 2001). Silva *et al.* (2013) observed this species in laying hen nests, feathers, and abandoned bird nests.

Analgidae Trouessart, 1915

Megninia ginglymura (Mégnin, 1877)

Analges ginglymura Mégnin 1877:1-193.

Locality of the specimens examined: **Feather:** A1: XI-2013(3), XII-2013(63), I-2014(80), II-2014(80), III-2014(11), V-2014(1); A2: IX-2013(1), X-2013(21), XI-2013(69), XII-2013(117), I-2014(387), II-2014(1050), III-2014(386), IV-2014(17), V-2014(40), VI-2014(2), VII-2014(46), VIII-2014(75); A3: IX-2013(1), X-2013(1), II-2014(16), III-2014(543), IV-2014(834), V-2014(108), VI-2014(41), VII-2014(68), VIII-2014(15); SI: VIII-2013(317), IX-2013(340), X-2013(982), XI-2013(895), XII-2013(1080), I-2014(638), II-2014(1169), III-2014(1222), IV-2014(1151), V-2014(979), VI-2014(461); S2: VIII-2013(154), IX-2013(226), X-2013(493), XI-2013(494), XII-2013(905), I-2014(637), II-2014(972), III-2014(1177), IV-2014(1175), V-2014(955), VI-2014(297), VII-2014(939), VIII-2014(697); FR: VIII-2013(537), IX-2013(539), X-2013(1046), XI-2013(573), XII-2013(149), I-2014(27), II-2014(331), III-2014(608), IV-2014(673), V-2014(597), VI-2014(291), VII-2014(502). **Trap:** A1: XI-2013(1), XII-2013(1), I-2014(23), II-2014(41), III-2014(12), IV-2014(2), VI-2014(5), VII-2014(1); A2: XI-2013(2), I-2014(10), II-2014(50), III-2014(6), VI-2014(8), VII-2014(1), VIII-2014(4); A3: IX-2013(1), II-2014(7), III-2014(9), IV-2014(14), V-2014(17), VI-2014(2), VIII-2014(1); SI: IX-2013(33), X-2013(54), XI-2013(88), XII-2013(56), I-2014(72), II-2014(78), III-2014(65), V-2014(119), VI-2014(95); S2: IX-2013(10), X-2013(7), XI-2013(7), XI-2013(10), XII-2013(3), I-2014(2), II-2014(43), III-2014(56), IV-2014(12), V-2014(6), VI-2014(16), VII-2014(4), VIII-2014(12); FR: IX-2013(51), X-2013(77), XI-2013(15), XII-2013(1), I-2014(1), II-2014(4), III-2014(23), IV-2014(3), V-2014(6), VI-2014(61), VI-2014(27).

Comments: It feeds on the feathers of infested birds and hens. This mite's saliva causes allergic reaction, stress, and intense itching, which leads to the formation of crusts, facilitating secondary bacterial infections and pyoderma. Itching may cause petechiae and hemorrhagic blisters on the skin of the host (Tucci *et al.* 2005). Silva *et al.* (2013) observed this species in laying hen nests, feathers, and traps in poultry houses.

Carpoglyphidae Oudemans, 1923

Carpoglyphus lactis (Linnaeus, 1767)

Acarus lactis Linnaeus, 1767:1024.

Locality of the specimens examined: **Trap:** A1: VIII-2014(1).

Comments: *Carpoglyphus* species are reported as stored food mites. *Carpoglyphus lactis* is a cosmopolitan species observed in dried fruits, honeycombs, pollen in rotting bee hives, potatoes, cheese, old flour, cocoa beans, and groundnuts (Hughes 1976).

Chortoglyphidae Berlese, 1897

Chortoglyphus arcuatus (Troupeau, 1879)

Tyroglyphus arcuatus Troupeau, 1879

Locality of the specimens examined: **Trap:** S2: VIII-2014(1); FR: X-2013(2), I-2014(6), II-2014(2), III-2014(3), IV-2014(1), V-2014(12), VI-2014(22), VII-2014(42).

Comments: It has been identified in dust samples mattress, and is commonly found in rural areas of Central Europe, being responsible for allergies in farmers (Schulz *et al.* 2004). It is common in the floor dust of barns, mills, stables, and granaries and is frequently found in flour and heaps of old straw (Hughes 1976). Silva *et al.* (2013) observed this species in laying hen nests, feathers, and abandoned bird nests in poultry houses.

Epidermoptidae Trouessart, 1892

Locality of the specimens examined: **Trap:** SI: XII-2013(1), I-2013(2).

Comments: Parasitic of feather follicles or skin lesions of numerous avian orders. Some species of Epidermoptidae are unusual as they have developed hyperparasitic relationships with parasitic flies of the Hippoboscidae family. Adult females of *Myialges* and *Promyialges* attach to the abdomen of the dipteran host (Krantz and Walter 2009).

Glycyphagidae Cunliffe, 1958

Ctenoglyphus sp. nov.

Locality of the specimens examined: **Trap:** FR: I-2014(12), III-2014(1), VI-2014(1).

Comments: *Ctenoglyphus plumiger* (Koch, 1836) occurs in barns, wheat, oats and barley, grass seed, fishmeal, and it sometimes appears in large populations in hay (Hughes 1976). *Ctenoglyphus canestrinii* (Armanelli, 1887) is associated with the dust of stables and hay lofts and *Ctenoglyphus palmifer* (Fumouze and Robin, 1868) has been found in chaff, stable dust, and oat mill. Our species differs from others of the genus by having body setae pectinate and ribbon-shaped.

Glycyphagus destructor (Schrank, 1781)

Acarus destructor Schrank, 1781:552.

Locality of the specimens examined: **Trap:** AI: VI-2014(1), S2: VIII-2014(1); FR: X-2013(1), V-2014(1), VI-2014(51), VII-2014(67).

Comments: It is common in stored food and is frequently found in association with *Acarus siro* L. (1758) and *C. eruditus* or *C. malaccensis* (Hughes 1976). It is also associated to soil in agricultural zones. Silva *et al.* (2013) observed this species in laying hen nests and traps in poultry houses.

Pyroglyphidae Cunliffe, 1958

Dermatophagoides farinae (Hughes, 1961)

Dermatophagoides farinae Hughes, 1961:1-287.

Locality of the specimens examined: **Feather:** A2: VIII-2014(1).

Comments: It has been isolated from poultry and pig-rearing meal, and was also observed in house dust, dogmeal, wheat pollards, and biscuit meal (Hughes 1976).

Tucciglyphus setosus Horn and Klimov, 2017

Locality of the specimens examined: **Feather:** AI: XII-2013(2), V-2014(2), VI-2014(1); A2: XI-2013(1), XII-2013(1), IV-2013(4); A3: III-2014(2), IV-2014(1), VI-2014(2), VII-2014(7), VIII-2014(1); S2: VI-2014(1), VII-2014(4), VIII-2014(2). **Trap:** AI: IX-2013(7), X-2013(29), XI-2013(13), XII-2013(39), I-2014(196), II-2014(48), III-2014(14), IV-2014(3), V-2014(10), VI-2014(26), VII-2014(39), VIII-2014(57); A2: IX-2013(6), X-2013(59), XI-2013(63), XII-2013(19), I-2014(22), II-2014(12), III-2014(2), V-2014(19), VI-2014(237), VII-2014(154), VIII-2014(680); A3: IX-2013(6), X-2013(9), I-2014(1), II-2014(72), III-2014(53), IV-2014(19), V-2014(48), VI-2014(41), VII-2014(11), VIII-2014(48); SI: IX-2013(14), X-2013(42), XI-2013(20), XII-2013(14), I-2014(17), II-2014(11), III-2014(9), IV-2014(6), V-2014(17), VI-2014(34); S2: IX-2013(53), X-2013(89), XI-2013(23), XII-2013(5), I-2014(3), II-2014(3), III-2014(51), IV-2014(41), V-2014(51), VI-2014(110), VII-2014(153), VIII-2014(350); FR: IX-2013(1), VI-2013(6), XII-2013(2), I-2014(4), III-2014(1), VI-2014(1), VII-2014(1). **Bird nests:** *Columbina picui*: XI-2014(37); *Columbina taupacoti*: XI-2014(1); *Zenaida auriculata*: XI-2014(8).

Comments: This species was described based on specimens collected in our study area (Horn *et al.* 2017). Silva *et al.* (2013) and Horn *et al.* (2016) misidentified it as *Pyroglyphus* sp.

Suidasiidae Hughes, 1948

Suidasia pontifica Oudemans, 1905

Suidasia pontifica Oudemans, 1905:209.

Locality of the specimens examined: **Trap:** SI: II-2014(3).

Comments: It has been found in the quills of the remiges of *Aramus* sp. from tropical America.

Suborder Mesostigmata

Melicharidae Hirschmann, 1962

Proctolaelaps pomorum (Oudemans, 1929)

Typhlodromus pomorum Oudemans, 1929:11-20.

Locality of the specimens examined: **Trap:** A3: IX-2013(1).

Comments: This species was associated to *A. siro* from a household and was also found on home-grown oats with *A. siro* and on bales of mouldy Algerian esparto grass heavily infested with *A. siro* and *Tyrophagus* sp. (Hughes 1976).

Blattisociidae Garman, 1948

Blattisocius dentriticus (Berlese, 1918)

Lasioseius (L.) *dentriticus* Berlese, 1918:7-16.

Locality of the specimens examined: **Feather:** A1: XII-2013(1). **Trap:** A1: XI-2013(1), XII-2013(3), VI-2014(1), VIII-2014(3); A2: IX-2013(2), X-2013(3), III-2014(1), V-2014(1) A3: IX-2013(1), X-2013(1), I-2014(1), III-2014(1), V-2014(2), VI-2014(3); **SI:** IX-2013(6), X-2013(22), XI-2013(19), XII-2013(6), I-2014(1), V-2014(2); **S2:** IX-2013(1), XI-2013(4), XII-2013(1), VIII-2014(5); **FR:** XI-2013(2). **Bird nests:** *Columbina picui*: XI-2014(5); *Zenaida auriculata*: XI-2014(51).

Comments: This species is a predator that competes with *C. eruditus* (Collins 2012). It feeds on *T. putrescentiae* and is associated with imported food in the United States (Hughes 1976). *Rhizoglyphus robini* (Claparède, 1869) proved to be the most favorable food (Mohamed 2013). *Blattisocius dentriticus* was tested feeding on *M. ginglymura* and showed lower life-table values than when feeding on *T. putrescentiae* (Silva et al. 2016a).

Blattisocius keegani (Fox, 1947)

Melichares (B.) *keegani* Fox, 1947: 598-603

Locality of the specimens examined: **Feather:** A2: IV-2014(1); A3: IV-2014(1); S2: XII-2013(1), IV-2014(1), VIII-2014(1). **Trap:** A1: IX-2013(8), X-2013(1), XI-2013(5), I-2014(4), II-2014(2), III-2014(13), IV-2014(1), VI-2014(10), VII-2014(2), VIII-2014(8); A2: IX-2013(2), X-2013(3), III-2014(1), V-2014(1); A3: IX-2013(7), X-2013(5), III-2014(2), V-2014(1), VII-2014(2), VIII-2014(28); **SI:** I-2014(1), IV-2014(61); **S2:** XI-2013(1), I-2014(1), VIII-2014(8). **Bird nests:** *Columbina picui*: XI-2014(20); *Columbina taupacoti*: XI-2014(7); *Zenaida auriculata*: XI-2014(64).

Comments: It was reported in stored rice (Flechtmann 1968), dried fishes (Flechtmann and Castelo 1982), and *Araucaria angustifolia* (Bertol.) (Araucariaceae) (Fenilli and Flechtmann 1990). Silva et al. (2013) observed this species in laying hen nests and traps in poultry houses.

Laelapidae Berlese, 1892

Androlaelaps casalis (Berlese, 1887)

Iphis casalis Berlese, 1887: 8

Locality of the specimens examined: **Bird nest:** *Zenaida auriculata*: XI-2014(3).

Comments: It is a generalist predatory mite of *T. putrescentiae*, *Glycyphagus domesticus* (De Geer, 1778), *B. keegani*, and of immature stages of *D. gallinae* (Hughes 1976; Lesna et al. 2009). It has been collected from bodies and also from the nests of mammals and bird species. Silva et al. (2013) observed this species in laying hen nests and abandoned bird nests in poultry houses.

Hypoaspis lubrica Voigts and Oudemans, 1904

Hypoaspis smithii Hughes, 1948:654.

Locality of the specimens examined: **Trap:** SI: IX-2013(1).

Comments: It is found in association with acaridae mites in grain debris, rotting oats, nests of small mammals, and swallow nests. It has also been found in the deep litter of broiler houses (Hughes 1976).

Macrochelidae Vitzthum, 1930

Macrocheles muscaedomesticae (Scopoli, 1772)

Acarus muscaedomesticae Scopoli, 1772:1-128.

Locality of the specimens examined: **Feather:** SI: X-2013(1). **Trap:** FR: IX-2013(7), V-2014(1).

Comments: It is a predator of house fly and related species (Lesna et al. 2009). It is found in manure, including poultry manure, which is a favorable habitat to the development of flies. Larvae and adults feed on fly eggs. Silva et al. (2013) observed this species in laying hen nests and abandoned bird nests in poultry houses.

Macronyssidae Oudemans, 1936

Ornithonyssus bursa (Berlese, 1888)

Leiognathus bursa Berlese, 1888:143.

Locality of the specimens examined: **Bird nests:** *Columbina picui*: XI-2014(5); *Zenaida auriculata*: XI-2014(1).

Comments: It is a cosmopolitan species and forms colonies in the cloaca and feathers of the cloacal region (Back 2004), remaining continuously on the hen's body (Tucci and Guimarães 1998; Soares et al. 2008). This species can be parasitic of humans (Oliveira et al. 2012).

Phytoseiidae Berlese, 1913

Typhlodromus transvaalensis (Nesbitt, 1951)

Kampimodromus transvaalensis Nesbitt, 1951:55.

Locality of the specimens examined: **Feather:** *A1*: VIII-2014(3); *S1*: III-2014(1); *S2*: XI-2013(1).

Trap: *A1*: IX-2013(4), X-2013(18), XI-2013(23), XII-2013(6), II-2014(1), III-2014(3), IV-2014(3), V-2014(1), VI-2014(20), VII-2014(2), VIII-2014(8); *A2*: X-2014(4), I-2014(1), VI-2014(4), VIII-2014(2); *A3*: IX-2013(1), X-2013(1), I-2014(5), II-2014(1), III-2014(1), V-2014(1), VI-2014(31), VII-2014(37), VIII-2014(55); *S1*: X-2013(1), XI-2013(1), I-2014(2), V-2014(1); *S2*: IX-2013(2), X-2013(11), XI-2013(19), XII-2013(16), I-2014(9), IV-2014(1), VII-2014(1), VIII-2014(6); *FR*: VII-2014(1). **Bird nests:** *Columbina picui*: XI-2014(3); *Zenaida auriculata*: XI-2014(1).

Comments: This species was collected from native vegetation and vines in the state of Rio Grande do Sul (Ferla and Moraes 2002; Ferla *et al.* 2011). Silva *et al.* (2013) observed this species in laying hen nests and traps in poultry houses.

Uropodidae Kramer, 1881

Fuscuropoda sp.

Locality of the specimens examined: **Trap:** *A1*: VI-2014(1); *S1*: III-2014(2).

Comments: They are mites that live in forests, fertile soil, and manure. They feed on bread, yeast, and immature stages of flies, fungal hyphae and spores, and they attack soft-bodied animals such as nematodes and immature stages of mites (Hughes 1976), and are phoretic mites that attach to the surface of their prey. Some studies have reported that some Uropodina are carnivores (Gerson and Smiley 1990).

Suborder Prostigmata

Caligonellidae Grandjean, 1944

Molotrognathus sp.

Locality of the specimens examined: **Trap:** *S1*: I-2014(1); *S2*: XI-2013(1).

Comments: Some species have been reported as feeding on eggs of spider mites (Summers and Schlinger 1955; Dosse 1967).

Paraneognathus wangae Fan and Li, 1995

Paraneognathus wangae Fan and Li, 1995: 323-327.

Locality of the specimens examined: **Trap:** *FR*: VII-2014(1); *S1*: II-2014(3), V-2014(1); *S2*: VI-2014(1).

Comments: The first observation of this species in Brazil was registered in our study area (Silva *et al.* 2015).

Raphignathidae Kramer, 1877

Raphignathus sp.

Locality of the specimens examined: **Traps:** *FR*: I-2014(1); VI-2014(1); **Bird nests:** *Columbina picui*: XI-2014(3); *Zenaida auriculata*: XI-2014(1).

Comments: Raphignathid mites can be found underneath tree bark and in litter, moss, lichens, soil, stored products, house dust, and bird nests (Dönel and Doğan, 2011).

Cheyletidae Leach, 1815

Chelacheles bipanus Summers and Price, 1970

Chelacheles bipanus Summers and Price, 1970:79.

Locality of the specimens examined: **Trap:** *S2*: XI-2013(1).

Comments: They have been reported on willow bark and twigs in California, USA (Summers and Price 1970).

Cheletomimus (Hemicheyletia) wellsi (Baker, 1949)

Cheyletia wellsi Baker, 1949a: 300-301.

Locality of the specimens examined: **Feather:** *S2*: XI-2013(1), XII-2013(1). **Trap:** *S1*: X-2013(5), XI-2013(22), XII-2013(23), I-2014(66), II-2014(22), III-2014(9), IV-2014(6), V-2014(10), VI-2014(6); *S2*: XI-2013(3), XII-2013(5), I-2014(8), II-2014(8), III-2014(7), IV-2014(4), V-2014(4). **Bird nests:** *Columbina picui*: XI-2014(16); *Zenaida auriculata*: XI-2014(10).

Comments: This species was described from Philadelphia (USA) (Baker 1949). It is a common species in South and Central America and the Philippines (De Leon 1962, Summers and Price 1970).

Cheyletus eruditus (Schrank, 1781)

Acarus eruditus Schrank, 1781:1-24.

Locality of the specimens examined: **Trap:** *FR*: IX-2013(11), X-2013(6), XI-2013(1).

Comments: It has been observed feeding on young forms of *D. gallinae* (Maurer and Hertzberg 2001) in poultry houses. This species practices cannibalism in the absence of food, or when food has low

nutritional value. There are reports of stored grains containing only *C. eruditus* without any prey (Cebolla *et al.* 2009). Apart from stored grains and farm detritus, it is also a regular inhabitant of bird and mammal nests. Silva *et al.* (2013) observed this species in laying hen nests and traps in poultry houses.

Cheyletus malaccensis (Oudemans, 1903)

Cheyletus malaccensis Oudemans, 1903:84.

Locality of the specimens examined: **Feather:** A2: IV-2014(2); A3: V-2014(1); S1: V-2014(1); S2: III-2014(3); FR: I-2014(1). **Trap:** A1: IX-2013(39), X-2013(63), XI-2013(104), XII-2013(41), I-2014(36), II-2014(96), III-2014(125), IV-2014(46), V-2014(32), VI-2014(95), VII-2014(10), VIII-2014(81); A2: IX-2013(38), X-2013(45), XI-2013(73), XII-2013(10), I-2014(139), II-2014(371), III-2014(325), V-2014(16), VI-2014(37), VII-2014(20), VIII-2014(21); A3: IX-2013(15), X-2013(6), I-2014(9), II-2014(30), III-2014(72), IV-2014(33), V-2014(78), VI-2014(96), VII-2014(78), VIII-2014(193); S1: XII-2013(9), I-2014(27), II-2014(1), III-2014(6), V-2014(1), VI-2014(4); S2: X-2013(2), XI-2013(59), XII-2013(72), I-2014(128), II-2014(60), III-2014(75), IV-2014(32), V-2014(17), VI-2014(13), VII-2014(6), VIII-2014(22); FR: IX-2013(46), X-2013(96), XI-2013(59), XII-2013(7), I-2014(20), II-2014(35), III-2014(56), IV-2014(26), V-2014(57), VI-2014(29), VII-2014(65). **Bird nests:** *Columbina picui*: XI-2014(40); *Columbina taupacoti*: XI-2014(10); *Zenaida auriculata*: XI-2014(94).

Comments: It is related to the biological control of prey and has proved very effective in controlling *G. destructor* and *T. putrescentiae*. This mite has also practiced cannibalism in the absence of food, or when food has low nutritional value (Cebolla *et al.* 2009). Silva *et al.* (2013) observed this species in laying hen nests and traps in poultry houses. *C. malaccensis* feeding on *D. gallinae*. This predatory species did not show preference for any prey stage, feeding on all of them (Toldi *et al.* 2014).

Cunaxidae Thor, 1902

Rubroscirus nidorum Ferla; Rocha, 2012

Rubroscirus nidorum Ferla; Rocha, 2012: 435-440

Locality of the specimens examined: **Feather:** S1: V-2014(9); S2: V-2014(2). **Trap:** S1: XI-2013, XII-2013(12), I-2014(8), II-2014(4), III-2014(7), IV-2014(4), V-2014(23), VI-2014(4); S2: I-2014(1), II-2014(1), V-2014(3), VII-2014(2), VIII-2014(4); S2: III-2014(3), IV-2014(3), VII-2014(1); FR: IX-2013(1), X-2013(1), XI-2013(2).

Comments: Cunaxids are mentioned by Gerson *et al.* (2003) as predators of tenuipalpids, eriophyids, and especially, nematodes. This species is reported in hen nests from the poultry industry in the same region as our study (Silva *et al.* 2013).

Stigmaeidae Oudemans, 1931

Storchia pacificus (Summers, 1964)

Apostigmaeus pacificus Summers, 1964: 184-186.

Locality of the specimens examined: **Trap:** FR: V-2014(1).

Comments: Species described based on specimens from Indonesia and the Philippines intercepted in Hawaii on *Manihot esculenta* Crantz (cassava or manioc) and *Oryza sativa* L. (rice) (Summers 1964). Silva *et al.* (2013) observed this species in laying hen nests in poultry houses.

Tarsonemidae Kramer, 1877

Tarsonemus granarius Lindquist, 1972

Tarsonemus granarius Lindquist, 1972: 1699 – 1708.

Locality of the specimens examined: **Trap:** A3: III-2014(1). **Bird nests:** *Columbina picui*: XI-2014(40); *Columbina taupacoti*: XI-2014(1); *Zenaida auriculata*: XI-2014(4).

Comments: This species is associated with fungi species which are likely to develop in stored grains (Sinha *et al.* 1969a, b) in Canada. In Japan, it has more often been found on granary floors than in stored wheat or rice.

Tenuipalpidae Berlese, 1913

Brevipalpus phoenicis (Geijskes, 1939)

Tenuipalpus phoenicis Geijskes 1939:23.

Locality of the specimens examined: **Trap:** S1: IX-2013(1).

Comments: It is a cosmopolitan plant mite and it is the vector of the citrus leprous virus (Chiavegato 1980).

Tetranychidae Donnadieu, 1975

Tetranychus sp.

Locality of the specimens examined: **Feather:** A2: IV-2014(3); S2: X-2013(1). **Trap:** FR: X-2013(2); S1: IX-2013(1); S2: X-2013(1). **Bird nest:** *Zenaida auriculata*: XI-2014(1).

Comments: *Tetranychus* is one of the most economically important genera of spider mites in agriculture, due to its high potential to damage crops (Bolland *et al.* 1998).

Tydeidae Kramer, 1877

Brachytydeus argentinensis (Baker, 1970)

Tydeus argentinensis Baker, 1970: 167.

Locality of the specimens examined: **Bird nest:** *Columbina picui*: XI-2014(4).
 Comments: Originally described from females and males reported in North and South America in soil (Baker 1970).

Brachytydeus australensis (Baker, 1970)

Tydeus australensis 1979: 168.

Locality of the specimens examined: **Bird nests:** *Columbina picui*: XI-2014(37); *Zenaida auriculata*: XI-2014(2).

Comments: This species was described on celery leaves in Australia (Baker 1970).

Brachytydeus obnoxia (Kuznetsov and Zapletina, 1972)

Tydeus obnoxius Kuznetsov and Zapletina, 1972: 1579.

Locality of the specimens examined: **Bird nest:** *Zenaida auriculata*: XI-2014(1).

Comments: Species related to nuts in Azerbaijan (Livshitz *et al.* 1972).

Brachytydeus oregonensis (Baker, 1970)

Tydeus oregonensis Baker 1970: 171.

Locality of the specimens examined: **Trap:** *A1*: IX-2013(1), I-2014(1), II-2014(4), III-2014(4), IV-2014(11), V-2014(15), VI-2014(21), VII-2014(2); *A2*: I-2014(1), II-2014(3), III-2014(1), V-2014(12); *A3*: I-2014(1); *S1*: X-2013(1), II-2014(5), III-2014(9), V-2014(4), VI-2014(4); *S2*: II-2014(4), III-2014(5), IV-2014(2), V-2014(3), VI-2014(6), VII-2014(3), VIII-2014(2); *FR*: IX-2013(10), X-2013(15), I-2014(2), VII-2014(2). **Bird nest:** *Zenaida auriculata*: XI-2014(5).

Comments: Described in the United States of America on oatmeal (Baker 1970). Silva *et al.* (2013) observed this species associated with laying hen facilities and misidentified it as *Lorryia* sp..

Brachytydeus tuttlei (Baker, 1965)

Tydeus tuttlei Baker, 1965:100.

Locality of the specimens examined: **Trap:** *A1*: XI-2013(2), I-2014(3), VIII-2014(37); *A2*: X-2013(2), XII-2013(1), I-2014(9), II-2014(8), III-2014(8), V-2014(8), VI-2014(3), VII-2014(1); *A3*: X-2013(2), I-2014(8), II-2014(3), III-2014(6), IV-2014(1), V-2014(5), VI-2014(1), VIII-2014(2); *S1*: IX-2013(1), X-2013(6), XI-2013(92), XII-2013(16), I-2014(24), II-2014(30), III-2014(20), IV-2014(5), V-2014(13), VI-2014(5); *S2*: XI-2013(1), XII-2013(3), I-2014(9), II-2014(17), III-2014(43), IV-2014(8), V-2014(5), VI-2014(10), VII-2014(1), VIII-2014(10); *FR*: II-2014(2), IV-2014(1), V-2014(11), VI-2014(1), VII-2014(2).

Comments: Described on *Cynodon dactylon* (L.) in United States of America. *Brachytydeus tuttlei* was reported in *Serjanea* sp. associated to the soybean agro-ecosystem in Brazil (Reichert *et al.* 2014).

Suborder Oribatida

Locality of the specimens examined: **Bird nest:** *Zenaida auriculata*: XI-2014(1).

Comments: Oribatid mites are very common soil mites. They feed on fungi and fallen plants, and play an important role in decomposition of organic matter and soil formation (Zhang 1963). Oribatids mites were collected in traps, hen's nests and abandoned bird's nest in poultry farms in the South of Brazil (Silva *et al.* 2013).