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The genus *Typhlodromus* (Acari: Mesostigmata) in Norway

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Phytoseiidae, *Typhlodromus*, new species, Norway, geographical distribution, host plants

Abstract. Eight species of *Typhlodromus* Scheuten were collected during an extensive survey of phytoseiid mites in Norway. One of the species, *Typhlodromus norvegicus*, is described as a new taxon and *Typhlodromus ulex* Evans is considered to be a junior synonym of *Typhlodromus phialatus* Athias-Henriot. Keys are given for the identification of the genera of the Typhlodrominae and species of the genus *Typhlodromus* represented in the fauna of Norway. Distribution maps are provided for seven species and the frequency of *Typhlodromus* species on a range of host plants is given in tabular form. *Picea abies* showed the highest frequency of *Typhlodromus* spp. and all eight species were found on *Juniperus communis*.

INTRODUCTION

General aspects

The importance of the mite family Phytoseiidae in biological and integrated control of injurious plant mites has stimulated taxonomic and ecological work on the group. During the last 50 years, there has been a great increase in the number of described species in the family, and by 1990 more than 1,600 species had been described (Chant & Yoshida-Shaul, 1991).

Members of the Phytoseiidae are free-living terrestrial mites which live on the foliage and bark of many plants and in humus and other organic litter, in all parts of the world. The majority of the species are predacious, in particular on tetranychids and eriophyids, but also on tydeiid mites, small insects and nematodes. A few are parasitic (Chant, 1985; Karg, 1993). In the absence of living prey many of the species can survive and even reproduce by feeding on fungal spores and hyphae, pollen and plant tissues (Evans et al., 1985; Overmeer, 1985).

In natural habitats, some phytoseiids are important in preventing outbreaks of phytophagous mites, and many species are now being used as biocontrol agents in a number of agricultural ecosystems. They form a major component of ecological and integrated pest management systems. Thus, in the guidelines and standards for integrated fruit production (IFP) in Europe, special attention is given to phytoseiid mites and other beneficials. Priority must be given to natural, biological and similar methods of pest control, and the use of agrochemicals minimized. Further, it is stressed that populations of key natural enemies must be preserved, and if phytoseiid mites are absent from fruit orchards, they should be introduced where necessary (Dickler & Schäfermeyer, 1991).

In the Nordic countries (Denmark, Finland, Norway and Sweden), there was little knowledge of the phytoseiid fauna until the early 1980's. Generally, it was assumed that the climate in these countries was too cold for successful establishment of phytoseiid mites in the field. In his checklist of Norwegian mites, Mehl (1979) listed only two species, *Amblyseius jugortus* Athias-Henriot and *Amblyseius obtusus* (Koch).

Hansen & Johnsen (1986), in Denmark, studied phytoseiids from 39 plant species comprising fruit trees and other trees, shrubs and herbs. At least 17 species of the family were recorded, 11 of which were new for the country. A few years later, Steeghs et al. (1993) recorded 19 species of Phytoseiidae from 33 species of plants, mostly deciduous and coniferous trees in Sweden, and Tuovinen (1993), in Finland, listed 23 species, including three introduced species, from apple orchards and their surroundings.

In Norway a country-wide survey was started in 1984 to study the occurrence of phytoseiid species, their host plants and geographical distribution. During the first two years, some 2,100 specimens were collected from 11 counties of South Norway. They represented 15 identified and a number of unidentified species distributed in nine genera (Edland, 1987).

In addition to this survey a separate investigation was carried out in 1990–1995, using some commercial apple orchards, to study the species composition and densities in differently treated plots. Although the main results of this study have already been published (Edland, 1994), some additional information will be included in the present work.

The comprehensive data obtained during the 12 years of study, will be published in a series of papers. Only the genus *Typhlodromus* is dealt with in this paper.

Taxonomy

The only significant taxonomic study of Norwegian Phytoseiidae is that of Karg & Edland (1987) in which four species of *Typhlodromus* are listed or described, namely, *Typhlodromus pyri* Scheuten, *Typhlodromus eucervix* Karg & Edland, *Typhlodromus rodovae* Wainstein & Arutunjan and *Typhlodromus ajsel* (Abbasova). On examination, specimens attributed by W. Karg to *T. rodovae* (= *Typhlodromus corticis* Herbert) were found to comprise three species, *Typhlodromus ernesti* Ragusa & Swirski, *Typhlodromus laurae* Arutunjan and the presently described *T. norvegicus* sp. n. Later, Karg (1989) amended his identification of *T. rodovae* from *Picea abies* collected at "Langåra, Nesodden", Norway and proposed a new taxon *T. ernesti postici* for *T. rodovae* sensu Karg & Edland (1987). We have not found *T. corticis* or *T. ajsel* (= *Typhlodromus tubifer* Wainstein) in the material studied by us. The record of *T. ajsel* probably refers to *Typhlodromus bichaetae* Karg. Chant & Yoshida-Shaul (1987), in their world review of the *pyri*-group (of the genus *Typhlodromus* s. lat.), record *Typhlodromus pyri* Scheuten and *T. ernesti* from Norway.

MATERIAL AND METHODS

The main project, covering the whole country, was carried out in 1984–1996. During the survey, almost 2,000 samples from approx. 150 plant species were examined. Twigs from trees and bushes, or leaves and stems from herbaceous plants and grasses, were collected at various intervals during the whole year. The majority of samples, however, was collected during the spring, at budburst and shortly after, and in the autumn, mainly August–September. The size of the samples varied, most of them represented a volume of 4–6 litres of plant material. The samples were packed in plastic bags and brought to the laboratory where they were stored for a short period in a cold-storage chamber at 1–3°C, or treated immediately. When refrigerated, the samples were kept for some hours at about 20°C before the mites were extracted.

The mites were separated from the leaves or twigs by using a special washing method, which has proved well suited for the purpose. The samples were submerged in warm water (40–70°C), and a few droplets of soap ("Zalo") per 10 litres (approx. 0.01%) were added, which efficiently separated the mites from the plant material. After 12–30 h, the solution was filtered, first through a sieve of 1 mm mesh to remove the plant material, and thereafter through a 0.2 mm mesh to retain the mites. The filtrate were removed to 70% alcohol and stored in small tubes until preparation for study.

Samples of 25 leaves per tree were collected at different intervals during each season for the special investigation of phytoseiid mites in commercial apple orchards. The mites were separated from the leaves by means of a Californian mite brushing machine (Leedom Engineering). A pair of rotating brushes removes the mites from both sides of the leaves and they are deposited undamaged on a glass plate at the base of the apparatus. By this method, it is easy to select good specimens for preparation and identification.

A representative collection of the phytoseiid mites recorded in the survey, was mounted in a permanent medium, mainly Hoyers, and the coverslips sealed with various types of nail varnish. For the mites collected in the experiments with apple plots, a large number of specimens was selected and temporarily mounted in lactic acid for identification.

Terminology

The terminology for the chaetotaxy of the idiosoma and of the legs follows the systems of Lindquist & Evans (1965) and Evans (1963), respectively. The nomenclature used for the idiosomatic gland pores is that proposed by Athias-Henriot (1975). A diagrammatic representation of the chaetotaxy and distribution of poroids (putative slit organs) and gland pores of the dorsal shield is given in Fig. 1, and of the ventral setae referred to in the descriptions in Fig. 2.

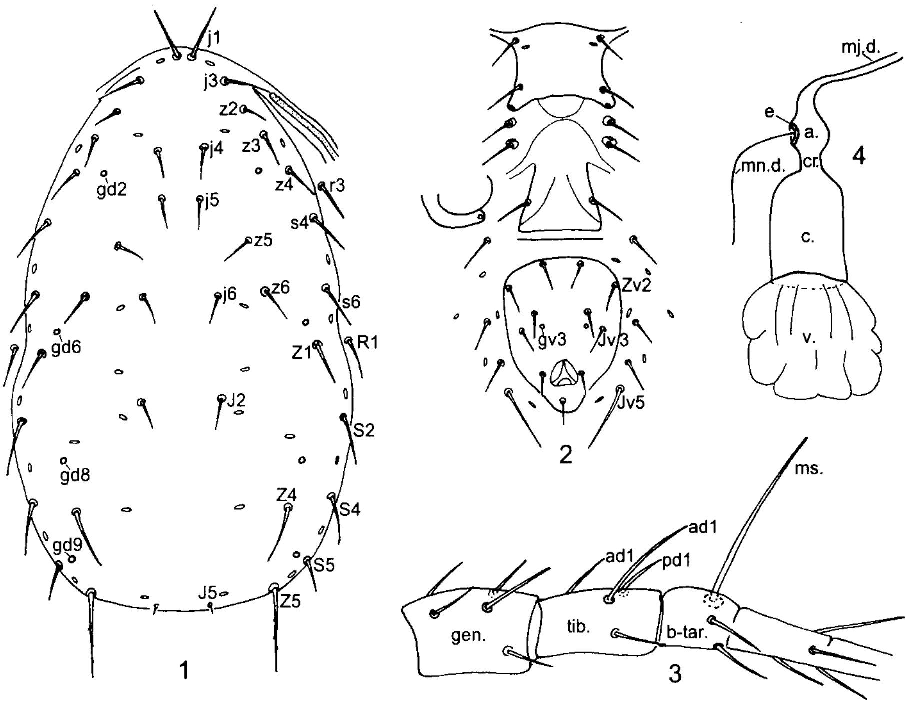
In addition to setal complement and pattern of individual podomeres, the length and form of certain setae of the genu, tibia and basitarsus of leg IV are used as taxonomic criteria. This applies particularly to setae ad1 of the genu and tibia and pd3 of the basitarsus. The latter, in *Typhlodromus*, is invariably conspicuous by its greater length and erect form in relation to other setae of the basitarsus and is termed a macroseta (Fig. 3). The macroseta may taper to a fine or blunt tip or be minutely capitate, that is, terminating in a small bulbous tip. Setae ad1 of genu and tibia IV in some species are considerably longer than pd1 and other setae of their podomere and are also referred to as macrosetae.

The terminology for the components of the spermatheca (sperm access system), widely used as taxonomic criteria in the Phytoseiidae, is shown diagrammatically in Fig. 4.

RESULTS

In the country-wide survey, phytoseiid mites occurred in 1,414 plant samples, approx. 70% of the total number of samples. The great majority of samples collected in the lowland regions of south Norway contained phytoseiids, often in high densities, whereas in the mountain regions and in the northern part of the country, these mites were not so common or abundant. In 293 samples from 35 plant species collected in late August 1991, at 80 different localities in north Norway (in the counties of Nordland, Troms and Finnmark) phytoseiid mites occurred in 58% of the samples. However, 60% of the samples containing mites had less than ten specimens. Only 4% of the samples contained more than 100 mites, and in one single sample from *Salix* sp. 270 specimens were recorded, indicating that the phytoseiid fauna may be rather dense on certain hosts even in the far North of the country.

During the survey, more than 11,000 specimens, recorded from 126 different plant species, were prepared for identification to species level. The occurrence of the eight species of *Typhlodromus*, dealt with in this work, on 62 different plants is given in Table 1. On the majority of the plants, only one or two species of *Typhlodromus* were recorded and this may be due to the very small number of samples examined. Six plants, each represented



Figs. 1–4. 1 – terminology for the chaetotaxy and porotaxy of the dorsal shield. 2 – chaetotaxy and ventral shields of the female. 3 – chaetotaxy of the genu, tibia and basitarsus of leg IV. 4 – components of the spermatheca or sperm access system. a. – atrium; ad. – antero-dorsal seta; b-tar. – basitarsus; c. – calyx; cr. – cervix or neck; e. – embolus; gen. – genu; gd – dorsal gland pore; j-J – dorso-central series; Jv. – medio-ventral seta; mj.d. – major duct; mn.d. – minor duct; ms. – macroseta; pd. – postero-dorsal seta; s-S – lateral series; tib. – tibia; v. – vesicle; Zv. – medio-lateral ventral seta; z-Z – medio-lateral series.

by 39–91 samples each, yielded four or five species, while from one host, *Juniperus communis*, with a total of 65 samples, all eight species were found. More than 64 samples per hostplant were collected from only eight species. As indicated by Table 1, *Picea abies* showed the highest frequency of *Typhlodromus* spp. mites, 74% of n: 91 samples, followed by *Juniperus communis* 65% (n: 65), *Pinus sylvestris* 63% (n: 79), *Corylus avellana* 17% (n: 71) and *Malus domestica* 16% (n: 86).

Species, plant hosts and distribution

We have followed Karg's (1993) concept of *Typhlodromus* Scheuten and *Anthoseius* De Leon in which each is given generic status rather than that of Chant & McMurtry (1994) who, in their critical review of the classification of the Phytoseiinae and Typhlodrominae, consider *Anthoseius* De Leon to be a subgenus of *Typhlodromus*. The concept of the subfamily Typhlodrominae follows Chant & McMurtry (1994).

The nomenclature used for the plants in this work follows Lid (1987) for wild growing species and van de Laar & de Jong (1995) for cultivated plants. The geographical distribution of the phytoseiid species is normally given on a base map for Norway, used in the

European Invertebrate Survey (EIS). In this map Norway is covered by 189 modified 50 km squares (Fig. 5). For some species, recorded in small numbers, the map is replaced by references to the EIS number in the text. In addition the locality of the northernmost record is given for each species.

TABLE 1. Host plants of *Typhlodromus* species, and their frequency in Norway. *Typhlodromus* species are abbreviated as follows: Tba (*T. baccettii*), Tbi (*T. bichaetae*), Ter (*T. ernesti*), Teu (*T. eucervix*), Tla (*T. laurae*), Tno (*T. norvegicus*), Tph (*T. phialatus*), Tpy (*T. pyri*).

	No. samples containing									
	Phytoseiid mites	*Typhlodromus* species	Tba	Tbi	Ter	Teu	Tla	Tno	Tph	Tpy
Abies alba	3	1			1					
Abies concolor	1	1			1					
Acer platanoides	38	4					1			3
Acer pseudoplatanus	14	1	1							1
Aesculus hippocastanum	14	3								3
Alnus glutinosa	37	4					1			3
Alnus incana	73	5			1	1	2			1
Artemisia vulgaris	1	1								1
Berberis vulgaris	3	1			1					
Betula pubescens	78	4			1		3			
Buxus sempervirens	2	1								1
Calluna vulgaris	40	3	1		2				1	
Chamaecyparis sp.	1	1			1					
Corylus avellana	71	12			2					11
Crataegus sp.	5	1	1							
Echium vulgare	2	1								1
Epilobium angustifolium	2	1					1			
Fagus sylvatica	11	1			1					
Fraxinus excelsior	34	7		1						6
Geranium sanguineum	4	3							1	2
Hedera helix	2	1								1
Hypericum maculatum	1	1								1
Juglans regia	2	1					1			
Juniperus communis	65	42	3	1	27	1	15	7	1	2
Larix sp.	7	1					1			
Lonicera periclymenum	10	6		1						5
Lotus corniculatus	1	1								1
Malus domestica	86	14	1							13
Malus sp.	8	2								2
Melilotus sp.	1	1								1
Picea abies	91	67			66	2	2			2
Picea sitchensis	5	1			1					
Pinus sylvestris	79	50		1	3	1	50			
Prunus avium	11	3								3
Prunus domestica	29	8				1				8
Prunus padus	21	1					1			
Prunus spinosa	2	2								2
Pyracantha coccinea	1	1								1
Pyrus c. cult	12	2	1		1					1
Quercus petraea	3	3		2		1				
Quercus robur	13	1								2

TABLE 1 (continued).

	No. samples containing									
	Phytoseiid mites	*Typhlodromus* species	Tba	Tbi	Ter	Teu	Tla	Tno	Tph	Tpy
Quercus rubra	1	1								1
Quercus sp.	38	13	1	8	3	1				3
Rhamnus catharticus	2	2								2
Ribes nigrum	10	3			1					3
Ribes rubrum	33	3				1				2
Ribes uva-crispa	5	2								2
Rosa sp.	1	1								1
Rubus fruticosus	42	6								6
Rubus idaeus	24	2	1							1
Salix caprea	42	2			2					
Salix sp.	39	5	1		1	1				2
Seseli libanotis	1	1					1			
Sorbus aucuparia	80	5		1	1		1			2
Syringa vulgaris	1	1								1
Taxus baccata	6	2			1		1			
Tilia cordata	18	2								2
Tilia platyphyllos	8	5					1			5
Tsuga sp.	1	1			1					
Ulmus glabra	21	2								2
Verbascum thapsus	8	1								1
Viburnum opulus	5	3			1					3

Family Phytoseiidae
Subfamily Typhlodrominae

Key to genera (adults) occurring in Norway

1 Setae z6 present; seta JV2 lacking and ventri-anal shield of female sole-shaped, much longer than wide, and with two pairs of ventri-anal setae .... *Paraseiulus* Muma
(Type: *Seiulus soleiger* Ribaga)
– Seta z6 absent; ventri-anal shield of female with three or four pairs of ventri-anal setae 2
2 Setae Z1 present .... *Neoseiulella* Muma
(Type: *Typhlodromus nesbitti* Womersley)
– Setae Z1 absent 3
3 Setae S5 present .... *Anthoseius* De Leon
(Type: *Anthoseius hebetis* De Leon)
– Setae S5 absent .... *Typhlodromus* Scheuten
(Type: *Typhlodromus pyri* Scheuten)

Genus *Typhlodromus* Scheuten

Key to females occurring in Norway

1 Dorsal shield with three pairs of gland pores (gd2, 6, 9), gd 8 lacking 2
– Dorsal shield with four pairs of gland pores (gd2, 6, 8, 9) (Fig. 1) 3
2 Genu II with 7 setae (2-2/0-2/0-1); spermatheca as in Figs 6, 7 .... *T. baccettii* Lombardini
– Genu II with 8 setae (2-2/1-2/0-1); spermatheca as in Fig. 27 .... *T. pyri* Scheuten
3 Ventri-anal shield with gland pores gv3 present; setae R1 longer than r3; Jv5 longer than Z5; spermatheca as in Figs 20–23 .... *T. eucervix* Karg & Edland

- Ventri-anal shield without gland pores gv3; setae R1 and r3 subequal or r3 longer than R1; Jv5 shorter, subequal or longer than Z5; spermatheca otherwise 4

4 Spermatheca with long neck, at least equal in length to the calyx (Figs 9–10); macroseta ad1 of tibia IV about two-thirds the length of the macroseta of basitarsus IV . . . . *T. bichaetae* Karg

- Neck of spermatheca, when present, less than one-half the length of the calyx (Figs 16–26); macroseta ad1 of tibia IV usually less than two-thirds the length of macroseta of basitarsus IV 5

5 Setae ad1 of tibia IV scarcely longer (about 1.1×) than pd1; spermatheca with calyx about 2× as long as broad (17/8 μm); peritreme extending to about the level of j1; setae Z4 distinctly spiculate . . . . *T. phialatus* (Athias-Henriot)

- Setae ad1 of tibia IV about 1.25–1.3× the length of pd1; spermatheca with calyx less than 2× as long as broad; peritreme extending to a level between s4 and j3, setae Z4 smooth or very sparsely spiculate 6

6 Setae Z4 shorter than S4; spermatheca with neck between calyx and atrium (Figs 24–26) . . . . *T. laurae* Arutunjan

- Setae Z4 subequal to or longer than S4; spermatheca with broad junction between calyx and atrium (Figs 16–18) 7

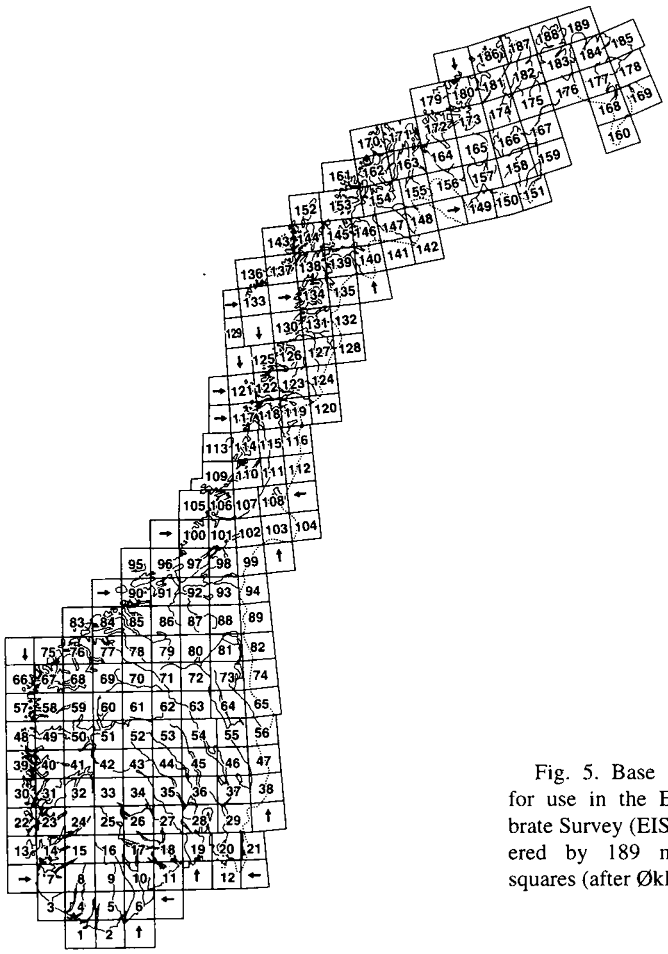


Fig. 5. Base map for Norway for use in the European Invertebrate Survey (EIS). Norway is covered by 189 modified 50 km squares (after Økland, 1977).

7 Z4 and S4 measure 35–41 µm (mean: x̄ = 37.8) and 29–33 µm (x̄ = 30.8) in length, respectively; setae j1 (24–27 µm) subequal to or shorter than j3 (27–30 µm); setae z3 and z4 22–25 µm and 20–23 µm, respectively; peritreme extending to a level between z2 and j3, about 140–160 µm long; spermatheca as in Figs 16–19 .... *T. ernesti* Ragusa & Swirski
– Z4 and S4 measure 24–30 µm (x̄ = 28.4) and 23–26 (x̄ = 24.75) in length, respectively; setae j1 (23–26 µm) longer than j3 (19–20 µm); setae z3 and z4 14–16 µm and 15–16 µm, respectively; peritreme often shorter extending to a level between s4 and z2, about 95–130 µm in length; spermatheca as in Figs 36–40 .... *T. norvegicus* sp. n.

Typhlodromus baccettii Lombardini, 1960

Typhlodromus baccettii Lombardini, 1960; Ragusa & Swirski, 1978; Chant & Yoshida-Shaul, 1987.
Typhlodromus (T.) helenae Schicha & Dosse, 1974.
Anthoseius oligadenus Athias-Henriot, 1978.

The Norwegian specimens of this species agree well with the redescriptions of Ragusa & Swirski (1978) and Chant & Yoshida-Shaul (1987) and have been compared with a female collected from *Cupressus* sp. at Sarteano, Italy (identified by S. Ragusa). The form of the spermatheca is shown in Figs 6 and 7. In all the specimens examined, the sternal shield is produced medially to the level of the third pair of sternal setae.

The type material was collected from *Cupressus sempervirens* in Firenze, Italy and the species has been found subsequently in other localities in Italy, in France on *Fraxinus* and in Australia on *Citrus* sp., *Juglans regia*, *Malus domestica*, *Prunus domestica*, *Quercus* sp. and *Ulmus* sp. (Schicha, 1987).

Plant hosts and localities. *T. baccetti* occurred as a rare species and was recorded on only nine plant species (Table 1), from five counties in south Norway (Fig. 14). The northernmost specimen was found at Høyanger, Sogn og Fjordane (EIS 49). Two samples, one from *Crataegus* (EIS 28) and one from *Pyrus* (EIS 49) had five specimens each of this species.

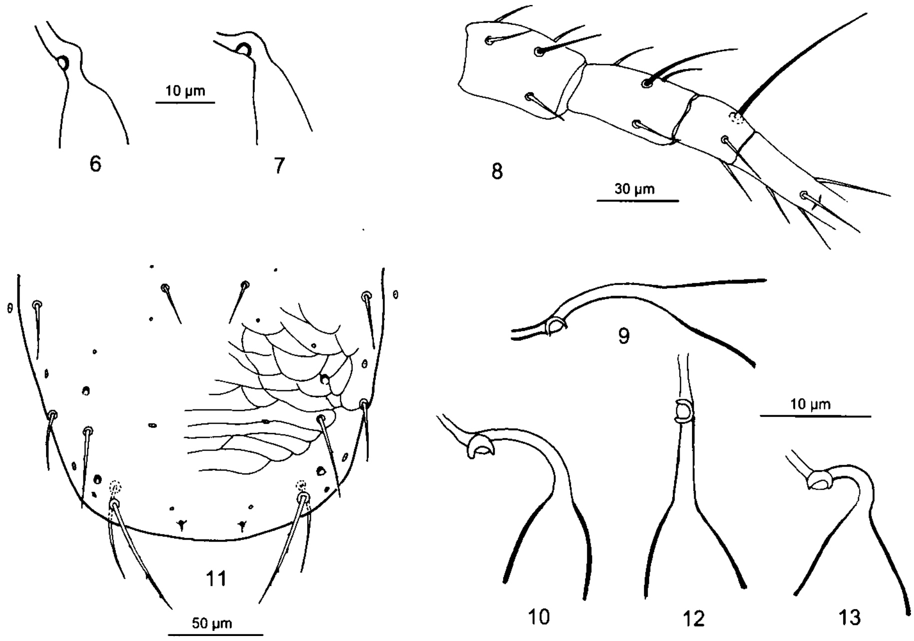
Typhlodromus bichaetae Karg, 1989

Typhlodromus bichaetae Karg, 1989.

The species mainly differs from *T. cotoneastri* Wainstein in the relative lengths of the macroseta of basitarsus IV and setae ad1 of tibia and genu IV (Fig. 8). The macroseta of basitarsus IV and setae ad1 of genu and tibia IV are markedly longer than in *T. cotoneastri* [measurements taken from the redescription of the holotype by Chant & Yoshida-Shaul (1987) and a specimen from *Acer* sp. collected in Italy], as indicated below:

	T. cotoneastri	*T. bichaetae*
mbt	39, 43 µm	51–68 µm (x̄ = 58.6)
ad1 (tib)	23 µm	32–39 µm (x̄ = 38.2)
ad1 (genu)	20 µm	25–27 µm (x̄ = 26.1)

The distance between the base of the basitarsal macrosetae and the dorsal slit organ of the telotarsus is 41 µm in *T. cotoneastri* and 41–44 µm in *T. bichaetae*.



Figs 6–13. 6–7 – *Typhlodromus baccettii* Lombardini, spermathecae. 8–11 – *T. bichaetae* Karg, female. 8 – genu, tibia and part of tarsus of leg IV showing macrosetae; 9–10 – spermathecae; 11 – posterior region of dorsal shield. 12–13 – *T. cotoneastri* Wainstein, spermathecae.

A comparison of the outline of the spermatheca in *T. cotoneastri* from Italy (Figs 12–13) with that of *T. bichaetae* (Figs 9–10) collected form *Quercus* sp. in Norway shows the tendency for the neck in the latter species to be longer relative to the calyx.

The length of the dorsal shield in the Norwegian specimens of *T. bichaetae* (320–339 µm) is similar to that of *T. cotoneastri*. A comparison of the lengths of the posterior setae of the dorsal shield (Fig. 11) and Jv5 are given below:

	T. cotoneastri	*T. bichaetae*
S2	34, 36 µm	33–36 µm
S4	28, 33 µm	31–35 µm
Z4	36, 38 µm	41–45 µm
Z5	55, 56 µm	63–68 µm
Jv5	39, 46 µm	49–54 µm

The specimens attributed to *T. ajsel* by Karg & Edland (1987) probably refer to *T. bichaetae*.

PLANT HOSTS AND LOCALITIES. A total of 40 specimens of *T. bichaetae* was recorded from 16 samples of eight different plants (Table 1). Most of them, one male and 30 females, occurred on *Quercus*. The species was distributed in seven counties of south Norway, and as far north as Låne, Balestrand, Sogn og Fjordane (EIS 50) (Fig. 15).

Typhlodromus ernesti Ragusa & Swirski, 1978

Typhlodromus ernesti Ragusa & Swirski, 1978; Chant & Yoshida-Shaul, 1987.

The Norwegian specimens of this species, females only, have been compared with paratypes kindly loaned by S. Ragusa. The lengths of the idiosomatic setae agree in general with those given for the holotype by Chant & Yoshida-Shaul (1987). The numbers in parentheses in the following table of setal lengths (μm) refer to the paratypes:

	Holotype	Norwegian material
j1	23 (24, 25)	24–27
j3	24 (27)	27–30
z2	17	16–17
z3	21 (22, 23)	22–25
z4	21	20–23
s4	23	23–27
s6	28	27–28
S2	31	32–34
S4	32 (29, 33)	29–33
Z4	35 (32, 37)	35–41
Z5	53 (47, 51)	45–60
r3	23 (24)	23–26
R1	22 (23)	24–26
Jv5	53 (44, 51)	46–52
mbt	47 (43, 46)	47–55
ad1 (tib. IV)	(27, 29)	29–30
ad1 (gen. IV)	(20, 21)	20–21

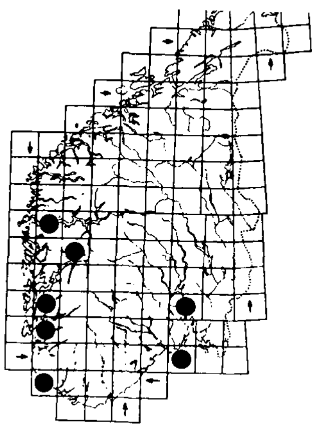


Fig. 14. Distribution of *Typhlodromus baccettii* Lombardini in Norway.

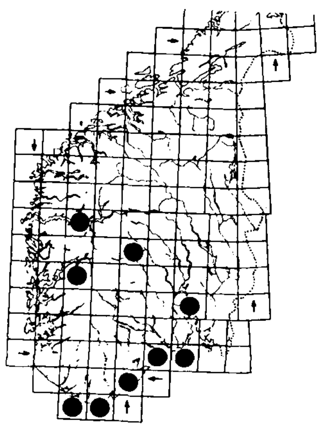


Fig. 15. Distribution of *Typhlodromus bichaetae* Karg in Norway.

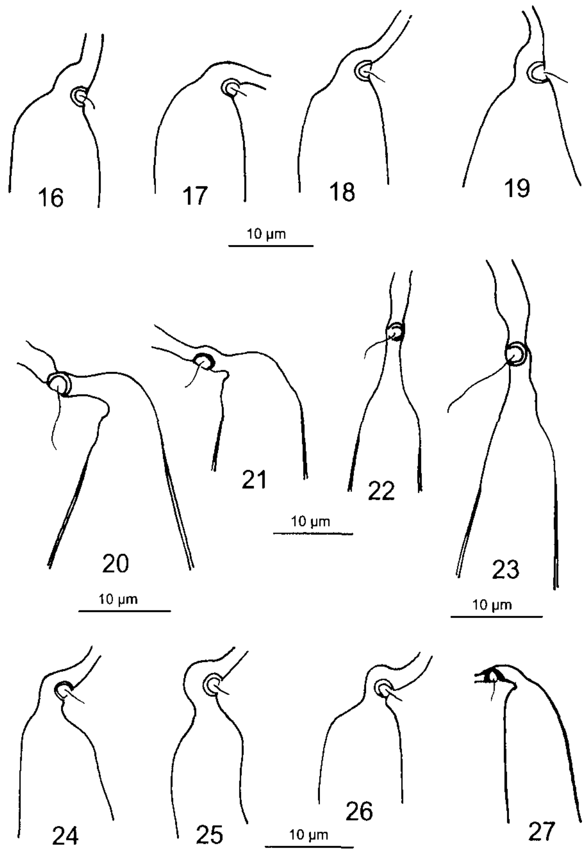
The length of seta z4 (20–23 μm) is usually about two-thirds the distance between z4 and s4 (26–32 μm). Chant & Yoshida-Shaul (1987) refer to the location of setae r3 on the margin of the dorsal shield in the holotype female and in a specimen from Norway. These setae are located on the lateral unsclerotized cuticle in the paratypes and, with rare exceptions, in the Norwegian material examined by us. An interesting feature of this species is the greater length of the left peritreme in comparison with the right. In the two paratypes, for example, the left measured 159 μm and the right 141 μm whilst in the Norwegian specimens difference in length between the two peritremes ranged from 4–18 μm.

The spermatheca in which the calyx is broadly joined to the atrium, exhibits a variety of shapes depending on orientation and degree of compression. A range of forms from different plant hosts in Norway and in a paratype are shown in Figs 16–18 and Fig. 19, respectively.

Karg (1989) has described a subspecies of *T. ernesti*, namely, *T. ernesti postici* from "*Picea abies*", "Langåra Nesodden", Norway (see Introduction). The subspecies is distinguished from the nominal species mainly by leg IV being clearly shorter (330 µm) than the length of the idiosoma (350–370 µm). The length of leg IV in the Norwegian material of *T. ernesti* ranged from 332–360 µm and the length of the dorsal shield from 315–350 µm. Chant & Yoshida-Shaul (1987) give 320 µm for the length of the dorsal shield (given as the measurement of the idiosoma by Karg, 1993) and 342 µm for leg IV in the holotype while in two paratypes we have examined the dorsal shield measured 336 µm (one damaged) and leg IV 340 and 360 µm. The measurements given by Karg to characterize the new taxon do not appear to take into account the intraspecific range of variation and this casts doubt on the validity of the subspecies.

The type material was collected from *Taxus baccata* in Tuscany, Italy. Chant & Yoshida-Shaul (1987) report its occurrence in "Germany, Austro-German border, Switzerland and Norway" as well as from Canada. European plant hosts include *Picea*, *Quercus*, *Betula*, *Juniperus communis*, *Pinus sylvestris* and *Sorbus aucuparia*.

Plant hosts and localities. *T. ernesti* is a very common species in Norway. It was recorded in all counties, except Hedmark, and as far north as Olderdalen, Kåfjord, Troms at



Figs 16–27. Spermathecae. 16–19 – *Typhlodromus ernesti* Ragusa & Swirski (Fig. 19 from a paratype); 20–23 – *T. eucervix* Karg & Edland; 24–26 – *T. laurae* Arutunjan (Figs 24–25 from *Pinus sylvestris*, Fig. 26 from *Tilia platyphyllos*); 27 – *T. pyri* Scheuten.

69°36′N (EIS 163) (Fig. 28). On its main host, *Picea abies*, it was frequently abundant, and occurred in 66 of the 91 samples. It also occurred commonly on *Juniperus communis*, in 27 of 65 examined samples. The species was recorded from a total of 21 plant species (Table 1), but only small numbers of specimens occurred on non-coniferous plants.

Typhlodromus eucervix Karg & Edland, 1987

Typhlodromus eucervix Karg & Edland, 1987.

Four taxa with conspicuously abbreviated peritremes have been described in the genus *Typhlodromus*. Of these, *T. klimenkoi* Kolodochka may be distinguished by lacking pre-anal pores (gv3), having longitudinal striae and not micropapillae on the floor of the peritreme and lacking a distinct neck (cervix) between the calyx and atrium of the spermatheca. The other three taxa, *T. pritchardi* Arutunjan, *T. andrei* Karg and *T. eucervix* are, at present, separated on the basis of the dimensions of certain idiosomatic setae and the apparent form of the spermatheca. Chant & Yoshida-Shaul (1987) have commented on the similarity (with possible synonymy) between *T. pritchardi* and *T. andrei* in which one

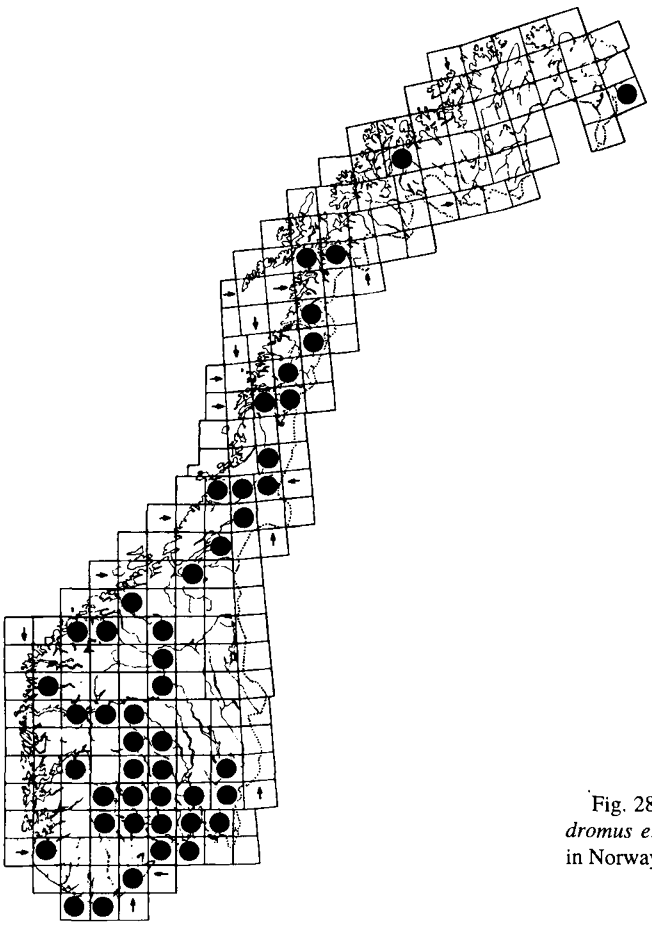


Fig. 28. Distribution of *Typhlodromus ernesti* Ragusa & Swirski in Norway.

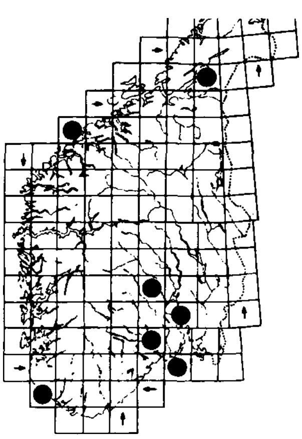


Fig. 29. Distribution of *Typhlodromus eucervix* Karg & Edland in Norway.

of the main distinguishing characters appears to be the very much greater difference in length between setae Z4 and Z5 in *T. pritchardi* (33/60 μm) than in *T. andrei* [39/44 μm in the holotype teste Chant & Yoshida-Shaul (1987)]. *T. eucervix* was decribed by Karg & Edland (1987) from Norwegian material. Surprisingly, these authors considered only *T. klimenkoi* in their "Differentialdiagnose" and overlooked the more closely related species *T. pritchardi* and *T. andrei*.

The female specimens at our disposal have the characteristics of *T. eucervix* except for the form of the spermatheca in which the neck is shorter and thicker (Figs 20–23) than that illustrated in the original description. There appears to be no great difference in the form of the spermatheca between this species and *T. andrei* (compare Fig. 20 with Fig. 11c in Karg, 1982). However, there are differences between the two taxa in the lengths of setae Z5, setae Jv5, the macroseta (mbt) of the basitarsus IV and setae ad1 of tibia and genu IV. The following measurements of the holotype females of *T. andrei* and *T. eucervix*, with the exception of ad1 of tibia IV, are taken from Chant & Yoshida-Shaul (1987) and Karg & Edland (1987), respectively. In addition, setal lengths of a specimen collected from foliose lichens on the bark of *Fraxinus* in Belgium (Frax-Belg.) and a range of measurements from specimens collected from *Picea*, *Juniperus*, *Alnus* and *Ribes* in Norway are given for comparative purposes.

	T. andrei	*T. eucervix*			*T. pritchardi*
	Holotype	Frax-Belg.	Holotype	Norway	Arutunjan (1971)
Z4	39 μm	39 μm	39 μm	35–39 μm	33 μm
Z5	44 μm	45 μm	53 μm	48–55 μm	60 μm
Jv5	46 μm	55 μm	60 μm	58–63 μm	—
mbt	50 μm	54 μm	55 μm	50–57 μm	57 μm
ad1 (tib)	24 μm	30 μm	—	29–32 μm	30 μm
ad1 (gen)	19 μm	28 μm	—	28–31 μm	30 μm

The significance of differences in setal lengths in the three taxa is difficult to assess in view of the small number of specimens available for study, which precludes statistical analyses. The description of the female of both *T. andrei* and *T. pritchardi* appears to have been based on a single specimen. The specimen from Belgium, (Frax-Belg) presents a different combination of setal-length characteristics from both *T. andrei* and *T. eucervix* in that it has the length of seta Z5 as in *T. andrei* but that of Jv5 and ad1 of genu and tibia IV as in *T. eucervix*! Published illustrations of the shape of the calyx, cervix (neck) and atrium would seem to indicate differences between the three species but these are due in part to the different orientation and degree of compression of the spermatheca. We have not observed the long slender neck illustrated by Karg & Edland (1987) in any of the specimens of *T. eucervix* examined by us from Norway although this character is used by Karg (1993) as a major feature separating *T. eucervix* from *T. andrei* and *T. pritchardi*. At present, males have been described only in *T. andrei*. The taxonomic status of the three taxa must await a more extensive study of larger populations from different geographical areas and plant hosts. It is possible that the three taxa will prove to be conspecific but, for the present, we accommodate the Norwegian specimens in *T. eucervix*. It is interesting to note that *T. andrei*, *T. eucervix* and *T. klimenkoi* have setae R1 distinctly longer than r3 whereas in other described species of the genus these two setae are subequal in length or r3 is longer than R1.

T. pritchardi has been recorded from wild strawberry in Armenia and from *Sorbus*, *Tilia* and various herbaceous plants in the area of Yaroslavl, Russia; *T. andrei* was collected from the bark of a fruit tree in Belgium. The holotype of *T. eucervix* is from *Juniperus communis*, Brønnøya, Asker, Akershus (EIS 28), Norway.

Plant hosts and localities. *T. eucervix* is a rare species. It occurs scattered in south Norway north to Molde, Møre og Romsdal (EIS 83) and Levanger, Nord Trøndelag (EIS 98). A total of 17 specimens has been recorded from nine plant species, both decidous and coniferous trees (Table 1). It is distributed in seven different counties (Fig. 29).

Typhlodromus laurae Arutunjan, 1974

Typhlodromus laurae Arutunjan, 1974; Chant & Yoshida-Shaul, 1987.

We have followed Chant & Yoshida-Shaul's (1987) concept of *T. laurae*. One of the characteristics of the species is the shorter length of Z4 in comparison with S4. The difference between the lengths of these two setae is less marked in material from *Juniperus* than from *Pinus* and *Picea*, as will be evident from the following comparative lengths (given in μm) of selected idiosomatic and leg setae:

	Pinus sylvestris and *Picea abies*	*Juniperus communis*
S4	31–34 ($\bar{x}$ = 32.2)	27–30 ($\bar{x}$ = 28.7)
Z4	24–29 ($\bar{x}$ = 26.9)	25–27 ($\bar{x}$ = 25.2)
Z5	47–54 ($\bar{x}$ = 49.8)	46–54 ($\bar{x}$ = 49.1)
JV5	49–55 ($\bar{x}$ = 52.2)	48–54 ($\bar{x}$ = 51.7)
mbt	52–53 ($\bar{x}$ = 52.4)	48–53 ($\bar{x}$ = 50.7)
ad1 (tib)	30–31 ($\bar{x}$ = 30.6)	30–32 ($\bar{x}$ = 30.9)
ad1 (gen)	23–25 ($\bar{x}$ = 23.8)	22–24 ($\bar{x}$ = 23.2)

Setae j1 (22–25 μm) are usually longer than j3 (18–24 μm), but may be subequal. Setae z4 (15–17 μm) are about one-half the length of the distance between z4 and s4 (27–32 μm). In our material, the dorsal shield measured 336–370 μm in length and leg IV 348–375 μm.

As in *T. ernesti* the left peritreme (161–175 μm) in *T. laurae* is distinctly longer than the right (145–163 μm) and reaches to a level between z3 and j3. Only females of this species were present in specimens collected from Norway. The calyx of the spermatheca is separated from the atrium by a short neck (Figs 24–25). In a single specimen from *Tilia platyphyllos*, the calyx was distinctly "shouldered" (Fig. 26) and resembled the condition in *T. exhilaratus* (Ragusa). However, the length and form of the body and leg setae agreed with those of *T. laurae* from *Pinus*. The fixed digit of the chelicera has four teeth and the movable digit a single tooth.

The female holotype was collected from *Pinus* in Armenia. It has been recorded subsequently from *Pinus* in the Netherlands and Germany.

PLANT HOSTS AND LOCALITIES. This species is widely distributed and as indicated by Fig. 30, it was recorded from all counties in Norway. It was collected as far north as Børselv, Porsanger, Finnmark at 70°19′N (EIS 182). *Pinus sylvestris* represents its main host. The species was recorded in 63, 23 and 2% of *Pinus sylvestris* (79 samples), *Juniperus communis* (65) and *Picea abies* (91), respectively. On deciduous trees and bushes it was always recorded in small numbers. *T. laurae* occurred on 15 different plant species (Table 1).

Typhlodromus phialatus Athias-Henriot, 1960

Typhlodromus phialatus Athias-Henriot, 1960; Kolodochka, 1978; Chant & Yoshida-Shaul, 1987.
Typhlodromus ulex Evans, 1988 syn. n.

We have compared our specimens (females) with syntypes of *T. phialatus* and *T. ulex* with which they agree in all details. The species has been found on a wide range of host

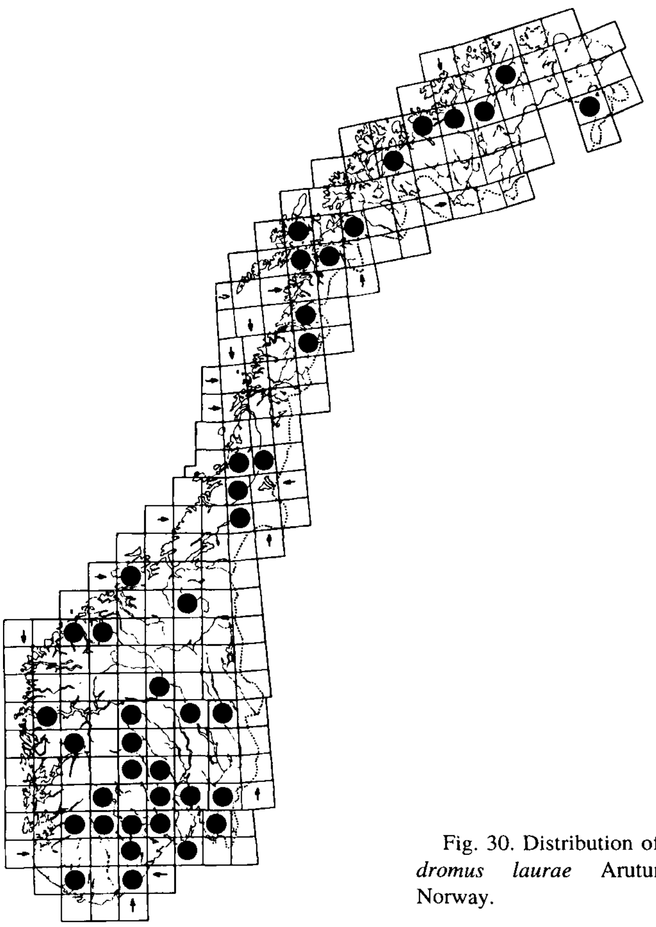


Fig. 30. Distribution of *Typhlodromus laurae* Arutunjan in Norway.

plants from localities in N. Africa, western Europe and Russia (Chant & Yoshida-Shaul, 1987).

PLANT HOSTS AND LOCALITIES. A total of seven specimens (all females) from three samples has been recorded in this study. One specimen was found on *Geranium sanguineum*, and five specimens on *Calluna vulgaris* on a small island, Langåra, in the Oslo-fjord, Frogn, Akershus (EIS 28). An additional specimen was collected in a sample from *Juniperus communis* at Verdens Ende, Tjøme, Vestfold (EIS 11b).

Typhlodromus pyri Scheuten, 1857

Typhlodromus pyri Scheuten, 1857; Chant & Yoshida-Shaul, 1987.

There has been considerable confusion in the literature concerning the identity of this species prior to the designation of a neotype by Chant & Yoshida-Shaul (1987) who also give a comprehensive list of plant hosts and localities. The spermatheca is illustrated in Fig. 27.

PLANT HOSTS AND LOCALITIES. In the main survey, a total of 106 specimens of *T. pyri* was recorded. The species occurred commonly, though seldom abundantly, on a range of different host plants, mainly on deciduous trees and shrubs, but also on a few conifers (*Juniperus*, *Picea abies*), evergreens (*Buxus*, *Hedera*, *Pyracantha*), and some herbs (*Artemisia*, *Echium*, *Geranium*, *Hypericum*, *Melilotus* and *Verbascum*). *T. pyri* was recorded from a total of 43 different plants in this study (Table 1).

As indicated by Fig. 31 this important predator is distributed in the coastal areas of the eastern and southern part and along the fjords in the western part of the country, as far north as Verdal, Nord Trøndelag (EIS 98). It was recorded from 12 counties. In the mountain region the species has been found sporadically, e.g. on *Ribes nigrum* at Valle, Setesdal (elevation approx. 300 m) Aust Agder (EIS 16), and on *Hypericum maculatum* at Garen, Eidfjord (elevation 750 m) Hordaland (EIS 33). The number of samples collected per host plant in this study varied greatly. For some plant species, each represented by 10–80 samples, the percentage of samples containing *T. pyri* was as follows: *Prunus domestica* 28, *Fraxinus excelsior* 18, *Corylus avellana* 16, *Malus domestica* 15 and *Rubus fruticosa* 14.

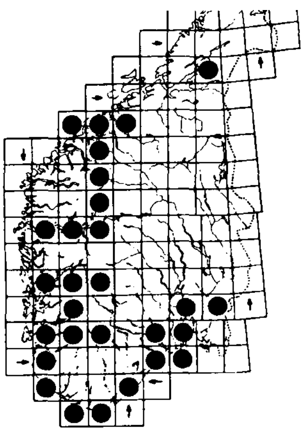


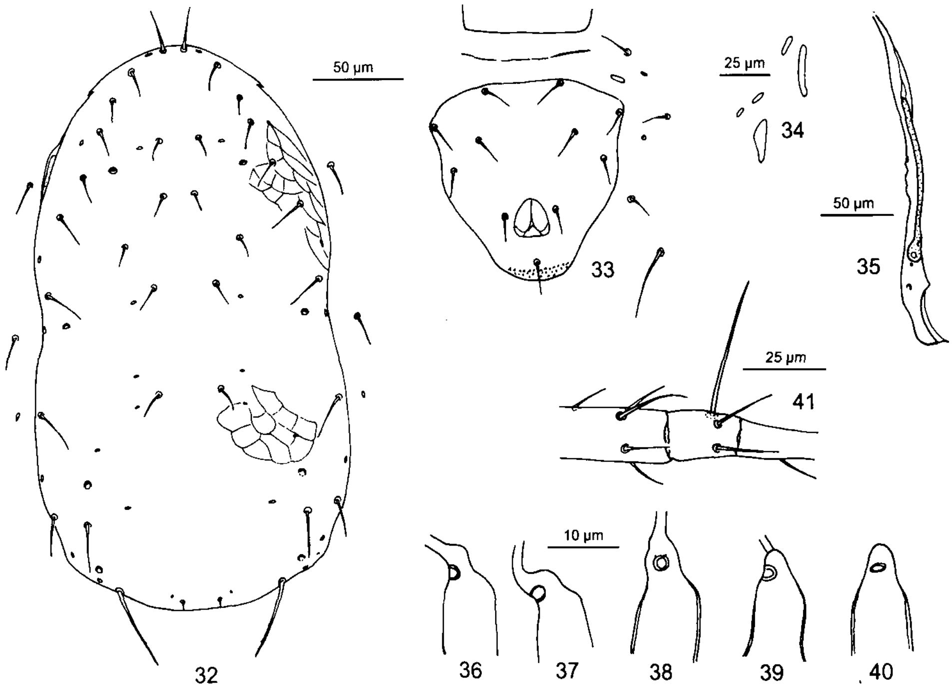
Fig. 31. Distribution of *Typhlodromus pyri* Scheuten in Norway.

In the investigation of phytoseiid occurrence in differently treated apple plots, the percentage of leaf samples which contained *T. pyri* was far higher. In 1991 and 1992, when more than 10,500 phytoseiid specimens were identified to species level, *T. pyri* represented 26.5% of the total number. Only *Paraseiulus soleiger* (Ribaga) was more abundant (37.2%). On some of the experimental trees, *T. pyri* was very common during the two years, and showed a density of 1–2 mites per leaf in August–September. At such high density, this predator reduced the number of leaf feeding mites to a low level, below the economic threshold (Edland, 1994). However, this native population of *T. pyri* is very sensitive to many pesticides, and to organophosphorus (OP) insecticides in particular. Thus, treatments with azinphosmethyl applied in 1994 to control heavy attacks of apple fruit moth, *Argyrestia conjugella* Zeller (Yponomeutidae), reduced the number of this important predator to a minimum.

Because *T. pyri* has proved to be a most efficient biocontrol agent in Norwegian orchards, an OP-resistant strain of this species was introduced from the UK and released in 1987 in some apple orchards in South Norway. This strain was successfully established and after a few years the density rose to a high level with at least one mite per leaf in the autumn. Further progress in the utilization of this predator for control of injurious mites in Norwegian commercial orchards has been discussed elsewhere (Edland, 1997).

Tyhlodromus norvegicus sp. n.

Amongst material of *Typhlodromus* collected from *Juniperus communis* at seven localities in Norway we have found females which cannot be accommodated in either *T. ernesti* or *T. laurae*. They resemble *T. ernesti* in the form of the spermatheca and in having Z4 subequal or longer than S4 but resemble *T. laurae* in having the length of z4 about one-half the distance between z4 and s4, and j3 shorter than j1. There is a tendency for the peritreme to be reduced in length. The new taxon which we are proposing has the following characteristics:



Figs 32–41. *Typhlodromus norvegicus* sp. n., female. 32 – dorsal shield; 33 – ventri-anal shield; 34 – metapodal shields; 35 – peritreme; 36–40 – spermathecae; 41 – macrosetae of tibia and basitarsus of leg IV.

Dorsal shield of female (325–360 µm in length) reticulated and with 14 pairs of poroids and four pairs of gland pores (gd 2, 6, 8, 9), distributed as in Fig. 32. Dorsal setae smooth except for Z5 which is sparsely spiculate. Length of dorsal setae (in µm) as follows:

j1	23–25	z2	13	s4	20–24	r3	19–21
j3	18–20	z3	14–16	s6	24–26	R1	19–20
j4	14–15	z4	15–16	S2	27–28		
j5	14–15	z5	13–14	S4	23–26		
j6	14–15	Z4	24–30				
J2	16–17	Z5	41–48				
J5	5						

Setae z4 (15–16 µm) about one-half the length of the distance between the bases of z4 and s4 (28–32 µm). Setae z3 and z4 considerably shorter than in *T. ernesti*.

Sternal shield with two pairs of setae and with a sclerotized posteromedian area. The ventri-anal shield is 107–116 µm ($\bar{x}$ = 112.5) long and 104–114 µm ($\bar{x}$ = 107.8) wide at the level of setae Zv2. There are normally four pairs of preanal setae (Fig. 33) but two of the

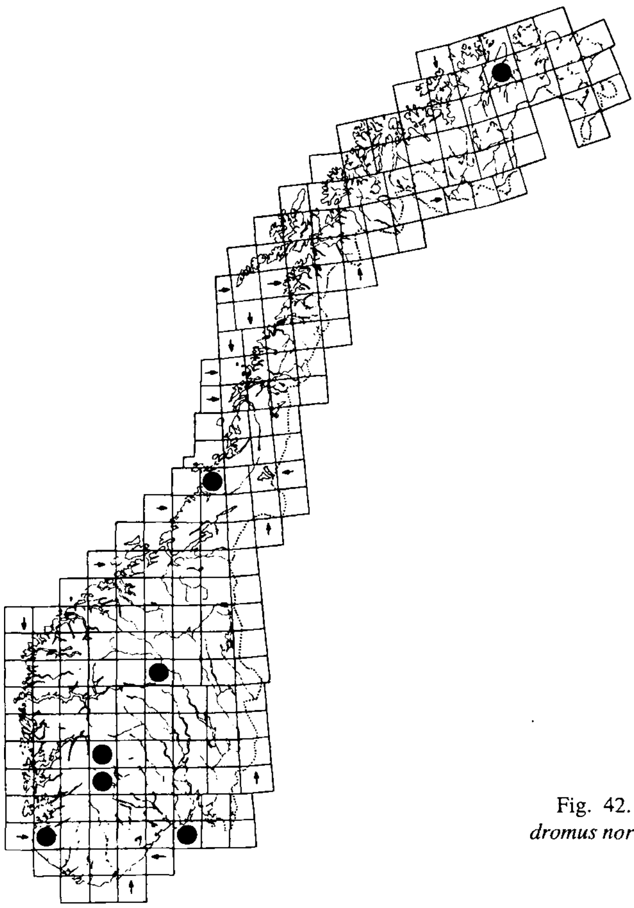


Fig. 42. Distribution of *Typhlodromus norvegicus* sp. n. in Norway.

specimens lacked Jv2 or Zv3 on the right side. Pores gv3 absent; setae Jv5, 36–40 µm in length. Metapodal shields as in Fig. 34.

Peritreme shorter than in *T. ernesti* and *T. laurae* but length variable between right and left side of the body as well as between populations (Fig. 35):

	Garen	Børselv	Raulandsgrend	Verdens Ende	Taksdal
Right	59–114 µm	96–122 µm	122 µm	127 µm	118–130 µm
Left	100–118 µm	105–127 µm	123 µm	132 µm	91–109 µm

The specimen from Garen, Eidfjord with the very short periteme (59 µm) on the right side of the idiosoma was the one that lacked seta Jv2 on the right side of the ventri-anal shield. Spermatheca with broad junction between calyx and atrium (Figs 36–40). The movable digit of the chelicera has a single tooth and the fixed digit four teeth.

Genu II with seven setae (2-2/0-2/0-1), chaetotaxy of other leg podomeres typical for the genus as given by Chant & Yoshida-Shaul (1987). Macroseta of basitarsus IV (Fig. 41) relatively slender and tapering to a blunt tip in females from Garen and Taksdal but thicker, less conspicuously tapering and blunt/capitate in those from Børselv, Raulandsgrend and Verdens Ende; 45–48 µm in length with the distance between its base and the dorsal slit organ of the telotarsus approximately equal to the length of the macroseta (Fig. 41). Setae ad1 of the genu and tibia IV, respectively, 18–20 µm and 23–26 µm. Leg IV measures 315–350 µm.

PLANT HOSTS AND LOCALITIES. All the specimens of this new species were collected from *Juniperus communis* – two females at Taksdal, Time, Rogaland (EIS 7), (Prep. No. 1132); one female from Verdens Ende, Tjöme, Vestfold (EIS 11b), (Prep. No. 3177); one female at Raulandsgrend, Vinje, Telemark (EIS 25), (Prep. No. 2711); four females at Garen, Eidfjord (elevation 750 m), Hordaland (EIS 33), (Prep. No. 1800, 1801); three females at Skjedalsætra, Nord Fron, Oppland (EIS 62), (Prep. No. 3556); one female at Sandvik, Namson, Nord Trøndelag (EIS 106), (Prep. No. 1451), and five females at Börselv, Porsanger, Finnmark (EIS 182), (Prep. No. 3828). Fig. 42 shows its geographical distribution. The holotype and three paratypes are from the sample taken at Garen and are deposited in the collection of The Natural History Museum, London, England.

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