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Autor: Kozár, Ferenc / Guignard, Eugene / Bachmann, Fritz

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The scale insect and whitefly species of Switzerland (Homoptera: Coccoidea and Aleyrodoidea)

FERENC KOZÁR¹, EUGENE GUIGNARD³, FRITZ BACHMANN⁴, ERWIN MANI²
& CARSTEN HIPPE²

¹Plant Protection Institute, Hungarian Academy of Sciences, P.O.Box 102, H-1525 Budapest

²Eidgenössische Forschungsanstalt für Obst-, Wein- und Gartenbau, CH-8820 Wädenswil

³Ch. Bourgogne 9, CH-1260 Nyon

⁴Inzlingerstr. 250, CH-4125 Riehen

A survey of scale insects and whiteflies was carried out in different parts of Switzerland. 87 scale insect species, belonging to 9 families, were found. Among them 34 proved to be new for Switzerland, and one is new for the European fauna. The total number of all species recorded from Switzerland, from nature and greenhouses, is now 115; 90 of them can be considered as "natural" and 25 as "greenhouse" species. Recently, some important pests of orchards (*Quadraspidiotus marani*, *Q. ostreaeformis*, *Q. pyri*) and of ornamental plants (*Pseudaulacaspis pentagona*, *Carulaspis juniperi*, *Eupulvinaria hydrangeae*) substantially increased their population density. The paper presents data on the localities, on host plants, on the preferred parts of plants, on developmental stages and on population densities. In the survey 8 species of whiteflies were also collected. Among them 6 proved to be new for the Swiss fauna. The total number of recorded whitefly species in Switzerland is at present 9.

Keywords: Scale insects, whiteflies, Switzerland, faunistics, ecology.

INTRODUCTION

The scale insect fauna of Switzerland was only superficially studied in the past. An early review can be found in LINDINGER (1912). The current monograph on scale insects of Central Europe (KOSZTARAB & KOZÁR, 1988) mentions only 56 species for Switzerland compared to 233 species known in Central Europe. The scale insect fauna of Swiss greenhouses was studied in more detail by HADORN (1940). He presented 27 species which can survive in Switzerland mostly under indoor conditions. Studies on economically important pests were carried out by BACHMANN (1952, 1953), BACHMANN & GEIER (1950), GEIER (1949), GEIER & BAGGIOLINI (1950), SUTER (1950), MANI & STAUB (1966), MANI (1970), WILDBOLZ (1992) and MANI *et al.* (1993).

The world catalogue of whiteflies (MOUND & HALSEY, 1978) mentions only two species for Switzerland, both known as pests (BOVEY, 1979). Recently a new species, *Bemisia tabaci* (GENNADIUS, 1889), appeared in the greenhouses of Central Europe, including Switzerland (KOCH, 1989; KOZÁR *et al.*, 1991).

In the last few years new scale insect and whitefly species have appeared from the Mediterranean area and from overseas. The detection of such newcomers is difficult unless the fauna is better known. Therefore a survey of these groups in the field and in collections became important.

MATERIAL AND METHODS

Most of the insects were sampled by the senior author in April and May 1992 from host plants. Pheromone traps for *Pseudaulacaspis pentagona* (TARGIONI-TOZZETTI, 1886) were placed from June to August in 1992. In addition to this survey the collections of F. BACHMANN and E. GUIGNARD were consulted. Samples from these collections are designated with FB and EG, respectively. The insects collected by the senior author are mainly deposited at the Plant Protection Institute, Hungarian Academy of Sciences (Budapest), as microscopic slides, dry material, or preserved in alcohol. Some of the slides and dry material are deposited at the Eidgenössische Forschungsanstalt für Obst-, Wein- und Gartenbau (Wädenswil, Switzerland). The collection of E. GUIGNARD is deposited at the Station Fédérale de Recherches Agronomiques de Changins (Nyon, Switzerland).

The samples were evaluated and described according to the method of KOZÁR *et al.* (1979). In the list of species collected the following data are mentioned:

– Time of collection: Day and month. The year is 1992, if not otherwise indicated.

– Host plant.

– Infested part of the plant

– Phenological stage of the insect.

– The intensity of the infestation indicated by a score system from F=0 to F=4.

– Sample number in KOZÁR's collection (in brackets).

The remarks in the list of species about their distribution are from KOSZTARAB & KOZÁR (1988).

The pheromone traps were of the Wädenswil type (ARN *et al.*, 1979). The pheromone dispensers for *P. pentagona* were produced by B. KOVALEV (Kishinev, Moldavia).

RESULTS

In the course of our survey 87 scale insect species belonging to 9 families were found: 3 in Ortheziidae, 2 in Margarodidae, 15 in Pseudococcidae, 7 in Eriococcidae, 2 in Cryptococcidae, 22 in Coccidae, 3 in Asterolecaniidae, 1 in Cerococcidae, 32 in Diaspididae. In our survey we also found 8 species of whiteflies.

New for the fauna of Switzerland are 34 scale insect and 6 whitefly species. With these additions the fauna of Switzerland comprises now 90 scale insect and 9 whitefly species.

List of the species found in the survey:

COCCOIDEA

I. ORTHEZIIDAE

Arctorthezia cataphracta (OLAFSEN, 1772) – Oberiberg, 13.9., *Vaccinium* sp. and under moss, female, F=1 (4065); Studen, 20.9., under moss, female 1st and 2nd instar larvae, F=1 (4071).

Orthezia urticae (LINNAEUS, 1758) – Gersau, 15.5., *Galium* sp., *Teucrium* sp., on leaves and stems, female and 2nd instar larvae, F=1 (3938); Gersau, 6.9., *Allium* sp., *Rubus* sp., female, 1st and 2nd instar larvae, F=3 (4046); Gersau, 6.9., *Hieratium staticifolium*, larvae, F=1 (4054); Sion, 18.5., *Clematis vitalba*, *Rubus caesius* and *Taraxacum* sp., female, 1st and 2nd instar larvae, F=3 (3954).

Ortheziola veydovskyi ŠULC, 1894 – Wädenswil (in the town), 17.5., under moss, female, 1st and 2nd instar larvae, F=1, (3943); Wädenswil (Eichmühle), 6.5., under moss, female, 1st and 2nd instar larvae, F=1, (3910); Richterswil, 27.5., under moss, female, 1st and 2nd instar larvae, F=1 (3988); Landquart, 9.10., *Dianthus* sp., on the roots, larvae, F=1 (4090).

II. MARGARODIDAE

Icerya purchasi MASKELL, 1895 – Brissago, 15.10.1946, 1st instar larvae (EG).

Paleococcus fuscipennis (BURMEISTER, 1835) – Brissago, 18.9., *Pinus* sp. (?) (collected by L. RESER among Lepidoptera from linen with light at night!), female, male and larvae, F=3 (4080).

III. PSEUDOCOCCIDAE

Atrococcus cracens WILLIAMS, 1962 – Gersau, 6.9., *Hieracium staticifolium*, *Knautia arvensis*, *Vaccinium vitis-idaea*, on roots, female and larvae, F=3 (4051, 4052, 4054); Unteriberg, 4.10., *Thymus* sp., on roots, female, F=1 (4084); Walenstadt, 12.9., *Vaccinium* sp., on roots, female, F=2 (4059).

Balanococcus boratynskii WILLIAMS, 1962 – Unteriberg, 19.9., *Poa* sp., in leaf sheaths, female and larvae, F=2 (4068).

Coccura comari (KÜNOW, 1880) – Sion, 18.5., *Rubus caesius*, on roots, female, F=1 (3953).

Dysmicoccus walkeri (NEWSTEAD, 1891) – Gersau, 6.9., *Brachypodium* sp., on leaves, female, F=1 (4047).

Heliococcus bohemicus ŠULC, 1912 – Wädenswil, 21.4., *Aesculus hippocastanum*, *Platanus occidentalis*, on branches, female, 2nd instar larvae, F=1 (3862); Wädenswil, 3.5., same hosts, female, eggs, F=1 (3908). – This species became in the last years a pest of grapes in Hungary and Italy, as well as earlier in the Rhine valley in Germany.

Heterococcus nudus (GREEN, 1926) – Gersau, 15.5., *Bromus* sp., in leaf sheaths, female, F=1 (3939); Gersau, 6.9., *Agrostis* sp., in leaf sheaths, female, larvae, F=1 (4055); Wädenswil (Eichmühle), 20.5., *Lolium perenne*, female, F=1 (3967); Wädenswil, 21.9., *Agropyron repens*, in leaf sheaths, dead female, eggs and 1st instar larvae, F=2 (4075).

Mirococcopsis nagyi KOZÁR, 1981 – Noes, 19.5., *Stipa pennata*, in leaf sheaths, female, F=1 (3957). – Until now this species was known only from Hungary.

Phenacoccus aceris (SIGNORET, 1875) – Luzern, 24.5., *Aesculus hippocastanum*, on branches, dead female, F=2 (3973); Muri, 8.5., *Prunus domestica* and *Malus pumila*, female, F=1 (3913); Sion, 18.5., *A. hippocastanum*, dead female F=1 (3946); Wädenswil, 3.5., *A. hippocastanum*, female, F=1 (3908); Wädenswil, 17.5., *Quercus turneri*, female, F=1 (3941); Zürich, 3.5., *Q. robur*, female, F=1 (3896); Zürich, 26.5., *Tilia platyphyllos*, dead female, F=1 (3983).

Phenacoccus piceae (LÖW, 1883) – Zürich, 3.5., *Picea orientalis*, on needles, female, F=2 (3898).

Planococcus citri (Risso, 1813) – Zürich, 10.5., *Acacia* sp., *Citrus* sp., on leaves and branches, in greenhouse, female, eggs, 1st and 2nd instar larvae, F=3 (3922); Wädenswil, 28.9., *Coffea arabica*, on branches and leaves, female, male, eggs and larvae, F=3 (4079).

Puto pilosella (ŠULC, 1898) – Unteriberg, 19.9., *Thymus* sp., on the leaves, female, F=1 (4069).

Spinococcus marrubii (KIRITCHENKO, 1935) – Uerikon, 23.5., *Thymus serpyllum*, on roots, female, eggs, F=1 (3969). – Until now the species was only known from Bulgaria, Hungary and Russia.

Spinococcus multispinosus (SIRAIWA, 1939) – Sion, 18.5., *Thymus serpyllum*, on the root, female, F=1 (3951). – Until now it was known only from Far East and from Caucasus (DANZIG, 1980).

Trionymus penium (WILLIAMS, 1962) (?) – Zürich, 3.5., *Pseudosasa japonica*, in the leaf sheaths, female, eggs, F=3 (3906); Zürich, 3.10., *Pseudosasa japonica*, female, larvae, F=4 (4081). – The species supposedly originates from South-East Asia and needs further studies.

Trionymus perrisii (SIGNORET, 1875) – Feldmeilen, 26.9., *Festuca* sp., in leaf sheaths, female, F=2 (4078); Wädenswil, 18.9., *Agropyron repens*, in leaf sheaths, female, eggs and 1st instar larvae, F=1 (4067).

IV. ERIOCOCCIDAE

Acanthococcus aceris SIGNORET, 1875 – Glarus, 1.5., *Carpinus betulus*, on branches, female, winged and wingless males, F=3 (3890); Zürich, 10.5., *Acer platanoides*, female, F=3 (3923); Zürich, 26.5., *A. pseudoplatanus*, female, F=1 (3984); Zürich, 3.5., *Carpinus betulus*, 2nd instar larvae, male pronymph, F=3 (3899); Zürich, 3.5., *Ulmus* sp., female, F=1 (3900).

Acanthococcus greeni (NEWSTEAD, 1898) – Noes, 19.5., *Stipa pennata*, on leaves, female, eggs, F=1 (3957).

- Acanthococcus roboris* (GOUX, 1931) – Luzern, 24.5., *Aesculus hippocastanum*, on branches, female, eggs, F=3 (3973).
- Eriococcus buxi* (FONSCOLOMBE, 1834) – Zürich, 23.5., *Buxus sempervirens*, on leaves and branches, female, male, eggs, F=3 (3068), Basel, 15.10., *Buxus* sp., dead female, F=1 (4097); Nyon, 30.9.1993, *Buxus sempervirens*, dead female, 2nd instar larvae, (EG).
- Gossyparia spuria* (MODEER, 1778) – Au, 13.5., female, F=2 (3928); Luzern, 24.5., female, F=3 (3974); Zürich, 26.4., female, 2nd instar larvae, F=1 (3874); Zürich, 26.5., all on *Ulmus* sp., on branches, F=3 (3980).
- Rhizococcus cynodontis* (KIRITCHENKO, 1940) – Unteriberg, 4. 10., *Festuca* sp., on leaves, female, F=1 (4082).
- Rhizococcus palustris* DZIEDZICKA & KOTEJA, 1971 – Studen, 20.9., *Luzula pilosa*, on leaves, female, F=1 (4072).

V. CRYPTOCOCCIDAE

- Cryptococcus fagisuga* LINDINGER, 1936 – Zürich, 10.5., *Fagus silvatica*, on bark, female, F=4 (3924).
- Pseudochermes fraxini* (KALTENBACH, 1860) – Nyon, 1.10.1993, female (EG); Zug, 9.5., female, F=2 (3918); Zürich, 26.5., all on *Fraxinus excelsior*, on bark, female, F=3 (3979).

VI. COCCIDAE

- Chloropulvinaria floccifera* (WESTWOOD, 1870) – Glarus, 1.5., *Taxus baccata*, on leaves, dead female, F=1 (3889); Richterswil, 22.4., *Taxus baccata*, 2nd instar larvae, F=2 (3866); Wädenswil, 26.4., *Mahonia* sp., *Ilex* sp., 2nd instar larvae, F=3 (3875); Wädenswil, 17.5., *Mahonia* sp., female, F=3 (3942); Wädenswil, 25.5., *T. baccata*, female, eggs, F=3 (3975); Zürich, 3.5., *Ilex* sp., 2nd instar larvae, F=3 (3907).
- Coccus hesperidum* LINNAEUS, 1758 – Wädenswil (outdoors!), 21.4., *Laurocerasus* sp., on leaves, female, F=1 (3865); Zürich (outdoors!), 3.5., *Laurocerasus* sp., female, F=1 ((3905)
- Eriopeltis festucae* (FONSCOLOMBE, 1834) – Unteriberg, 4.10., *Dactylis glomerata*, on leaves, female, eggs, F=1 (4083); Walenstadt, 12.10., *Brachypodium* sp., on leaves, F=1 (4062).
- Eulecanium tiliae* (LINNAEUS, 1758) – Basel, 15.10., *Ulmus* sp., dead female, F=1 (4098); Wädenswil, 17.5., *Aesculus hippocastanum*, on branches, female, male, F=2 (3944).
- Eupulvinaria hydrangeae* (STEINWEDEN, 1946) – Basel, 15.10., *Acer negundo*, on leaves, F=4 (4096); Gersau, 15.5., *Taxus baccata*, on leaves, female, F=1 (3932); Founex, 30.9.1993, *Hortensia* sp., dead female, 2nd instar larvae (EG); Nyon, 30.9.1993, *Hortensia* sp., dead female, 2nd instar larvae, (EG).
- Lecanopsis festucae* BORCHSENIUS, 1952 – Unteriberg, 4.10., *Festuca* sp., in leaf sheaths, female, F=1 (4082).
- Luzulaspis frontalis* GREEN, 1928 – Studen, 20.9., *Luzula pilosa*, on leaves, female, eggs, F=2 (4072); Unteriberg, 20.9., *Carex* sp., on leaves, female, eggs, F=2 (4074).
- Luzulaspis kosztarabi* KOTEJA & KOZÁR, 1979 – Walenstadt, 12.9., *Carex* sp., on leaves, female, F=1 (4061).
- Nemolecanium graniformis* (WÜNN, 1921) – Muri, 7.5., *Abies* sp., on needles, male, F=1 (3915).
- Palaeolecanium bituberculatum* (TARGIONI-TOZZETTI, 1868) – Jan./ Feb. 1952-54, *Malus pumila*, female (in contrary to literature), found several times on samples of branches coming from different localities north of the Alps (VOGEL & BACHMAN, 1956).
- Parafairmairia gracilis* GREEN, 1916 – Gersau, 6.9., *Carex* sp., on leaves, female, eggs, F=1 (4048).
- Parthenolecanium corni* (BOUCHÉ, 1844) – Au, 13.5., *Ulmus* sp., on branches, female, male, F=1 (3928); Gersau, *Rubus* sp. and *Spirea* sp., on branches, dead female, F=1 (4050, 4053); Glarus, 1.5., *Ulmus* sp., 2nd instar larvae, F=1 (3891); Güttingen, *Malus pumila*, dead female, 2nd instar larvae, F=2 (4094); Horgen, 16.5., *Vitis vinifera*, female, male, F=3 (3940); Luzern, 24.5., *Aesculus hippocastanum*, female, male, F=2 (3973); Richterswil, 23.5., *Prunus persica*, female, male, F=1 (3972); Richterswil, 27.5., *Rubus caesius*, on the root crown(!), female, eggs, F=2 (3987); Sion, 18.5., *P. cerasi*, female, F=3 (3955); Unteriberg, 19.9., *Rubus* sp., on leaves, 1st and 2nd instar larvae, F=1 (076); Wädenswil, 21.4., *Cotoneaster* sp., female, 2nd instar larvae, F=4 (3863); Wädenswil, 27.4., *P. domestica*, female, male pronymph, F=2 (3881); Richterswil, 22.4., *P. persica*, dead female, F=1 (3867); Wädenswil, 27.4., *P. pritchardi*, female, male pronymph, nymph, F=3 (3878); Wädenswil, 12.10., *Fragaria* sp., on leaves, 2nd instar larvae, F=1 (4091); Winterthur, *Ribes rubrum*, on branches, dead female, 2nd instar larvae, F=2 (4086); Zürich, 3.5., *Carpinus betulus*, 2nd instar larvae, male pronymph, F=2 (3899); Zürich, 3.5., *Cotynus cogygria*, female, F=3 (3895); Zürich, 26.4., *Ulmus* sp.,

- female, 2nd instar larvae, F=1 (3874); Zürich, 3.5., *Ulmus* sp., female, male pronymph, F=2 (3900); Zürich, 30.4., *Malus pumila*, 2nd instar larvae, F=1 (3887); Gersau, 15.5., *Platanus occidentalis*, female, F=1 (3933).
- Parthenolecanium fletcheri* (COCKERELL, 1893) – Wädenswil, 2.5., *Thuja occidentalis*, female, 2nd instar larvae, F=1 (3894).
- Parthenolecanium pomeranicum* (KAWECKI, 1954) – Gersau, 15.5., female, 2nd instar larvae, F=2 (3932); Glarus, 1.5., female, F=1 (3889); Wädenswil, 8.5., all on *Taxus baccata*, on needles, female, F=4 (3921).
- Parthenolecanium rufulum* (COCKERELL, 1903) – Conthey, 19.5., female, eggs, F=4 (3958); Wädenswil, 2.5., female, male pronymph, 2nd instar larvae, F=2 (3883); Zürich, 3.5., all on *Quercus robur*, on branches, female, male pronymph, F=1 (3896).
- Physokermes hemicryphus* (DALMAN, 1826) – Hochybrig, 5.9., *Picea abies*, on branches, dead female, eggs, 1st and 2nd instar larvae, F=2 (4044); Muri, 8.5., *P. abies*, on branches, dead female, F=1 (3912); Rapperswil, 23.5., *P. abies*, female, 2nd instar larvae, F=1 (3971); Wädenswil, 21.4., *P. abies*, dead female, 2nd instar larvae, F=1 (3864); Zürich, 3.5., *P. orientalis*, female, 2nd instar larvae, F=3 (3897). – This species earlier probably was mixed with *P. piceae*.
- Physokermes piceae* (SCHRANK, 1801) – Conthey, 19.5., *Picea omorica*, larva on needles, female on branches, female, eggs, F=3 (3965); Noes, 19.5., *P. abies*, female, F=3 (3964); Sion, 18.5., *P. abies*, dead female, 2nd instar larvae, F=3 (3952); Wädenswil, 21.5., *P. abies*, dead female, male pronymph, 2nd instar larvae, F=2 (3864); Zürich, 3.5., *P. orientalis*, dead female, 2nd instar larvae, F=1 (3897).
- Pulvinaria betulae* (LINNEAUS, 1758) – Gimel 25.9.1993, *Betula pendula*, female (EG); Gimel, 25.9.1993, *Ribes rubrum*, female, (EG).
- Pulvinaria regalis* CANARD, 1968 – Sion, 18.5., *Aesculus hippocastanum*, on bark, dead female, F=2 (3946). – This species is spreading all over Western Europe causing great problems on different ornamental trees.
- Saissetia coffeae* (WALKER, 1852) – Wädenswil (indoors), 28.5., *Ficus benjamina*, on leaves, female, F=1 (3885).
- Scythia craniumequinum* (KIRITCHENKO, 1938) – Noes, 19.5., *Stipa pennata*, on leaves, dead female, F=1 (3957). – Until now this typical steppic species, was known from Mongolia to Hungary
- Sphaerolecanium prunastri* (FONSCOLOMBE, 1834) – Gimel, 26.6.1958, 1st instar larvae, (EG).

VII. ASTEROLECANIIDAE

- Asterodiaspis quercicola* (BOUCHÉ, 1851) – Wädenswil, 27.4., *Quercus robur*, on branches, female, F=2 (3883).
- Asterodiaspis variolosa* (RATZEBURG, 1870) – Conthey, 19.5., female, eggs, F=1 (3956); Wädenswil, 27.4., female, F=2 (3883); Zürich, 3.5., female, F=1 (3896); Zürich, 10.5., all on *Quercus robur*, on branches, female, eggs, F=1 (3929).
- Planchonia arabis* SIGNORET, 1877 – Walenstadt, 12. 9., *Thymus serpyllum*, on branches, female, F=1 (4060).

VIII. CEROCOCCIDAE

- Cerococcus cycliger* GOUX, 1932 – Walenstadt, 12.9., *Thymus serpyllum* v. *rigidus*, on branches, female, F=1 (4060).

IX. DIASPIDIDAE

- Aonidia lauri* (BOUCHÉ, 1833) – Locarno, 17.9.1949, *Laurus* sp., female, 1st and 2nd instar larvae, (EG); Locarno, 20.4.1950, *Laurus nobilis*, 2nd instar larvae, (FB); Muralto, 24.9.1958, *Laurus* sp., female, (EG).
- Aspidiotus nerii* (BOUCHÉ, 1833) – Genève, 8.12.1966, *Hovea* sp., female, (EG), Küsnacht, 29.10.1954, *Datura* sp., female, (FB); Kilchberg, 11.5.1951, *Oleander* sp., female, (FB); Wädenswil (indoors), 25.10., *Agave* sp., *Phoenix* sp., on leaves, female, male, F=3 (4101).
- Aulacaspis rosae* (BOUCHÉ, 1833) – Nyon, 12.11.1962, *Rubus* sp., female, (EG); Gersau, 6.9., *Rubus* sp., on branches, female, eggs, F=3 (4050); Stäfa, 1.4.1950, *Rubus* sp., female, 1st instar larvae, (FB); Rapperswil, 23.5., *Rubus caesius*, on stem, female, 1st instar larvae, F=2 (3970); Sargans, 26.5., *Rosa canina*, *Rubus caesius*, female, F=1 (3986); Walenstadt, 12.9., *Rubus* sp., F=1 (4057); Wädenswil, 13.5., *Rosa* sp., female, F=3 (3930).
- Carulaspis juniperi* (BOUCHÉ, 1851) – Chavannes Renens, 18.11.1963, *Thuja occidentalis*, female, (EG); Genève, 15.12.1964, *Juniperus* sp., female, (EG); Valais, 3.4.1984, *Sequoia* sp., female,

- (EG); Riehen, 3.1959, *Thuja* sp., female, (FB); Sion, 18.5., *Juniperus sabina*, female, eggs, F=3 (3949); Wädenswil, 2.5., *Thuja occidentalis*, female, F=2 (3894); Wädenswil, 26.4., *Chamaecyparis* sp., female, F=1 (3877); Zürich, 26.4., *Thuja* sp., female, F=1 (3873).
- Chionaspis salicis* (LINNAEUS, 1758) – Gersau, 6.9., *Fraxinus excelsior*, F=1 (4056); Sattellegg, 12.9., *Salix* sp., F=3; Studen, 20.9., *Salix* sp., F=3; Sustenpass, 16.8.1951, *Vaccinium myrtillus*, female (FB); Gersau, 15.5., *Salix* sp., on branches, eggs, F=2 (3934); Glarus, 1.5., *Fraxinus excelsior*, eggs, F=1 (3892); Unteriberg, 13.9., *Fraxinus excelsior*, *Alnus glutinosa*, F=1 (4064); Unteriberg, 19.9., *Vaccinium* sp., female, eggs, F=3 (4070); Wädenswil, 27.4., *F. excelsior*, eggs, F=1 (3881); Wädenswil, 27.4., *Malus pumila*, eggs, F=3 (3882); Wädenswil, 27.4., *Pyrus communis*, eggs, F=1 (3879); Weglosen, 5.9., *Salix* sp., Female, F=1 (4043); Zug, 9.5., *Sorbus* sp., eggs, F=3 (3919); Zug, 9.5., *Crateagus* sp., eggs, F=2 (3920). – An outbreak and the distribution of the species was studied in more detail by MANI & STAUB (1966).
- Diaspidiotus bavaricus* (LINDINGER, 1912) – Verscio, 18.5.1953, *Calluna vulgaris*, female, 2nd instar larvae, (FB).
- Diaspidiotus osborni* (NEWELL & COCKERELL, 1898) – Zürich, 26.5., *Corylus avellana*, on branches, female, 2nd instar larvae, F=3 (3976); Nyon, 30.9.1993, *Gleditsia triacanthos*, female, eggs, 1st and 2nd instar larvae, (EG). – Until now this American species was known only from southern Europe and only from *Platanus*.
- Diaspidiotus wuenni* LINDINGER, 1923 – Biasca, 22.3.1948, *Castanea sativa*, 2nd instar larvae, (FB); Malvaglia, April 1950, *Castanea sativa*, female, (FB); Sion, 25.5.1965, *Quercus pedunculata*, female, (EG); Zürich, 26.4., *Ulmus* sp., dead female, F=1 (3874).
- Diaspis boisduvali* SIGNORET, 1869 – Tenero, 15.10.1951, *Orchis* sp. female, (EG).
- Dynaspidiotus britannicus* (NEWSTEAD, 1898) – Wädenswil, 20.4.1950, *Hedera helix*, 2nd instar larvae, (FB).
- Epidiaspis leperii* (SIGNORET, 1869) – Gudo, 6.4.1950, *Crataegus oxyacantha*, female, (FB); Petit-Lancy, *Malus pumila*, female, (EG); Genève, 11.1.1967, *Amelanchier alnifolia*, female, (EG); Noes, 19.5., *Pyrus communis*, on branches, female, eggs, F=3 (3962); Zürich, 30.4., *Malus pumila*, female, F=1 (3887); Zürich, 26.5., *P. communis*, female, eggs, F=2 (3977).
- Furchadaspis zamiae* (MORGAN, 1890) – Gudo, 11.7.1961, *Cycas* sp., female, (EG).
- Lepidosaphes conchiformis* (GMELIN, 1789). – Riehen, 10.4.1979, *Syringa vulgaris*, female, (FB).
- Lepidosaphes minima* (NEWSTEAD, 1897) – Genève, 15.12.1966, *Alnus rubra*, female, (EG).
- Lepidosaphes ulmi* (LINNAEUS, 1758) – Bad Ragaz, 24.4., *Malus pumila*, on branches, dead female, eggs, F=1 (3872); Conthey, 19.5., *Quercus robur*, dead female, F=2 (3956); Lindau, 8.10., *M. pumila*, F=2 (4087); Noes, 19.5., *M. pumila*, dead female, eggs, 1st instar larvae, F=2 (3963); Noes, 19.5., *Populus nigra*, dead female, eggs, 1st instar larvae, F=3 (3961); Richterswil, 22.4., *M. pumila*, dead female, F=1 (3868); Sion, 18.5., *Prunus cerasi*, dead female, eggs, 1st instar larvae, F=1 (3955); Wädenswil, 27.4., *M. pumila*, dead female, eggs, F=1 (3882); Winterthur, 8.10., *M. pumila*, eggs, F=1 (4085); Winterthur, 8.10., *Ribes rubrum*, eggs, F=1 (4086); Zürich, 30.4., *Ribes nigrum*, dead female, F=1 (3888); Zürich, 26.5., *M. pumila*, dead female, F=3 (3982).
- Lepidosaphes newsteadi* (ŠULC, 1895) – Alvaschein, 31.3.1954, *Pinus silvestris*, female, (FB); Muri, 7.5., *Abies* sp., on needles, dead female, F=1 (3915).
- Leucaspis loewi* COLVÉE, 1882 – Muri, 4.12.48, *Pinus* sp., 2nd instar larvae, (FB); Alvaschein, 31.3.1954, *Pinus silvestris*, 2nd instar larvae, (FB); Conthey, 19.5., *Pinus mugo*, on needles, female, F=4 (3966); Sion, 18.5., *P. nigra*, female, eggs, F=3 (3947, 3948); Wädenswil, 24.4., *P. mugo*, 2nd instar larvae, male nymph, F=3 (3869); Wädenswil, 27.4., *P. nigra*, female, male pronymph and nymph, 2nd instar larvae, F=3 (3884); Zürich, 3.5., *P. mugo*, female, puparium, F=3 (3901); Zürich, 10.5., *P. pumila*, puparium, F=1 (3925); Zürich, 10.5., *P. thunbergiana*, puparium, F=2 (3926); Zürich, 10.5., *P. uncinata*, female, puparium, 2nd instar larvae, F=2 (3927).
- Leucaspis pini* (HARTIG, 1939) – Alvaschein, 31.3.1954, *Pinus silvestris*, 2nd instar larvae, (FB); Gersau, 15.5., *Pinus mugo*, on needles, female, F=2 (3936); Zürich, 3.5., *P. nigra*, female, puparium, F=3 (3902); Zürich, 3.5., *P. silvestris*, female, puparium, 2nd instar larvae, F=3 (3903).
- Leucaspis pusilla* LÖW, 1883 – Noes, 19.5., *Pinus nigra*, female, male, eggs, F=3 (3960).
- Nuculaspis abietis* (SCHRANK, 1776) – Alvaschein, 31.3.1954, *Pinus silvestris*, 2nd instar larvae, (FB); Otelfingen, 19.11.1953, *Abies alba*, female, (FB); Gersau, 15.5., *Pinus mugo*, on the needles, female, F=1 (3936); Muri, 4.12.1948, *Pinus* sp., 2nd instar larvae, (FB); Muri, 7.5., *Abies* sp., female, 2nd instar larvae, F=1 (3915); Wädenswil, 19.12.1953, *Abies alba*, female, (FB); Wädenswil, 21.4., *Picea abies*, female, F=1 (3864); Wädenswil, 24.4., *P. mugo*, dead female, F=1 (3869); Wädenswil, 27.4., *P. nigra*, female, 2nd instar larvae, F=1 (3884); Zürich, 10.5., *P. uncinata*, female, F=1 (3927).
- Parlatoria pergandei* COMSTOCK, 1881 – Muralto, 20.9.1958, *Camelia* sp., female, (EG).

- Pseudaulacaspis pentagona* (TARGIONI-TOZZETTI, 1886) – Wädenswil, 15.9., *Aesculus hippocastanum*, female, F=2 (4066); Wädenswil, 8.5., *Juglans nigra*, on branches and stem, female, F=2 (3917); Wädenswil, *Sophora japonica*, female, F=4 (3916); Wädenswil, 17.5., *Aesculus pavia*, female, F=3 (3945); Zürich, 3.5., *S. japonica*, F=4 (3904); Winterthur, *Campsis* sp., only dead females, F=3 (FB); Nyon, 25.6.-17.8., *Choysia ternata*, males collected by pheromone traps; Cadenazzo, 26.6.-28.7., *J. regia*, males collected by pheromone traps; Muzzaro, 26.6.-28.7., *S. japonica*, males collected by pheromone traps. – In Switzerland the species was known only in the Ticino (BOVEY, 1979). Recently it was reported from Nyon (BAGGIOLINI *et al.*, 1993). We can expect a spread into other parts of the country, seriously damaging ornamental trees. Later it may infest orchards. Results of a more detailed survey will be the subject of another paper.
- Quadraspidiotus gigas* (THIEM & GERNECK, 1934) – Loco, 6.12.1949, *Salix* sp., 2nd instar larvae, (FB); Zürich, 8.12.1948, *Salix* sp., 2nd instar larvae, (FB); La Sarraz, 22.12.1959, *Salix* sp., 2nd instar larvae, (EG); La Sarraz, 23.11.1964, *Populus* sp., 1st and 2nd instar larvae, (EG); Adliswil, *Populus* sp., 31.8.1948, 2nd instar larvae; Noes, 19.5., *Populus nigra*, on branches, dead female, F=1 (3961); Zürich, 3.5., *P. simonii*, dead female, F=1 (3909).
- Quadraspidiotus labiatarum* (MARCHAL, 1909) – *Thymus serpyllum*, on the leaves and branches, dead female, F=2 (3958).
- Quadraspidiotus lenticularis* (LINDINGER, 1912) – Zizers, 15.10.1947, *Prunus domestica*, female, (FB); Wädenswil (Au), 7.4.1950, *Quercus* sp., female, (FB); Gudo, 11.4.1950, *Quercus* sp., female, (FB); Verscio, 18.5.1953, *Castanea sativa*, female, (FB); Saxon, Februar 1959, *Prunus* sp., female, (EG); Châteauneuf, 3.2.1960, *Quercus pedunculata*, female, (EG); Genève, 30.6.1961, *Ribes* sp., female, (EG); Changins, 30.4.1965, *Ribes* sp., female, (EG); Founex, 14.9.1988, *Ribes rubrum*, female, (EG).
- Quadraspidiotus marani* ZAHRADNIK, 1952 – Yverdon, 6.9.1947, *Malus pumila*, female, (EG); Vallorbe, 10.3.1953, *Pyrus communis*, female, (EG); Saxon, 29.12.1959, *Malus pumila*, female, (EG); Fully, 4.11.1959, *Pyrus communis*, female, (EG); Nyon, 20.1.1960, *Fraxinus excelsior*, female, (EG); Nyon, 21.1.1960, *Prunus spinosa*, female, (EG); Pont Riddes, *Malus pumila*, female (EG); Pont Russin, 10.2.1960, (EG); Châteauneuf, 18.3.1963, *Pyrus communis*, female, (EG); Gelfingen, 7.5., *Malus pumila*, on the branches, female, F=1 (3914); Uttwil, 13.10., *M. pumila*, female, male, 2nd instar larvae, F=2 (4095); Wädenswil, 20.10., *M. pumila*, female, F=2 (4099). – The spread of this species (as *Q. schneideri*) was described by BACHMANN (1953).
- Quadraspidiotus ostreaeformis* (CURTIS, 1843) – Verscio, 18.5.1953, *Betula alba*, *Populus* sp., female, (FB); Bätterkinden, 13.8.1950, *Pyrus communis*, female, 2nd instar larvae, (FB); Boncourt, 22.4.1953, *Tilia* sp., female, (FB); Otelfingen, 31.1.1953, *Prunus cerasus*, 2nd instar larvae, (FB); Männedorf, 20.3.1950, *Aesculus hippocastanum*, 2nd instar larvae, (FB); Winterthur, 7.3.1948, *Betula alba*, 2nd instar larvae, (FB); Gudo, 3.3.1950, *Alnus* sp., female, (FB); Uznach, 26.3.1952, *Malus pumila*, 2nd instar larvae; Frauenfeld, 21.12.1949, not identified host plant, female, (FB); Au, 7.4.1950, *Salix* sp., 2nd instar larvae, (FB); Le Prese, 7.5.1947, *Prunus* sp., female, (FB); Landquart, 8.6.1949, *Betula alba*, female, (FB); Saxon, 10.6.1948, *Malus pumila*, female, (FB); Changins, 3.12.1963, *Betula alba*, 2nd instar larvae, (EG); Obrist Riddes, 20.5.1959, *Malus pumila*, female, (EG); Pont Russin, 10.2.1961, *Ligustrum* sp., 2nd instar larvae, (EG); Genève, 15.12.1964, *Alnus rubra*, 2nd instar larvae, (EG); Russin, 16.11.1964, *Corylus avellana*, 2nd instar larvae, (EG); Nyon, 30.11.1965, *Carpinus* sp., 2nd instar larvae, (EG); La Sarraz, 25.5.1965, *Alnus* sp., female, (EG); Bad Ragaz, *Malus pumila*, on the branches and stems, dead female, F=4 (3872); Güttingen, 24.4., *M. pumila*, dead female, male nymph and pronymph, 2nd instar larvae, F=3 (3870); Güttingen, 13.10., *M. pumila*, 2nd instar larvae, F=2 ((4094); Lindau, 8.10., *Prunus domestica*, 2nd instar larvae, F=1 (4088); Muri, 8.5., *Prunus domestica*, female, F=2 (3911); Wädenswil, 30.4., *Betula pendula*, dead female, male nymph and pronymph, 2nd instar larvae, F=3 (3886); Richterswil, 22.4., *M. pumila*, dead female, F=1 (3868), Richterswil, 22.4., *P. persicae*, dead female, F=2 (3867); Wädenswil, 27.4., *P. domestica*, female, F=1 (3880); Winterthur, 8.10., *M. pumila*, dead female, 2nd instar larvae, F=1 (4085); Zürich, 30.4., *M. pumila*, dead female, F=1 (3887); Zürich, 30.4., *Ribes nigrum*, dead female, 2nd instar larvae, F=2 (3888).
- Quadraspidiotus perniciosus* (COMSTOCK, 1881) – Noes, 19.5., *Malus pumila*, on branches, female, F=3 (3963); Saxon, 20.9., *M. pumila*, female, male, 1st and 2nd instar larvae, F=2 (4077); Sion, 18.5., *Rosa* sp., female, F=3 (3950). – The spread of this species in Switzerland was described by MANI (1970).
- Quadraspidiotus pyri* (LICHTENSTEIN, 1881) – Fully, 4.11.1959, *Pyrus communis*, 2nd instar larvae, (EG); Fully, 4.11.1959, *Malus pumila*, 2nd instar larvae, (EG); Pont Riddes, 9.1.1961, *Malus pumila*, 2nd instar larvae, (EG); Gudo, 25.2.1965, *Prunus avium*, 2nd instar larvae, (EG); Changins, 3.12.1965, *Crataegus* sp., 2nd instar larvae, (EG); Monteggio, 19.5.1965, *Fraxinus excel-*

- sior*, female, (EG); Gelfingen, 7.5., *Malus pumila*, on branches, female, male pronymph, F=3 (3914); Landquart, 24.4., *Pyrus communis*, male nymph and pronymph, 2nd instar larvae, F=4 (3870a); Landquart, 13.10., *P. communis*, on the branches and fruits, 2nd instar larvae, F=3 (4092); Landquart, 24.4., *M. pumila*, male nymph and pronymph, 2nd instar larvae, F=4 (3871); Landquart, 13.10., *M. pumila*, on branches and fruits, 2nd instar larvae, F=3 (4093); Wädenswil, 27.4., *Fraxinus excelsior*, 2nd instar larvae, F=1 (3881); Wädenswil, 27.4., *M. pumila*, female, F=1 (3882). – The spread of this species was described by BACHMANN (1953).
- Quadraspidiotus zonatus* (Frauenfeld, 1868) – Winterthur, 11.4.1950, *Quercus* sp., female, (FB); Stäfa, 1.4.1950, *Quercus* sp., female, (FB); Duiller, 15.12.1959, *Quercus pedunculata*, female, (EG); Vich, 8.4.1959, *Quercus* sp., female, (EG); Nyon, 10.12.1960, *Quercus pedunculata*, female, (EG); Pont Russin, 10.2.1961, *Quercus* sp., female, (EG); Châteauneuf, *Quercus* sp., female (EG); Trélex, 26.11.1964, *Quercus pedunculata*, female (EG); Ecône, 17.1.1966, *Quercus* sp., female, (EG); Conthey, 19.5., *Quercus robur*, female, F=1 (3956); Noes, 19.5., *Quercus robur*, female, eggs, 1st instar larvae, F=2 (3959); Wädenswil, 2.3.1954, *Fagus sylvatica*, female, (FB); Wädenswil, 27.4., *Quercus robur*, on branches, 2nd instar larvae, F=1 (3883).
- Rhizaspidiotus canariensis* (LINDINGER, 1911) – Noes, 19.5., *Thymus serpyllum*, on root, dead female, F=1 (3958).
- Unaspis euonymi* (COMSTOCK, 1881) – Gudo, 22.10.1952, *Euonymus europaeus*, female, (FB); Duiller, 15.12.1959, *Euonymus europaeus*, female, (EG); Thonex, 17.11.1960. *Euonymus* sp., female, (EG).

ALEYRODOIDEA

- Aleurochiton acerinus* HAUPT, 1934 – Walenstadt, *Acer campestre*, F=1 (220).
- Aleurochiton aceris* (MODEER, 1778) – Gersau, 6.9., *Acer platanoides*, F=1 (215).
- Aleurochiton pseudoplatani* VISNYA, 1936 – Basel, 15.10., *Acer platanoides*, F=1 (229); Wädenswil, 15.9., *A. platanoides*, F=1 (223).
- Aleyrodes lonicerae* WALKER, 1852 – Unteriberg, 20.9., *Rubus* sp., F=1 (225); Wädenswil, 12.10., *Fragaria* sp., F=1 (228); *Ranunculus* sp., F=2 (224); Wädenswil, 7.9., *Rubus* sp., puparium, adult, F=2 (216).
- Aleyrodes proletella* LINNAEUS, 1758 – Wädenswil, 10.9., *Chelidonium majus*, adult, puparium, eggs, F=3 (218); Wädenswil, 15.9., *Brassica* sp., adult, puparium, F=3 (222).
- Aleyrotrachelus jelineki* (FRAUENFELD, 1867) – Changins, 20.9.1993, *Viburnum tinus*, puparium (collected by S. FISCHER).
- Siphoninus phillyreae* (HALIDAY, 1835) – Feldmeilen, 26.9., *Crataegus monogyna*, F=3 (227); Walenstadt, 12.9., *Fraxinus excelsior*, F=2 (221); Wädenswil, 11.9., *Crataegus intricata*, adult, puparium, F=2 (219); Wädenswil, 7.9., *Fraxinus excelsior*, adult, puparium, F=3 (217).
- Trialeurodes vaporariorum* WESTWOOD, 1856 – Wädenswil (indoor), 22.9., *Solanum melongana*, F=3 (226).

LIST OF SPECIES NEW FOR THE FAUNA OF SWITZERLAND

1. Scale insects:

- Orthezia urticae* (LINNAEUS, 1758)
Atrococcus cracens WILLIAMS, 1962
Balanococcus boratynskii WILLIAMS, 1962
Coccura comari (KÜNOW, 1880)
Dysmicoccus walkeri (NEWSTEAD, 1891)
Heliooccus bohemicus ŠULC, 1912
Heterococcus nudus (GREEN, 1926)
Mirococcopsis nagy KOZÁR, 1981
Spinococcus marrubii (KIRITCHENKO, 1935)
Spinococcus multispinosus (SIRAIWA, 1939)
Trionymus penium (WILLIAMS, 1962) (?)
Trionymus perrisii (SIGNORET, 1875)
Acanthococcus greeni (NEWSTEAD, 1898)
Acanthococcus roboris (GOUX, 1931)
Rhizococcus cynodontis (KIRITCHENKO, 1940)
Rhizococcus palustris DZIEDZICKA & KOTEJA, 1971

Eupulvinaria hydrangeae (STEINWEDEN, 1946)
Lecanopsis festucae BORCHSENIUS, 1952
Luzulaspis frontalis GREEN, 1928
Luzulaspis kosztarabi KOTEJA & KOZÁR, 1979
Parafairmairia gracilis GREEN, 1916
Parthenolecanium rufulum (COCKERELL, 1903)
Physokermes hemicryphus (DALMAN, 1826)
Pulvinaria regalis CANARD, 1968
Scythia craniumequinum (KIRITCHENKO, 1938)
Asterodiaspis quercicola (BOUCHÉ, 1851)
Planchonia arabidis SIGNORET, 1877
Cerococcus cycliger GOUX, 1932
Aonidia lauri (BOUCHÉ, 1833)
Diaspidiotus osborni (NEWELL & COCKERELL, 1898)
Diaspis bouisduvalii SIGNORET, 1869
Lepidosaphes minima (NEWSTEAD, 1897)
Leucaspis pusilla LÖW, 1883
Rhizaspidotus canariensis (LINDINGER, 1911)

2. Whiteflies:

Aleurochiton acerinus HAUPT, 1934
Aleurochiton aceris (MODEER, 1778)
Aleurochiton pseudoplatani VISNYA, 1936
Aleurotrachelus jelineki (FRAUENFELD, 1867)
Aleyrodes loniceræ WALKER, 1852
Siphoninus phillyrae (HALIDAY, 1835)

DISCUSSION

Our survey has increased the number of recorded species of scale insects in Switzerland considerably. New species were mainly found in families such as Pseudococcidae (11), Coccidae (9) and Eriococcidae (4), on which very few studies have been done so far. Several species already published for the Swiss fauna (LINDINGER, 1912; KOSZTARAB AND KOZÁR, 1988) were not found by us:

Porphyrophora polonica (LINNAEUS, 1758)
Xylococcus filiferus LÖW, 1882
Puto antennatus SIGNORET, 1875
Lecanopsis formicarum NEWSTEAD, 1893
Parthenolecanium persicae (FABRICIUS, 1776)
Acanthococcus devoniensis (GREEN, 1896)
Carulaspis visci (SCHRANK, 1781)
Chionaspis austriaca LINDINGER, 1912
Chionaspis lepineyi BALACHOWSKY, 1928
Diaspidiotus distinctus (LEONARDI, 1900)
Lepidosaphes juniperi LINDINGER, 1912.

HADORN (1940) collected scale insect species in Swiss greenhouses. The following list gives the current names of those species not found by us:

Orthesia insignis DOUGLAS, 1887
Nipaecoccus nipae (MASKELL, 1893) (= *Ceroputo nipae*)
Pseudococcus longispinus (TARGIONI-TOZZETTI, 1868) (= *P. adonidum*)
Rhizoecus falcifer KÜNCKEL D'HERCULAIS, 1878 (= *Ripersia (Rhizoecus) falcifera*)
Coccus longulus (DOUGLAS, 1887) (= *Lecanium elongatum*)
Saissetia oleae (OLIVIER, 1791) (= *Lecanium oleae*)
Parasaissetia nigra (NIETNER, 1861)
Chrysomphalus dictyospermi (MORGAN, 1889)
Chrysomphalus aonidum (LINNAEUS, 1758) (= *C. ficus*)

Hemiberlesia lataniae (SIGNORET, 1869) (= *Aspidiotus lataniae*)
Diaspis bromeliae (KERNER, 1778)
Diaspis echinocacti (BOUCHÉ, 1833)
Diaspis cymbidii McINTIRE, 1888
Pinnaspis aspidistrae (SIGNORET, 1869)
Eucornuaspis pinnaeformis (BOUCHÉ, 1851) (= *Lepidosaphes tuberculata* = *L. pinniformis*)
Mycetaspis personata (COMSTOCK, 1889) (= *Melanaspis personata*)
Asterolecanium epidendri (BOUCHÉ, 1844) (= *A. aureum*).

Because of the synonymy of *L. tuberculata* the total number of the species recorded from greenhouses is 28; 11 of them we found and also cited in our list. The 3 species *I. purchasi*, *C. floccifera* and *D. britannicus* listed by HADORN are mainly found in the nature, so we transferred them to the list of natural species.

The total number of all species recorded from Switzerland (from nature and greenhouses) is now 115; 90 of them can be considered as “natural” and 25 as “greenhouse” species. The real total number must be much higher, probably more than 200. This guess can be made considering the 233 species known for Central Europe (KOSZTARAB & KOZÁR, 1988) and considering additional Mediterranean species probably living in the south of Switzerland. As expected we found the most interesting species in warm, dry regions such as the Valais. Another important site was Gersau-Oberholz at the border of Lake Lucerne. RÉZBÁNYAI-RESER (1984) had shown before that the fauna of this warm and sunny place is especially rich. Steppe elements typical for Hungary and Russia are rarely found in Switzerland. Therefore the detection of *Scythia craniumequinum* on *Stipa* in Sion is worth mentioning. The insect was found in a place where the climate and flora resemble the steppe more than at any other place in Switzerland. *Spinococcus multispinus* on *Thymus* in Sion was found for the first time in Europe. This shows that the European fauna, well studied in many countries, is far from being complete.

Some remarkable catches of thermophilous species have been made: *Coccus hesperidum*, a species normally living only indoors in our region, has been found outdoors in Wädenswil and Zürich. *Chloropulvinaria floccifera* and *Eupulvinaria hydrangeae*, two thermophilous species, have also been detected in high density in different locations. A general increase has also taken place in some scale pests of ornamentals and fruit trees in the last years. *Pseudaulacaspis pentagona* has obviously extended its range of distribution. The population densities of *Quadraspidiotus perniciosus*, *Q. marani*, *Q. pyri*, *Q. ostreaeformis*, *Lepidosaphes ulmi* and *Parthenolecanium corni* have distinctly increased after many years of low occurrence (MANI *et al.*, 1993; WILDBOLZ, 1992). The reasons for this increase may be at least partially meteorological. The last years were in general characterised by mild winters and by periods of warm weather in summer and autumn.

Our survey has also increased the list of whitefly species of Switzerland: 9 species have now been recorded. More species may be found in the future since the whitefly fauna of Central Europe comprises about 20 species (MOUND & HALSEY, 1978; KOZÁR & BINK-MOENEN, 1988). In the southern regions of the country some Mediterranean species may also be present.

In conclusion, we see that Switzerland has a rich fauna of scale insects and whiteflies. However, further studies are necessary to complete our knowledge.

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