J. Acarol. Soc. Jpn., 13 (2): 141-160. 2004

Phytoseiid Mites (Acari: Phytoseiidae) of Coconut Growing Areas in Sri Lanka, with Descriptions of Three New Species

G. J. de MORAES[1,2]*, P. C. LOPES[2] and L. C. P. FERNANDO[3]

[1]*CNPq Researcher*

[2]*Depto. Entomologia, Fitopatologia e Zoologia Agricola, Escola Superior de Agricultura Luiz de Queiroz, Universidade de Sao Paulo, 13418–900 Piracicaba-SP, Brazil*

[3]*Coconut Research Institute, Lunuwila, Sri Lanka*

(Received 30 July 2004; Accepted 21 September 2004)

ABSTRACT

Coconut (*Cocos nucifera* L.) is a major crop in tropical Asia. The coconut mite, *Aceria guerreronis* Keifer, was recently introduced to Sri Lanka and southern India where it is causing considerable damage to that crop. The objective of this study was to identify the phytoseiid mites in the main coconut growing areas where the pest has been reported in Sri Lanka and to determine plants on which phytoseiid predators of *A. guerreronis* could be found. Twenty species were found in a survey conducted in July 2003, 3 of which are new to science and are here described. They are *Euseius ceylonicus* Moraes and Lopes, n. sp., *Euseius pauciventripilis* Moraes and Lopes, n. sp. and *Phytoseius calopogonium* Moraes and Lopes, n. sp.. Five species were found on coconut plants, 3 of which, *Amblyseius largoensis* (Muma), *Neoseiulus baraki* (Athias-Henriot) and *Neoseiulus paspalivorus* (DeLeon), on fruits, in association with *A. guerreronis*. In addition to coconut, *A. largoensis* was found on 11 plant species, whereas *N. baraki* was also found on 2 plant species; *N. paspalivorus* was found only on coconut. The latter 2 phytoseiids were by far the most numerous in association with *A. guerreronis*.

Key words: biological control, predators, taxonomy, Phytoseiidae, coconut

INTRODUCTION

Coconut (*Cocos nucifera* L.) is a major crop in tropical areas of Asia. The coconut mite, *Aceria guerreronis* Keifer, was known until recently only from countries in the American and African continents. At the end of the 1990's, the mite was registered for the first time in Sri Lanka (Fernando, 1998; Fernando et al., 2002) and southern India (Sathiamma et al., 1998), where it has been causing considerable damage to coconut. Because of the significant impact of the introduction of this pest, considerable efforts have been dedicated to the determination of appropriate control measures of *A. guerreronis* in Asia. Because of the possible effects of the prospective measures on the environment, cost, difficulty of application and the fact that the pest was introduced, studies on the possibility to control it biologically have been considered a priority (Moraes and Zacarias, 2002). Classical biological control, involving the search for effective natural enemies in the place of origin of the pest and their ultimate introduction in the new environment would seem most appropriate, but the

* Corresponding author: e-mail: gjmoraes@carpa.ciagri.usp.br

possible management of native natural enemies already present in the new area have also been considered pertinent. In both cases, an *a priori* identification of the natural enemies of the pest in the new environment is a pre-requisite.

Phytoseiid mites have been generally considered the most promising group of predators of pest mites on different crops (Gerson et al., 2003). Thus, species of this group should naturally be some of the first to be considered for use in the control of *A. guerreronis*. The taxonomy and distribution of phytoseiids have been extensively studied in different parts of India, as summarized by Gupta (1986) and several other authors reported in Moraes et al. (2004). However, basically nothing is known about the phytoseiids of Sri Lanka.

The objective of this study was to identify the phytoseiids in the main coconut growing areas where that pest has been reported in Sri Lanka and to determine plants on which predators of *A. guerreronis* belonging to that family could be found. A survey was conducted in July 2003, sampling different parts of coconut plants and of plants of other species commonly found in the area of study. The samples were taken to a laboratory to collect the mites and to mount them on microscope slides for identification.

A list of the species collected is subsequently provided. Unless otherwise specified, mites were collected from leaves of each mentioned plant species. Idiosomal setal patterns of each new species are given in accordance with Chant and Yoshida-Shaul (1992). Setal nomenclature for dorsal and ventral surfaces of the idiosoma is that of Rowel et al. (1978) and Chant and Yoshida-Shaul (1991), respectively. Redescriptions of known species are based on adults collected in Sri Lanka. Measurements are given in micrometers; each measurement corresponds to the average for the number of individuals indicated, followed (in parentheses) by the corresponding range. Abbreviation used in the text are: ESALQ-USP—Escola Superior de Agricultura Luiz de Queiroz, Universidade de São Paulo; Piracicaba-SP; Brazil. USNM/FSCA—United States National Museum of Natural History; Florida State Collection of Arthropods, Entomology Section, Division of Plant Industry; Florida Department of Agriculture and Consumer Services; Gainesville-FL, USA..

AMBLYSEIINAE Muma

Amblyseius adathodae Muma

Amblyseius adathodae Muma, 1967: 268; Denmark and Muma, 1989: 63; Gupta, 1986: 37; Moraes et al., 1989b: 79.

SPECIMENS EXAMINED: 7 ♀ : Lunuwila, on *Brachiaria brizantha*.

PREVIOUS RECORDS: India, Kenya, Pakistan.

REMARKS: The specimens found in this study are slightly smaller than the holotype and the specimens reported by Moraes et al. (1989b) from Kenya; concurrently, they also have most of the dorsal shield setae and leg macrosetae shorter, especially SgeIV and StiIV. Measurements of 3 adult females collected in this study are: dorsal shield length 351 (343–360), width at level of s4 251 (250–253); j1 35 (35–36), j3 45 (44–45), j4 5, j5 and j6 5, J2 7, J5 9, z2 7, z4 8, z5 5, Z1 7, Z4 142 (139–142), Z5 280 (276–280), s4 112, S2 11, S4 10, S5 10, r3 10, R1 11, Sge I 45, Sge II 38, Sge III 50, Sti III 38, Sge IV 116 (115–117), Sti IV 86 (85–87), St IV 79 (78–80); calyx of spermatheca 30 long.

Amblyseius duplicesetus Moraes and McMurtry

Amblyseius duplicesetus Moraes and McMurtry, 1988: 13.

SPECIMENS EXAMINED: 12 ♀ : Lunuwila, on *Acalypha* sp., Araceae, Indian willow, *Mangifera indica*, *Plumeria* sp. with rust yellow fungus, *Psidium guajava*; 2 ♀ : Mirigama, on *C. nucifera*.

PREVIOUS RECORDS: Kenya.

REMARKS: Measurements of the specimens collected in this study correspond closely to those of the original description. This is the first report of this species after its original description from Kenya. Measurements of 3 adult females collected in this study are: dorsal shield length 352 (335–368), width at level of s4 242 (225–257); j1 39 (36–42), j3 46 (43–50), j4 7 (7–8), j5 6, j6 7 (7–8), J2 10, J5 9, z2 12, z4 9, z5 6 (5–6), Z1 12 (12–13), Z4 89 (87–90), Z5 300 (290–308), s4 97 (93–100), S2 13, S4 12, S5 9 (9–10), r3 15 (15–16), R1 12 (12–13); Sge I 46 (45–47), Sti I 30 (28–34), Sge II 42 (38–46), Sti II 30, Sge III 48 (48–49), Sti III 43 (40–46), Sge IV 154 (144–163), Sti IV 113 (98–120), St IV 74 (72–76); distances between setae St1-St3 64 (62–66), St2-St2 66 (65–67), St5-St5 68 (67–68); ventrianal shield length 109 (107–110), width at ZV2 level 56 (54–57), width at anus level 63 (60–66); fixed cheliceral digit 32 (32–33) long; movable cheliceral digit 34 (34–35) long; calyx of spermatheca 11 (10–12) long.

Amblyseius largoensis (Muma)

Amblyseiopsis largoensis Muma, 1955: 266; Garman, 1958: 76.

Amblyseius largoensis, Muma et al. 1970: 69; Denmark and Muma, 1973: 238; 1989: 55; McMurtry and Moraes, 1984: 29.

SPECIMENS EXAMINED: 33 ♀, 3 ♂: Kalpitiya, on *Catharanthus* sp., *C. nucifera*, *Manihot esculenta*; 6 ♀: Lunuwila, on *Acalypha* sp., *B. brizantha*, *Capsicum annuum*, *C. nucifera*, *Nephellium lappaceum*, *Plumeria* sp. with rust yellow fungus, *Syzygium* sp., *Thangaseis calipia*; 1 ♀ : Negombo, on *Cucumber sativus*; 1 ♀ : Urapola, on *Persea americana*.

PREVIOUS RECORDS: Cosmopolitan.

REMARKS: Measurements of the specimens collected in this study correspond closely to those of the original description, except for the longer Z5. Measurements of 3 adult females collected in this study are: dorsal shield length 346 (338–352), width at level of s4 243 (240–245); j1 36 (34–39), j3 51 (50–52), j4 7, j5 6, j6 8 (8–9), J2 10, J5 9 (9–10), z2 11 (11–12), z4 9 (8–11), z5 8 (7–8), Z1 13 (12–14), Z4 87 (86–88), Z5 280 (270–290), s4 92 (89–95), S2 13 (13–14), S4 14 (13–15), S5 12, r3 15 (14–15), R1 11 (11–12); Sge I 39 (39–40), Sti I 33 (31–35), Sge II 36 (35–38), Sti II 28 (26–29), Sge III 51 (50–52), Sti III 39 (36–42), Sge IV 119 (112–125), Sti IV 96 (94–98), St IV 67 (65–70); distances between setae St1-St3 63 (62–64), St2-St2 67, St5-St5 69 (67–70); ventrianal shield length 112, width at ZV2 level 51 (50–52), width at anus level 66 (65–67); fixed cheliceral digit 31 (30–32) long; movable cheliceral digit 33 (32–33) long; calyx of spermatheca 25 long.

Amblyseius tamatavensis Blommers

Amblyseius tamatavensis Blommers, 1974: 144; Denmark and Muma, 1989: 13; Ehara and Amano, 2004: 17.

Amblyseius (*Amblyseius*) *tamatavensis*, Ehara, 2002: 33; Ehara and Amano, 2002: 322.

Amblyseius aegyptiacus, Denmark and Matthysse in Mattysse and Denmark, 1981 (synonymy according to Denmark and Muma, 1989).

Amblyseius maai, Tseng, 1976: 123 (synonymy according to Denmark and Muma, 1989).

SPECIMENS EXAMINED: 5 ♀, 2 ♂: Lunuwila, on *Tridax procumbens*.

PREVIOUS RECORDS: Australia, Brazil, Cuba, Fiji, Indonesia, Japan, Guadeloupe, Kenya, Madagascar, Malaysia, Marie Galante, Martinique, Nigeria, Papua New Guinea, Philippines, Reunion Islands, Singapore, South Africa, Vanuatu, Western Samoa.

REMARKS: The specimens collected in this study fit the original description of the species. Measurements of 3 adult females collected in this study are: dorsal shield length 305 (300–310), width at level of s4 200 (183–207); j1 27 (25–30), j3 48 (48–50), j4 4 (4–5), j5 4 (4–5), j6 5 (4–5), J2 6 (5–6), J5 7 (7–8), z2 7 (6–7), z4 7 (6–8), z5 4, Z1 6 (6–7), Z4 103 (100–107), Z5 224 (221–230), s4 79 (76–81), S2 7 (6–8), S4 6 (5–7), S5 6 (5–7), r3 12 (10–14), R1 8 (7–9); SgeI 37 (35–38), Sti I 23 (22–23), Sge II 35 (35–37), Sti II 24 (22–26), Sge III 51 (47–53), Sti III 42 (40–44), Sge IV 97 (96–98), Sti IV 63 (59–67), St IV 63 (60–65); distances between setae St1-St3 54 (52–55), St2-St2 64 (63–66), St5-St5 63 (62–64); ventrianal shield length 109 (108–110), width at ZV2 level 85 (83–87), width at anus level 76 (75–78); fixed cheliceral digit 31 (30–32) long; movable cheliceral digit 32 (31–34) long; calyx of spermatheca 30 long.

Euseius alstoniae (Gupta)

Amblyseius alstoniae Gupta, 1975: 31; 1977: 29.

Amblyseius (*Euseius*) *alstoniae*, Gupta, 1985: 344; 1986: 74.

SPECIMENS EXAMINED: 3 ♀: Kalpitiya, on *Cassia auriculata*.

PREVIOUS RECORDS: India.

REMARKS: Three adult females of this species were collected in a single occasion, on a same plant. They are quite variable in relation to the lengths of some of the dorsal shield setae, but the lengths of each of those setae are always directly related to length of the dorsal shield of the corresponding individual. Most setae of the specimens collected in this study are shorter than indicated in the original description of the species and in Gupta (1986), but the specimens collected are also smaller than those reported in those publications. Concurrently, the peritreme in the specimens collected only extend to the level between z2 and z4, instead of to the level of j3, indicated in the original description, or to the level between j3 and z2, indicated in Gupta (1986). A reticulated pattern is distinct on the dorsal shield of the largest specimen collected, whereas in the other specimens the shield is almost totally smooth. Measurements of the specimens collected are provided subsequently: dorsal shield length 304 (290–312), width at level of s4 196 (176–212); j1 25 (23–28), j3 24 (20–27), j4 11 (9–13), j5 12 (9–14), j6 and J2 18 (13–22), z2 22 (19–26), z4 26 (22–29), z5 12 (9–14), Z1 15 (12–17), Z4 18 (16–20), Z5 51 (44–56), s4 38 (35–42), S2 18 (14–22), S4 16 (13–19),

S5 18 (14–21), r3 16 (14–18), R1 11 (10–12), Sge IV 42 (37–45), Sti IV 32 (29–35), St IV 55 (51–58), calyx of spermatheca 34 (30–38) long.

Euseius ceylonicus Moraes and Lopes, n. sp.

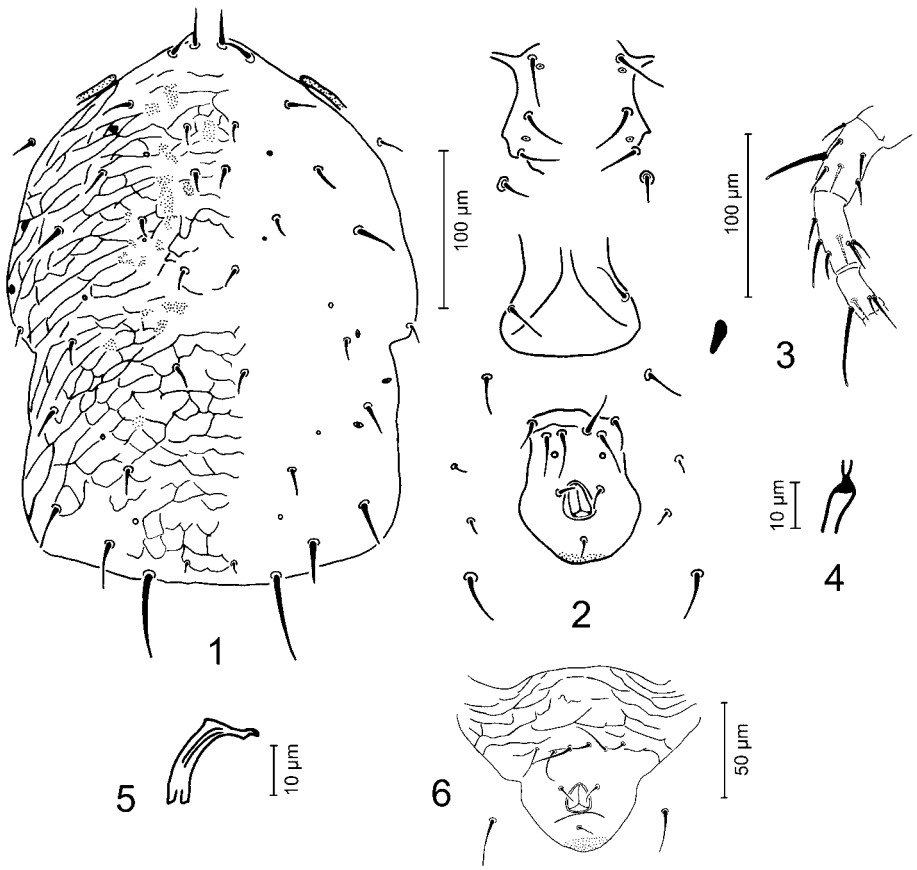
(Figs. 1–6)

Female. Idiosomal setal pattern: 10A:9B/JV-3:ZV. Eight adults measured.

Dorsum. Dorsal shield reticulated; reticulation most distinct on posterior half of the shield, 323 (289–352) long, 242 (209–258) wide at level of s4, j1 29 (25–33), j3 22 (18–28), j4 12 (11–12), j5 12 (11–12), j6 13 (12–14), J2 14 (13–15), J5 5 (4–5), z2 17 (16–21), z4 19 (17–23), z5 12 (10–12), Z1 15 (14–15), Z4 16 (14–17), Z5 56 (50–60), s4 27 (24–31), S2 20 (17–22), S4 22 (19–29), S5 26 (22–30), r3 15 (13–16), R1 14 (12–15). R1 inserted on margin of dorsal shield. All dorsal setae smooth.

Peritreme. Reaching level between j3 and z2.

Venter. All ventral shields smooth, except for transversal line near preanal setae.



Figs. 1–6. *Euseius ceylonicus* n. sp.. Female. 1, dorsum; 2, venter; 3, genu, tibia and basitarsus of leg IV; 4, spermatheca. Male. 5, spermatodactyl; 6, ventrianal shield.

Distances between St1-St3 53 (50–58), St2-St2 60 (54–64), St5-St5 71 (63–75). With a pair of metapodal shields. Ventrianal shield 94 (86, 101) long, 51 (45–57) wide at ZV2 level, 76 (68–87) wide at anus level.

Chelicera. Fixed digit 27 (25–28) long, with 5 teeth; movable digit 24 (22–25), with a single tooth.

Spermatheca. Calyx 8 (7–9) long, bulbous proximally and constricted distally; atrium indistinct.

Legs. Macrosetae of the following length: SgeIII 26 (25–27), StiIII 21 (19–23), Sge IV 42 (40–46), Sti IV 30 (27–35), St IV 49 (47–52); all macrosetae with tips blunt and hyaline.

Male. Idiosomal setal pattern: 10A:9B/JV-3,4:ZV-1,3. Four adults measured.

Dorsum. Reticulation of dorsal shield similar to female, 236 (217–251) long, 179 (163–197) wide, j1 23 (21–25), j3 25 (24–25), j4 10 (9–11), j5 10 (9–11), j6 11 (10–12), J2 12 (10–13), J5 6 (5–6), z2 18 (16–19), z4 19 (17–22), z5 10 (7–11), Z1 13 (11–15), Z4 14 (12–15), Z5 44 (39–48), s4 28 (26–29), S2 18 (17–19), S4 22 (20–25), S5 23 (22–24), r3 14 (13–14), R1 13 (11–14). All dorsal setae smooth.

Peritreme. Reaching level between z2 and z4.

Venter. Sternogenital shield lightly reticulated; ventrianal shield reticulated, subtriangular, 95 long, 145 wide at anterior corners, with 3 pairs of setae.

Chelicera. Fixed digit 20 long; movable digit 20 (19–21) long. Spermatodactyl 18 long.

Legs. Macrosetae of the following lengths: Sge III 21 (19–25), StiIII 20 (18–23), Sge IV 31 (30–34), StiIV 24 (21–28), StIV 40 (37–42); all macrosetae with tips blunt and hyaline.

Type series. Holotype and 3 paratype females, Negombo, Sri Lanka, on *Psophocarpus tetragonolobus*, July 2003, G. J. de Moraes, deposited at ESALQ-USP; 1 paratype female and 1 paratype male, Lunuwila, Sri Lanka, on *Cassia fistula*, July 2003, G. J. de Moraes, deposited at ESALQ-USP; 1 paratype female, on *C. fistula*, July 2003, G. J. de Moraes, deposited at USNM/FSCA; 2 paratype males and 2 paratype female, on *Panicum maximum*, July 2003, G. J. de Moraes, deposited at USNM/FSCA; 2 paratype females and 2 paratype male, on *Caesalpinia pulcherrima*, July 2003, G. J. de Moraes, deposited at ESALQ-USP.

Remarks. *Euseius haramotoi* (Prasad, 1968), *Euseius okumae* (Ehara and Bhandhufalck, 1977) and *Euseius sojaensis* (Ehara, 1964) are similar to this new species but differ from it by having R1 off the dorsal shield. In addition, *E. haramotoi* has SgeIV as long as StiIV, whereas SgeIV is longer than StiIV in this new species; *E. okumae* has most of the dorsal setae longer and the macrosetae shorter than this new species; *E. sojaensis* has sharp tipped macrosetae of leg IV, instead of blunt tipped in the new species, and the calyx of the spermatheca is not distally as constricted as in the new species.

Etymology. The species name *ceylonicus* refers to the previous name of Sri Lanka (Ceylon).

Euseius ovalis (Evans)

Typhlodromus ovalis Evans, 1953: 458.
Typhlodromus (*Amblyseius*) *ovalis*, Narayanan et al. (1960): 388.
Amblyseius (*Amblyseius*) *ovalis*, Ehara, 1966: 24.
Amblyseius ovalis, Schicha, 1977: 127.
Euseius ovalis, Gupta, 1978: 336.

SPECIMENS EXAMINED: 1 ♀: Alhena, on *Alocasia* sp.; 1 ♀: Andiambalana, on unidentified plant; 1 ♀ : Kalpitiya, on *Luffa acutangula*; 2 ♀ : Lunuwila, on *C. annuum*; 7 ♀ : Negombo, on *Vigna sinensis*.

PREVIOUS RECORDS: Australia, China, Cook Islands, Fiji, Hawaii, Hong Kong, India, Indonesia, Japan, Malaysia, Mauritius, Mexico, New Zealand, Papua New Guinea, Philippines, Taiwan.

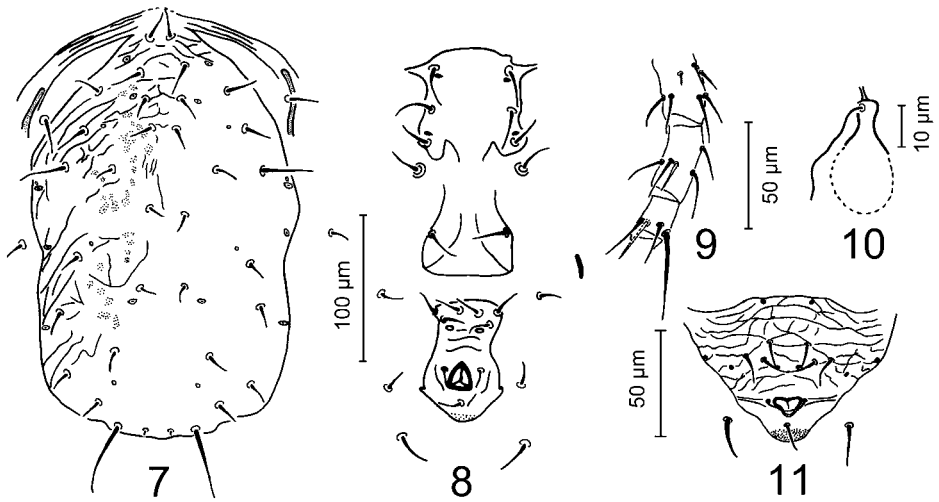
REMARKS: Measurements of the specimens collected are very similar to those given by Ehara (1967) for specimens for specimen from Okinawa Island, Japan. The mites reported by that author and those found in this study have s4 ca. 30% shorter than reported by Schicha (1977) for the holotype. Measurements of 3 adult females collected in this study are: dorsal shield length 340 (328–350), width at level of s4 242 (233–250); j1 32 (30–34), j3 15 (13–17), j4 6 (6–7), j5 7 (6–7), j6 8 (7–8), J2 9 (8–10), J5 5, z2 9 (8–10), z4 9 (8–10), z5 8 (6–8), Z1 10 (9–11), Z4 10 (9–11), Z5 53 (51–56), s4 13 (12–15), S2 12 (12–13), S4 12, S5 11 (10–11), r3 12, R1 11 (10–12); Sge III 26 (24–28), Sti III 21 (20–23), Sge IV 34 (34–35), Sti IV 33 (32–33), St IV 51 (49–52); distances between setae St1-St3 56 (54–58), St2-St2 61 (60–62), St5-St5 69 (67–71); ventrianal shield length 103 (98–112), width at ZV2 level 47 (46–48), width at anus level 80 (74–84); fixed cheliceral digit 22 (22–23) long; movable cheliceral digit 24 (23–24) long; calyx of spermatheca 14 (13–15) long.

Euseius pauciventripilis Moraes and Lopes, n. sp.

(Figs. 7–11)

Female. Idiosomal setal pattern: 10A:9B/JV-3:ZV-3. Five adults measured.

Dorsum. Dorsal shield lightly striated, 270 (260–275) long, (165–175) wide at level of s4; j1 21 (21–22), j3 24 (22–25), j4 17 (16–18), j5 17 (16–18), j6 15, J2 15 (14–16), J5 6 (6–7), z2 22 (21–25), z4 24 (23–25), z5 14 (13–15), Z1 14 (13–15), Z4 15 (14–16), Z5 47 (42–



Figs. 7–11. *Euseius pauciventripilis* n. sp.. Female. 7, dorsum; 8, venter; 9, genu, tibia and basitarsus of leg IV; 10, spermatheca. Male. 11, ventrianal shield.

50), s4 34 (31–36), S2 19 (18–20), S4 16 (14–17), S5 19 (18–21), r3 23 (22–25), R1 14 (13–15). All dorsal setae smooth.

Peritreme. Reaching level between z2 and z4.

Venter. Sternal and genital shields smooth. Distances between setae: St1-St3 46 (44–48), St2-St2 49 (48–50), St5-St5 49 (48–50). With a pair of metapodal shields. Ventrianal shield with a few transversal striae between preanal pores and anus; 83 (81–85) long, 48 (46–50) wide at ZV2 level, 50 (48–52) wide at anus level. Seta ZV3 absent.

Chelicera. Fixed digit 23 (23–24); movable digit 21 (21–22).

Spermatheca. Calyx 12 long, inflate near atrium and flaring towards vesicle; atrium indistinct.

Legs. Distinct macrosetae only on leg IV, sharp tipped; Sge 23 (22–24), Sti 22 (21–22), St 40 (38–42).

Male. Idiosomal setal pattern: 10A:9B/JV-3,4:ZV-1,3. One adult measured.

Dorsum. Dorsal shield lightly striated, 212 long, 140 wide at level of s4; j1 20, j3 23, j4 19, j5 19, j6 16, J2 13, J5 4, z2 25, z4 27, z5 16, Z1 16, Z4 13, Z5 36, s4 35, S2 18, S4 16, S5 18, r3 21, R1 13. All dorsal setae smooth.

Peritreme. Reaching level slightly posterior to r3.

Venter. Sternogenital shield with few lateral striae; ventrianal shield reticulated, subtriangular, 80 long, 116 wide at anterior corners, with 3 pairs of setae.

Chelicera. Fixed digit 21, movable digit 20.

Legs. Distinct macrosetae only on leg IV, sharp tipped; Sge 20, Sti 22, St 37.

Type series. Holotype, 3 paratype females and 1 paratype male, Lunuwila, Sri Lanka, on *Calopogonium* sp., July 2003, G. J. de Moraes, deposited at ESALQ-USP; 1 paratype female, same data as holotype, deposited at USNM/FSCA.

Remarks. *Euseius densus* (Wu, 1984), *E. okumae*, *Euseius proreraformis* (Schicha and Corpuz-Raros, 1992), *Euseius subplebeius* (Wu and Li, 1984) and *Euseius utilis* (Liang and Ke, 1983) differ from this new species by the shape of the spermatheca; in none of them the spermatheca has globular atrium, as in this new species. This new species seems to differ from all *Euseius* species mentioned in Moraes et al. (2004) by lacking seta ZV3.

Etymology. The species name *pauciventripilis* refers to the reduced number of caudoventral setae in females, because of the absence of seta ZV3.

Euseius sacchari (Ghai and Menon)

Amblyseius sacchari Ghai and Menon, 1967: 75.

Amblyseius (*Euseius*) *sacchari* Gupta, 1985: 349.

SPECIMENS EXAMINED: 5 ♀ : Lunuwila, on *Curculigo* sp..

PREVIOUS RECORDS: India.

REMARKS: No measurements of setae were provided in the original description of this species; only measurements of lengths and widths of dorsal and ventrianal shields of males and females were given. Measurements of setae were provided by Gupta (1977, 1986). Measurements of 5 adult females collected in this study are given subsequently; they are close to those reported by Gupta (1986): dorsal shield length 294 (283–313), width at level of s4 202 (200–205); j1 29 (27–30), j3 13 (12–14), j4 7 (6–8), j5 7, j6 10 (10–11), J2 12 (11–

13), J5 7 (6–7), z2 9 (9–10), z4 9 (9–10), z5 8 (8–9), Z1 and Z4 11, Z5 39 (35–41), s4 14, S2 13, S4 14, S5 13, r3 9 (8–10), R1 9 (9–10), SgeIV 27 (25–28), StiIV 27 (24–29), StIV 41 (39–42); calyx of spermatheca 25 long; dorsal shield striated anterolaterally but smooth elsewhere; peritreme reaching anteriorly to level between z2 and z4; leg macrosetae blunt.

Indoseiulus liturivorus (Ehara)

Amblyseius (*Indoseiulus*) *liturivorus* Ehara, 1982: 43; McMurtry and Moraes, 1984: 29; Ehara, 1985: 120.

Amblyseius (*Amblyseius*) *liturivorus*, Tseng, 1983: 54.

Indoseiulus liturivorus, Moraes et al., 1986: 60; Denmark and Kolodochka, 1993: 253; Ehara et al., 1994: 139; Ehara and Amano, 1998: 48.

SPECIMENS EXAMINED: 2 ♀ : Lunuwila, on *Phyllanthus acidus*.

PREVIOUS RECORDS: Japan, Taiwan.

REMARKS: Measurements of 2 adult females collected are: dorsal shield length 368 (362–375), width at level of s4 239 (237–242); j1 16 (16–17), j3 18 (17–19), j4 17 (16–18), j5 15 (15–16), j6 13, J2 15, J5 9 (8–10), z2 16 (16–17), z4 18 (17–19), z5 14 (13–16), Z1 20, Z4 19 (18–20), Z5 30, s4 16, S2 20 (20–21), S5 19 (18–20), r3 12 (12–13), R1 17 (17–18), SgeII 14, SgeIII 30, StiIII 35, Sge IV 37, Sti IV 50 (49–52), St IV 48 (47–50); distances between setae St1-St3 69 (68–70), St2-St2 69 (69–70), St5-St5 84 (81–92); ventrianal shield length 105, width at ZV2 level 70, width at anus level 65; calyx of spermatheca ca. 25 long. These measurements are close to those given in the original description of the species, except for the slightly longer j4 and Z5. However, they are generally longer than those given by Denmark and Kolodochka (1993), based on 2 paratypes, except for the shorter j1. Genu I of the specimens collected has no macroseta on its usual dorso-postero-distal position, but it has a distinctly longer antero-latero-proximal seta, 35 long. Denmark and Kolodochka (1993) give measurements for leg macrosetae, without mentioning a macroseta on genu I. However, in the drawing provided in that publication, the antero-latero-proximal seta of genu I is distinctly longer than other setae on the same segment. A similar pattern in relation to genu I setae is also clearly shown by those authors for *Indoseiulus ghaiae* Denmark and Kolodochka, 1993, but not for *Indoseiulus ricini* Ghai and Menon, 1969.

Neoseiulus baraki (Athias-Henriot)

Amblyseius baraki Athias-Henriot, 1966: 211; Shicha, 1981: 207.

Amblyseius (*Amblyseius*) *baraki*, Ehara and Bhandhufalck, 1977: 54.

Amblyseius (*Neoseiulus*) *baraki*, Gupta, 1986: 105.

Neoseiulus baraki, Chant and McMurtry, 2003: 27.

Neoseiulus dhooriai (Gupta, 1977): 30 (synonymy according to Gupta, 1986).

SPECIMENS EXAMINED: 15 ♀ , 3 ♂: Kalpitiya, on *Pisonia grandis*, fruits of *Borassus flabellifer* and of *C. nucifera*; 6 ♀ : Kurighanpitiya—Kalpitiya, on *C. nucifera*; 26 ♀ , 3 ♂ : Lunuwila, on *C. nucifera*; 9 ♀: Mannar, on *C. nucifera*; 1 ♀: Mirigama, on *C. nucifera*; 35 ♀: Thangarani, on *C. nucifera*.

PREVIOUS RECORDS: China, Puerto Rico, Taiwan, Thailand.

REMARKS: Measurements of the specimens collected are close to those provided by Ehara and Bhandhufalck (1977). Measurements of 21 adult females are provided subsequently: dorsal shield length 350 (330–375), width at level of s4 160 (146–175); j1 14 (13–16), j3 17 (13–19), j4 11 (9–12), j5 11 (10–18), j6 13 (11–15), J2 12 (10–13), J5 11 (10–13), z2 11 (10–13), z4 14 (10–15), z5 10 (9–15), Z1 12 (11–14), Z4 21 (19–25), Z5 69 (60–73), s4 16 (14–17), S2 15 (14–16), S4 25 (23–27), S5 25 (21–28), r3 15 (13–16), R1 13 (12–15), StIV 38 (31–42); distances between setae: St1-St3 83 (78–87), St2-St2 51 (49–53), St5-St5 58 (55–60); ventrianal shield length 112 (88–120), width at ZV2 level 87 (71–118), length at anus level 83 (73–95); fixed cheliceral digit 31 (30–33) long, with 10–11 teeth; movable cheliceral digit 29 (27–31) long, with 2 teeth; calyx of spermatheca 2 (2–3) long and 10 (9–11) in diameter near vesicle. This species seems most similar to *Neoseiulus mumai* (Denmark), differing from it mostly by the considerably closer preanal pores. It is also similar to *Neoseiulus paspalivorus* (DeLeon), from which it differs by having most of the dorsal shield setae and StIV considerably longer, by the closer preanal pores, the larger number of teeth on fixed and movable cheliceral digits and the shallower cup-shaped spermathecal calyx.

Neoseiulus longispinosus (Evans)

Typhlodromus longispinosus Evans, 1952: 413; Evans, 1953: 465; Womersley, 1954: 177.
Typhlodromus (*Amblyseius*) *longispinosus*, Chant, 1959: 74.
Amblyseius longispinosus, Corpuz-Raros and Rimando, 1966: 129; Schicha, 1975: 103.
Neoseiulus longispinosus, Gupta, 1978a: 334; Moraes et al., 1989a: 129; 2000: 245.

SPECIMENS EXAMINED: 6♀, 1♂: Lunuwila, on *M. esculenta*, *P. maximum*.

PREVIOUS RECORDS: Australia, China, Egypt, Guadeloupe, Hawaii, Hong Kong, India, Indonesia, Les Saintes, Malaysia, Marie Galante, Martinique, New Zealand, Pakistan, Papua New Guinea, Philippines, Russia, Saint Barthelemy, South Korea, Taiwan, Thailand.

REMARKS: Measurements of the dorsal shield setae of the specimens collected are similar to those given by Moraes et al. (2000) for specimens from the French Antilles. In both cases, some of the setae are 15–20% longer than the measurements provided by Schicha (1975) for a type specimen, which in turn are slightly shorter than those given in the original description of the species. In addition, the specimens collected have StIV ca. 15% shorter than the measurement given by Schicha (1975) and Moraes et al. (2000). Measurements of 3 adult females collected in this study are: dorsal shield length 321 (313–338), width at level of s4 187 (175–208); j1 18 (17–19), j3 62 (61–64), j4 58 (56–60), j5 70 (69–71), j6 70 (68–72), J2 77 (75–79), J5 8, z2 69 (68–70), z4 73 (73–75), z5 32 (32–38), Z1 77 (76–78), Z4 72 (71–73), Z5 80 (80–81), s4 82 (80–83), S2 73 (70–79), S4 59 (57–62), S5 21 (19–23), r3 55 (55–56), R1 60 (59–62), StIV 68 (68–70); distances between setae: St1-St3 55 (53–56), St2-St2 53 (50–55), St5-St5 53 (51–54); ventrianal shield length 106 (103–111), width at ZV2 level 91 (89–93), width at anus level 75 (73–77); fixed cheliceral digit 22 (21–22) long, with 5 teeth; movable cheliceral digit 25 (23–25) long, with 2 teeth; calyx of spermatheca 21 (20–21) long.

Neoseiulus paspalivorus (De Leon)

Typhlodromus paspalivorus De Leon, 1957: 143.

Neoseiulus paspalivorus, Muma and Denmark 1969a: 69.

Amblyseius paspalivorus, Schicha, 1981: 210.

SPECIMENS EXAMINED: 1 ♀ : Attanagalla, on fruits of *C. nucifera*; 4 ♀ : Mirigama, on fruits of *C. nucifera*; 2 ♀ : Urapola, on fruits of *C. nucifera*.

PREVIOUS RECORDS: Cuba, Guadeloupe, India, Jamaica, Philippines, USA.

REMARKS: Measurements of the specimens collected are close to those provided in the original description of the species. Average measurements of 7 adult females are: dorsal shield length 322 (307–340), width at level of s4 134 (127–142); j1 10 (9–11), j3 10 (8–11), j4 9 (8–10), j5 9 (8–10), j6 10 (9–15), J2 10 (8–11), J5 8 (7–9), z2 10 (9–10), z4 10 (9–11), z5 9 (8–9), Z1 10 (9–11), Z4 15 (13–17), Z5 48 (45–52), s4 12 (11–12), S2 12 (10–13), S4 14 (13–15), S5 18 (16–20), r3 10 (8–11), R1 10 (9–10), St IV 19 (17–21); distances between setae: St1-St3 74 (72–76), St2-St2 48 (45–53), St5-St5 50 (49–53); ventrianal shield length 103 (95–115), width at ZV2 level 78 (70–85), length at anus level 73 (67–80); fixed cheliceral digit 25 (23–29) long, with 6 teeth; movable cheliceral digit 23 (20–26) long, with 1 tooth; calyx of spermatheca 7 long. This species is similar to *N. baraki*, differing from it as discussed in this paper under that species.

Paraphytoseius seychellensis Schicha and Corpuz-Raros

Paraphytoseius seychellensis Schicha and Corpuz-Raros, 1985: 71; Schicha, 1987: 165, Beard and Walter, 1996: 237; Ehara, 2002b: 130.

SPECIMENS EXAMINED: 1 ♀ : Lunuwila, on *Calopogonium* sp.

PREVIOUS RECORDS: Australia, Indonesia, Seychelles.

REMARKS: Measurements of the single adult female found in this study are very close to those provided in the original description of the species: dorsal shield length 267, width immediately posterior to s4 149; j1 33, j3 85, j4 6, j5 5, j6 8, J5 5, z2 14, z4 12, z5 7, Z1 8, Z4 67, Z5 103, s4 111, r3 44, R1 41, Sge IV 21, Sti IV 27, St IV 32; distances between setae St1-St3 64, St2-St2 64, St5-St5 82; ventrianal shield length 100, width at ZV2 level 50, width at anus level 52; calyx of spermatheca plate shaped, 10 in diameter.

Proprioseiopsis ovatus (Garman)

Amblyseiopsis ovatus Garman, 1958: 78.

Amblyseius ovatus, Moraes and McMurtry, 1983: 133.

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

Amblyseius (*Amblyseius*) *peltatus* Van der Merwe, 1968: 119 (synonymy according to Tseng, 1983).

Amblyseius peltatus, Schicha, 1983: 115.

Amblyseius (*Proprioseiopsis*) *peltatus*, Blommers, 1976: 100; Ehara and Bhandhufalck, 1977: 71; Gupta, 1986: 134.

Iphiseius punicae Gupta, 1980: 213 (synonymy according to Gupta, 1986).

Amblyseius parapeltatus Wu and Chou, 1981: 274 (synonymy according to Tseng, 1983).

SPECIMENS EXAMINED: 1 ♀ : Lunuwila, on *Curculigo* sp..

PREVIOUS RECORDS: Brazil, Costa Rica, Cuba, Ecuador, Egypt, Hawaii, Honduras, Philippines, Puerto Rico, Taiwan, USA.

REMARKS: Measurements of a single adult female collected agree well with those of the holotype of *P. ovatus*, given by Moraes and McMurtry (1983). Measurements of that specimen are: length of dorsal shield 357, width at level of s4 292; j1 27, j3 61, j4 5, j6 8, J5 9, z2 45, z4 20, z5 5, Z1 20, Z4 107, Z5 96, s4 96, S2 22, S4 13, S5 11, r3 20, R1 11, Sge III 25, Sge IV 50, Sti IV 37, St IV 79; distances between setae: St1-St3 47, St2-St2 70, St5-St5 93; ventrianal shield length 115, width at ZV2 level 113, width at anus level. 90; fixed cheliceral digit 32 long, with 6–7 teeth; movable cheliceral digit 30 long, with 1 tooth; calyx of spermatheca 18 long.

Typhlodromips asiaticus (Evans)

Typhlodromus asiaticus Evans, 1953: 461.

Amblyseius asiaticus, Schicha, 1987: 94; Schicha and Corpuz-Raros, 1992: 60.

Amblyseius (*Amblyseius*) *asiaticus*, Ehara and Bhandhufalck, 1977: 58.

Amblyseius (*Amblyseius*) *siaki* Ehara and Lee, 1971: 64 (synonymy according to Ehara and Bhandhufalck, 1977).

Amblyseius linearis Corpuz-Raros and Rimando, 1966: 125 (synonymy according to Schicha and Corpuz-Raros, 1992).

SPECIMENS EXAMINED: 1 ♀ : Lunuwila, on *Centella asiatica*.

PREVIOUS RECORDS: Angola, China, Hong Kong, India, Indonesia, Malaysia, Philippines, Singapore, Thailand.

REMARKS: The single adult female collected in this study fits well the redescription of *T. asiaticus* given by Ehara and Bhandhufalck (1977), except for the shorter macrosetae, which is consistent with the fact that it is smaller than the specimen used in that redescription. Measurements of the specimen collected are: dorsal shield length 287, width at level of s4 182; j1 19, j3 13, j4 8, j5 8, j6 9, J2 9, J5 6, z2 12, z4 14, z5 7, Z4 45, Z5 68, s4 17, S2 13, S4 12, S5 11, r3 11, R1 11; Sge III 14, Sti III 15, Sge IV 22, Sti IV 18, St IV 45; distances between setae: St1-St3 48, St2-St2 52, St5-St5 54; ventrianal shield length 97, width at ZV2 level 79, width at anus level 65; calyx of spermatheca 27 long.

Typhlodromips tetranychivorus Gupta

Typhlodromips tetranychivorus Gupta, 1978: 337

Amblyseius (*Typhlodromips*) *tetranychivorus*, Gupta, 1986: 190

SPECIMENS EXAMINED: 4 ♀ , 2 ♂: Andiambalama, on unidentified herb.

PREVIOUS RECORDS: India.

REMARKS: The specimens collected fit closely the original description of the species, except for the shorter macrosetae. Measurements of 3 adult females collected are: dorsal shield length 317 (315–317), width at level of s4 179 (177–186); j1 25, j3 47 (45–50), j4 8 (8–9), j5 8 (7–8), j6 9 (8–9), J2 8 (7–8), J5 8, z2 18, z4 36 (33–37), z5 7 (6–7), Z1 9 (9–10), Z4 66

(65–68), Z5 90 (90–91), s4 72 (71–74), S2 32, S4 10 (9–10), S5 8 (7–8), r3 25 (24–26), R1 12; Sge III 23 (22–23), Sti III 22 (21–22), Sge IV 45 (44–47), Sti IV 34 (33–35), St IV 55 (54–57); distances between setae: St1-St3 55 (55–56), St2-St2 61 (58–63), St5-St5 64 (62–65); ventrianal shield length 105 (100–109), width at ZV2 level 84 (82–85), width at anus level 69 (68–72); fixed cheliceral digit 33 (32–34); movable cheliceral digit 32 (31–33); calyx of spermatheca 10 (9–10) long. This species seems very similar to *Typhlodromips similis* (Koch, 1839), from which it apparently differs by having the calyx of the spermatheca longer.

PHYTOSEIINAE Berlese

Phytoseius mayottae Schicha

Phytoseius mayottae Schicha, 1984: 124; Corpuz-Raros and Garcia, 1994: 475; Schicha, 1987: 161.

SPECIMENS EXAMINED: 7 ♀, 2 ♂: Kalpitiya, on *T. procumbens*; 17 ♀, 6 ♂: Lunuwila, on *Acalypha* sp., *Curculigo* sp., *P. guajava*, *Turnera* sp..

PREVIOUS RECORDS: Australia, New Caledonia, Philippines, Seychelles, Vanuatu.

REMARKS: Measurements of the adult females collected agree well with those given in the original description of the species. Measurements of 3 adult females are: dorsal shield length 264 (255–270), width at level of s4 145 (135–150); j1 28 (25–29), j3 45 (43–47), j4 6, j5 6, j6 7, J5 7, z2 10 (9–12), z3 20 (17–21), z4 8 (7–8), z5 7, Z4 75 (74–76), Z5 74 (70–78), s4 109 (107–112), s6 79 (77–80), r3 44 (41–47), Sge IV 18 (18–19), Sti IV 47 (45–49), St IV 32 (32–33); distances between setae: St1-St3 54 (53–54), St2-St2 65 (64–66), St5-St5 66 (62–70); ventrianal shield length 86 (80–93), width at ZV2 level 50 (48–53), width at anus level 48 (45–50); fixed cheliceral digit 25 (24–25) long, with 3 teeth anterior to *pilus dentilis* and an apparently "double" tooth posterior to it; movable cheliceral digit 26 (26–27) long, with 1 teeth; calyx of spermatheca 18 long.

Phytoseius calopogonium Moraes and Lopes, n. sp.

(Figs. 12–15)

Female. Idiosomal setal pattern: 12A:5A/JV-3,4:ZV. Four adults measured.

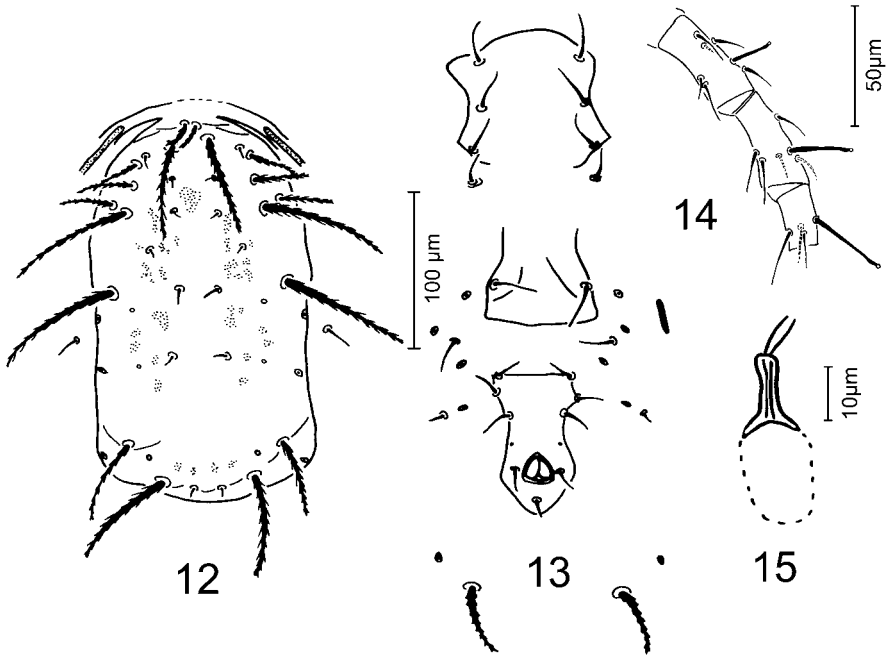
Dorsum. Dorsal shield with few lateral striae, 239 (231–242) long, 114 (109–119) wide at level of s4; j1 19 (19–20), j3 60 (60–61), j4 6, j5 5, j6 9 (7–10), J2 9 (9–10), J5 5 (5–6), z2 10, z3 31 (30–32), z4 31 (29–34), z5 6 (6–8), Z4 49 (47–52), Z5 62 (57–65), s4 73 (71–73), s6 76 (74–76), r3 34 (31–34), R1 15 (14–15). Setae j4, j5, j6, J2, J5, z2, z5 and R1 smooth; other setae serrate.

Peritreme. Reaching level between j3 and z2.

Venter. Ventral shields smooth. Distances between setae: St1-St3 53 (50–55), St2-St2 59 (58–60), St5-St5 50 (48–51). With a pair of metapodal shields. Ventrianal shield 91 (87–96) long, 53 (47–55) wide at ZV2 level, 41 (40–46) wide at anus level. Without solenostome on ventrianal shield.

Chelicera. Fixed digit 22 (21–23) long, apparently with 3 teeth distal to *pilus dentilis*; movable digit 23 long, with 3 teeth.

Spermatheca. Calyx 15 (14–15) long, mostly cylindrical, except for the flared distal



Figs. 12–15. *Phytoseius calopogonium* n. sp.. Female. 12, dorsum; 13, venter; 14, genu, tibia and basitarsus of leg IV; 15, spermatheca.

fourth; atrium globular.

Legs. Distinct macrosetae only on leg IV, hyaline and knobbed distally; Sge and Sti slightly flattened subterminally; Sge 18 (18–19), Sti 22 (22–24), St 31 (29–33).

Male. Unknown.

Type series. Holotype and 2 paratype females, Lunuwila, Sri Lanka, on *Calopogonium* sp., July 2003, G. J. de Moraes, deposited at ESALQ-USP; 1 paratype female, same data as holotype, deposited at USNM/FSCA.

Remarks. *Phytoseius danutae* Walter and Beard, 1997 and *Phytoseius improcerus* Corpuz-Raros, 1966 can be distinguished from this new species by the length of the peritreme; in the former it is considerably longer, extending forward to the level of j1, whereas in the latter it is considerably shorter, extending forward only to the level of z4. As depicted by different authors (Chant and Athias-Henriot, 1960; Livshitz and Mitrofanov, 1981; Swirski et al., 1998) *Phytoseius plumifer* (Canestrini and Fanzago, 1876) differs from this new species by having z4 considerably shorter than r3.

Etymology. The species name *calopogonium* refers to the name of the genus of the plant on which the types were collected.

TYPHLODROMINAE Wainstein

Typhlodromus (*Anthoseius*) *bifurcutus* Wu

Typhlodromus bifurcutus Wu, 1983: 15

Amblydromella (*Aphanoseia*) *bifurcata*, Denmark and Welbourn, 2002: 308.

SPECIMENS EXAMINED: 1 ♀ : Kalpitiya, on *Hibiscus* sp..

PREVIOUS RECORDS: China.

REMARKS: Measurements of the single adult female collected agree generally well with those of the original description of this species. It also resembles *Typhlodromus* (*Anthoseius*) *drymis* Ueckermann and Loots, 1988, known from South Africa, *Typhlodromus* (*Anthoseius*) *gutierrezi* Blommers, 1973, known from Madagascar, and *Typhlodromus* (*Anthoseius*) *sonprayagensis* Gupta, 1985, known from India, except for the fact that it is smaller than the type specimens of those species and, concurrently, it has shorter dorsal setae and leg macrosetae. Measurements of the specimen collected are: dorsal shield length 293, width at level of s4 293; j1 14, j3 17, j4 12, j5 14, j6 15, J2 16, J5 8, z2 14, z4 19, z5 12, Z4 19, Z5 35, s4 16, s6 18, S2 19, S4 20, S5 12, r3 15, R1 13, Sge IV 9, Sti IV 12, St IV 15; distances between setae: St1-St3 52, St2-St2 51, St5-St5 52; length of ventrianal shield 95, width at ZV2 level 71, width at anus level 66; calyx of spermatheca 10 long. The specimen collected has 5 teeth on the fixed cheliceral digit and apparently 2 teeth on the movable cheliceral digit.

DISCUSSION

Similarly to what has been commonly observed in surveys in tropical and subtropical regions, the Amblyseiinae was much more diverse than the Phytoseiinae and the Typhlodrominae. Seventeen of the species collected belonged to the first subfamily, whereas only 2 belonged to the second and one to the third subfamilies. The abundance of Amblyseiinae was also much higher than that of other subfamilies. As a whole, the species found in largest numbers were *A. largoensis*, *N. baraki* and *Phytoseius mayottae*.

Three species were found on coconut leaves, namely *A. duplicesetus*, *A. largoensis* and *I. liturivorus*. Also 3 species were found on coconut fruits, associated with *A. guerreronis*: *A. largoensis*, *N. baraki* and *N. paspalivorus*; *N. baraki* was by far the most abundant phytoseiid species on coconut fruits. *A. largoensis* had already been reported in association with *A. guerreronis* on coconut in the USA (Howard et al., 1990). *N. baraki* had also been reported on coconut fruits associated with *A. guerreronis* in Puerto Rico (Howard et al., 1990), whereas *N. paspalivorus* had been reported on the same substrate, in association with the same prey, in the USA (Howard et al., 1990), Cuba (Cabrera et al., 1992) and India (Mallik et al., 2003; Murumuthu et al., 2003; Ramaraju et al., 2002). Reports of *N.* aff. *paspalivorus* in Sri Lanka (Fernando and Aratchige, 2003; Fernando et al., 2002, 2003) most probably refer to *N. baraki*, which is much more abundant than *N. paspalivorus*. Similarly, the report of *N. paspalivorus* from Sri Lanka (Fernando et al., 2002) should also refer to *N. baraki*. The general structure of *N. baraki* is very similar to that of *N. paspalivorus* as well as to that of at least 10 other phytoseiid species (Schicha, 1981); they have flat and elongate idiosoma and short dorsal shield setae. Such pattern is very appropriate for *N. baraki* and *N. paspalivorus* to access the area between the bracts and the surface of a coconut fruit, where *A. guerreronis* colony is usually found. *N. mumai*, which also belongs to this group of species, was also mentioned on coconut in association with *A. guerreronis* in the USA

(Howard et al., 1990).

In the present study, *N. paspalivorus* was found just on coconut plants, whereas *N. baraki* was also found on 2 other plants, *B. flabellifer* and *P. grandis*. Complementary studies could indicate the presence of either of both of those predators on still other plant species. *B. flabellifer* is a palm tree native to Asia, which can also host *A. guerreronis* (Ramaraju and Rabindra, 2002). In fact, *N. baraki* was found in the present study in association with *A. guerreronis* on fruits of that plant. *P. grandis* is a common tree of medicinal value in the indigenous medicine of Sri Lanka. *N. paspalivorus* and *N. baraki* have been reported in the literature from several plant species in addition to coconut, *B. flabellifer* and *P. grandis* (Moraes et al., 1986; 2004). Future studies are warranted to evaluate the possibility of using some of those plants in management strategies to enhance the presence of those predators in coconut growing areas, so as to promote the biological control of *A. guerreronis*.

ACKNOWLEDGEMENTS

To C. Wawagedara, M. Kumari, D. Appuhamy, C. Hapuarachchi, R. de Silva and the staff of the Crop Protection Division of the Coconut Research Institute, Sri Lanka, for their valuable help in the collection of the specimens treated in this paper. This work was partially supported by the Coconut Research Institute, through coconut CESS Fund.

REFERENCES

Athias-Henriot, C. (1966) Contribution a l' etude des *Amblyseius* palearctiques (Acariens anactinotriches, Phytoseiidae). *Bulletin Scientifique de Bourgogne*, 24: 181–230.

Beard, J. J. and D. E. Walter (1996) Australian mites of the genera *Paraphytoseius* Swirski and Shechter and *Paraamblyseius* Muma (Acarina: Phytoseiidae). *Australian Journal of Entomology*, 35: 235–241.

Blommers, L. (1974) Species of the genus *Amblyseius* Berlese, 1914, from Tamatave, east Madagascar (Acarina: Phytoseiidae). *Bulletin Zoologisch Museum Universiteit van Amsterdam*, 3: 143–155.

Blommers, L. (1976) Some Phytoseiidae (Acarina: Mesostigmata) from Madagascar, with descriptions of eight new species and notes on their biology. *Bijdragen tot Dierkunde*, 46: 80–106.

Cabrera, R. I., G. Otero-Colina and N. Rodríguez (1992) Principales enemigos naturales del acaro del cocotero *Aceria guerreronis* (Eriophyidae) en Cuba. *Agrociencia, Serie Protección Vegetal*, 3(2): 83–89.

Canestrini, G. and F. Fanzago (1876) Nuovi acari italiani (Seconda Serie). *Atti Societa Veneto-Trentina di Scienze Naturali*, 5: 130–142.

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. *The Canadian Entomologist, Supplement 12*, 166 p.

Chant, D. A. and C. Athias-Henriot (1960) The genus *Phytoseius* Ribaga, 1902 (Acarina: Phytoseiidae). *Entomophaga*, 5: 213–228.

Chant, D. A. and E. Yoshida-Shaul (1991) Adult ventral setal patterns in the family Phytoseiidae (Acari: Gamasina). *International Journal of Acarology*, 17: 187–199.

Chant, D. A. and E. Yoshida-Shaul (1992) Adult idiosomal setal patterns in the family Phytoseiidae (Acari: Gamasina). *International Journal of Acarology*, 18: 177–193.

Chant, D. A. and J. A. McMurtry (2003) A review of the subfamily Amblyseiinae Muma (Acari: Phytoseiidae): Part I. Neoseiulini new tribe. *International Journal of Acarology*, 29: 3–46.

Corpuz-Raros, L. A. (1966) Seven new species of mites of the genera *Typhlodromus* and *Phytoseius* (Phytoseiidae: Acarina). *The Philippine Agriculturist*, 50: 729–738.

Corpuz-Raros, L. A. and L. Rimando (1966) Some Philippine Amblyseiinae (Phytoseiidae: Acarina). *The Philippine*

Agriculturist, 50: 114–136.

Corpuz-Raros, L. A. and R. C. Garcia (1994) Two additional records and a key to the species of *Phytoseius* (Phytoseiidae, Acari) from the Philippines. *The Philippine Agriculturist*, 77: 473–479.

De Leon, D. (1957) Three new *Typhlodromus* from southern Florida (Acarina: Phtyoseiidae). *The Florida Entomologist*, 40: 141–144.

Denmark, H. A. and M. H. Muma (1973) Phytoseiid mites of Brazil (Acarina: Phytoseiidae). *Revista Brasileira de Biologia*, 33: 235–276.

Denmark, H. A. and M. H. Muma (1989) A revision of the genus *Amblyseius* Berlese, 1914 (Acari: Phytoseiidae). *Occasional Papers of the Florida State Collection of Arthropods, 4*, 149 p.

Denmark, H. A. and L. A. Kolodochka (1993) Revision of the genus *Indoseiulus* Ehara (Acari: Phytoseiidae). *International Journal of Acarology*, 19: 249–257.

Denmark, H. A., G. A. Evans, H. Aguilar, C. Vargas and R. Ochoa (1999) Phytoseiidae of Central America (Acari: Mesostigmata), 125 p., Indira Publishing House, West Bloomfield, Michigan, USA.

Dennmark, H. A. and W. C. Welbourn (2002) Revision of the genera *Amblydromella* Muma and *Anthoseius* De Leon (Acari: Phytoseiidae). *International Journal of Acarology*, 28: 291–316.

Ehara, S. (1964) Some mites of the families Phytoseiidae and Blattisocidae from Japan (Acarina: Mesostigmata). *Journal of the Faculty of Science, Hokkaido University, Series 6 Zoology*, 15: 378–394.

Ehara, S. (1966a) A tentative catalogue of predatory mites of Phytoseiidae known from Asia, with descriptions of five new species from Japan. *Mushi*, 39: 9–30.

Ehara, S. (1966b) Some mites associated with plants in the state of Sao Paulo, Brazil, with a list of plant mites of South America. *Japanese Journal of Zoology*, 15: 129–150.

Ehara, S. (1967) Phytoseiid mites from Okinawa Island (Acarina: Mesostigmata). *Mushi*, 40: 67–82.

Ehara, S. and L. H. Y. Lee (1971) Mites associated with plants in Hong Kong. *Journal of the Faculty of Education, Tottori University, Natural Science*, 22: 61–78.

Ehara, S. and A. Bhandhufalck (1977) Phytoseiid mites of Thailand (Acarina: Mesotigmata). *Journal of the Faculty of Education, Tottori University, Natural Science*, 27: 43–82.

Ehara, S. (1982) Two new species of phytoseiid mites from Japan (Acarina: Phytoseiidae). *Applied Entomology and Zoology*, 17: 40–45.

Ehara, S. (1985) Five species of phytoseiid mites from Japan with descriptions of two new species (Acarina, Phytoseiidae). *Zoological Science*, 2: 115–121.

Ehara, S., Y. Okada and H. Kato (1994) Contribution to the knowledge of the mite family Phytoseiidae in Japan (Acari: Gamasina). *Journal of the Faculty of Education, Tottori University, Natural Science*, 42: 119–160.

Ehara, S. and H. Amano (1998) A revision of the mite family Phytoseiidae in Japan (Acari: Gamasina), with remarks on its biology. *Species Diversity*, 3: 25–73.

Ehara, S. (2002a) Some phytoseiid mites (Arachnida: Acari: Phytoseiidae) from West Malaysia. *Species Diversity*, 7: 29–46.

Ehara, S. (2002b) Phytoseiid mites (Acari: Phytoseiidae) from Sumatra with a description of a new species. *Acta Arachnologica*, 51: 125–133.

Ehara, S. and H. Amano (2002) Some Japanese phytoseiid mites (Acari: Phytoseiidae) mostly from Ishigaki and Taketomi Islands. *Entomological Science*, 5: 321–329.

Ehara, S. and H. Amano (2004) Checklist and Keys to Japanese Amblyseiinae (Acari: Gamasina: Phytoseiidae). *Journal of the Acarological Society of Japan*, 13: 1–30.

Evans, G. O. (1952) A new typhlodromid mite predaceous on *Tetranychus bimaculatus* Harvey in Indonesia. *Annual Magazine of Natural History*, 5: 413–416.

Evans, G. O. (1953) On some mites of the genus *Typhlodromus* Scheuten, 1857, from S. E. Asia. *Annual Magazine of Natural History*, 6: 449–467.

Fernando, L. C. P. (1998). Report of the Crop Protection Division. In: Annual Report of the Coconut Research Institute of Sri Lanka, p. 135–156. Coconut Research Institute, Lunuwila, Sri Lanka.

Fernando, L. C. P., I. R. Wickramananda and N. S. Aratchige (2002) Status of coconut mite, *Aceria guerreronis* in Sri Lanka. In: Proceedings of the International Workshop on Coconut Mite (*Aceria guerreronis*), January 6–8, 2000. (eds., Fernando, L. C. P., G. J. de Moraes and I. R. Wickramananda), p. 1–8. Coconut Research Institute,

Lunuwila, Sri Lanka.

Fernando, L. C. P. and N. S. Aratchige (2003) Use of predatory mite *Neoseiulus* aff. *paspalivorus* in management of coconut mite. In: Proceedings of the International Workshop on Coconut Mite, April 5–7, 2003. (eds., Singh, H. P. and P. Rethinam), p. 43–49. Coconut Development Board, Bangalore, India.

Fernando, L. C. P., N. S. Aratchige and T. S. G. Peiris (2003) Distribution patterns of coconut mite, *Aceria guerreronis*, and its predator *Neoseiulus* aff. *paspalivorus* in coconut palms. *Experimental and Applied Acarology*, 31: 71–78.

Garman, P. (1958) New species belonging to the genera *Amblyseius* and *Amblyseiopsis* with keys to *Amblyseius*, *Amblyseiopsis*, and *Phytoseiulus*. *Annals of the Entomological Society of America*, 51: 69–79.

Gerson, U., R. L. Smiley and R. Ochoa (2003) Mites (Acari) for Pest Control. 539 p., Blackwell Science Ltd., UK.

Ghai, S. and M. G. R. Menon (1967) Taxonomic studies on Indian mites of the family Phytoseiidae (Acarina). I. New species and new records of the genus *Amblyseus* Berlese from India (Acarina: Phytoseiidae) with a key to the Indian species. *Oriental Insects*, 1: 65–79.

Gupta, S. K. (1975) Mites of the genus *Amblyseius* (Acarina: Phytoseiidae) from India with descriptions of eight new species. *International Journal of Acarology*, 1: 26–45.

Gupta, S. K. (1977) (1976) Some undescribed and little-known species of *Amblyseius* (Acarina: Phytoseiidae) from western and northern India. *Indian Journal of Acarology*, 1: 28–37.

Gupta, S. K. (1978a) Some Phytoseiidae from south India with descriptions of five new species. *Oriental Insects*, 12: 327–338.

Gupta, S. K. (1978b) (1977) Some new species and records of *Amblyseius* from eastern India (Acari: Phytoseiidae). *Indian Journal of Acarology*, 2: 60–77.

Gupta, S. K. (1980) (1979) New species of *Iphiseius* Berlese and *Paraamblyseius* Muma from India (Acarina: Phytoseiidae). *Entomologist's Monthly Magazine*, 115: 213–217.

Gupta, S. K. (1985) Plant mites of India, 5. 520 p., Zooogical Survey of India Handbook Series, Calcutta, India.

Gupta, S. K. (1986) Fauna of India (Acari: Mesostigmata) Family Phytoseiidae. 350 p., Zoological Survey of India, Calcutta, India.

Howard, F. W., E. Abreu-Rodriguez and H. A. Denmark (1990) Geographical and seasonal distribution of the coconut mite, *Aceria guerreronis* (Acari: Eriophyidae), in Puerto Rico and Florida, USA. *Journal of Agriculture of the University of Puerto Rico*, 74: 237–251.

Koch, C. L. (1839) Deutschlands Crustaceen, Myriapoden und Arachniden. Regensburg, Germany, 5–6(25), 22; 5–6(27), 6, 13.

Liang, L. R. and L. S. Ke (1983) Notes on the *finlandicus* group of *Amblyseius* Berlese of China [in Chinese]. *Acta Zootaxonomica Sinica*, 8: 162–172. (In Chinese with English summary)

Livshitz, I. Z. and V. I. Mitrofanov (1981) Beneficial insects and mites in fruit orchards. *Zaschita Rasteniy*, 6: 49–52. (In Russian with English summary)

Mallik, B., G. Chinnamade, J. Jayappa, H. Guruprasad and S. Onkarappa (2003) Coconut eriophyid mite—Issues and strategies. In: Proceedings of the International Workshop on Coconut Mite, April 5–7, 2003. (eds., Singh, H. P. and P. Rethinam), p. 27–34. Coconut Development Board, Bangalore, India.

Matthysse, J. G. and H. A. Denmark (1981) Some phytoseiids of Nigeria (Acarina: Mesostigmata). *The Florida Entomologist*, 64: 340–357.

McMurtry, J. A. and G. J. de Moraes (1984) Some phytoseiid mites from the South Pacific, with descriptions of new species and a definition of the *Amblyseius largoensis* species group. *International Journal of Acarology*, 10: 27–37.

Moraes, G. J. de and J. A. McMurtry (1983) Phytoseiid mites (Acarina) of northeastern Brazil with descriptions of four new species. *International Journal of Acarology*, 9: 131–148.

Moraes, G. J. de, J. A. McMurtry and H. A. Denmark (1986) A catalog of the mite family Phytoseiidae. References to taxonomy, synonymy, distribution and habitat. 353 p., EMBRAPA-DDT, Brasilia, Brazil.

Moraes, G. J. de and J. A. McMurtry (1988) Some phytoseiid mites from Kenya, with description of three new species. *Acarologia*, 29: 13–18.

Moraes, G. J. de, H. A. Denmark, H. van den Berg and A. Bellotti (1989a) Some phytoseiid mites (Acari: Phytoseiidae) from the Far East, with description of a new species. *International Journal of Acarology*, 15: 129–133.

Moraes, G. J. de, J. A. McMurtry, H. van den Berg and J. S. Yaninek (1989b) Phytoseiid mites (Acari: Phytoseiidae)

of Kenya, with descriptions of five new species and complementary descriptions of eight species. *International Journal of Acarology*, 15: 79–93.

Moraes, G. J. de, S. Kreiter and A. C. Lofego (2000) (1999) Plant mites (Acari) of the French Antilles. 3. Phytoseiidae (Gamasida). *Acarologia*, 40: 237–264.

Moraes, G. J. de and M. S. Zacarias (2002) Use of predatory mites for the control of eriophyid mites. In: Proceedings of the International Workshop on Coconut mite (*Aceria guerreronis*), January 6–8, 2000. (eds., Fernando, L. C. P., G. J. de Moraes and I. R. Wickramananda), p. 78–88. Coconut Research Institute, Lunuwila, Sri Lanka.

Moraes, G. J. de, J. A. McMurtry, H. A. Denmark and C. B. Campos (2004) A Revised Catalog of the Mite Family Phytoseiidae. 494 p., Zootaxa, Magnolia Press, New Zealand.

Muma, M. H. (1955) Phytoseiidae (Acarina) associated with citrus in Florida. *Annals of the Entomological Society of America*, 48: 262–272.

Muma, M. H. (1967) New Phytoseiidae (Acarina: Mesostigmata) from southern Asia. *The Florida Entomologist*, 50: 267–280.

Muma, M. H. and H. A. Denmark (1969a) Sibling species of Phytoseiidae (Acarina: Mesostigmata). *The Florida Entomologist*, 52: 67–72.

Muma, M. H., H. A. Denmark and D. De Leon (1970) Phytoseiidae of Florida. Arthropods of Florida and neighboring land areas, 6. 150 p., Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Gainesville, USA.

Murumuthu, T., S. Palanisamy and K. Ramaraju (2003) Integrated management of coconut eriophyid mite (*Aceria guerreronis* Keifer) in Tamil Nadu. In: Proceedings of the International Workshop on Coconut Mite, April 5–7, 2003. (eds., Singh, H. P. and P. Rethinam), p. 81–86. Coconut Development Board, Bangalore, India.

Narayanam, E. S., R. B. Kaur and S. Ghai (1960) Importance of some taxonomic characters in the family Phytoseiidae Berl., 1916, (predatory mites) with new records and descriptions of species. *Proceedings of the National Institute of Science of India*, 26B: 384–394.

Prasad, V. (1968) *Amblyseius* mites from Hawaii. *Annals of the Entomological Society of America*, 61: 1514–1521.

Ramaraju, K. and R. J. Rabindra (2002) Palmyra, *Borassus flabellier* Linn. (Palmae): a host of the coconut eriophyid mite *Aceria guerreronis* Keifer. *Pest Management in Horticulture Ecosystems*, 7: 149–151.

Ramaraju, K., K. Natarajan, P. C. Sundara Babu, S. Palanisamy and R. J. Rabindra (2002) Studies on coconut eriophyid mite, *Aceria guerreronis* Keifer in Tamil Nadu, India. In: Proceedings of the International Workshop on Coconut Mite (*Aceria guerreronis*), January 6–8, 2000. (eds., Fernando, L. C. P., G. J. de Moraes and I. R. Wickramananda), p. 13–31. Coconut Research Institute, Lunuwila, Sri Lanka.

Rowell, H. J., D. A. Chant, and R. I. C. Hansell (1978) The determination of setal homologies and setal patterns on the dorsal shield in the family Phytoseiidae (Acarina: Mesostigmata). *Canadian Entomologist*, 110: 859–876.

Sathiamma, B., C. P. Radhakrishnan Nair and P. K. Khosy (1998) Outbreak of a nut infesting eriophyid mite *Eriophyes guerreronis* (K.) in coconut plantations in India. *Indian Coconut Journal*, 29 : 1–3.

Schicha, E. (1975) A new predacious species of *Amblyseius* Berlese from strawberry in Australia, and *A. longispinosus* (Evans) redescribed (Acari: Phytoseiidae). *Journal of the Australian Entomological Society*, 14: 101–106.

Schicha, E. (1977) *Amblyseius victoriensis* (Womersley) and *A. ovalis* (Evans) compared with a new congener from Australia (Acari: Phytoseiidae). *Journal of the Australian Entomological Society*, 16: 123–135.

Schicha, E. (1981) A new species of *Amblyseius* (Acari: Phytoseiidae) from Australia compared with ten closely related species from Asia, America & Africa. *International Journal of Acarology*, 7: 203–216.

Schicha, E. (1983) New species, new records, and redescriptions of phytoseiid mites from Australia, Tahiti, and the African region (Acari: Phytoseiidae). *International Journal of Entomology*, 25: 103–126.

Schicha, E. (1984) Contribution to the knowledge of the genus *Phytoseius* Ribaga in Australia, the South Pacific and Indian Ocean regions with four new species and records of known species (Acarina: Phytoseiidae). *International Journal of Acarology*, 10: 117–128.

Schicha, E. and L. A. Corpuz-Raros (1985) Contribution to the knowledge of the genus *Paraphytoseius* Swirski and Shechter (Acarina: Phytoseiidae). *International Journal of Acarology*, 11: 67–73.

Schicha, E. (1987) Phytoseiidae of Australia and neighboring areas. 187 p., Indira Publishing House, West Bloomfield, Michigan, USA.

Schicha, E. and L. A. Corpuz-Raros (1992) Phytoseiidae of the Philippines. 190 p., Indira Publishing House, West

Bloomfield, Michigan, USA.
Swirski, E., S. Ragusa Di Chiara and H. Tsolakis (1998) Keys to the phytoseiid mites (Parasitiformes, Phytoseiidae) of Israel. *Phytophaga*, 8: 85–154.
Tseng, Y. H. (1976) Systematics of the mite family Phytoseiidae from Taiwan, with a revised key to genera of the world (II). *Journal of the Agricultural Association of China, New Series*, 94: 85–128.
Tseng, Y. H. (1983) Further study on phytoseiid mites from Taiwan (Acarina: Mesostigmata). *Chinese Journal of Entomology*, 3: 33–74.
Ueckermann, E. A. and G. C. Loots (1988) The African species of the subgenera *Anthoseius* De Leon and *Amblyseius* Berlese (Acari: Phytoseiidae). *Entomology Memoir, Department of Agriculture and Water Supply, Republic of South Africa*, 73. 168 p.
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. *Entomology Memoirs*, *South Africa Department of Agricultural Technical Services, South Africa*, 18. 198 p.
Walter, D. E. and J. J. Beard (1997) A review of the Australian Phytoseiinae (Acari: Mesostigmata: Phytoseiidae). *Invertebrate Taxonomy*, 11: 823–860.
Womersley, H. (1954) Species of the subfamily Phytoseiinae (Acarina: Laelaptidae) from Australia. *Australian Journal of Zoology*, 2: 169–191.
Wu, W. N. and F. W. Chou (1981) A new species of *Amblyseius* (Acarina: Phytoseiidae) from Guangdong Province. *Zoological Research*, 2: 273–274. (In Chinese)
Wu, W. N. (1983) Two new species of *Typhlodromus* Scheuten (Acarina: Phytoseiidae) from China. *Zoological Research*, 4: 15–18. (In Chinese)
Wu, W. N. (1984) Two new species of *Amblyseius* from Yunnan Province, China (Acarina: Phytoseiidae). *Acta Zootaxonomica Sinica*, 9: 156–158. (In Chinese)
Wu, W. N. and Z. Q. Li (1984a) Four new species of the phytoseiid mites from China (Acarina: Phytoseiidae). *Acta Entomologica Sinica*, 27: 98–103. (In Chinese)
Wu, W. N. and Z. Q. Li (1984b) Three new species of the genus *Phytoseius* from south China (Acarina: Phytoseiidae). *Acta Entomologica Sinica*, 27: 457–461. (In Chinese)
Wu, W. N. and Z. Q. Li (1984c) Three new species of Phytoseiidae from Shennongjia, Hubei Province (Acarina: Phytoseiidae). *Acta Zootaxonomica Sinica*, 9: 44–48. (In Chinese)
Wu, W. N., L. R. Liang and W. M. Lan (1997) Acari: Phytoseiidae. Economic Insect Fauna of China, 53. 227 p., Science Press, Beijing, China. (In Chinese)