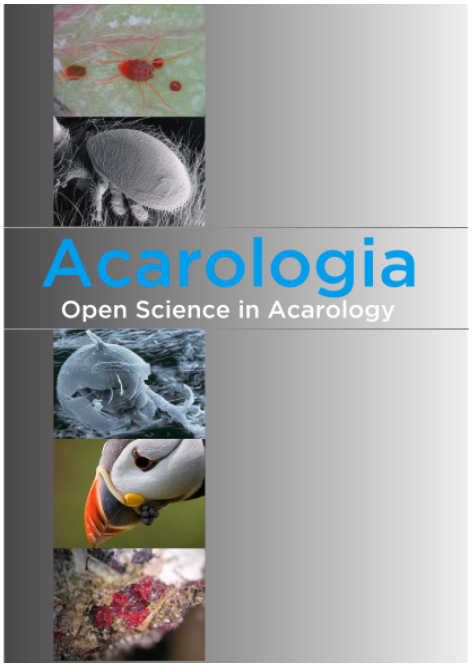

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New records of phytoseiid mites from Italy, with description of a new species and a redescription of other two (Parasitiformes, Phytoseiidae)

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Original research

ABSTRACT

The Italian phytoseiid fauna consists of 91 valid species. Eighteen of them were described as new species from materials collected in various Italian localities. In the present paper we report nine new records from the Italian fauna and describe the new species, *Neoseiulus mediterraneus* belonging to the subfamily Amblyseiinae. Complementary descriptions of two rare species, namely: *Typhlodromus* (*Anthoseius*) *singularis* and *Typhlodromus* (*Typhlodromus*) *knisleyi*, were also added.

Keywords Mesostigmata; Phytoseiidae; new species; descriptions; Italy
Zoobank http://zoobank.org/7550FED8-09B9-4955-AFEC-1ABDAFBBA08F

Introduction

The family Phytoseiidae (Acari, Parasitiformes) being predatory, plays an important regulation role both in agricultural and natural ecosystems (McMurtry *et al.* 2013, 2015; Calvo *et al.* 2015; Lorenzon *et al.* 2018), and includes about 2,521 valid species (Demite *et al.* 2020). Many of them are considered important biocontrol agents of phytophagous mites and insects on crops, but despite more than a half century of intensive studies on this family and the great number of species described, only 20 species are presently reared in commercial insectaries (Knapp *et al.* 2018). It should be mentioned that this number has significantly grown in the last two decades with the increasing number of studies on bio-ethology, food preferences and ecology of less known or rare species (Quilici *et al.* 1997; Kreiter *et al.* 2002; Sznajder *et al.* 2011; Szabó *et al.* 2013; Tsolakis *et al.* 2016; Tsolakis and Ragusa 2017). The use of indigenous phytoseiid species, to control infestations of both endemic and invasive mite and insect pests, still represents the lower environmental impact strategy in agricultural ecosystems, and this should be the main scope of specialists in this field. It is commonly accepted that periodic surveys of phytoseiid mites on cultivated and spontaneous plants, are important to discover some rare species that could become future biocontrol agents of phytophagous mites on agricultural crops. As a matter of fact, it should be mentioned that the most common phytoseiids reared in insectaries world wide, i.e., *Phytoseiulus persimilis* Athias-Henriot, *Neoseiulus cucumeris* (Oudemans), *Neoseiulus californicus* (McGregor), *Amblyseius swirskii* Athias-Henriot, are rare species in natural ecosystems. Studies on phytoseiid mites in Italy, started in the 19th century by Canestrini and Fanzago (1876) and Berlese (1887, 1889), and continued by the latter author and Ribaga up to the first two decades of 20th century (Ribaga 1904; Berlese 1923). Afterwards, after a block of about 50 years, the studies on phytoseiid mites were resumed in a constant way starting from the 70s up to today (Ivancich-Gambaro 1975; Ragusa and Swirski 1976, 1978, 1982; Ragusa 1979, 1981; Ragusa and Paoletti 1985;

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Duso and Sbrissa 1990; Tsolakis and Ragusa Di Chiara 1993; Ragusa Di Chiara and Tsolakis 1996; Tsolakis and Ragusa 1999; Tsolakis *et al.* 2000, 2013; Duso *et al.* 2004; Tsolakis and Ragusa 2015, 2017; Lorenzon *et al.* 2018). At present, ninety-one valid phytoseiid species have been surveyed in Italy and 18 of them, were described as new species (Demite *et al.* 2020).

In the present paper we report nine new phytoseiid records from the Italian fauna, we describe a new species of *Neoseiulus* and redescribe two rare species, adding new information on them.

Materials and methods

Phytoseiid mites reported in the present paper were collected in different localities of Italy with the branch-shaking method (Tsolakis and Ragusa 1999). Specimens, fallen on a black plastic table, were collected using micro-aspirator and preserved in alcohol 70%. In laboratory they were cleared in Nesbitt solution and mounted on microscopic slides in Hoyer's medium. For the identification of the species and measurements, a differential interference contrast microscope (DIC) Zeiss Axioplan was used. Specimens of all species are kept in the Acari collection of the Laboratory of Agricultural and Applied Acarology "Eliahu Swirski", Department of Agricultural, Food and Forest Sciences, University of Palermo (Italy). All measurements are given in micrometres (μm), reporting mean (min-max) and were made using the Axiovision 40V 4.6.1.0 application (Zeiss, 2002–2007). In the description of the new species, and the redescriptions we followed the nomenclature proposed by Lindquist & Evans (1965) as adapted to the Phytoseiidae by Rowell *et al.* (1978) for the dorsal and Chant and Yoshida-Shaul (1991) for the ventral chaetotaxy. For the terminology of various sections of the insemination apparatus (spermathecal apparatus), we followed Beard (2001), with some additions and changes. For setal patterns of leg IV podomeres (genu, tibia, tarsus), the formulae proposed by Evans and Till (1979) were adopted. For the macrosetae, we considered the concept defined by Beard (2001). Nomenclature of the adenotaxy was the one suggested by Athias-Henriot (1975). The following descriptive terms were here adopted after Athias-Henriot (1977): *Habitus* = a cluster of characters that determine the appearance of a structure, i.e., the shape of the dorsal shield, its reticulation (strong, slight, absent), the position of the setae, the shape of some setae, and isotrichy or anisotrichy; *Hoplochorous* = situated on a shield; *Tylochorous* = situated on a microsclerite, a small platelet on interscutal membrane; *Gymnochorous* = situated on the interscutal membrane; *Holoadeny* = presence of all dorsal solenostomes reported up to now for the Phytoseiidae family; *Meriadeny* = absence of one or more solenostomes; *Receptaculum* = the proximal segment of the major duct after the opening between the 3rd and the 4th pair of coxae, it may be simple or differentiate, in the latter case it is defined receptaculum; *Embolus* = the dimple present in the atrium on which the minor duct is inserted. The identification of the host plants was based on Pignatti (1982) and on the direct contribution of different botanists of the University of Palermo. For some species, we referred to various recent papers on Sicilian flora (Gianguzzi and La Mantia 2009; Musarella *et al.* 2018).

Results

All the phytoseiid species of the present work belong to our Acari collection. Various slides were labelled with the generic name followed by sp. (i.e., *Neoseiulus* spp.). Reorganising the collection, we classified them in their correct taxon status and we described the new species reported below.

Subfamily Amblyseiinae Muma 1961

Tribe Neoseiulini Chant and McMurtry 2003

Genus *Neoseiulus* Hughes 1948

Neoseiulus mediterraneus Tsolakis & Ragusa sp. nov.

Zoobank: 2AAC66F1-7B31-406D-98EA-3789093D5470

Diagnosis of female

Dorsal shield slightly reticulated with a restriction at level of setae R1. Dorsal and peritrematal shields are fused at level of setae j1. All dorsal setae are slender and smooth except setae Z5 which are slightly serrated and the longest. Adenotaxy complete; solenostome gd3 well visible on peritrematal shield. Peritreme reaches the bases of setae j1. Sternal shield smooth with three pairs of setae (ST1–ST3) and two pairs of poroids (iv1 and iv2). Setae ST4 and poroids iv3 tylochorous. Genital shield with longitudinal striae; sigilla 1st–3rd pairs well visible. Sigilla of 4th and 5th pair well visible on the interscutal membrane between setae ZV1; sigilla of 6th pair posteroparaxial to setae ZV1. Ventrianal shield mostly reticulated with three pairs of preanal setae and a pair of small crateriform solenostomes (gv3). Setae JV5 smooth. Calyx of the insemination apparatus cup-shaped, without basal neck. Atrium nodular; minor duct well visible. Major duct cylindrical and narrow. Fixed digit of chelicera with seven teeth, movable digit with two teeth. Nine setae on genu II; three smooth and pointed macrosetae are present on leg IV, being of that on basitarsus the longest one.

Female

The description is based on 16 females.

(Figure 1 A–F)

Dorsum (Figure 1A) — Dorsal shield oval, waisted at level of setae *R1*, mostly reticulate. Seven pairs of small crescentic solenostomes are visible on the dorsal shield: *gd1* posteroantiaxial to setae *j3*, *gd2* posteroantiaxial to setae *j4*, *gd4* posteroantiaxial to setae *s4*, *gd5* posteroparaxial to setae *z5*, *gd6* anteroparaxial to *Z1*, *gd8* anteroantiaxial or anterior to *Z4* and *gd9* anteroparaxial to *S5*. Some poroids are visible on the dorsal shield. Some sigilla (muscle marks) are visible on the shield (Figure 1A). The dorsal setae *s4*, *S2*, *Z4* almost of the same length. Setae *Z5* is the longest one. Same length have also the dorsocentral setae *j1*, *j4* and *j6*. Setae *r3* and *R1* on the interscutal membrane. All setae are slender and smooth, except for *Z5*, thicker and slightly serrated. Measurements of dorsal and sublateral setae are as follows: mean (min-max) (mean of setae of the holotype are given in square brackets after the measurements of other specimens): *j1* 21 (19–24) [21], *j3* 35 (31–38) [34], *j4* 20 (19–23) [19], *j5* 17 (15–18) [16], *j6* 21 (19–23) [19], *J2* 25 (22–27) [26], *J5* 11 (9–14) [10], *z2* 27 (25–30) [27], *z4* 34 (31–37) [32], *z5* 18 (17– 20) [18], *s4* 49 (44–54) [52], *Z1* 28 (24–31) [29], *Z4* 48 (43–52) [52], *Z5* 61 (52–65) [64], *S2* 44 (41–47) [45], *S4* 30 (25–32) [31], *S5* 31 (24–35) [34], *r3* 31 (27–35) [31], *R1* 25 (21–27) [25]. Length of dorsal shield (*j1*-end of shield) 325 (303–345) [319], width at level of setae *s4* 171 (162–184) [171], width at level of setae *S2* 191(172–199) [185] and width at level of setae *S4* 183 (170–200) [176].

Peritreme (Figure 1A) — Apex of peritreme reaches the bases of setae *j1*; 195 (183–202) [193] long. Solenostome *gd3* sometimes visible on peritrematal shield at level of setae *z4*. Solenostome *gdp* crescentic, posterior to the opening of the stigma (Figure 1A).

Ventral idiosoma (Figure 1B) — Sternal shield almost smooth; a slight reticulation is visible in some specimens. Posterior margin straight, anterior arms visible. Setae *ST1*, *ST2* and *ST3* inserted on the shield. Setae *ST4* tylochorous. Poroids *iv1* and *iv2* hoplochorus; poroids *iv3* tylochorous (Figure 1B). Length of sternal shield (*ST1-ST3*) 60 (55–64) [61], width (*ST1–ST1*) 53 (49–56) [52], width (*ST3–ST3*) 68 (65–71) [70]. Epigynial shield with longitudinal striae, flask shaped with a straight posterior margin. Genital sigilla (1–3 pairs) well visible on majority

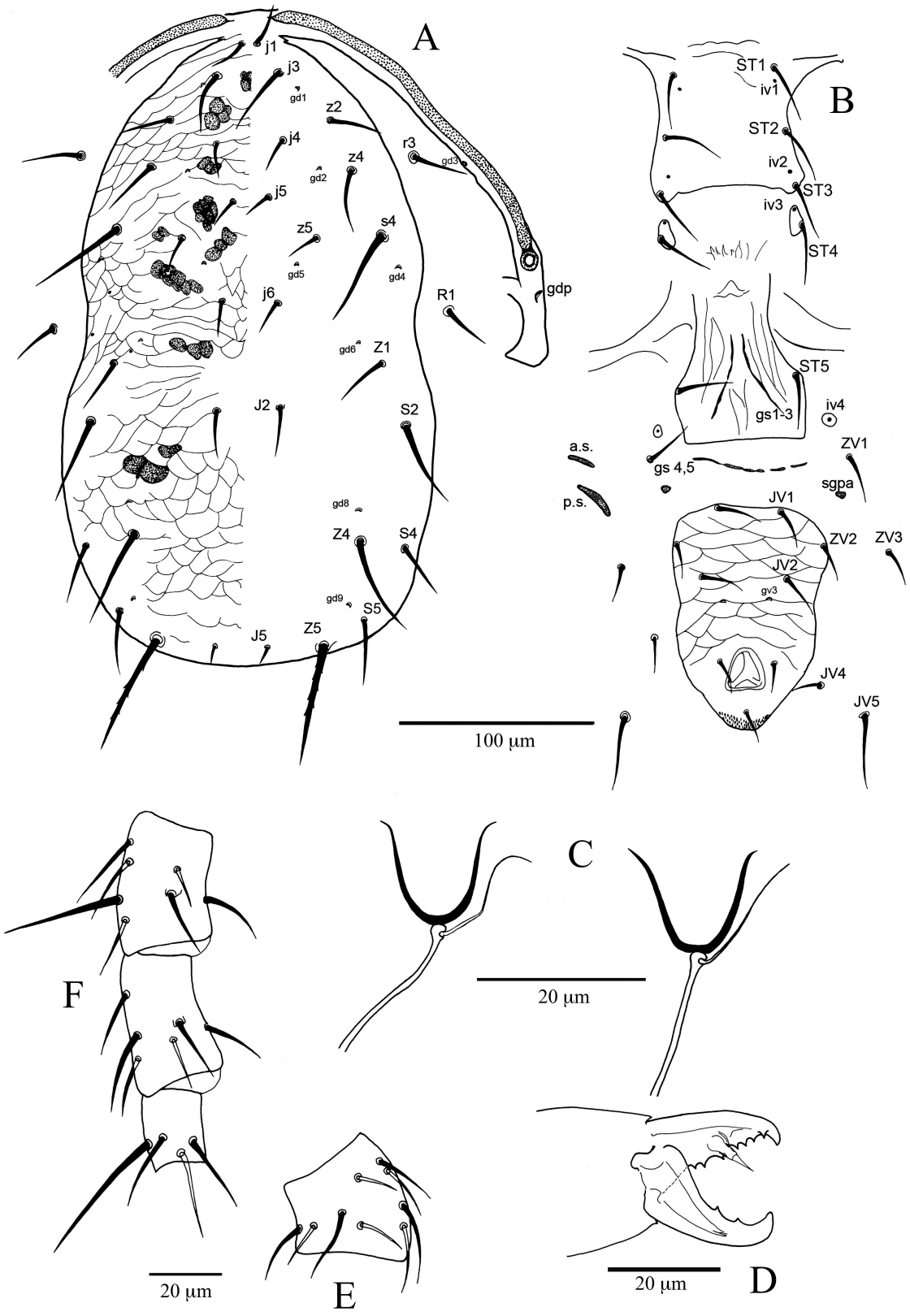

Figure 1 *Neoseiulus mediterraneus* sp. nov. Female: A – Dorsal shield; B – Ventral view; C – Insemination apparatus. D – Chelicera; E – Genu II; F – Genu, tibia and basitarsus of leg IV. *a.s.* Anterior inguinal sigillum; *p.s.* – Posterior inguinal sigillum; *gs* – Genital sigilla; *sgpa* – Sigilla of 69th pair.

of specimens. Poroids *iv4* on the interscutal membrane posteroantiaxial to *st5*. Genital sigilla of 4th and 5th pair well visible between bases of setae *ZV1*. Sigilla of 6th pair (*sgpa*) on the interscutal membrane, posteroparaxial to setae *ZV1*. Ventrianal shield (VAS) subpentagonal, waisted at level of the solenostomes *gv3*, and allover reticulated; three pairs of setae (*JV1*, *ZV2* and *JV2*), besides circumanal setae, are present on VAS. Solenostomes *gv3* well visible posteroparaxially to setae *JV2*. Distance between solenostomes *gv3* 25 (18–30) [24]. Ratio of distances *JV2-JV2*/*gv3-gv3* 1.9 (1.7-2-2) [1.9]. (Length of VAS 113 (100–120) [113], widths: at level of *ZV2* 85 (76–89) [79], at level of *JV2* 80 (68–86) [75], at level of *gv3* 76 (67–82) [69], at level of paranal setae [70 (65–73) [65]. Ratio length/width VAS at level of *ZV2* 1.3 (1.2–1.4) [1.4], at level of *JV2* 1.4 (1.2–1.5) [1.5]. Four pairs of setae *JV4*, *JV5*, *ZV1* and *ZV3* on interscutal membrane. Setae *JV5* smooth and the longest of the setae surrounding the VAS, 38 (35–42) [38]. Anterior inguinal sigilla (metapodal platelets), 15 (13–19) [15] long; posterior inguinal sigilla 23 (20–26) [23] long and 6 (4–6) [5] width (Figure 1B).

Insemination apparatus (Figure 1C) — Major duct cylindrical, narrow and slightly sclerotised. About 1.5 times the length of the calyx. Receptaculum slightly enlarged, not always visible. Atrium nodular, free and separate from the calyx. Embolus well visible; minor duct thin, clearly visible. Calyx broadbell shaped (cup-shaped), thick walled all over, without basal neck or stalk 14 (12–15) [13] long and 12 (9–15) [14] wide. The membranous vesicle is well visible.

Chelicerae (Figure 1D) — Fixed cheliceral digit, 25 (23–26) [24] long, commonly with seven teeth plus the apical tooth (80% of specimens); few specimens with six teeth and only one with eight teeth. *Pilus dentilis* evident. Movable digit with two teeth plus the apical one, 29 (26–31) [28] long.

Legs (Figure 1E, F) — Ten setae are presente on genu of leg I (2 2/1 2/1 2). Nine setae are present on genu of leg II (2 2/1 2/1 1). Seven setae are presente on genua of leg III (1 2/1 2/0 1) and IV (1 2/1 2/0 1). Three smooth and pointed macrosetae are present on leg IV: *Sge IV* 32 (26–38) [34], *Sti IV* 24 (20-27) [23] and *St IV* 40 (36-42) [40].

Distribution and location of types

Holotype female and one paratype female (No. 8656A) collected on *Cirsium* spp. (Asteraceae) at Dadia National Park (41°6′0.49″ N, 26°13′19.29″ E, m 124 a.s.l.), Evros (Greece) 16 Aug. 2016; one paratype female collected on the same data as the holotype. Ten paratype females collected on *Cirsium* spp. (Asteraceae) at Ficuzza (37°53′03.0″ N, 13°23′23.7″ E, m 708 a.s.l.), Palermo (Italy) 1 Nov. 1980. Two paratype females (No. S 544 A) collected on lichens at Ficuzza (37°53′00.4″ N, 13°23′05.1″ E, m 675 a.s.l.) Palermo (Italy) 24 Oct. 1980. One paratype female collected on *Clinopodium nepeta* (L.) Kuntze (Lamiaceae), at Vena di Maida (38°53′39.97″ N, 16°24′26.82″ E, m 157 a.s.l.), Catanzaro (Italy) 15 Sept. 1989. Type materials deposited in the Acari collection of the Laboratory of Applied Acarology "Eliahu Swirski", Department of Agricultural, Food and Forest Sciences, University of Palermo (Italy).

Etymology

The name "*mediterraneus*" refers to the Mediterranean countries where the type materials were found.

Remarks

Various slides with specimens of the new species were kept in the above mentioned Acari collection and labelled as *Amblyseius* sp. near *umbraticus*. Putting in order the collection and after the discovery of some specimens from Greece, we decided to describe the new species, considering the characters that differentiate it from the other nearer species.

Neoseiulus mediterraneus belongs to the *cucumeris* species group as defined by Chant and McMurtry (2003). Although it has been demonstrated that the above mentioned group is polyphyletic (Tsolakis *et al.* 2012), we adopted this taxonomy because no reorganization

of this group has been proposed yet. Among the species included in the *cucumeris* species group, the new species resembles two other palearctic species, *Neoseiulus umbraticus* and *N. pseudoumbraticus*. Chant and Yoshida-Shaul (1982) described the latter species from specimens collected in Algeria, distinguishing it from *N. umbraticus* for some discrete characters: a different chaetotactic formula of genu II, presence/absence of pilus dentilis, different lengths of peritreme and number of macrosetae on leg IV (see Table 1). *Neoseiulus mediterraneus* shows the ancestral chaetotactic formula of genu II (2-2/1-2/1-1) among the above mentioned species, as well as for the whole *cucumeris* species group. Other ancestral characters are the distance between solenostomes *gv3*, greater in *N. mediterraneus*, the length of peritreme, longer in the new species, and a shorter macroseta on basitarsus IV.

Tribe Amblyseiini Muma 1961

Subtribe Proprioseiopsina Chant & McMurtry 2004

Genus *Proprioseiopsis* Muma 1961

Proprioseiopsis dacus (Wainstein 1973)

Amblyseius (*Amblyseius*) *dacus* Wainstein (1973) (original designation)
Amblyseius dacus Gilyarov *et al.* (1977)
Proprioseiopsis (*Amblyseiulus*) *dacus* Karg (1989)

Specimens examined — Two females at Ficuzza (Palermo), (37°53′06.9″ N, 13°23′33.2″ E, m 732 a.s.l.), on *Rubus* spp. (Rosaceae) 24 Oct. 1980.

Remarks — The species has been reported up to now only for Moldova (Wainstein 1973) and Iran (Faraji *et al.* 2007). The latter authors redescribed the species from one female collected on *Citrus* leaves. They reported some discordances with the original description regardings the lengths of various dorsal setae and the presence of a tooth on the movable digit that Wainstein (1973) considered edentate. In both our specimens a tooth is present on the movable digit, but in one of them it is vestigial. Wainstein described the species from only one specimen and probably he did not notice it or it was actually absent in the holotype. In the original description more than three teeth were reported on fixed digit, while Faraji *et al.* (2007) reported three teeth. On both our specimens we found four teeth (three between *pilus* dentilis and apical tooth and one beyond *pilus dentilis*). Waintein (1973) reported "seven pairs of small and large pores" on dorsal shield, while (Faraji *et al.* 2007) reported ten small visible pores. Evidently, the latter authors did not distinguish between solenostomes and poroids. In our specimens we verified the presence of seven small, but crataeriform solenostomes (*gd1*, *gd2*, *gd4*, *gd5*, *gd6*, *gd8*, *gd9*). Our measurements fit well with Waintein's original description, except for the setae *j1* and *z2*, but also with Faraji's and co-authors' redescription (see Table 2). *Proprioseiopsis dacus* is reported in Italy for the first time.

Table 1 Distinguishing characters between the three considered species.

Character	*N. mediterraneus*	*N. pseudoumbraticus*	*N. umbraticus*
No of setae on genu II	9	8	8
Formula of setae on genu II	2-2/1-2/1-1	2-2/1-2/0-1	2 -2/0-2/1-1
Apex of peritreme	j1	j1-j3	j3
Teeth on fixed digit	7(6-8)	8	7
Presence of *pilus dentilis*	Yes	No	Yes
Reticulation of dorsal shield	Light	Strong	Light
Macrosetae	3	2	3

Subfamily Typhlodrominae Wainstein 1962

Tribe Typhlodromini Wainstein 1962

Genus *Typhloseiulus* Chant & McMurtry 1994

Typhloseiulus subsimplex (Arutunjan, 1972)

Seiulus subsimplex Arutunjan (1972) (original designation)
Seiulus (*Seiulus*) *subsimplex* Beglyarov (1981)
Typhlodromus subsimplex Chant & Yoshida-Shaul (1983)

Specimens examined — One female at Palazzo Adriano (Palermo), (37°40′23.03″ N, 13°22′0.50″ E, m 671 a.s.l.), on *Quercus* gr. *pubescens* Willd. (Fagaceae) 29 Sept. 2007.

Remarks — The species have been reported up to now only for Armenia. This is the first record from Italy.

Genus *Neoseiulella* Muma 1961

Neoseiulella carmeli (Rivnay & Swirski 1980)

Typhloctonus carmeli Rivnay & Swirski (1980) (original designation)
Typhlodromus carmeli Chant & Yoshida-Shaul (1989)
Neoseiulella (*Typhloctona*) *carmeli* Denmark & Rather (1996)

Specimens examined — 36 ♀♀, 7 ♂♂ and 1 immature in total. All specimens were collected in the island of Pantelleria at the following places: Aeroporto (36°49′11.31″ N, 11°58′21.80″ E, m 158 a.s.l.), 4♀♀ and 1♂ on *Vitis vinifera* L. (Vitaceae) 29 May 1994;

Table 2 Diagnostic characters and measurements of adult females of *Proprioseiopsis dacus* collected in Sicily, compared with the original description of the species and a specimen collected in Iran.

Characters	Sicily *	Wainstein 1972 O.D.	Faraji *et al*. (2007)
j1	25	16	25
j3	46	47	53
j4	6	5	5
j5	4	5	5
j6	10	11	9
J5	10	-	9
z2	41	23	35
z4	55	56	59
z5	5	5	5
s4	66	74	77
Z1	16	18	21
S2	32	31	45
S4	14	10	18
S5	14	15	18
Z4	64	65	71
Z5	64	58	72
r3	26	25	29
R1	29	20	21
JV5	43	-	51
Dm	1	no	1
Df	4 plus apical	more than 3	3 plus apical
Dm length	30	-	30
Sge IV	49	55	55
Sti IV	37	47	45
St IV	72	85	82

Characters	Sicily *	Wainstein 1972 O.D.	Faraji *et al*. (2007)
N. setae Genu I	10	-	10
N. setae Genu II	8	07-août	8
N. setae Genu III	7	-	7
N. setae Genu IV	7	-	7
Apex of peritreme	j1	j1	j1
Peritreme length	215	-	-
Solenostomes (gd)	1,2,4,5,6,8,9	n. 7	?
Dorsal shield (Ds) length	386	365	436
Ds W. (*j6*)	263	255	266
VAS n. of setae	3	3	3
VAS length	136	-	148
VAS width (*ZV2*)	139	-	135
gv3	yes	yes	yes
gv3-gv3	51	-	-
JV2-JV2	79	-	-
Anterior inguinal sigillum length	16	-	17
Posterior inguinal Sigillum length	34	-	32
Calyx Length	18	-	21 with atrium
Calyx Width (distal)	17	-	-
Atrium	6	-	-
Major duct	61	-	-

* Measurements referred to the mean of two specimens

Contrada (C.da) Bue Marino (36°49′28.14″ N, 11°58′43.75″ E, m 77 a.s.l.), 1♀ on *Capparis spinosa* L. (Capparaceae) 28 May 1994; C.da Campobello (36°49′17.36″ N, 11°59′2.72″ E, m 51 a.s.l.), 1♀ on *Mioporum* spp. (Scrophulariaceae) 29 May 1994; C.da Cannachi (36°48′0.44″ N, 11°57′58.34″ E, m 230 a.s.l.), 1♀ on *Parietaria* spp. (Urticaceae) 28 May 1994; C.da Khufura (36°47′56.14″ N, 11°58′17.79″ E, m 241 a.s.l.), 2♀♀ on *Malus domestica* Borkh. (Rosaceae) 28 May 1994; C.da Scirafi (36°47′40.40″ N, 11°57′6.86″ E, m 149 a.s.l.), 20♀♀, 2♂♂ and 1 immature on *Tamarix* spp. (Tamaricaceae) 04 Oct. 1994; C.da Suachi (36°47′52.54″ N, 11°56′7.24″ E, m 13 a.s.l.), 1♀ on *Lycopersicon esculentum* Mill. (Solanaceae) 04 Oct. 1994; C.da Tracino (36°46′38.79″ N, 11°59′52.82″ E, m 738 a.s.l.) 1♀ on *Quercus ilex* L. (Fagaceae) 05 Oct. 1994; Calami (36°47′11.69″ N, 11°57′1.82″ E, m 63 a.s.l.), 1♀ on *Vitis vinifera* L. (Vitaceae) 04 Oct. 1994; Cuddia Attalora (36°47′14.44″ N, 11°59′44.78″ E, m 574 a.s.l.), 2♀♀ on *Mentha* spp. (Lamiaceae) 05 Oct. 1994; Cuddia Attalora (36°47′12.98″ N, 12°0′8.61″ E, m 648 a.s.l.), 1♀ and 2♂♂ on *Lavandula stoechas* L. (Lamiaceae) 05 Oct. 1994; Lago di Venere (36°48′59.93″ N, 11°59′0.05″ E, m 17 a.s.l.), 1♀ on *Cynodon dactylon* (L.) Pers. (Poaceae) 29 May 1994; Lago di Venere (36°48′56.95″ N, 11°59′21.25″ E, m 5 a.s.l.), 1♂ on *Capparis spinosa* L. (Capparaceae) 29 May 1994; Pineta Montagna grande (36°47′43.75″ N, 11°59′8.92″ E, m 346 a.s.l.), 1♂ on *Pistacia lentiscus* L. (Anacardiaceae) 28 May 1994.

Remarks — *Neoseiulella carmeli* has been reported up to now only from Israel (Rivnay and Swirski 1980; Swirski and Amitai 1997). The species in the island of Pantelleria was wide spread both on cultivated and wild plants. The island is nearer to the African continent than to Sicily, where we never found this species in more than 50 years of constant surveys.

Genus *Typhlodromus* Scheuten 1857

Subgenus *Anthoseius* De Leon 1959

Typhlodromus (*Anthoseius*) *jordanis* Rivnay & Swirski 1980

Anthoseius jordanis Rivnay & Swirski (1980) (original designation)
Amblydromella jordanis Moraes *et al.* (1986)
Amblydromella (*Aphanoseia*) *jordanis* Denmark & Welbourn (2002)

Specimens examined — Two females and one immature collected in the island of Pantelleria (Trapani) (36°47′40.40″ N, 11°57′6.86″ E, m 149 a.s.l.), on *Tamarix* spp. (Tamaricaceae) 04 Oct. 1994.

Remarks — As the previous species, *Typhlodromus* (*A.*) *jordanis* has been reported up to now only from Israel (Rivnay and Swirski 1980). We found this species on *Tamarix* spp. at the island of Pantelleria, but we never found it in Sicily. No information is available on the bio-ecology of this species.

Typhlodromus (*Anthoseius*) *singularis* Chant 1957

Typhlodromus singularis Chant (1957) (original designation)
Typhlodromus (*Typhlodromus*) *singularis* Chant (1959)
Neoseiulus singularis Muma (1961)
Mumaseius singularis De Leon (1965)
Anthoseius singularis Charlet & McMurtry (1977)
Amblydromella singularis Moraes *et al.* (1986)
Amblydromella (*Lindquistoseia*) *singularis* Denmark & Welbourn (2002)
Neoseiulus polonicus (Willmann 1949) (synonymy by Athias-Henriot 1960)

Female

The redescription is based on seven females. (Figure 2 A–E)

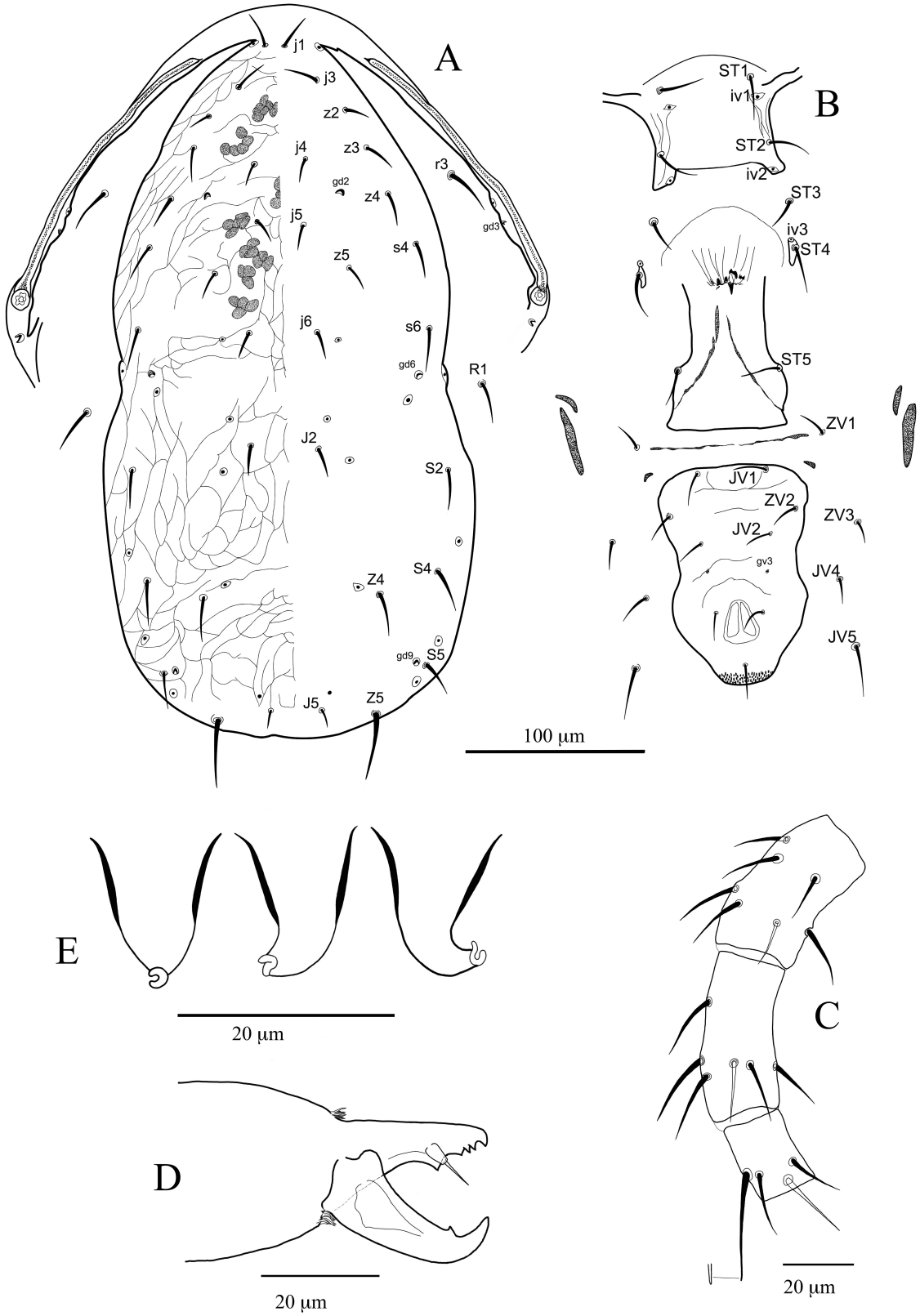

Figure 2 *Typhlodromus* (*Anthoseius*) *singularis* Chant. Female: A – Dorsal shield; B – Ventral view; C – Genu, tibia and basitarsus of leg IV; D – Chelicera; E – Insemination apparatus.

Dorsum (Figure 2A) — Dorsal shield almost ovoid, waisted at level of solenostome *gd6* and weakly ornamented almost all over. Three pairs of crescentic solenostomes are visible on the dorsal shield: *gd2* posteroantiaxial to setae *j4* and posteroparaxial to setae *z3*, *gd6* posteroparaxial to *s6* and *gd9* anteroantiaxial to *S5*. Some poroids are visible on the dorsal shield and sigilla on the podonotal region (Figure 2A). The mediolateral (*z3*, *z4*), lateral (*s4*-*S5*) and marginal (*r3*, *R1*) setae have similar lengths (Table 3). All setae are slender and smooth. Setae *Z5* are the longest one 36 (32–40). Setae *S4* anteriorly to the level of setae *Z4*. Solenostome *gd9* near to the bases of setae *S5* 8 (7–10). Measurements of dorsal and sublateral setae are as follows: *j1* 20 (20–21), *j3* 20 (18–21), *j4* 14 (12–15), *j5* 15 (14–15), *j6* 16 (15–16), *J2* 17 (16–19), *J5* 10 (9–12), *z2* 14 (13–15), *z3* 19 (18–21), *z4* 19 (18–20), *z5* 15 (13–16), *s4* 21 (21–22), *s6* 24 (21–25), *Z4* 25 (23–27), *Z5* 36 (32–40), *S2* 22 (20–24), *S4* 23 (21–26), *S5* 19 (18–21), *r3* 21 (20–22), *R1* 20 (19–21). Length of dorsal shield (*j1*-end of shield) 381 (366–389), width at level of setae *s4* 174 (168–178), width at level of setae *s6* 180 (176–183), width at level of setae *S2* 194 (188–206) and width at level of setae *S4* 197 (190–207).

Peritreme (Figure 2A) — Apex of peritreme reaches the bases of setae *j3*, in some specimens between *j3*-*j1*. Solenostome *gd3* and poroid *id3* well visible on peritrematal shield. Solenostome *gdp* crescentic, posterior to the opening of the stigma. Length of peritreme 171 (156–188).

Ventral idiosoma (Figure 2B) — Sternal shield smooth with lateral margins slightly striated. Setae *ST1* and *ST2* inserted on the shield. Setae *ST3* gymnochorous, setae *ST4* tylochorous. Poroids *iv1* and *iv2* hoplochorus; the latter on the internal part of the projection of the shield. The posterior margin of the shield almost straight; poroids *iv3* tylochorous (Figure 2B). Distances between setae *ST1–ST1* 52, *ST2–ST2* 63 and *ST1–ST2* 39. Epigynial shield smooth, with a straight posterior margin and lateral identations at the posterior end of genital sigilla (1–3rd pairs). Distance between setae *st5*, 58. Poroids *iv4* on the interscutal membrane near the basis of the shield. Genital sigilla (4th and 5th pairs) well visible. Sigilla of 6th pair (*sgpa*) on the interscutal membrane, posteroparaxial to setae *ZV1*. In one specimen the right sigillum was on the anterior margin of the ventrianal shield. Ventrianal shield (VAS) almost sub-pentagonal, elongate, waisted at level of solenostomes *gv3*, and slightly striate; three pairs of setae (*JV1*, *ZV2* and *JV2*), besides circumanal setae are present on VAS. Solenostomes *gv3* small, posteriorly or light posteroparaxial to setae *JV2*. Length of VAS 121 (114–126), widths: at level of *ZV2* 87, at level of *JV2* 75 (71–78) and at level of paranal setae 76 (75–78). Ratio length/width VAS at level of *ZV2* 1.4, at level of *JV2* 1.6. Four pairs of setae, *JV4*, *JV5*, *ZV1* and *ZV3* on interscutal membrane. Setae *JV5* smooth, 27 long. Anterior inguinal sigilla (metapodal platelets), 16 (15–18) long; posterior inguinal sigilla 37 (34–41) long and 5 (4–5) wide (Figure 2B).

Insemination apparatus (Figure 2E) — Major duct short (4 long) and membranous. Receptaculum not visible. Atrium differentiated, slightly larger in comparison to the major duct (Ø 2), inserted at the basis of the calyx. A prominent ring enfolds the embolus; minor duct rarely visible. Calyx campanulate, membranous at the basis for about 1/3 of its length, thick walled afterwards, 13 long, 11 wide at the distal part and 9 at the mean distance. The membranous vesicle is commonly visible.

Chelicerae (Figure 2D) — Fixed cheliceral digit 25 (24–25) long, with four teeth plus the apical one; three anteriorly and one posteriorly to *pilus dentilis*. Movable digit with one tooth plus the apical one, 27 long.

Legs (Figure 2C) — Ten setae are present on genu of leg I. Seven setae are present on genua of the remaining legs. A smooth, short and blunted macroseta is present on basitarsus of leg IV, *St IV* 29 (28–31). Lengths of genu IV 48 (46–50), tibia IV 48 (44–51) and basitarsus 25 (23–26).

Specimens examined

Cogne (Valle D'Aosta), (45°36′24.94″ N, 7°20′51.67″ E, m 1549 a.s.l.), 1♀ and 1♂ on *Larix decidua* Mill. (Pinaceae) 06 Aug. 1997; La Visaille (Valle D'Aosta), (45°47′31.29″ N,

6°55′9.67″ E, m 1696 a.s.l.), 2♀♀ on *Larix decidua* Mill. (Pinaceae), and 1♀ on *Salix caprea* L. (Salicaceae) 11 Aug. 1997; Pont Serrand (Valle D'Aosta), (45°42′40.43″ N, 6°55′29.60″ E, m 1684 a.s.l.), 1♀ and 1♂ on *Larix decidua* Mill. (Pinaceae) 14 Aug. 1997; Degioz (Valle D'Aosta), (45°35′28.09″ N, 7°12′21.01″ E, m 1570 a.s.l.), 2♀♀ on *Sorbus aucuparia* L. (Rosaceae), 09 Aug. 1997.

Table 3 Diagnostic characters and measurements of adult females of *Typhlodromus* (*Anthoseius*) *singularis* collected in Italy (1), compared with the original (2), and other descriptions of the species. 1- mean of our specimens; 2- Chant (1957); 3- Chant *et al.* (1974); 4- Schuster and Pritchard (1963); 5- Congdon (2002).

Characters	1	2	3	4	5
j1	20	-	-	25	18
j3	20	-	14	27	20
j4	14	-	-	21	14
j5	15	-	-	21	13
j6	16	-	-	-	15
J2	17	-	-	-	18
J5	10	-	-	12	10
z2	14	-	14	25	14
z3	19	-	15	30	18
z4	19	-	14	30	19
z5	15	-	-	21	13
s4	21	-	14	34	24
s6	23	-	15	38	-
S2	22	-	21	36	25
S4	23	-	25	38	25
S5	19	-	18	32	18
Z4	25	-	20	32	22
Z5	36	-	41	48	37
r3	21	-	-	34	24
R1	20	-	-	34	21
Dm	1	1	1	-	1
Df	4	3	2	-	4
Dm length	27	-	-	-	25
Df length	25	-	-	-	26
St IV	29	-	short macroseta	34	32
Apex of peritreme	j3	-	z4 - z3 - j3	z4	z3
Dorsal shield (Ds) length	381	329	334	-	362
Ds width (*s4*)	174	-	-	-	168
Ds width (*s6*)	180	159	159	-	-
VAS n. of setae	3	3	3	3	3
VAS length	121	109	114	120	115
VAS width (ZV2)	87	-	-	-	82
VAS width (JV2)	75	74	56	80	-
Anterior inguinal sigillum length	16	-	-	12	-
Posterior inguinal Sigillum length	37	-	-	37	-
Posterior inguinal sigillum width	5	-	-	5	-

Remarks

In the original description (Chant 1957) the author reported only measurements of dorsal and ventral shields, presence of a tooth on the movable digit and of three teeth on the fixed one and no macrosetae on leg IV. Afterwards, Schuster and Pritchard (1963) redescribed the species from a single specimen from California, reporting some measurements and a clear drawing of the insemination apparatus. The above authors noted longer anterolateral setae in their specimen, a 34 long macroseta on basitarsus IV and a short and thick peritreme (reaching the level of setae *z4*). About a decade after, Chant *et al.* (1974) redescribed the species, adding measurements of some dorsal setae and giving information of some other discrete characters: chaeotaxic formulae of genua II and III, presence of a short macroseta on basitarsus IV, of three pairs of solenostome on dorsal shield (from the description we individuated them as *gd2*, *gd6* and *gd9*), giving a schematic drawing of the insemination apparatus and reporting the presence of solenostome *gv3* (Table 3). The above authors reported also a significant variation on peritreme's length and lengths of macrosetae on basitarsus IV, among specimens collected in various Canadian regions. They noted that in specimens with a short peritreme (apex reached at level of setae *z4*), an indistinguishable macroseta on basitarsus IV is present, while in specimens with a longer peritreme (apex at level of setae *j3*) there was a conspicuous macroseta on basitarsus IV, but they did not report any measurements of it. Chant *et al.* (1974) also noted that this species was collected also in the United States, but no remarks on Schuster and Pritchard redescription are mentioned. Congdon (2002) measured a specimen found on *Tsuga heterophylla* (Raf.) Sarg. (Pinaceae) in western Washington, reporting that this specimen matches the redescription given by Chant *et al.* (1974) in most characters, but it is intermediate between the specimen described by Schuster and Pritchard (1963) and Chant *et al.* (1974) as far as lengths of various dorsal setae are concerned (Table 3). Similarly, our specimens are intermediate between specimens reported in the latter two references and well match the specimen measured by Congdon (2002), except for the peritreme's length (Table 3). The species was, up to now, reported only from the Nearctic region (Canada and USA). This is the first record from the Palearctic region. For its distribution see Demite *et al.* (2020).

Subgenus *Typhlodromus* Scheuten 1857

Typhlodromus (*Typhlodromus*) *knisleyi* Denmark 1992

Typhlodromus knisleyi Denmark (1992) (original designation)

Female

The redescription is based on the holotype with additions based on four specimens.

(Figure 3 A–E)

Dorsum (Figure 3A) — Dorsal shield almost oblong, rounded at the anterior and posterior levels, slightly waisted at level of setae *R1* and weakly ornamented almost all over. Four pairs of crescentic solenostomes are visible on the dorsal shield: *gd2* posteroantiaxial to setae *j4* and posteroparaxial to setae *z3*, *gd6* posteroparaxial to *s6*, *gd8* anteroantiaxial or anterior to *Z4* and *gd9* anteroantiaxial to *Z5*. No poroids are visible on the dorsal shield and only sigilla *saXIII* and *saXIV* are visible on the shield (Figure 12). The dorsal setae *j1* and *j3* of the same length (23); the remaining dorsocentral setae, except *J5*, almost of the same length (14–17) (Table 3). Similar lengths have the series *z* setae (15–19), while the anterolateral series *s4* and *s6* are quite longer (22 and 25 respectively). The longest setae on the dorsal shield are *Z5* (57). Setae *r3* and *R1* on the interscutal membrane, of equal length (21). All setae are slender and smooth. Measurements of dorsal and sublateral setae of Sicilian specimen are as follows (in parentheses our measurements of the holotype and in brackets measurements reported in the original description): *j1* 21 (23) [24], *j3* 29 (23) [27], *j4* 16 (14) [16], *j5* 17 (14) [14], *j6* 19 (15) [17], *J2* 20 (17) [17], *J5* 6 (6) [5], *z2* 15 (17) [17], *z3* 23 (19) [19], *z4* 23 (18) [20], *z5* 16 (15) [16], *s4* 27 (23) [24], *s6* 29 (22) [24], *Z4* 33 (28) [28], *Z5* 59 (57) [58], *S2* 30 (25) [25], *S4* 35

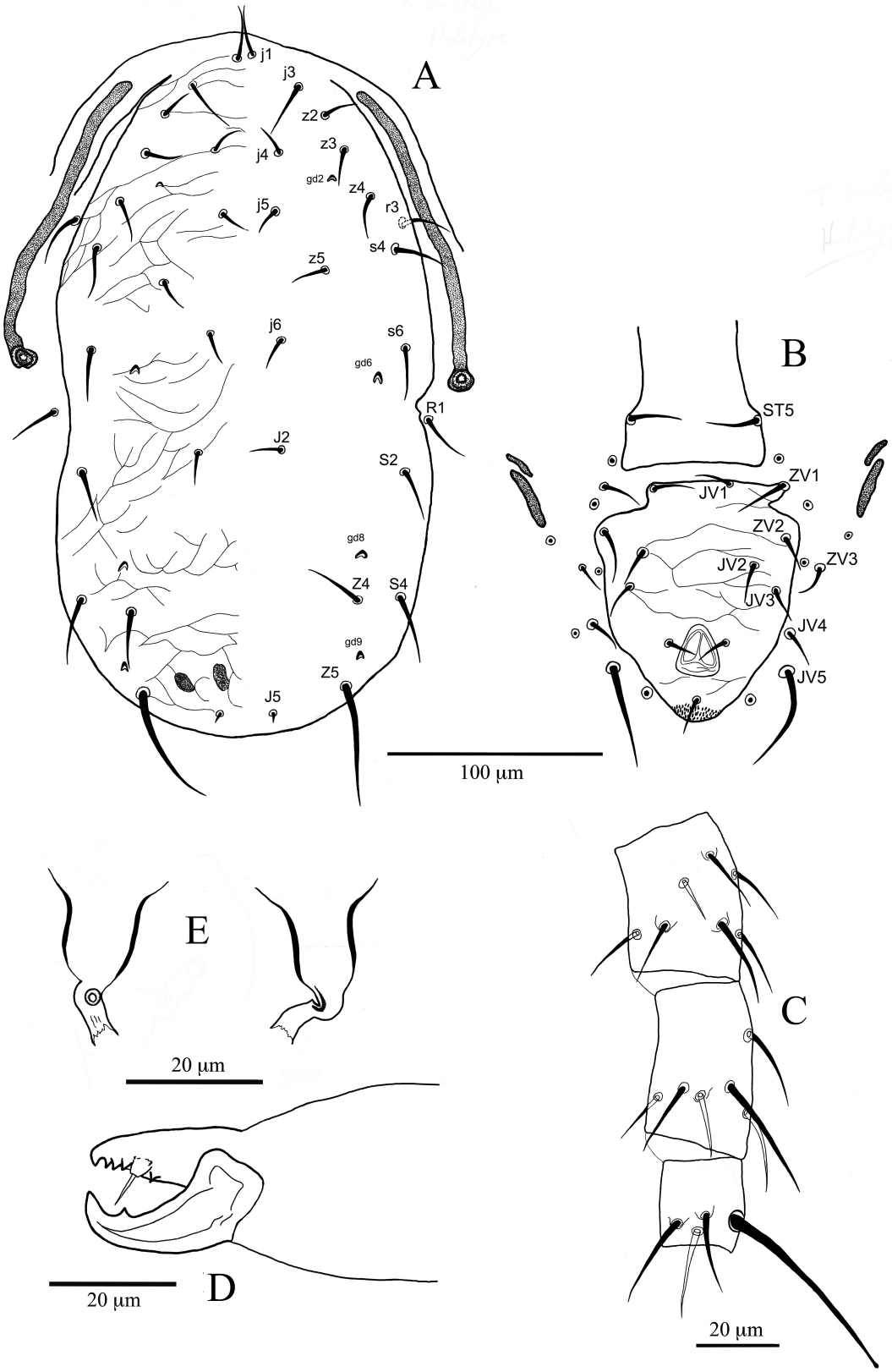

Figure 3 *Typhlodromus* (*Typhlodromus*) *knisleyi* Denmark. Female: A – Dorsal shield; B – Ventral view; C – Genu, tibia and basitarsus of leg IV; D – Chelicera; E – Insemination apparatus.

(32) [32], *r3* 24 (21) [21], *R1* 21 (21) [22]. Length of dorsal shield (*j1*-end of shield) 312 (318), width at level of setae *s4* 162 (171), width at level of setae *s6* 170 (164), width at level of setae *S2* 172 (164) and width at level of setae *S4* 159 (159).

Peritreme (Figure 3A) — Apex of peritreme reaches anteriorly setae *z2* (between setae *j3* and *z2*). Solenostome *gd3* not visible on peritrematal shield. Solenostome *gdp* crescentic, posterior to the opening of the stigma. Peritreme 139 (140) long.

Ventral idiosoma (Figure 3B) — Sternal shield smooth with margins not well visible. Setae *ST1* and *ST2* inserted on the shield. Setae *ST3* and *ST4* tylochorous. Poroids *iv1* and probably *iv2* hoplochorus, the posterior margin of the shield is not well visible, but in our specimen *iv2* is hoplochorus; poroids *iv3* tylochorous. Length of sternal shield is not reported because of the bad position in the holotype. In our specimen distances between setae *ST1–ST1*, *ST2–ST2* and *ST1–ST2* are respectively 48, 57 and 30. Epigynial shield smooth, with a straight posterior margin. Genital sigilla not visible. Length between setae *ST5*, 55. Poroids *iv4* on the interscutal membrane near the basis of the shield. Genital sigilla of 4th and 5th pair not visible in the holotype. Sigilla of 6th pair (*sgpa*) on the interscutal membrane, posteroparaxial to setae *ZV1*. The right *ZV1* on a protrusion of the ventrianal shield. Ventrianal shield (VAS) almost triangular or sub-pentagonal, slightly waisted at level of setae *JV2*, and slightly reticulated; four pairs of setae (*JV1*-*JV3* and *ZV2*), besides circumanal setae are present on VAS. Absence of the solenostomes *gv3*. The VAS of the holotype shows a lack of sclerotisation anteriorly to setae *ZV2* in the left part of the scutum and a protrusion in the right part which included the seta *ZV1*. Length of VAS 106 (113), widths: at level of *ZV2* 97 (95), at level of *JV2* 89 (91), at level of *JV3* 83 (87), at level of paranal setae 70 (74). Ratio length/width VAS at level of *ZV2* 1.2, at level of *JV2* 1.2. Four pairs of setae, *JV4*, *JV5*, *ZV1* and *ZV3* on interscutal membrane. Setae *JV5* smooth and the longest of the setae present on the ventral part, 48 (48). Anterior inguinal sigilla (metapodal platelets), 11 (15) long; posterior inguinal sigilla 26 (28) long and 5 (5) width (Figure 13).

Insemination apparatus (Figure 3E) — Major duct short and slightly sclerotised, 6 long and 3 wide. Receptaculum of the same width of the major duct. Atrium differentiated, slightly larger in comparison to the major duct (Ø 4); a light incidence distinguishes it from the calyx. A prominent ring enfolds the embolus; minor duct thin, poorly visible. Calyx campanulate, membranous at the base, thick walled afterwards, 16 long, 15 wide at the distal part and 11 at the mean distance. The membranous vesicle is always visible.

Chelicerae (Figure 3D) — Fixed cheliceral digit 25 long, with four teeth plus the apical tooth; three anteriorly and one posteriorly to *pilus dentilis*. Movable digit with one tooth plus the apical one, 29 long.

Legs (Figure 3C) — Ten setae are present on genu of leg I. Seven setae are present on genua of the remaining legs. Three smooth and pointed macrosetae are present on leg IV; on *Sge* and *Sti* macrosetae are pointed, on basitarsus slightly knobbed: *Sge IV* 24 (22), *Sti IV* 27 (33) and *St IV* 49 (51).

Specimens examined

One female at Piano Zucchi (Palermo), (37°53′54.1″ N, 13°59′38.4″ E, m 1066 a.s.l.), on *Quercus* spp. (Fagaceae) 28 Oct. 1975; Holotype, St. Forest, N.J. 21 Aug. 1972, C.B. Knisley on *Tsuga canadensis* (L.) Carrière (Pinaceae).

Remarks

Typhlodromus (*Typhlodromus*) *knisleyi* was kept for a long time in the Acari collection of our laboratory and labelled as *Typhlodromus* sp. After its description from material collected at New Jersey (USA), only one specimen of *T. knisley* was reported from the Fraktò virgin forest (Greece) (Tsolakis and Ragusa 2009). This is the first record from Italy. It is certainly, a rare species mainly associated with forest plants. We have had the type material of *T.* (*T.*) *knisleyi* in loan by Harold Denmark and here we redescribe the species adding some characters not

reported in the original description. Our measurements of the holotype are almost the same as those reported in the original description except for the setae *j3* (27 in the original description and 23 measured by us) and the number of teeth on the fixid digit (two reported in the original description, but four, plus the apical one, in the present work: three anteriorly to *pilus dentilis* and one posteriorly).

Typhlodromus (*Typhlodromus*) *kykladiticus* Papadoulis & Emmanouel 1993

Typhlodromus kykladiticus Papadoulis & Emmanouel (1993) (original designation)

Specimens examined — 35 ♀♀ in total. Mussomeli (Caltanissetta) (37°34′59.19″ N, 13°43′32.32″ E, m 803 a.s.l.), 1♀ on *Sideritis italica* (Mill.) Greuter & Burdet (Lamiaceae) 02 Jul. 1980; Palazzo Adriano (Palermo), (37°40′18.50″ N, 13°22′23.91″ E, m 707 a.s.l.), 6♀♀ on *Artemisia arborescens* L. (Asteraceae) 16 Jul. 2007; S. Stefano di Camastra (Messina), (38°0′42.48″ N, 14°20′27.53″ E, m 22 a.s.l.), 2♀♀ on *Vitis vinifera* L. (Vitaceae) 14 Oct. 1986; Selinunte (Trapani), (37°35′7.30″ N, 12°49′38.26″ E, m 5 a.s.l.), 1♀ on *Senecio vulgaris* L. (Asteraceae) 22 Jul. 1980; Termini Imerese (Palermo), (37°59′25.02″ N, 13°41′22.68″ E, m 31 a.s.l.), 10♀♀ on *Cycas revoluta* Thunb. (Cycadaceae) 11 Oct. 1978; Termini Imerese (Palermo), (37°59′29.41″ N, 13°40′58.95″ E, m 5 a.s.l.), 15♀♀ on *Citrus limon* (L.) Osbeck (Rutaceae) 02 May 1979.

Remarks — As above, also this species was collected in Sicily about a decade before its first description and kept in the Acari colection of our laboratory, labelled as *Typhlodromus* sp. The species has been reported up to now only from Greece.

Typhlodromus (*Typhlodromus*) *pentelicus* Papadoulis & Emmanouel 1990

Typhlodromus pentelicus Papadoulis & Emmanouel (1990) (original designation)

Specimens examined — Eight females and two males at Palazzo Adriano (Palermo), (37°40′49.81″ N, 13°21′32.91″ E, m 652 a.s.l.), on *Cupressus sempervirens* L. (Cupressaceae) 10 Jul. 2007.

Remarks — As the previous species, *Typhlodromus* (*T.*) *pentelicus* was reported up to now only for Greece.

Acknowledgements

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References

Arutunjan E.S. 1972. New species of mites of the genus *Seiulus* Berlese, 1887 (Parasitiformes: Phytoseiidae). Doklady Akademii Nauk Armyanskoi SSR, 54: 237-240. [in Russian].

Athias-Henriot C. 1960. Phytoseiidae et Aceosejidae (Acarina: Gamasina) d' Algerie. IV. Genre *Typhlodromus* Scheuten, 1857. Bulletin de la Societe d'Histoire Naturelle de l'Afrique du Nord, 51: 62-107.

Athias-Henriot C. 1975. Nouvelles notes sur les Amblyseiini II- Le relevé organotaxique de la face dorsale adulte (Gamasides Protoadeniques, Phytoseiidae). Acarologia, 17(1): 20-29.

Athias-Henriot C. 1977. Nouvelles notes sur les Amblyseiini III. Sur le genre *Cydnodromus* : Redéfinition, Composition (Parasitiformes, Phytoseiidae). Entomophaga, 22(1): 61-73. doi:10.1007/BF02372991

Beard J.J. 2001. A review of Australian *Neoseiulus* Hughes and *Typhlodromips* De Leon (Acari: Phytoseiidae: Amblyseiinae). Invertebrate Taxonomy 15: 73-158. doi:10.1071/IT99017

Beglyarov G.A. 1981. Keys to the determination of phytoseiid mites of the USSR. Information Bulletin International Organization for Biological Control of Noxious Animals and Plants, East Palaearctic Section, Leningrad, Russia, 2, 1-97. [in Russian].

Berlese A. 1887. Acari, Myriopoda et Scorpiones hucusque in Italia reperta. Tipografia del Seminario, Padova, Italy, 4(38): 6-7.

Berlese A. 1889. Acari, Myriopoda et Scorpiones hucusque in Italia reperta. Tipografia del Seminario, Padova, Italy, 6(54): 7-9.

Berlese A. 1923. Centuria sesta di Acari nuovi. Redia, 15: 237-262.
Calvo J.F., Knapp M., van Houten Y.M., Hoogerbrugge H., Belda J.E.2015. *Amblyseius swirskii*: What made this predatory mite such a successful biocontrol agent? Exp. Appl. Acarol., 65: 419-433. doi:10.1007/s10493-014-9873-0
Canestrini G., Fanzago F. 1876. Nuovi acari italiani (Seconda Serie). Atti Società Veneto-Trentina di Scienze Naturali, Italy, 5: 130-142.
Chant D.A. 1957. Note on the status of some genera in the family Phytoseiidae (Acarina). Can. Entomol., 89(11): 528-532. doi:10.4039/Ent89528-11
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, withdescriptions of thirty-eight new species. Can. Entomol., Supplement 12, 166 pp. doi:10.4039/entm9112fv
Chant D.A., McMurtry J.A. 1994. A review of the subfamilies Phytoseiinae and Typhlodrominae (Acari: Phytoseiidae). Int. J. Acarol., 20: 223-310. doi:10.1080/01647959408684022
Chant D.A., McMurtry J.A. 2003. A review of the subfamilies Amblyseiinae (Acari: Phytoseiidae): Part II. Neoseiulini new tribe. Int. J. Acarol., 29: 3-46. doi:10.1080/01647950308684319
Chant D.A., McMurtry J.A. 2004. A review of the subfamily Amblyseiinae Muma (Acari: Phytoseiidae): Part III. The tribe Amblyseiini Wainstein, subtribe Amblyseiina N. subtribe. Int. J. Acarol. 30: 171-228. doi:10.1080/01647950408684388
Chant D.A., Yoshida-Shaul E. 1982. On the identity of *Amblyseius umbraticus* (Chant) (Acarina: Phytoseiidae). Can. J. Zool., 60(8): 1998-2005. doi:10.1139/z82-257
Chant D.A., Yoshida-Shaul E. 1983. A world review of the simplex species group in the genus *Typhlodromus* Scheuten (Acarina: Phytoseiidae). Can. J. Zool., 61(5): 1142-1151. doi:10.1139/z83-151
Chant D.A., Yoshida-Shaul E. 1989. Adult dorsal setal patterns in the family Phytoseiidae (Acari: Gamasina). Int. J. Acarol., 15: 219-233. doi:10.1080/01647958908683852
Chant D.A., Yoshida-Shaul E. 1991. Adult ventral setal patterns in the family Phytoseiidae (Acari: Gamasina). Int. J. Acarol., 17: 187-199. doi:10.1080/01647959108683906
Chant D.A., Hansell R.I.C., Yoshida-Shaul E. 1974. The genus *Typhlodromus* Scheuten (Acarina: Phytoseiidae) in Canada and Alaska. Can. J. Zool., 52: 1265-1291. doi:10.1139/z74-168
Charlet L.D., McMurtry J.A. 1977. Systematics and bionomics of predaceous and phytophagous mites associated with pine foliage in California. Hilgardia, 45(7), 173-236. doi:10.3733/hilg.v45n07p173
Congdon B.D. 2002. The family Phytoseiidae (Acari) in western Washington State with descriptions of three new species. Int. J. Acarol., 28(1): 3-27. doi:10.1080/01647950208684275
De Leon D. 1959. Two new genera of phytoseiid mites with a note on *Proprioseius meridionalis* Chant (Acarina: Phytoseiidae). Entomological News, Philadelphia, 70(10): 257-262.
De Leon D. 1965. A note on *Neoseiulus* Hughes 1948 and new synonymy (Acarina: Phytoseiidae). Proceedings of the Entomological Society of Washington, 67(1), 23.
Demite P.R., Moraes G.J. de, McMurtry J.A., Denmark H.A., Castilho R.C. 2020. Phytoseiidae Database. Available from: www.lea.esalq.usp.br/phytoseiidae (accessed 2/03/2020).
Denmark H.A. 1992. A revision of the genus *Typhlodromus* Scheuten (Acari: Phytoseiidae). Occasional Papers of the Florida State Collection of Arthropods, 7: 1-43.
Denmark H.A., Rather A.Q. 1996. Revision of the genus *Neoseiulella* Muma (Acari: Phytoseiidae). Int. J. Acarol., 22(1): 43-77. doi:10.1080/01647959608684080
Denmark H.A., Welbourn W.C. 2002. Revision of the genera *Amblydromella* Muma and *Anthoseius* De Leon (Acari: Phytoseiidae). Int. J. Acarol., 28(4): 291-316. doi:10.1080/01647950208684308
Duso C., Sbrissa F. 1990. Gli Acari fitoseidi (Acari Phytoseiidae) del melo nell'Italia settentrionale: distribuzione, biologia, ecologia ed importanza economica. Boll. Zool. Agr. Bachic., Serie II, 22(1): 53-89.
Duso C., Malagnini V., Paganelli A., Aldegheri L., Bottini M., Otto S. 2004. Pollen availability and abundance of predatory phytoseiid mites on natural and secondary hedgerows. BioControl, 49: 397-415. doi:10.1023/B:BICO.0000034601.95956.89
Evans G.O., Till W.M. 1979. Mesostigmatic mites of Britain and Ireland (Chelicerata: Acari-Parasitiformes). An introduction to their external morphology and classification. Trans. Zool. Soc., 35: 139-270. doi:10.1111/j.1096-3642.1979.tb00059.x
Faraji A.R., Shiroodbakhshi M., Ostovan H., McMurtry J.A. 2007. Redescription of the female of *Paraseiulus triporus* and *Proprioseiopsis dacus* (Acari: Phytoseiidae) based on material collected from citrus in northern Iran. Syst. Appl. Acarol., 12: 199-204. doi:10.11158/saa.12.3.4
Gianguzzi L., La Mantia A. 2009. Contributo alla conoscenza della vegetazione e del paesaggio vegetale della Riserva Naturale "Monte Cofano" (Sicilia occidentale) (con allegata Carta sinfitosociologica della vegetazione, scala 1:20.000). Fitosociologia, 45(1) Suppl. 1: 1-55.
Gilyarov M.S., Bregetova N.G., Wainstein B.A., Kadite B.A., Koroleva E.V., Petrova A.D., Tikhomirov S.I., Shcherbak G.I. 1977. Manual of edaphic mites (Mesostigmata). Akademiya Nauk SSSR, Nauka Publishing House, Leningrad, Russia: 1-718 pp. [in Russian].
Hughes A.M. 1948. The mites associated with stored food products. Ministry of Agriculture and Fisheries, H.M. Stationary Office, London, 1-168 pp.
Ivancich-Gambaro P. 1975. Observations on the biology and behaviour of the predacious mite *Typhlodromus italicus* (Acarina: Phytoseiidae) in peach orchards. Entomophaga, 20: 171-177. doi:10.1007/BF02371657
Karg W. 1989. Neue Raubmilbenarten der Gattuig *Proprioseiopsis* Muma, 1961 (Acarina, Parasitiformes) mit Bestimmungsschlusseln. Zoologische Jahrbucher Systematik, 116(2), 199-216.
Knapp M., van Houten Y., van Baal E., Groot T. 2018. Use of predatory mites in commercial biocontrol: current status and future prospects. Acarologia, 58(Suppl): 72-82. doi:10.24349/acarologia/20184275

Kreiter S., Ueckermann E.A., Quilici S. 2002. Seven new phytoseiid species, with a new generic assignement and a key to the species of La Reunion Island (Acari: Mesostigmata). Acarologia, 42(4): 335-350.
Lindquist E, Evans GW. 1965. Taxonomic concepts in the Ascidae, with a modified setal nomenclature for the idiosoma of the Gamasina (Acarina: Mesostigmata). Mem. Ent. Soc. Can., 47: 1-64. doi:10.4039/entm9747fv
Lorenzon M., Pozzebon A., Duso C. 2018. Biological control of spider mites in North-Italian vineyards using pesticide resistant predatory mites. Acarologia, 58(Suppl): 98-118. doi:10.24349/acarologia/20184277
McMurtry J.A., Famah Sourassou N., Demite P.R. 2015. The Phytoseiidae (Acari: Mesostigmata) as Biological Control Agents. In: Carrillo *et al.* (Eds.), Prospects for Biological Control of Plant Feeding Mites and Other Harmful Organisms, Progress in Biological Control, 19, pp. 133- 149. doi:10.1007/978-3-319-15042-0_5
McMurtry J.A., Moraes G.J.de, Famah Sourassou N. 2013. Revision of the lifestyles of phytoseiid mites (Acari: Phytoseiidae) and implications for biological control strategies. Syst. Appl. Acarol., 18(4): 297-320. doi:10.11158/saa.18.4.1
Moraes G.J.de, McMurtry J.A., Denmark H.A. 1986. A catalog of the mite family Phytoseiidae. References to taxonomy, synonymy, distribution and habitat. EMBRAPA - DDT, Brasilia, Brazil: 1-353.
Muma M.H. 1961. Subfamilies, genera and species of Phytoseiidae (Acarina: Mesostigmata). Bull. Fl St. Mus., 5: 267-302.
Musarella C.M., Mendoza-Fernández A.J., Mota J.F., Alessandrini A., Bacchetta G., Brullo S., Caldarella O., Ciaschetti G., Conti F., Di Martino L., Falci A., Gianguzzi L., Guarino R., Manzi A., Minissale P., Montanari S., Pasta S., Peruzzi L., Podda L., Sciandrello S., Scuderi L., Troia A., Spampinato G. 2018. Checklist of the gypsophilous vascular flora in Italy. PhytoKeys, 103: 61-82. doi:10.3897/phytokeys.103.25690
Papadoulis G.Th., Emmanouel N.G. 1990. Two new species of the genus *Typhlodromus* Scheuten (Acari: Phytoseiidae) from Greece. Entomologia Hellenica, 8: 11-19. doi:10.12681/eh.13974
Papadoulis G.Th., Emmanouel N.G. 1993. New records of phytoseiid mites from Greece with descriptions of two new species of *Typhlodromus* Scheuten (Acarina: Phytoseiidae). Int. J. Acarol., 19(4): 321-328. doi:10.1080/01647959308683986
Pignatti S. 1982. Flora d'Italia, 1-3. Edagricole, Bologna.
Quilici S., Kreiter S., Ueckermann E.A., Vincenot D. 1997. Predatory mites (Acari) from various crops on Réunion Island. Int. J. Acarol., 23(4): 283-291. doi:10.1080/01647959708683578
Ragusa Di Chiara S., Tsolakis H. 1996. A survey of phytoseiid mites (Parasitiformes, Phytoseiidae) associated with various plants in Sicily (Italy). In: Mitchell R., Horn D.J., Needham G.R., Welbourn W.C. (Eds). Acarology IX, 1 Proceedings, Xvi +718 pp Ohio Biological Survey, Columbus, Ohio: 253-256.
Ragusa S. 1979. Laboratory studies on the food habits of the predaceous mite *Typhlodromus exhilaratus*. Advances in Acarology, 1: 485-490. doi:10.1016/B978-0-12-592201-2.50068-3
Ragusa S. 1981. Influence of different kinds of foood substances on the developmental time in young stage of the predacious mite *Typhlodromus exhilaratus* Ragusa (Acarina: Phytoseiidae). Redia, 64: 237-243.
Ragusa S., Paoletti M.G. 1985. Phytoseiid mites (Parasitiformes: Phytoseiidae) of corn and soybean agroecosystem in the low-layng plain of Veneto (N-E Italy.). Redia, 68: 69-89.
Ragusa S., Swirski E. 1976. Notes on predacious mites of Italy, with a description of two new species and of an unknown male (Acarina: Phytoseiidae). Redia, 59: 179-196.
Ragusa S., Swirski E. 1978. Description of three new species of *Typhlodromus* Scheuten from Italy with redescription of *Typhlodromus baccettii* Lombardini (Acari: Phytoseiidae). Int. J. Acarol., 4(3): 211-220. doi:10.1080/01647957808683118
Ragusa S., Swirski E. 1982. A new species of *Phytoseius* (Acarina: Phytoseiidee) from Italy. Redia, 65: 293-301.
Ribaga C. 1904. Gamasidi planticoli. Rivista di Patologia Vegetale, 10: 175-178.
Rivnay T., Swirski E. 1980. Four new species of phytoseiid mites (Acarina: Mesostigmata) from Israel. Phytoparasitica, 8: 173-187. doi:10.1007/BF03158314
Rowell H.J., Chant D.A., Hansell R.I.C. 1978. The determination of setal homologies and setal patterns on the dorsal shield in the family Phytoseiidae (Acarina: Mesostigmata). Can. Ent., 110: 859-876. doi:10.4039/Ent110859-8
Scheuten A. 1857. Einiges uber Milben. Archiv fur Naturgeschichte, 23: 104-112.
Schuster R.O., Pritchard A.E. 1963. Phytoseiid mites of California. Hilgardia, 34(7): 191-285. doi:10.3733/hilg.v34n07p191
Swirski E., Amitai S. 1997. Notes on phytoseiid mites (Mesostigmata: Phytoseiidae) of Mt. Carmel (Israel), with descriptions of two new species. Israel J. Entomol., 31: 1-20.
Szabó A., Pénzes B., Sipos P., Hegyi T., Hajdú Z., Markó V. 2013. Pest management systems affect composition but not abundance of phytoseiid mites (Acari: Phytoseiidae) in apple orchards. Exp. Appl. Acarol., 62:525-537. doi:10.1007/s10493-013-9752-0
Sznajder B., Sabelis M.W., Egas M. 2011. Innate responses of the predatory mite *Phytoseiulus persimilis* to a herbivore-induced plant volatile. Exp. Appl. Acarol., 54: 125-138. doi:10.1007/s10493-011-9430-z
Tsolakis H., Ragusa Di Chiara S. 1993. Effetti collaterali di alcuni fitofarmaci nei confronti di *Amblyseius andersoni* (Chant) (Parasitiformes, Phytoseiidae). Boll. Zool. agr. Bachic. Ser. II, 25(2): 205-212.
Tsolakis H., Ragusa E. 2017. Phytoseiid mites from Basilicata region (Southern Italy): species diversity and redescription of *Typhloseiulus arzakanicus* (Arutunjan) with a key of the species of *Typhloseiulus*

Chant and McMurtry 1994 (Parasitiformes: Phytoseiidae). Acarologia, 57(4): 805-821. doi: 10.24349/acarologia/20174195
Tsolakis H., Ragusa S. 1999. Overwintering of phytoseiid mites (Parasitiformes, Phytoseiidae) on hazelnut (*Corylus avellanae* L.) in Sicily (Italy). In: Bruin, van der Geest, Sabelis (Eds). Ecology and Evolution of the Acari, Kluwer Academic Publishers. pp. 625-635. doi:10.1007/978-94-017-1343-6_54
Tsolakis H., Ragusa S. 2009. Phytoseiid mites associated with forest trees in two "Natura 2000" location: S. Adriano woods (Sicily) and Fraktò virgin forest (Greece). IOBC/WPRS, work group Integrated control of plant-feeding mites, Florence 9-12 march 2009, 24 (abstract).
Tsolakis H., Ragusa S. 2015. Considerations on systematics of the Phytoseiidae (Acari: Mesostigmata), with definition of a new species group and description of a new species. Zootaxa, 3926 (2): 229-243. doi:10.11646/zootaxa.3926.2.4
Tsolakis H., Ragusa E., Ragusa Di Chiara S. 2000. Distribution of phytoseiid mites (Parasitiformes, Phytoseiidae) on hazelnut at two different altitudes in Sicily. Env. Entomol., 29(6): 1251-1257. doi:10.1603/0046-225X-29.6.1251
Tsolakis H., Tixier M.-S., Kreiter S., Ragusa S. 2012. The concept of genus within the family Phytoseiidae (Acari: Parasitiformes): historical review and phylogenetic analyses of the genus Neoseiulus Hughes. Zool. J. Linnean Soc., 165: 253-273. doi:10.1111/j.1096-3642.2011.00809.x
Tsolakis H., Sinacori M., Ragusa S. 2013. Predation of *Typhlodromus longilaterus* Athias-Henriot (Parasitiformes, Phytoseiidae) females on eggs and juveniles of the tetranychid mites *Tetranychus urticae* (Koch) and *Panonychus citri* (McGregor) (Acariformes, Tetranychidae). IOBC-WPRS Bulletin 93: 129-132.
Tsolakis H., Principato D., Jordà Palomero R., Lombardo A. 2016. Biological and life table parameters of *Typhlodromus laurentii* and *Iphiseius degenerans* (Acari, Phytoseiidae) fed on *Panonychus citri* and pollen of *Oxalis pes-caprae* under laboratory conditions. Exp. Appl. Acarol., 70(2): 205-218. doi:10.1007/s10493-016-0076-8
Wainstein BA.1962. Révision du genre *Typhlodromus* Scheuten,1857 et sistématique de la famille des phytoseiidae (Berlese, 1916) (Acarina: Parasitiformes). Acarologia, 4(1): 5-30.
Wainstein B.A. 1973. Predatory mites of the family Phytoseiidae (Parasitiformes) of the fauna of the Moldavian SSR. Fauna i Biologiya Nasekomykh Moldavii, Akademiya Nauk Moldavskoy SSR, Institut Zoologii, 12: 176-180 [in Russian].
Willmann C. 1949. Beitrage zur Kenntnis des Salzgebietes von Ciechocinek. 1. Milben aus den Salzwiesen und Salzmooren von Ciechocinek an der Weichsel. Veröffentlichungen Museum Bremen, 14A, 106-135 + 141-142.