Identification and occurrence of phytoseiid mites (Gamasina: Phytoseiidae) in Finnish apple plantations and their surroundings

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Twelve species in eight genera of the family Phytoseiidae have been found to occur on apple trees and an additional eight species on various trees or bushes in their surroundings in Finland. Identification keys, supported by figures, are presented for 23 species, including three introduced species. The keys are based on published literature and on the examination of adult females collected in 1985–1991. The aim of the keys and descriptions is to help non-taxonomist researchers with identification. Notes on the occurrence of the species on apple and other host plants in Finland are included.

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1. Introduction

Phytoseiid mites are known as effective natural enemies of spider mites (Tetranychidae) (Helle & Sabelis 1985). In Scandinavia, Hansen & Johnsen (1986), Edland (1987) and Karg & Edland (1987) have recently published records on Phytoseiidae.

In Finland phytoseiid mites were observed to be natural enemies of the European red spider mite *Panonychus ulmi* (Koch) on apple trees as early as the 1930s (Listo et al. 1939). Previous identification and reports of Phytoseiidae in Finland were made by Oudemans (1915), who described *Euseius (Seiulus) finlandicus* (Oudemans) and identified *Phytoseius macropilis (Seiulus spoofi)* (Banks) on *Salix* sp. and later *E. finlandicus* on *Prunus domestica*, and by Athias-Henriot (ref. Moraes et al. 1986), who identified *E. finlandicus* on *P. domestica*. No comprehensive data on phytoseiid mites were available subsequent to these notes until Kropczynska and Tuovinen (1987, 1988) reported on a study made in 1985.

The material presented here proves that phytoseiid mites are common on the leaves of various wild and cultivated trees and bushes (Table 1). However, although at least twenty species occur naturally outdoors in Finland, only a few of them are common and widespread on a variety of host plants. *E. finlandicus*, *P. macropilis*, and *Paraseiulus soleiger* (Ribaga) are so widely distributed and occur in such amounts that they can be expected to play important roles on apple trees (Table 2). Also the other species are considered to be important natural resources, although their relevance to the natural or biological control of pests needs further studies on different host plants.

As the value of phytoseiid mite species in integrated control is variable, correct diagnosis

of the species is essential. Quite often, the same species from different regions have been described as different species by many authors. The terminology of the morphological features differs between authors, causing confusion for non-taxonomists. The aim of this study is to provide keys for identification of the phytoseiid genera and species found in Finland, and update the data on the occurrence of phytoseiid mites in Finnish apple plantations and their surroundings.

Table 1. List of host plants of Phytoseiidae in Finland.

Host plant	Phytoseiid species
Acer platanoides	*S. aceri, P. triporus, A. bakeri, A. richteri, E. finlandicus*
Aesculus hippocastani	*P. macropilis, P. triporus, E. finlandicus*
Alnus glutinosa	*A. rhenanus*
A. incana	*E. finlandicus*
Amelanchier spicata	*E. finlandicus*
Aristolochia macrophylla	*E. finlandicus, A. reductus*
Betula lutea	*P. soleiger, E. finlandicus*
Cornus alba	*E. finlandicus*
Corylus avellana	*P. macropilis, P. soleiger, P. triporus, E. finlandicus*
Crataegus coccinea	*P. soleiger, A. rhenanus, E. finlandicus, A. subsolidus*
Fagus grandifolia	*P. macropilis, P. soleiger, E. finlandicus*
Fragaria × ananassa	*P. macropilis, P. talbii, A. rhenanus, P. okanagensis, E. finlandicus, (A. cucumeris), A. reductus, A. tenuis, A. zwoelferi*
F. vesca	*P. triporus, E. finlandicus, A. reductus*
Fraxinus excelsior	*P. soleiger, E. finlandicus*
Juglans ailanthifolia	*P. talbii, A. rhenanus, E. finlandicus*
J. cinerea	*P. soleiger, A. rhenanus, E. finlandicus*
J. mandschurica	*P. soleiger, E. finlandicus*
Lonicera xylosteum	*P. macropilis, E. finlandicus, A. reductus*
Malus domestica	*P. macropilis, P. soleiger, P. talbii, P. triporus, A. bakeri, A. rhenanus, A. richteri, A. suecicus, A. viktorovi, (P. persimilis), E. finlandicus, A. reductus, A. subsolidus*
Prunus cerasus	*P. macropilis, P. triporus, A. rhenanus, E. finlandicus*
P. padus	*P. macropilis, P. triporus, E. finlandicus, A. subsolidus*
Pterocarya rhoifolia	*P. soleiger, P. triporus, T. andrei, E. finlandicus*
Pyrus communis	*E. finlandicus*
Quercus robur	*P. soleiger, E. finlandicus*
Ribes nigrum	*P. macropilis, P. soleiger, A. bakeri, A. rhenanus, T. laurae, P. okanagensis, E. finlandicus, A. zwoelferi*
R. rubrum	*P. macropilis, P. juvenis, P. triporus, A. bakeri, A. rhenanus, T. pyri, E. finlandicus, A. reductus*
R. uva-crispa	*P. triporus, E. finlandicus*
Rubus fruticosus	*P. macropilis, E. finlandicus*
R. idaeus	*P. macropilis, P. juvenis, P. soleiger, A. rhenanus, E. finlandicus, A. reductus*
R. odoratus	*P. triporus, E. finlandicus*
Salix caprea	*P. macropilis, E. finlandicus*
Salix sp	*P. macropilis, P. soleiger, E. finlandicus*
Sorbus aucuparia	*P. macropilis, P. triporus, A. richteri, A. rhenanus, E. finlandicus*
S. thuringiaca	*P. macropilis, P. soleiger, E finlandicus*
Tilia americana	*P macropilis, E. finlandicus*
T. cordata	*P. soleiger, E. finlandicus*
T. euchlora	*P. soleiger, E. finlandicus*
Tussilago farfara	*A. reductus*
Ulmus glabra	*P. macropilis, P. soleiger, P. triporus, E. finlandicus, A. reductus*
Urtica dioica	*E. finlandicus, A. reductus*
Viburnum opulus	*P. macropilis, E. finlandicus*

2. Materials and methods

Phytoseiid mites were collected in southern Finland during 1985–1991 from sprayed and unsprayed fruit trees as well as other deciduous trees and bushes, in forest margins or nearby apple plantations. A normal leaf sample consisted of 100 leaves taken from a few plants at the same locality. The material used in this study included 270 leaf samples of 48 plant species.

The leaves were either inspected under a stereomicroscope or they were first soaked in hot (65–70°C) soapy water for one day and then sieved to extract mites. Phytoseiid mites were then stored in 70% alcohol before mounting. Mites were mounted using a medium prepared as follows: fine grinded, purified gum arabic, 50 g, and distilled water, 50 ml, are mixed carefully; the mixture is then preserved for 3–4 days in a closed bottle at +35°C, and after that chloral-hydrate, 125 g, and glycerol, 30 ml, are added and mixed in. After 10 days preservation at +35°C the mixture is usable. The specimens were macerated in 70% lactic acid and then washed in alcohol before mounting. The cover slides were sealed with nail polish.

Mites were examined using 250–500 × magnification. The lengths of the idiosoma, dorsal setae and the longest macroseta on leg IV were measured. The figures were drawn from microphotographs taken from representative specimens.

Table 2. Relative abundance (%) of phytoseiid mite species on apple leaf samples and number of samples including the species in 1985 and 1989.

	Species		Samples
	1985	1989	1985–89
Euseius finlandicus	31.5	45.4	70
Phytoseius macropilis	37.0	28.9	60
Paraseiulus soleiger	25.5	12.6	41
Amblyseius subsolidus	3.2	10.0	13
Amblyseius reductus	1.6	0.9	13
Anthoseius rhenanus	0.0	1.3	7
Paraseiulus triporus	–	0.8	8
Anthoseius suecicus	0.8	0.0	2
Anthoseius richteri	0.2	0.1	6
Anthoseius bakeri	0.2	–	1
Paraseiulus talbii	–	0.0	1
Anthoseius viktorovi	–	0.0	1
Total individuals/samples	1920	2474	105

3. Species of Phytoseiidae

Phytoseiids are free-living, terrestrial mites and they occur on foliage, bark, and humus in all parts of the world (Chant 1985).

The following description is based on Chant (1985). Phytoseiids are 300–500 µm long, their bodies are divided into two major parts, the gnathosoma, which includes the chelicerae and palps, and the idiosoma, to which the four pairs of legs are attached (Fig. 1B). The idiosoma is covered by an undivided dorsal shield, which may be smooth or sclerotized and sculptured or reticulated. The dorsal shield bears at most 20 pairs of setae, excluding the sublateral setae, which may also be situated on the dorsal shield (in *Phytoseius*) (Fig. 1A). There are 2 pairs of sublateral setae, r3 and R1 (in Finnish genera).

Ventrally, phytoseiids have three sclerotized shields: the sternal shield, genital shield and ventrianal shield (Fig. 1B). The ventrianal shield bears 1–4 pairs of setae anterior to the anus (preanal setae), a pair of para-anal setae on both sides of the anus and a single postanal seta. The shape of the ventrianal shield is variable.

The gnathosoma is used for capturing and eating prey, and in the male also for copulation. The female chelicera consists of a fixed digit and a movable digit (Fig. 2B). There are several teeth on the fixed digit and fewer on the movable digit. The male chelicera has a fleshy spermatodactyl (Fig. 2C), which transfers spermatophores from the genital opening to the female sperm induction pore. The spermatophore is then transferred via a major duct to the spermatheca and into the cervix (Fig. 2A).

Adult males are usually smaller than females. Their dorsal setae are in most cases arranged as in females, but they differ in shape of ventrianal shield and in form of chelicerae. Phytoseiid larvae have only three pairs of legs. Larvae and nymphal stages are smaller and they have fewer setae on the dorsal shield than adults.

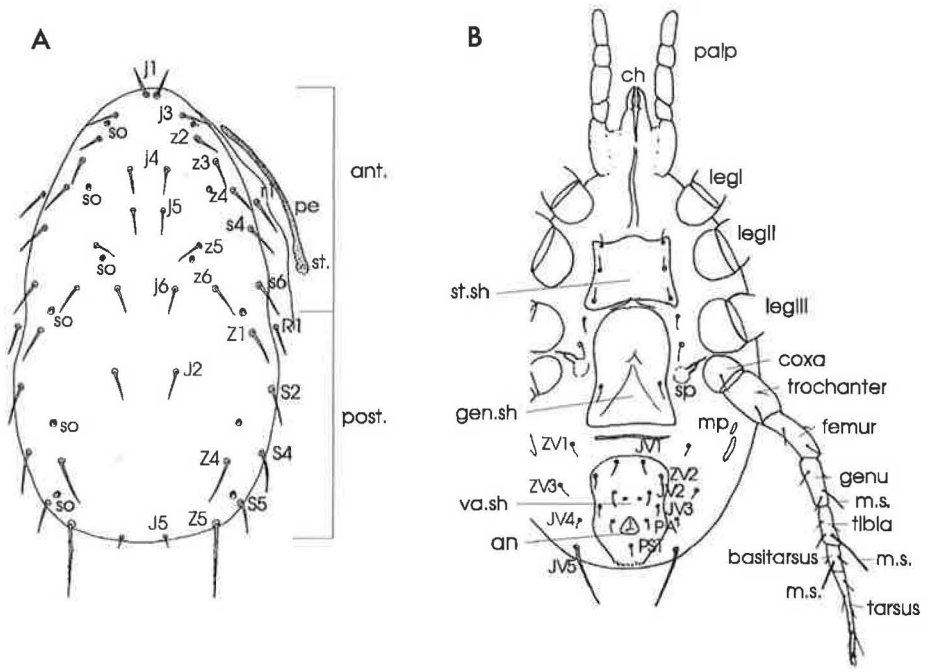

Fig. 1. Scheme of adult female phytoseiid. — A. Dorsal shield with terminology and locations of dorsal setae and main pores. ant. = anterior part of dorsal shield (proscutum); post. = posterior part of dorsal shield (postscutum); pe = peritreme; so = solenostome; st. = stigma. Setal nomenclature: jl = verticals; j3, z2, z3, z4, s4, s6 = prolateral setae; j4, j5, j6, J2 = dorsocentral setae; z5, z6 = promediolateral setae; Zl, S2, S4, S5, Z5 = postlateral setae; Z3, Z4 = postmediolateral setae; J5 = clunals. (Z3 are situated anterior to Z4; if Z3 are present, Zl or s6 are missing). — B. Ventral view with terminology and locations of diagnostic characteristics. ch = chelicera; gen.sh = genital shield; st.sh = sternal shield; va.sh = ventrianal shield, an = anus, po = pore on ventrianal shield; leg IV: coxa, trochanter, femur, genu, tibia, basitarsus, tarsus, m.s. = macroseta; mp = metapodal plates; sp = spermatheca. Setal nomenclature: JVl, JV2, JV3, JV4, JV5 = medial setae; ZVl, ZV2, ZV3 = mediolateral setae; PA = para-anal setae; PST = post-anal seta.

3.1. Keys and descriptions

The identification keys for females have been worked out using the mite specimens collected to determine the characteristics of the species. The descriptions and keys of Chant (1957, 1959, 1965), Chant & Hansell (1971), Chant & Yoshida-Shaul (1982, 1987), Dosse (1958), Karg (1970, 1971, 1982, 1983, 1991), Beglyarov (1981), and Miedema (1987) have been used as reference guides for keys. The main synonyms are from the above references and from Moraes et al. (1986).

Chant & Yoshida-Shaul (1986) divided the family Phytoseiidae into four subfamilies, Phytoseiinae, Amblyseiinae, Chantiinae, and Cydnodromellinae. This division is used in the following keys. The European phytoseiids belong to the subfamilies Phytoseiinae and Amblyseiinae (Evans 1987).

In the keys to subfamilies and genera, the concepts of Evans (1987), based mainly on Karg (1983), have been followed, except that the genus *Amblyseius* Berlese also includes here the genera *Neoseiulus* Hughes and *Typhlodromips* De Leon. The genus *Anthoseius* De Leon is presented as a separate genera in Karg (1983), and this concept is followed here.

The keys to genera are based primarily on the presence and relative lengths of dorsal setae and on the shape of the ventrianal shield and the number of setae on it (Fig. 1A, B). For the identi-

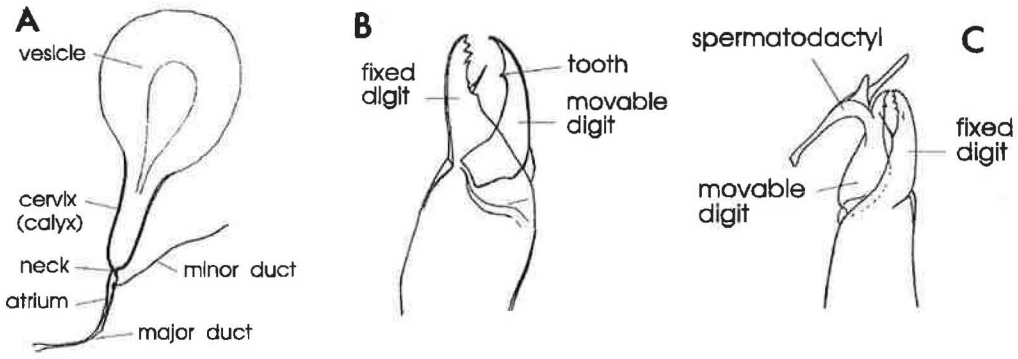

Fig. 2. Diagnostic characters of adult phytoseiid mite. — A. Spermatheca. — B. Female chelicera. — C. Male chelicera.

fication of the species the number of solenostomes or pores on the dorsal shield and the presence of pores on the ventrianal shield, and the shape of the spermatheca (Fig. 2A) has to be considered. Other characteristics, the presence of macrosetae on the basitarsus, tibia and genu of leg IV (Fig. 1B), the number of setae on the genu of leg II, the extension of the peritremes (Fig. 1A), and the number of teeth on the movable digit of the chelicerae (Fig. 2B) are used only occasionally in the keys. The mean, minimum and maximum of 10–20 measurements are presented, if enough specimens have been available. The keys to genera and species are valid only for the included species.

Different terminologies of the dorsal setae have been used by various authors, and that of Rowell et al. (1978) is adopted here (Table 3).

Key to genera (females) of Phytoseiidae

1. 6 pairs (j3, z2, z3, z4, s4, s6) of prolateral setae present (Phytoseiinae) 2
— 4 pairs (j3, z2, z4, s4) of prolateral setae present (Amblyseiinae) 6
2. Some dorsal setae, especially s4, s6, Z4 and Z5 thick and thorn-like; S2, S4 and S5 absent; J2 absent; r3 *on* dorsal shield; Rl absent ..... *Phytoseius*, p. 100

Table 3. Comparison of setal terminology for dorsum of idiosoma in the descriptive taxonomy of Phytoseiidae. — Row = Rowell et al. 1978, Karg = Karg 1971, 1981, Beg = Beglyarov 1980, Kol = Kolodochka 1984, Den = Denmark et al. 1984.

Setae	Row	Karg	Beg	Kol	Den
Anterior dorsocentral	j1	i1	D1	D1	V
	j3	i2	L1	AM1	L1
	j4	i3	D2	D2	D1
	j5	i4	D3	D3	D2
	j6	i5	D4	D4	D3
mediolateral	z2	s2	L2	AL1	L2
	z3	s3	L3	AL2	L3
	z4	z1	L4	AL3	L4
	z5	z2	AM	AM2	M1
	z6	z3	–	AM3	–
lateral	s4	s5	L5	AL4	L5
	s6	s7	L6	AL5	L6
marginal	r3	r5	AS	AS	S1
Posterior dorsocentral	J2	I2	D5	D5	D4
mediolateral	J5	I5	D6	D6	C1
	Z1	Z1	–	ML	M2
	Z3	Z3	–	PM1	–
	Z4	Z4	PM	PM2	M3
	Z5	Z5	PL	PM3	L10
lateral	S2	S2	L7	PL1	L7
	S4	S4	L8	PL2	L8
	S5	S5	L9	PL3	L9
marginal	R1	R1	PS	PS	S2

— s4 and s6 never thick and thorn-like; 1–3 pairs of setae S2, S4 and S5 present; J2 present; r3 not on dorsal shield; Rl present 3
3. Zl present ..... *Seiulus*, p. 100
— Zl absent 4
4. S5 present 5
— S5 absent ..... *Typhlodromus*, p. 103
5. z6 present, additionally Z3 may be present; JV2 absent ..... *Paraseiulus*, p. 101
— z6 and Z3 always absent; JV2 present .. *Anthoseius*, p. 102
6. J2 absent 7
— J2 present 8
7. j6 long (>100 µm), equal to about one half of the width of the dorsal shield; S4 absent; preanal setae absent ..... *Phytoseiulus*, p. 104
— j6 short (ca. 10 µm); S4 present; 2 or 3 pairs of preanal setae ..... *Proprioseiopsis*, p. 104
8. 3 pairs of preanal setae arranged in a 'zigzag' row on anterior part of ventrianal shield ..... *Euseius*, p. 105
— 3 pairs of preanal setae on ventrianal shield not arranged as above ..... *Amblyseius*, p. 105

Genus *Phytoseius* Ribaga

Key to species

1. s4 considerably longer than other dorsal setae; s4:s6 = ca. 1.4 ..... *macropilis*
— s4 about as long as s6 ..... *juvenis*

Phytoseius macropilis (Banks)

Fig. 3

Sejus macropilis Banks; *Phytoseius (Seiulus) spoofi* (Oudemans), Nesbitt; *Typhlodromus macropilis* (Banks), Westerboer & Bernhard; *Dubininellus macropilis* (Banks), according to Karg (1991).

Diagnosis: Idiosoma 341 µm (320–368). Dorsal shield pale, variably sclerotized and heavily sculptured. Ventrianal shield smooth, usually with 2–3 pairs of preanal setae (or unpaired 2+3, 1+3 or 1+2). Shape of spermatheca variable, but always with a wide base, cervix only partly sclerotized, not always easily detectable. Movable digit of chelicerae has 1 tooth. Lobe-ending macrosetae (85 µm, 72–96) present on tibia of leg IV, and much shorter macrosetae on genu and basitarsus.

Distribution and host plants: Common on deciduous trees and bushes; found on *Aesculus*, *Corylus*, *Fagus*, *Fragaria*, *Malus*, *Prunus*, *Ribes*, *Rubus*, *Salix*, *Sorbus*, *Tilia*, *Ulmus* and *Viburnum*. After *E. finlandicus*, *P. macropilis* was the commonest species on apple trees. It has been recorded on numerous deciduous trees and bushes and some herbaceous plants from Europe, Asia and North and South America (Moraes et al. 1986).

Phytoseius juvenis Wainstein & Arutunjan

Fig. 4

Dubininellus juvenis (Wainstein & Arutunjan), according to Karg (1991).

Diagnosis: Idiosoma 325 µm (310–340). Dorsal shield pale, variably sclerotized and heavily sculptured. Ventrianal shield smooth, with 1–2 pairs of preanal setae (or unpaired 2+1, 0+1 or 2+3). Spermatheca wide with a bowed neck. Movable digit of chelicerae has 1 tooth. Lobe-ending macrosetae (93 µm 84–112) on tibia of leg IV and shorter macrosetae on genu and basitarsus.

Distribution and host plants: Found on *Ribes rubrum* in Kokemäki (61°16′N, 22°15′E) and on *Rubus idaeus* in Åland (60°15′N, 19°58′E). *P. juvenis* has been recorded on fruit trees and berry plants in Eastern Europe (Karg 1991).

Genus *Seiulus* Berlese

Seiulus aceri (Collyer)

Fig. 5

Typhlodromus aceri Collyer; *Typhloctonus aceri* (Collyer), according to Moraes et al. (1986).

Diagnosis: Idiosoma 328 µm (320–336). Dorsal shield reticulated and sclerotized, with 3 pairs of small solenostomes. Ventrianal shield rectangular, with 4 pairs of preanal setae, and with none or 1 pair of small pores. Spermatheca with a long neck. Movable digit of chelicerae has 1 small, hardly visible tooth. No macrosetae on leg IV.

Distribution and host plants: Found only on *Acer platanoides*. *S. aceri* is specialized in regard to its hostplants. It is recorded from *Acer platanoides*, *A. campestre*, *Corylus* sp., *Cerasus*

sp. *Juglans* sp., *Prunus* sp., *Rubus* sp. and *Zelkova* sp. in Europe and Asia (Moraes et al. 1986).

Genus *Paraseiulus* Muma

Key to species

1. Z3 present ..... *talbii*
— Z3 absent 2
2. Dorsal shield without prominent pores; spermatheca narrow, bowed horn-shaped ..... *soleiger*
— 3 pairs of prominent pores on dorsal shield; spermatheca with wide cervix ..... *triporus*

Paraseiulus talbii (Athias-Henriot)

Fig. 6

Typhlodromus talbii Athias-Henriot; *Paraseiulus subsoleiger* Wainstein, Karg; *Typhlodromus tetramedius* Zaher & Shehata, Chant & Yoshida-Shaul; *Seiulus amaliae* Ragusa & Swirski, Chant & Yoshida-Shaul; *Paraseiulus ostiolatus* Athias-Henriot, Chant & Yoshida-Shaul; *Bawus talbii* (Athias-Henriot), according to Moraes et al. (1986).

Diagnosis: Idiosoma 381 µm (356–400). Dorsal shield distinctly reticulated and strongly sclerotized, especially in posterior part, with 3 pairs of distinct, invaginated solenostomes. Ventrianal shield narrow, 'slipper-shaped', sparsely striated, with 2 pairs of preanal setae. Spermatheca cervix wide, vase-shaped. Movable digit of chelicerae without teeth. No macrosetae on leg IV. *Note*: One female missing setae z6 was found on wild *Malus sp.* In *Paraseiulus* some variation in number of dorsal setae has been noted earlier (Chant & Yoshida-Shaul 1989).

Distribution and host plants: Found on *Fragaria* × *ananassa*, *Juglans ailanthifolia*, *Malus* sp. *P. talbii* has previously been recorded in Europe and Asia from many trees and bushes, including fruit trees (Moraes et al. 1986).

Paraseiulus soleiger (Ribaga)

Fig. 7

Seiulus soleiger Ribaga; *Typhlodromus soleiger* (Ribaga), Nesbitt; *Paraseiulus incognitus* Wainstein & Arutunjan, 1967, Chant & Yoshida-Shaul; *Typhlodromus trimediosetus* Xin, Liang & Ke, Chant & Yoshida-Shaul.

Diagnosis: Idiosoma 324 µm (304–364). Dorsal shield strongly sclerotized and reticulated. Ventrianal shield weakly striated or reticulated, with 2 pairs of preanal setae. Spermatheca long, horn-shaped. Movable digit of chelicerae without teeth. No macrosetae on leg IV. *Note*: A few females missing setae z6 were found (less than 1 % of the material collected). Males of *P. soleiger* always lack setae z6.

Distribution and host plants: Widespread, occasionally in large numbers, found on *Betula lutea*, *Corylus avellana*, *Crataegus coccinea*, *Fagus grandifolia*, *Fraxinus excelsior*, *Juglans cinerea*, *J. mandshurica*, *Malus* sp., *Pterocarya rhoifolia*, *Quercus robur*, *Ribes nigrum*, *Rubus idaeus*, *Sorbus thuringiaca*, *Tilia cordata*, *Tilia* × *euchlora*, *Ulmus glabra*. *P. soleiger* has been recorded on numerous trees and bushes, and also in litter and grass, from Europe, Asia and North America (Moraes et al. 1986). It preys especially on tydeid mites (Dosse 1956).

Paraseiulus triporus (Chant & Yoshida-Shaul)

Fig. 8

Typhlodromus triporus Chant & Yoshida-Shaul.

Diagnosis: Idiosoma 390 µm (360–408). Dorsal shield strongly sclerotized and reticulate, with 3 pairs of distinct, invaginated solenostomes. Ventrianal shield lightly striated, with 2 pairs of preanal setae. Spermatheca variable in shape, weakly sclerotized. Movable digit of chelicerae has 1 tooth. No macrosetae on leg IV. *Note*: One specimen with a single seta J1 between J2 and j6 was found.

Distribution and host plants: Found in Finland on *Acer platanoides*, *Aesculus hippocastani*, *Corylus avellana*, *Fragaria vesca*, *Malus* sp., *Prunus avium*, *Prunus padus*, *Pterocarya rhoifolia*, *Ribes rubrum*, *Ribes uva-crispa*, *Sorbus aucuparia*, *Rubus odoratus*, *Ulmus glabra*. *P. triporus* has previously been reported from Europe and North America on many orchard trees, as well as other deciduous trees and bushes (Moraes et al. 1986).

Genus *Anthoseius* De Leon

Key to species

1. Ventrianal shield with 3 pairs of preanal setae 2
— Ventrianal shield with 4 pairs of preanal setae 3
2. Movable digit with 2 teeth; genu II with 6 setae; no distinct macrosetae on basitarsus IV; distinct pores close to S5 ..... *viktorovi*
— Movable digit with 1 tooth; genu II with 7 setae; macrosetae on basitarsus IV ending in a small lobe; distance of pores from the base of S5 about the same as the length of S5 ..... *suecicus*
3. Spermatheca cilinder-shaped; movable digit with 1 tooth ..... *rhenanus*
— Spermatheca with long cervix; movable digit with 2 or 3 teeth 4
4. Ventrianal shield widest anteriorly; movable digit with 2 teeth ..... *richteri*
— Ventrianal shield widest medially; movable digit with 3 teeth ..... *bakeri*

Anthoseius viktorovi Wainstein

Fig. 9

Amblydromella viktorovi (Wainstein), according to Moraes et al. (1986).

Diagnosis: Idiosoma 370 µm. Dorsal shield lightly reticulated and sclerotized, with 4–5 pairs of pores, 3 distinct ones, one pair close to setae S5. Three pairs of preanal setae and one pair of faint pores on ventrianal shield. Shape of spermatheca conical. The movable digit of chelicerae has 2 teeth. No macrosetae on leg IV.

Distribution and host plants: Only one female was found on *Malus domestica*, Pälkäne (61°20′N, 24°12′E). *A. viktorovi* has previously been recorded on pine in Yaroslavl Province, Russia (Moraes et al. 1986).

Anthoseius suecicus (Sellnick)

Fig. 10

Neoseiulus suecicus Sellnick; *Typhlodromus suecicus* (Sellnick), Karg; *Amblydromella suecica* (Sellnick), according to Moraes et al. (1986); *Typhlodromus gilvus* Wainstein (E. Shaul in litt.).

Diagnosis: Idiosoma 387 µm (380–392). Dorsal shield lightly reticulate and sclerotized, with variable number of pores, of which 3 pairs are distinct. 3 pairs of preanal setae on ventrianal shield (or unpaired 2+3), 1 pair of pores. Spermatheca cup-shaped, with a short atrium. Movable digit of chelicerae has 1 tooth. Hardly differentiated, lobe-ending macrosetae (25 µm, 24–28) on basitarsus on leg IV. — *A. suecicus* and *A. gilvus* (Wainstein) are proposed as synonyms (Eiko Shaul, pers. comm. 1989).

Distribution and host plants: Found only on *Malus domestica* in Mietoinen (60°47′N, 21°24′E) and Pälkäne (61°47′N, 24°12′E). *A. suecicus* has previously been recorded on grass in Sweden, and on bird cherry in Yaroslavl, Russia, where it was described as *A. gilvus* (Moraes et al. 1986).

Anthoseius rhenanus (Oudemans)

Fig. 11

Seiulus rhenanus Oudemans; *Typhlodromus foenilis* Oudemans, Chant; *Typhlodromus* (*Neoseiulus*) *rhenanus* (Oudemans), Nesbitt; *Typhlodromus kazachstanicus* Wainstein, Chant; *Amblydromella* (*Seiulus*) *rhenana* (Oudemans), according to Moraes et al. (1986).

Diagnosis: Idiosoma 323 µm (312–328). Dorsal shield reticulate and sclerotized, with 3 pairs of small indistinct pores. Setae Z5, Z4 and S5 faintly serrated. Usually 4 pairs of preanal setae and 1 pair of small, sometimes invisible pores on ventrianal shield. Spermatheca cylindrical. Movable digit of chelicerae has 1 tooth. Slightly differentiated macrosetae (29 µm, 25–32) on basitarsus on leg IV.

Distribution and host plants: Found on *Alnus glutinosa*, *Crataegus coccinea*, *Fragaria* × *ananassa*, *Juglans ailanthifolia*, *Malus* sp., *Prunus avium*, *Ribes nigrum*, *R. rubrum*, *Rubus idaeus*, *Sorbus aucuparia*. *A. rhenanus* has been recorded on numerous trees, bushes and herbaceous plants in Europe, Asia and North America (Moraes et al. 1986). In the present study, *A. rhenanus* occurred commonly on unsprayed strawberries.

Anthoseius richteri (Karg)

Fig. 12

Typhlodromus richteri Karg; *Amblydromella (Typhlodromus richteri* (Karg), according to Moraes et al. (1986).

Diagnosis: Idiosoma 432 µm (416–464). Dorsal shield distinctly sclerotized and sculptured, with 4 pairs of pores, sometimes hardly visible. Dorsal setae relatively thick and stiff, setae Z5, Z4 and S4 faintly serrated. Ventrianal shield widest in anterior part, with 4 pairs of preanal setae and 1 pair of pores. Spermatheca funnel-shaped with a long, narrow, often bowed neck. Movable digit of chelicerae has 2 teeth. Macrosetae (44 µm, 40–46) on basitarsus of leg IV. — In the description of *A. richteri* there are Zl instead of S2 setae (Karg 1970). However, this type of pattern is not listed in the setal patterns presented by Chant & Yoshida-Shaul (1989).

Distribution and host plants: Found on *Acer platanoides*, *Malus domestica* and *Sorbus aucuparia*. *A. richteri* has been recorded on deciduous trees in Central Europe and in Norway (Karg & Edland 1987, Karg 1991).

Anthoseius bakeri (Garman)

Fig. 13

Seiulus bakeri Garman; *Typhlodromus bakeri* (Garman), Nesbitt; *Amblydromella* (*Seiulus*) *bakeri* (Garman), according to Moraes et al. 1986.

Diagnosis: Idiosoma 402 µm (328–480). Dorsal shield heavily sclerotized and sculptured, with no distinct pores. Setae Z5 serrated. Ventrianal shield widest in medial part, with 4 pairs of preanal setae and a pair of faint pores (not always visible). Spermatheca horn-shaped, with a long and narrow atrium. Movable digit of chelicerae has 3 teeth. Macrosetae (34 µm, 31–40) on basitarsus of leg IV.

Distribution and host plants: Found on *Malus* sp., *Ribes nigrum* and *R. rubrum*. *A. bakeri* is a bark inhabiting species, and may be more common on apple than the leaf samples show (Karg 1991). It has been recorded on numerous trees and bushes in North America, Europe, Asia and Australia (Moraes et al. 1986).

Genus *Typhlodromus* Scheuten

Key to species

1. 4 pairs of prominent pores on dorsal shield; 1 pair of pores anterior to Z4 2
— 3 pairs of pores on dorsal shield; no pores anterior to setae Z4 ..... *pyri*
2. Peritremes extend forward between j3 and z2; spermatheca spur-shaped; Z5 about twice as long as setae Z4 ..... *laurae*
— Peritremes extend forward to the level of z4; spermatheca wide V-shaped funnel without neck; Z5 only slightly longer than Z4 ..... *andrei*

Typhlodromus pyri Scheuten

Fig. 14

Diagnosis: Idiosoma 342 µm (336–348). Dorsal shield lightly sclerotized and distinctly reticulated, with 3 pairs of prominent solenostomes, but no pores anterior to setae Z4. Setae Z4 and Z5 slightly serrated. Ventrianal shield with four pairs of preanal setae (20 µm). Spermatheca bell-shaped. Movable digit of chelicerae has 2 teeth. Macrosetae (38 µm, 36–40) on basitarsus of leg IV.

Distribution and host plants: Found only in Åland (60°15′N, 19°58′E) on red currant *Ribes rubrum* and black currant *R. nigrum*. *T. pyri* is widely used in the biological control of spider mites in orchards. As *T. pyri* has not been found on apple trees nor on other trees in Finland it is possible that it cannot overwinter here on trees. The occurrence of the species on currants in Åland, where the climate is more favourable than on the mainland, support this conclusion. In Norway, *T. pyri* occurs commonly on apple trees (Edland 1987). *T. pyri* has been recorded on numerous trees and bushes in Europe, Asia, North Africa, North America, Australia and New Zealand (Chant & Yoshida-Shaul 1987).

Typhlodromus laurae Arutunjan

Fig. 15

Diagnosis: Idiosoma 363 µm. Dorsal shield reticulated and lightly sclerotized, with 4 pairs of

prominent pores, one of them anterior to setae Z4. Setae Z5 with very faint serration. Ventrianal shield with 4 pairs of preanal setae (15 µm). Spermatheca narrow spur-shaped. Movable digit of chelicerae has 2 teeth. Macrosetae on basitarsus (50 µm), and shorter macrosetae on tibia of leg IV.

Distribution and host plants: Only one female found in Piikkiö (60°23′N, 22°33′E) on *Ribes nigrum*. *T. laurae* has been recorded on *Pinus* sp. in Armenia (ref. Chant & Yoshida-Shaul 1987), and in Norway (Karg & Edland 1987), the Netherlands and Germany (Chant & Yoshida-Shaul 1987).

Typhlodromus andrei Karg

Fig. 16

Typhlodromus pritchardi Arutunjan (suspected synonym, Chant & Yoshida-Shaul 1987).

Diagnosis: Idiosoma 376 µm. Dorsal shield lightly reticulated, with 4 pairs of distinct solenostomes plus smaller pores anteriorly and posteriorly to setae J2. Ventrianal shield with 4 pairs of preanal setae (15 µm) and one pair of pores. Spermatheca cup-shaped, with sharp angular bottom. Movable digit of chelicerae has 2 teeth. Macrosetae (52 µm) on basitarsus of leg IV. — *T. andrei* and *T. pritchardi* Arutunjan are considered as possible synonyms (Chant & Yoshida-Shaul 1987), and this conception is adopted here.

Distribution and host plants: Found only in Elimäki (60°44′N, 26°24′E) on *Pterocarya rhoifolia*. *T. andrei* has been recorded on bark of fruit trees in Belgium (Karg 1982), *T. pritchardi* on *Fragaria* sp., *Pinus* sp., *Primula vulgaris* and *Prunus spinosa* in Armenia and Yaroslavl, Russia (Moraes et al. 1986).

Genus *Phytoseiulus* Evans

Phytoseiulus persimilis Athias-Henriot

Fig. 17

Phytoseiulus riegeli Dosse, Chant; *Amblyseius tardi* Lombardini, Kennett & Caltagirone.

Diagnosis: Idiosoma 340 µm, orange coloured. Dorsal shield smooth, without reticulation, weakly sclerotized, with 7 pairs of small but distinct pores. Setae are serrated except jl, z2, z5, S5 and J5. Ventrianal shield small, with no preanal setae. Spermatheca narrow, with a stricture. Movable digit of chelicerae has 1 tooth. Macrosetae (116 µm) on basitarsus on leg IV.

Distribution and host plants: One specimen found in Paimio (60°25′N, 22°42′E) on *Malus domestica*, obviously originating from a glasshouse. *P. persimilis* is used in glasshouses for the control of spider mites. It has been recorded on various trees, bushes and herbaceous plants in Mediterranean countries and South America (Moraes et al. 1986). The species has been introduced and is established in many countries. It probably cannot survive the Finnish climate, because of its temperature requirements (Kennett & Caltagirone, 1968).

Genus *Proprioseiopsis* Muma

Proprioseiopsis okanagensis (Chant)

Fig. 18

Typhlodromus (*Amblyseius*) *okanagensis* Chant; *Typhlodromus okanagensis levis* Wainstein, Karg.

Diagnosis: Idiosoma 401 µm (392–412). Dorsal shield smooth, without reticulation, weakly sclerotized, with 9 pairs of pores. Ventrianal shield reticulate, lightly sculptured, with 3 pairs of preanal setae and 1 pair of small, distinct pores. Spermatheca narrow bell-shaped, distinctly scleroticed. Movable digit of chelicerae has 1 tooth. Macrosetae on basitarsus (61–64 µm), genu and tibia of leg IV.

Distribution and host plants: Found in Juva (61°53′N, 26°51′E) on cultivated strawberry *Fragaria* × *ananassa* and in Åland (60°15′N, 19°58′E) on *Ribes nigrum*. *P. okanagensis* has been recorded on fruit trees, herbaceous plants and in litter and soil in North America and Europe (Moraes et al. 1986).

Genus *Euseius* Wainstein

Euseius finlandicus (Oudemans)

Fig. 19

Seiulus finlandicus Oudemans; *Typhlodromus* (*Amblyseius*) *finlandicus* (Oudemans), Chant.

Diagnosis: Idiosoma 328 µm (304–344). Dorsal shield pale, weakly sclerotized, faintly reticulated, with 4–6 pairs of pores. Ventrianal shield with 1 pair of distinct, crescentic pores and 3 pairs of preanal setae in anterior part of the shield. Spermatheca narrow, with a stricture in neck. Movable digit of chelicerae has 1 or 2 teeth. Macrosetae on basitarsus (53 µm, 44–62) and shorter macrosetae on tibia and genu of leg IV.

Distribution and host plants: Common on deciduous trees and bushes; found on *Acer platanoides*, *Aesculus hippocastani*, *Alnus incana*, *Amelanchier spicata*, *Aristolochia macrophylla*, *Betula lutea*, *Cornus alba*, *Corylus avellana*, *Crataegus coccinea*, *Fagus grandifolia*, *Fragaria vesca*, *Fraxinus excelsior*, *Juglans ailanthifolia*, *J. cinerea*, *J. mandshurica*, *Malus* sp., *Prunus avium*, *P. padus*, *Pterycaria rhoifolia*, *Pyrus communis*, *Quercus robur*, *Ribes nigrum*, *R. rubrum*, *R. uva-crispa*, *Rubus fruticosus*, *R. odoratus*, *Salix* sp., *S. caprea*, *Sorbus thuringiana*, *Tilia americana*, *T. cordata*, *Tilia* × *euchlora*, *Ulmus glabra*, *Viburnum opulus*. *E. finlandicus* is the most widespread and abundant species in Finland. It has been recorded on numerous trees and bushes, less frequently on herbaceous plants, in all parts of the world. Only one report of the total of 123 references listed by Moraes et al. (1986) states that the species was found in litter, and there are no observations of the species in soil.

Genus *Amblyseius* Berlese

Key to species

1. Great differences in lengths of dorsal setae, j3 at least three times longer than j4, j5 and z5 2
— j4, j5 and z5 normal, not much shorter than j3 3
2. Z4 (89 µm, 76–96) longer than Z5 (68 µm, 60–80), dorsal shield heavily sclerotized and reticulated, often brown coloured; spermatheca long, narrow v-shaped; ventrianal shield with one pair of pores ..... *subsolidus*
— Z5 (71 µm, 68–72) longer than Z4 (52 µm, 50–53); dorsum not brown; spermatheca dish-shaped, strongly sclerotized with a prominent atrium; no pores on ventrianal shield ..... *tenuis*
3. J2 and Z1 shorter than S2; spermatheca bell-shaped .4
— J2 and Z1 about equal to S2; spermatheca not bell-shaped 5
4. Ventrianal shield with one pair of distinct 'eye-shaped' pores; ratio of Z4 (44 µm, 34–48) : S4 (28 µm, 19–32) = 1.5–1.6; length of idiosoma under 360 µm *reductus*
— Ventrianal shield with one pair of normal circular pores; length of Z4 (38 µm) about equal to S4 (33 µm); length of idiosoma over 360 µm ..... *cucumeris*
5. Dorsal shield reticulated; spermatheca a wide v-shaped funnel with a neck ..... *zwoelferi*
— Dorsal shield without reticulation; spermatheca narrow, long tube-shaped ..... *barkeri*

Amblyseius subsolidus (Beglyarov)

Fig. 20

Typhlodromus subsolidus Beglyarov; *Neoseiulus* (*Amblyseius*) *canadensis* (Chant & Hansell), Wainstein; *Neoseiulus subsolidus* (Beglyarov), according to Moraes et al. (1986); *Typhlodromips subsolidus* (Beglyarov), according to Karg (1991).

Diagnosis: Idiosoma 389 µm (356–440). Dorsal shield heavily sclerotized and markedly reticulate, often brown-coloured, with 3–6 pairs of obscure pores. Setae Z5 serrated.

Ventrianal shield large, convex, about as long as wide, reticulate, with 1 pair of pores and 3 pairs of preanal setae. Spermatheca long, V-shaped. Movable digit of chelicerae has 2 prominent teeth. 3 short, barely differentiated macrosetae on basitarsus of leg IV, the longest one 27 µm (20–30). — Dutch specimens of *A. subsolidus* have longer setae than Canadian specimens (Miedema 1987) and the same is also true of Finnish specimens.

Distribution and host plants: Found on *Crataegus coccinea*, *Malus* sp., *Prunus padus*. *A. subsolidus* has been recorded on trees and bushes in Leningrad and Yaroslavl regions in Russia, in Alaska and in Canada (Moraes et al. 1986).

Amblyseius tenuis (Hirschmann)

Fig. 21

Typhlodromus tenuis Hirschmann; *Typhlodromips (Typhlodromus) tenuis* (Hirschmann), according to Moraes et al. (1986).

Diagnosis: Idiosoma 357 µm (356–360). Dorsal shield smooth, with 4–5 pairs of obscure pores plus 1 pair of prominent pores anterior to setae S5. Setae Z5 and Z4 very faintly serrated. Ventrianal shield with 3 pairs of preanal setae. Spermatheca heavily sclerotized, with a distinct atrium. Movable digit of chelicerae has 2 teeth. Macrosetae (74 µm, 73–76) on basitarsus of leg IV. Shorter macrosetae on genu and tibia.

Distribution and host plants: Found in Finland only in Juva (61°53′N, 26°51′E) on *Fragaria* × *ananassa*. Earlier records of *A. tenuis* are on 'burnt wood' in Germany and on *Rubus* sp. in Canada (Moraes et al. 1986) and, according to Karg (1991), in litter in central Europe.

Amblyseius reductus Wainstein

Fig. 22

Neoseiulus (Amblyseius) reductus (Wainstein), according to Moraes et al. (1986).

Diagnosis: Idiosoma 336 µm (328–344). Dorsal shield lightly reticulated and sclerotized, with 3–5 pairs of distinct pores on dorsal shield. Setae Z5 slightly serrated. Ventrianal shield pentagonal, lightly reticulated, with 1 pair of slender 'eye-shaped' pores and 3 pairs of preanal setae. Spermatheca bell-shaped, twice as long as broad. Movable digit of chelicerae with 1 tooth. Macrosetae (45 µm, 40–56) on basitarsus of leg IV.

Distribution and host plants: Found in Finland on *Aristolochia macrophylla*, *Fragaria vesca*, *Fragaria* × *ananassa*, *Malus* sp., *Ribes rubrum*, *Rubus idaeus*, *Tussilago farfara*, and *Ulmus glabra*. *A. reductus* has been recorded on various trees, bushes and herbaceous plants in Eurasia (Moraes et al. 1986). It has been used in the biological control of mites on strawberry in Russia (Tokunova & Malov 1988).

Amblyseius cucumeris (Oudemans)

Fig. 23

Typhlodromus cucumeris Oudemans; *Neoseiulus (Typhlodromus) thripsi* (MacGill), Evans; *Amblyseius coprophilus* Karg, Karg; *Neoseiulus (Typhlodromus) cucumeris* (Oudemans), according to Moraes et al. (1986).

Diagnosis: Idiosoma 375 µm (370–380). Dorsal shield lightly reticulated, with 5 pairs of distinct pores. Setae Z5 faintly serrated. Ventrianal shield with 3 pairs of preanal setae and 1 pair of pores. Spermatheca narrow bell-shaped. Movable digit of chelicerae has 1 tooth. Macrosetae (48 µm) on basitarsus on leg IV.

Distribution and host plants: Found outdoors only in Piikkiö (60°23′N, 22°33′E) on *Fragaria* × *ananassa* (originating from earlier artificially introduced specimens). *A. cucumeris* is used in biological control of the onion thrips *Thrips tabaci* Lind. It has been recorded on various trees, bushes and herbaceous plants, e.g. on strawberries in Europe, North America and New Zealand (Moraes et al. 1986). Karg (1991) lists *Phytonemus pallidus* ssp. *fragariae* (Zimm.) among its prey species.

Amblyseius zwoelferi (Dosse)

Fig. 24

Typhlodromus zwölferi Dosse, 1957; *Neoseiulus zeitunicus* Wainstein & Arutunjan, Wainstein; *Neoseiulus (Typhlodromus) zwölferi* (Dosse), according to Moraes et al. (1986).

Diagnosis: Idiosoma 418 µm (408–440). Dorsal shield distinctly reticulated, often with pigmented areas present, and with 7 pairs of small pores. Setae Z5 slightly serrated. Ventrianal shield reticulated, with 3 pairs of preanal setae and 0–1 pair of small pores. Spermatheca wide funnel-shaped without neck. Movable digit of chelicerae without teeth. Macrosetae on basitarsus (51 µm, 48–54), another much shorter macroseta on tibia of leg IV.

Distribution and host plants: Found in Åland (60°15′N, 19°58′E) on *Ribes nigrum* and *Fragaria* × *ananassa* and in Mikkeli (61°40′N, 27°12′E) on

Fragaria × *ananassa*. *A. zwoelferi* has been recorded earlier mainly on herbaceous plants and fruit trees in Europe and North America (Moraes et al. 1986).

Amblyseius barkeri (Hughes)

Fig. 25

Neoseiulus barkeri Hughes; *Amblyseius mckenziei* Schuster & Pritchard, Ragusa & Athias-Henriot.

Diagnosis: Idiosoma 384 µm (372–406). Dorsal shield slightly reticulated, with 4 pairs of distinct pores. Setae Z5 faintly serrated. Ventrianal shield indistinctly striated, with 1 pair of distinct pores and 3 pairs of preanal setae. Spermatheca tube-shaped, atrium heavily sclerotized. Movable digit of chelicerae has 1 tooth. Macrosetae (70 µm, 66–74) on basitarsus of leg IV.

Distribution and host plants: Only in glasshouses where *A. barkeri* is used for the biological control of thrips. *A. barkeri* has been recorded on various trees, bushes and herbaceous plants in Europe and Asia (Moraes et al. 1986).

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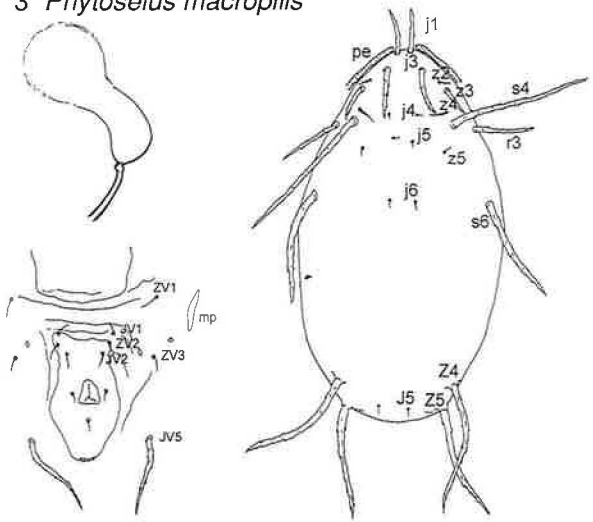
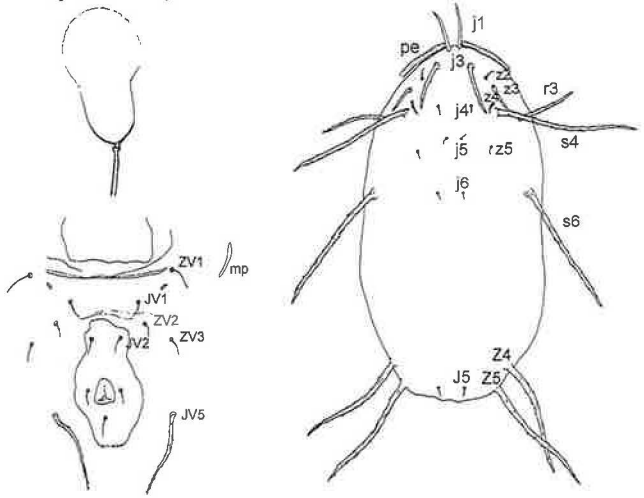
Figs. 3–25. Species of Phytoseiidae. — Females: spermatheca, ventrianal area, dorsal shield (scale bar for dorsal shield, 100 μm).

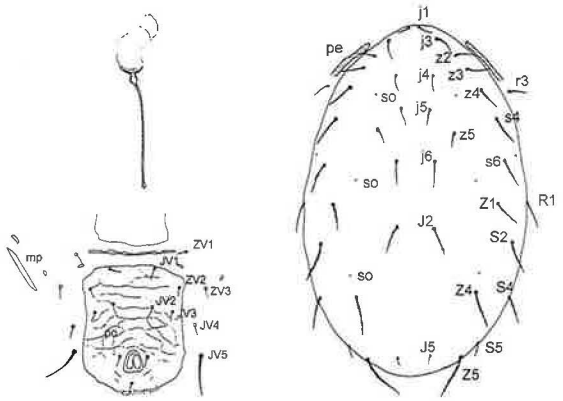
3 *Phytoseius macropilis*



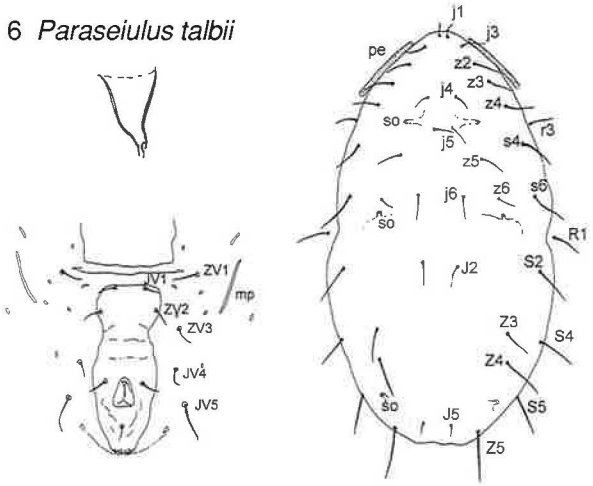
4 *Phytoseius juvenis*



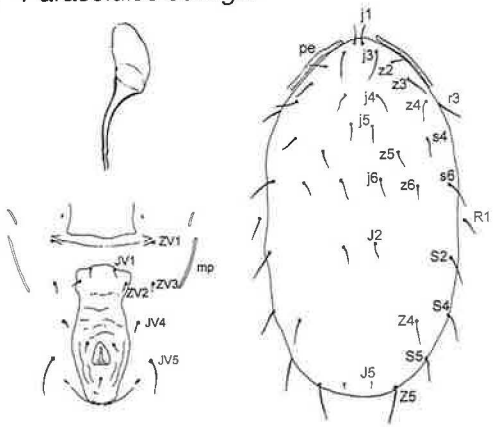
5 *Seiulus aceri*



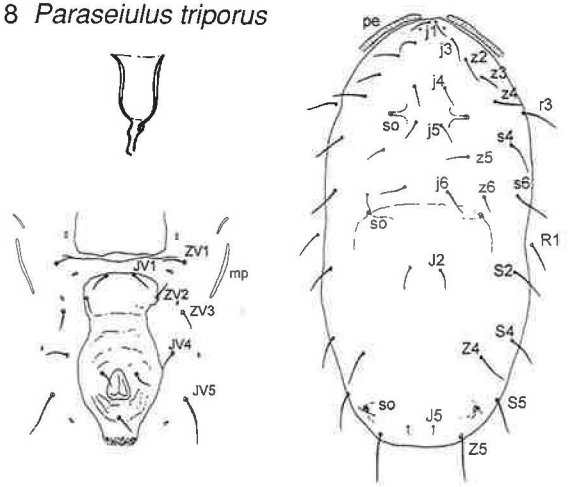
6 *Paraseiulus talbii*



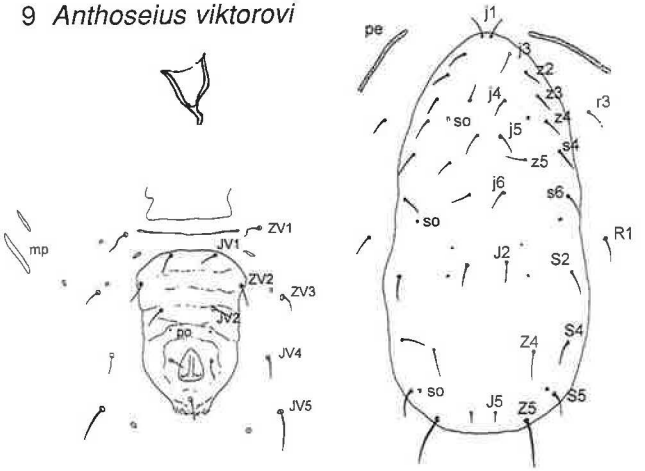
7 *Paraseiulus soleiger*



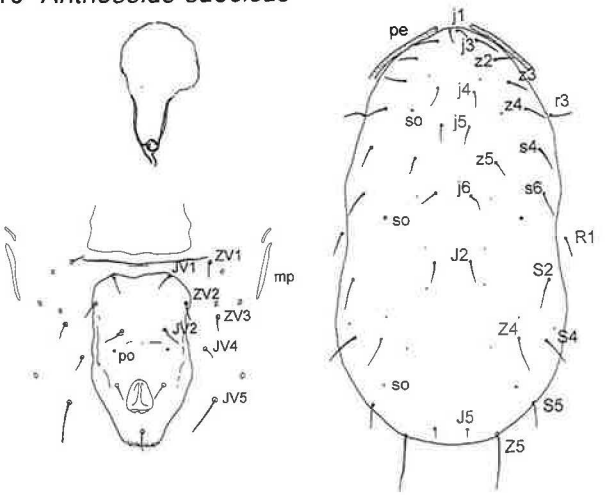
8 *Paraseiulus triporus*



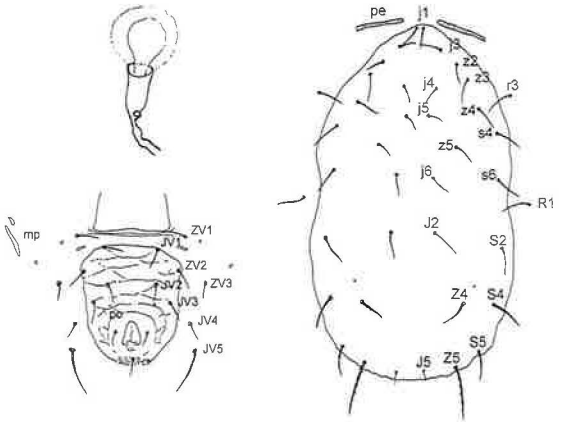
9 *Anthoseius viktorovi*



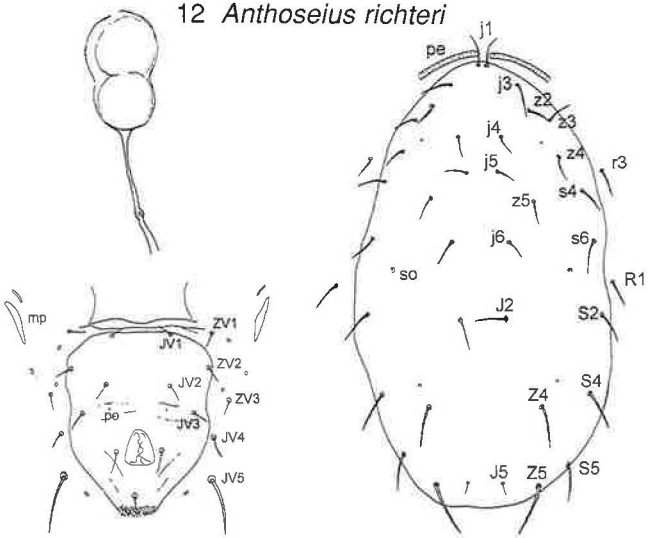
10 *Anthoseius suecicus*



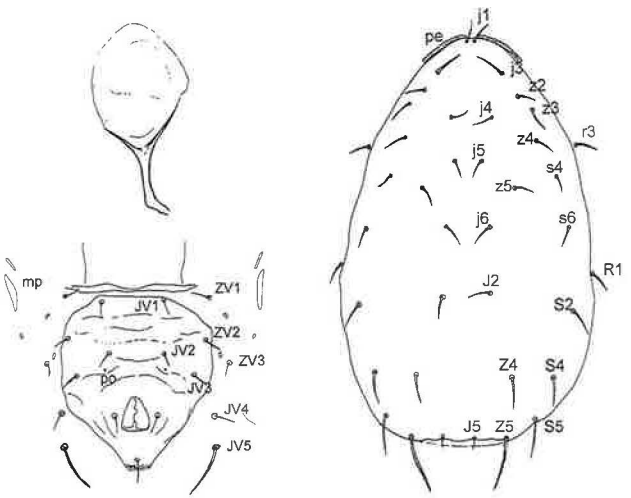
11 *Anthoseius rhenanus*



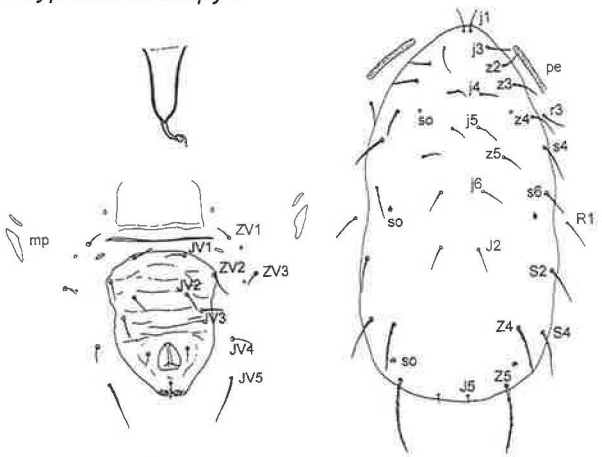
12 *Anthoseius richteri*



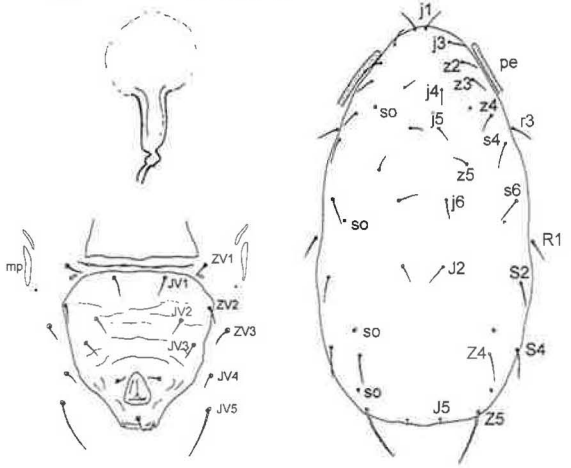
13 *Anthoseius bakeri*



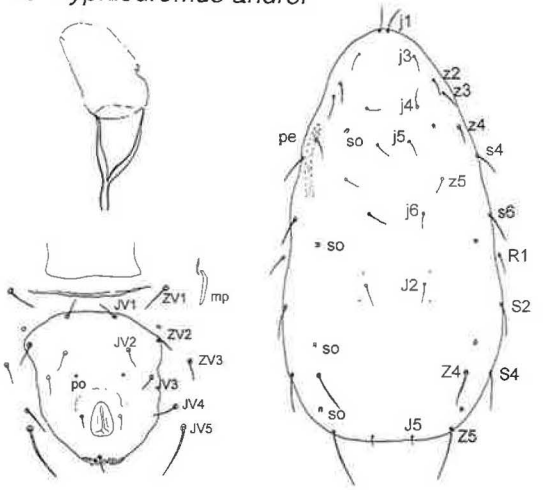
14 *Typhlodromus pyri*



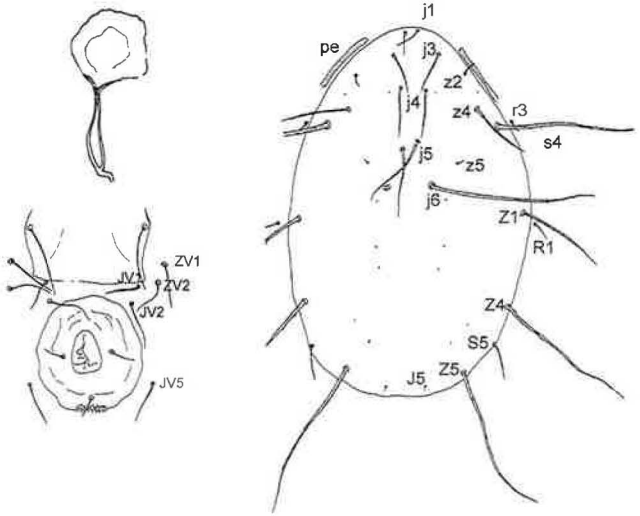
15 *Typhlodromus laurae*



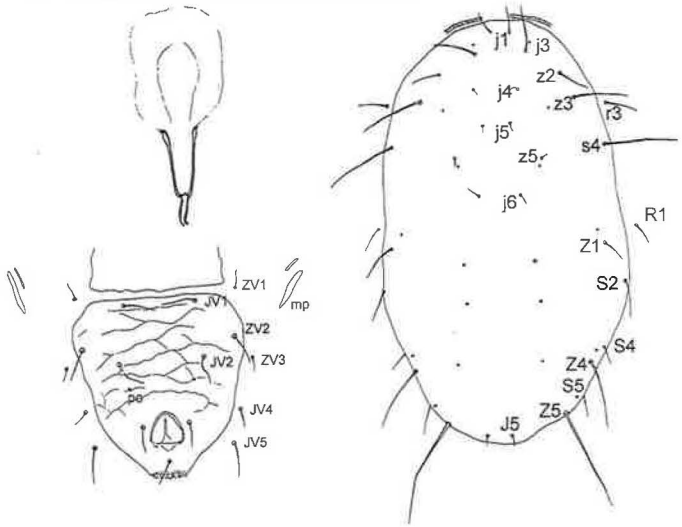
16 *Typhlodromus andrei*



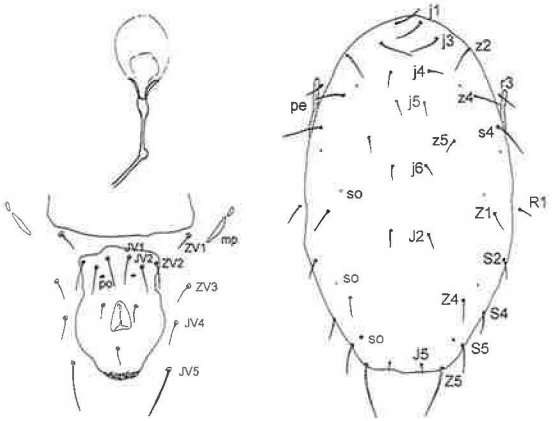
17 *Phytoseiulus persimilis*



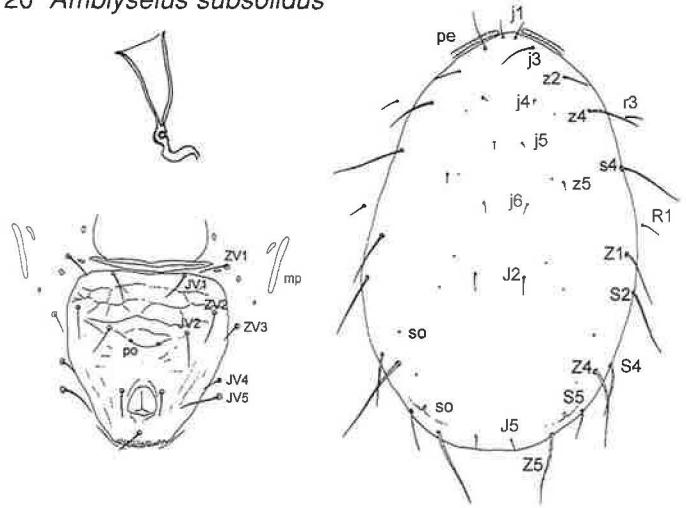
18 *Proprioseiopsis okanagensis*



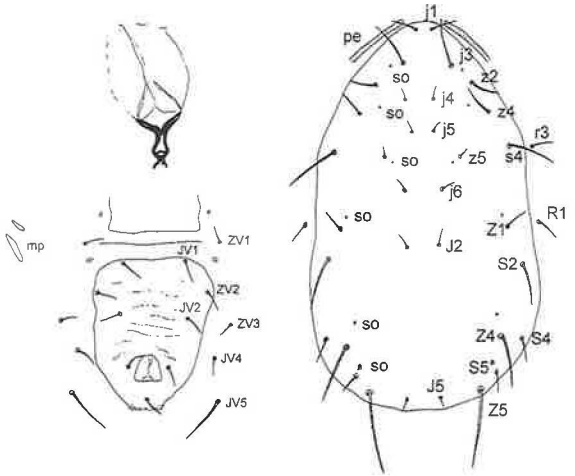
19 *Euseius finlandicus*



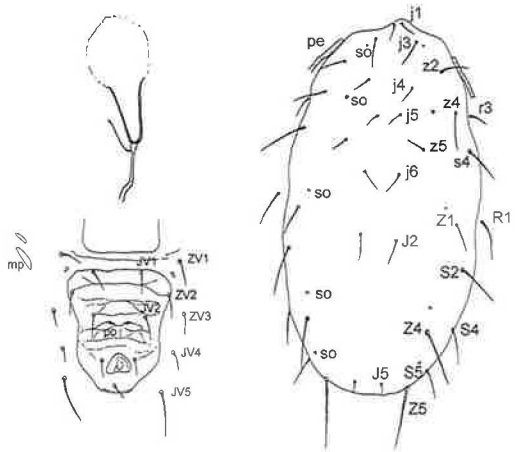
20 *Amblyseius subsolidus*



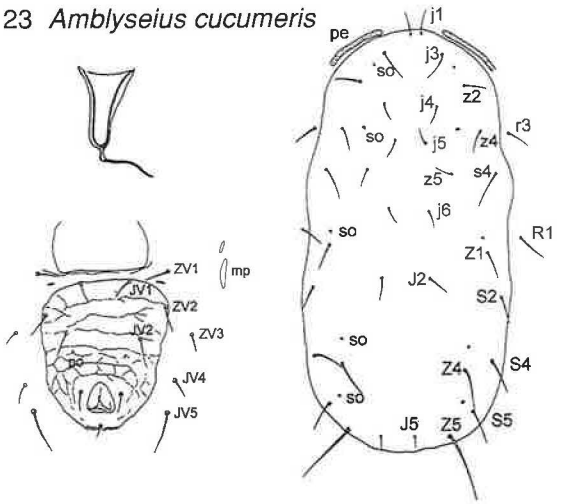
21 *Amblyseius tenuis*



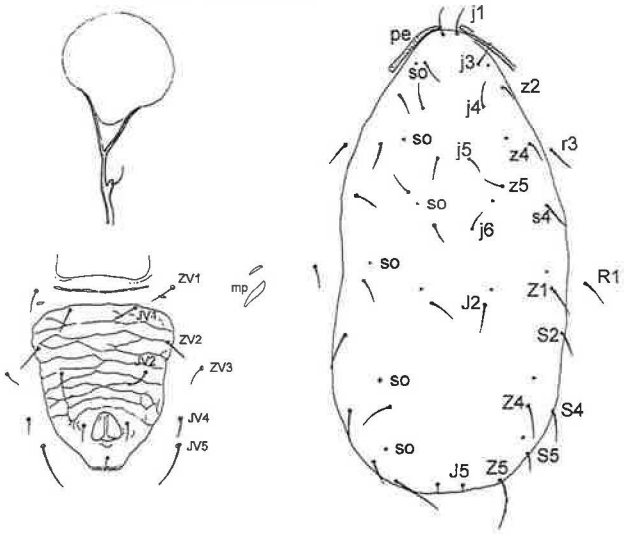
22 *Amblyseius reductus*



23 *Amblyseius cucumeris*



24 *Amblyseius zwoelferi*



25 *Amblyseius barkeri*