

A study on the Relationship of the Lachnidae, Chaitophoridae, Thelaxidae, Eriosomatidae, Adelgidae, Phylloxeridae and their Aphidiid Parasites in (Central) Europe

(Homoptera: Aphidoidea; Hymenoptera: Aphidiidae)

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1. Introduction

This paper represents a further part of author's studies on the relationship of various aphid groups and their aphidiid parasites in (Central) Europe. The aim of this work is to recognize the factors that influence the host-specificity in the *Aphidiidae* and aphid $\times$ parasite relationships in general. Such studies are necessary for the appreciation of different parasite species in biological control of aphids.

In this paper the aphid families *Lachnidae*, *Chaitophoridae*, *Thelaxidae*, *Eriosomatidae*, *Adelgidae*, *Phylloxeridae*, and their parasites in (Central) Europe are dealt with. The material was collected mostly in Czechoslovakia, into a lesser degree in Germany, Poland, Hungary, northern Italy and European part of the U.S.S.R. It is believed the results may be generalized for the greatest part of Europe.

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2. Host — parasite catalogue

Family: *Lachnidae*

1. Subfamily: *Cinarinae*

1. Tribe: *Protolachnini*

Protolachnus THEO.

P. agilis (KALT.): *Diaeretus leucopterus* (HALIDAY) (*Pinus silvestris*, *Pinus nigra*). (This species was recorded as a parasite of *Schizolachnus pineti* because of mixed host colonies.)

P. sp.: *Praon bicolor* MACKAUER (*Pinus silvestris*).

Note: Strictly specialized host-complex (*Diaeretus leucopterus* (HAL.), *Praon bicolor* MACKAUER).

2. Tribe: *Schizolachnini*

Schizolachnus MORDW.

S. pineti (F.): *Pauesia unilachni* (GAHAN) (*Pinus silvestris*, *Pinus nigra*).

S. sp.: *Pauesia unilachni* (GAHAN) (*Pinus uliginosa*).

Note: Strictly specialized parasite complex (*Pauesia unilachni* (GAHAN)).

3. Tribe: *Cinarini**Cinara* CURTIS

C. laricis (WALKER): *Pauesia abietis* (MARSHALL) (*Larix decidua*). — *Pauesia pini* (HAL.) (*Larix decidua*).

C. neubergeri (ARNH.): *Metaphidius trioxyformis* (STARÝ & SEDLAG) (*Larix decidua*).

C. nuda (MORDW.): *Pauesia laricis* (HALIDAY) (*Pinus silvestris*). — *Pauesia picta* (HALIDAY) (*Pinus silvestris*). — *Pauesia pini* (HALIDAY) (*Pinus silvestris*). — *Pauesia pinicollis* (STARÝ) (*Pinus silvestris*).

C. pilicornis (HTG.): *Pauesia* sp.

C. pini (L.): *Pauesia picta* (HAL.) (*Pinus silvestris*). — *Pauesia pinicollis* (STARÝ) (*Pinus silvestris*).

C. spp.: *Pauesia laricis* (HALIDAY) (*Pinus silvestris*, *Picea excelsa*). — *Pauesia piceaeaeollis* (STARÝ) (*Picea excelsa*). — *Pauesia pini* (HALIDAY) (*Pinus silvestris*). — *Pauesia silvestris* (STARÝ) (*Pinus silvestris*).

Buchneria BÖRNER

B. pectinatae NÖRDL.: *Pauesia infulata* (HALIDAY) (*Abies alba*).

Todolachnus MATS.

T. abieticola (CHOL.): *Pauesia grossa* (FAHRINGER) (*Abies alba*).

Cupressobium BÖRNER

C. juniperi (DEG.): *Pauesia cupressobii* (STARÝ) (*Juniperus communis*). — *Pauesia infulata* (HALIDAY) (*Juniperus communis*). — *Pauesia juniperorum* (STARÝ) (*Juniperus communis*).

Note: Widely oligophagous parasite complex (*Pauesia* spp.), some species of this complex seem to be more specialized (*P. grossa* (FAHR.)).

2. Subfamily: *Lachninae*1. Tribe: *Lachnini**Tuberolachnus* MORDV.*Maculolachnus* GAUMONT

M. submacula (WALK.); *Pauesia maculolachni* (STARÝ) (*Rosa* sp.).

Schizodryobius V. D. G.*Lachnus* ILLIG.

L. roboris (L.): Parasites were not recognized although numerous material was reared.

Pterochloroides MORDV.2. Tribe: *Stomaphidini**Stomaphis* WALKER

S. quercus (L.): *Protaphidius wissmannii* (RATZBURG) (*Betula verrucosa*).

Note: Strictly specialized parasite complex (*Pauesia maculolachni* (STARÝ), *Protaphidius wissmannii* (RATZBURG)). Oligophagous species are known from Asia.

3. Tribe: *Traminae**Protrama* BCKT.*Trama* v. HEYD.

Note: Only mummified aphids of this tribe were recorded in literature.

Family: *Chaitophoridae*1. Tribe: *Periphyllini**Periphyllus* v. D. G.

P. villosus (HTG.): *Aphidius setiger* (MACKAUER) (*Acer platanoides*, *Acer campestre*). — *Praon* sp. (*Acer platanoides*). — *Trioxyx falcatus* MACKAUER (*Acer platanoides*, *Acer campestre*).

Note: Strictly specialized parasite complex (*Aphidius setiger* (MACKAUER), *Trioxyx falcatus* MACKAUER).

2. Tribe: *Chaitophorini**Chaitophorus* KOCH s. lat.

Ch. spp.: *Lysiphlebus laticephalus* (TELENGA) (*Populus* sp.). — *Ephedrus plagiator* (NEES) (*Populus* sp.). — *Trioxyx* sp. (*Populus* sp.).

Note: Strictly specialized (*Lysiphlebus laticephalus* (TELENGA)) and polyphagous (*Ephedrus plagiator* (NEES)) parasite complexes.

3. Tribe: *Atheroidini**Laingia* THEOB.*Atheroides* HALID.*Sipha* PASS.*Rungsia* MIM.

R. maydis (PASS.): *Lysiphlebus arvicola* STARÝ (*Agropyrum repens*, *Cynodon* sp., *Medicago falcata*).

Chaetosiphella HRL.*Caricosipha* BÖRNER

Note: Strictly specialized parasite complex (*Lysiphlebus arvicola* STARÝ).

Family: *Thelaxidae*1. Subfamily: *Anoeciinae**Neanoecia* BÖRNER*Anoecia* KOCH

A. corni (F.): *Lysiphlebus dissolutus* (NEES) (*Agrostis alba*).

A. spp.: *Aphidius* sp. (*Agropyrum repens*). — *Lipolexis gracilis* FOERSTER (*Cornus sanguinea*). — *Paralipsis enervis* (NEES) (*Agropyrum repens*). — *Aclitus obscuripennis* FOERSTER.

Note: Polyphagous parasite complex (*Lysiphlebus dissolutus* (NEES), *Lipolexis gracilis* FOERSTER, *Paralipsis enervis* (NEES), *Aclitus obscuripennis* FOERSTER).

2. Subfamily: *Thelaxinae*1. Tribe: *Thelaxini**Glyphina* KOCH*G. betulae* KALT.: Parasites are known from *Siberia*.*Thelaxes* WESTW.*T. dryophila* (SCHRK.): *Lysiphlebus thelaxis* STARÝ (*Quercus* spp.).2. Tribe: *Mindarini**Mindarus* KOCH*Phloeomyzus* HORV.3. Subfamily: *Hormaphidinae*1. Tribe: *Oregmini**Cerataphis* LICHTS.*Abamalekia* D. GU.*Hormaphidula* BÖRNER*Mansakia* MATS.

Note: Oligophagous parasite complex (*Lysiphlebus thelaxis* STARÝ) in Europe).

Family: *Eriosomatidae*1. Subfamily: *Eriosomatinae*1. Tribe: *Eriosomatini**Schizoneura* HTG.

S. ulmi (L.): *Areopraon lepelleyi* (WATERSTON) (*Ulmus laevis*). — *Ephedrus plagiator* (NEES) (*Ulmus laevis*).

Eriosoma LEACH

Note: Strictly specialized (*Areopraon lepelleyi* (WATERSTON)) and polyphagous parasite complexes (*Ephedrus plagiator* (NEES)).

2. Tribe: *Byrsocryptini**Colopha* MONELL*Kaltenbachiella* SCHOUT.*Byrsocrypta* HAL.*B. ulmi* (L.): *Paralipsis enervis* (NEES) (*Hordeum vulgare*, *Avena sativa*).

Note: Polyphagous parasite complex (*Paralipsis enervis* (NEES)).

2. Subfamily: *Pemphiginae*1. Tribe: *Pachypappini**Patchiella* TULLGR.*Asiphon* KOCH*A. tremulae* (L.): *Ephedrus plagiator* (NEES) (*Populus tremula*).*Pachypappa* KOCH*Pachypappella* BAKER*Stagona* KOCH

Paraprociophilus MORDV.

Prociophilus KOCH

P. fraxini (HTG.): *Ephedrus plagiator* (NEES) (*Fraxinus excelsior*).

Note Polyphagous parasite complex (*Ephedrus plagiator* (NEES)).

2. Tribe: *Pemphigini*

Thecabius KOCH

Parathecabius BÖRNER

Pemphigus HTG.

P. sp.: *Lysiphlebus fabarum* (MARSHALL) (*Helichrysum arenarium*).

Mimeuria BÖRNER

Note: Polyphagous parasite complex (*Lysiphlebus fabarum* (MARSH.)).

3. Subfamily: *Fordinae*

1 Tribe: *Fordini*

Paracletus v. HEYD.

Hemitrama MORDV.

Forda v. HEYD.

F. formicaria v. HEYD.: *Paralipsis enervis* (NEES) (*Poa pratensis*).

F. hirsuta mordwilkoii BÖRNER: *Monoctonia pistaciaecola* STARÝ (*Pistacia* sp. — in Crimea).

Smynthuroides WESTW.

Note: Polyphagous (*Paralipsis enervis* (NEES)) and strictly specialized parasite complexes (*Monoctonia pistaciaecola* STARÝ).

2. Tribe: *Baizongiini*

Baizongia ROND.

Aploneura PASS.

Geoica HART.

Family: *Adelgidae*, *Phylloxeridae*

Aphidiid parasites have not been ascertained in Europe.

3. Ecological characteristics of parasites

Aclitus obscuripennis (FÖRSTER): Probably oligophagous parasites of some (?) root aphids (*Anoecia* spp.) in forest type habitats.

Areopraon lepelleyi (WATERSTON): Probably oligophagous parasite of *Schizoneura* spp. on *Ulmus* (primary hostplant) in forest type habitats.

Diaeretus leucopterus (HALIDAY): Oligophagous parasite of *Protolachnus* spp. in forest type habitats.

Ephedrus plagiator (NEES): Widely polyphagous species that occurs mostly in forest type habitats, where it parasitizes quite a number in dense colonies living, leaf-curling, etc. aphids, mainly: *Acyrtosiphon caraganae* CHOL. on *Caragana arborescens*, *Aphis idaei* (v. D. G.) on *Rubus*, *Aphis fabae* SCOP. on *Euonymus europaea*, etc., *Brachycaudus cardui* (L.) on *Prunus domestica* et spp., *Ceruraphis eriopohri* (WALK.) on *Viburnum opulus*, *Dysa-*

phis spp. on *Malus silvestris* and *Sorbus aucuparia*, *Hyperomyzus lactucae* (L.) on *Ribes nigrum*, *Macrosiphum rosae* (L.) on *Rosa* sp., *Myzus cerasi* (F.) on *Prunus* sp., *Prociphilus fraxini* (HTG.) on *Fraxinus excelsior*, *Rhopalosiphum padi* (L.) on *Padus racemosa*, *Schizoneura ulni* (L.) on *Ulmus laevis*, etc.

Lipolexis gracilis FÖRSTER: Commonly occurring parasite in steppe type habitats (rarely edges of woods or parks), its hosts being: *Anoecia* sp. on *Cornus sanguinea*, *Aphis* spp., *Brachycaudus* spp.

Lysiphlebus arvicola STARÝ: Monophagous (or oligophagous?) parasite of *Rungia maydis* in steppe habitats.

Lysiphlebus dissolutus (NEES): Probably oligophagous parasite of various root aphids (*Anoecia*), mostly in forest type habitats.

Lysiphlebus fabarum (MARSHALL): Widely polyphagous species occurring in steppe type of habitats. Hosts: *Aphis* spp., *Brachycaudus* spp., *Hyperomyzus lactucae* (L.), *Paczoskia major* BÖRNER, *Pemphigus* sp., *Protaphis carlinae* (BÖRNER), *Rhopalosiphum nymphaeae* (L.), *Sitobium avenae* (FABR.), etc.

Lysiphlebus laticephalus (TELENGA): Typical oligophagous parasite of *Chaitophorus* spp. on *Salix*, *Populus*, etc. in forest type habitats.

Lysiphlebus thelaxis STARÝ: Oligophagous parasite of *Thelaxes* sp. on *Quercus* sp. in forest type habitats.

Metaphidius trioxyformis (STARÝ & SEDLAG): Oligophagous species, parasite of *Cinara* spp. in forest type habitats.

Monoctonia pistaciaecola STARÝ: Probably oligophagous parasite of *Forda* spp. in forest type habitats.

Paralipsis enervis (NEES): Typical, in steppe type habitats occurring polyphagous parasite of root aphids (*Anoecia* sp., *Anuraphis subterranea* WALK. on *Pastinaca sativa*, *Brachycaudus* sp. on *Ballota nigra*, *Carduus crispus*, *Arctium lappa*, *Dysaphis crataegi* (KALT.) on *Daucus carota*, *Forda* spp. on *Poa pratensis*, *Agropyrum repens*, *Byrsocrypta ulmi* (L.) on *Hordeum vulgare*, *Avena sativa*).

Pauesia spp.: Mostly oligophagous parasites of *Cinara* spp. in forest habitats. Some of them are more specialized (*P. grossa* (FAHR.), *P. maculolachni* (STARÝ)).

Protaphidius wissmannii (RATZEBURG): Monophagous parasite of *Stomaphis quercus* (L.) in forest type habitats.

Trioxyis falcatus MACKAUER: Monophagous parasite of *Periphyllus villosus* (HTG.) on *Acer platanoides*, *Acer campestre*, in forest type habitats.

4. Discussion

We have shown in our previous studies on some aphid groups × parasite relationship that the host specificity in the aphidiid wasps is determined by two main factors, i. e. 1. by the habitat, 2. by the presence of suitable hosts in the frame of this habitat. The host suitability is determined by the phylogenetic adaptation of a parasite to a given host, on the other hand by the ecological plasticity of the parasite species, i. e. by its ability to infest

and develop in a host that has a similar mode of life but different phylogeny when compared with the original host.

Thus, the aphid species that change the type of habitat in the connection with migration from primary to secondary host plants are infested by different parasite species or complexes of species of the corresponding type of habitat. The migration of aphids is also sometimes connected with the change of mode of life (root aphids, gall producing aphids, free living aphids, etc.).

Some examples which confirm our above mentioned previous results may be shown also in the aphid groups and their aphidiid parasites dealt with in this paper.

The *Lachnidae* are mostly monoecious species. The dioecious species, too, do not change the type of habitat (forest — forest), so that they are infested by the same parasite complex during all the season. There is a similar situation in the *Chaitophoridae*, *Thelaxae* spp., etc.

In the dioecious *Anoecia* spp., the aphids are infested on primary host plants, in type — intermediary habitat (edges of woods) by *Lipolexis gracilis* FÖRST., and on roots — on secondary host plants — by *Paralipsis enervis* (NÈES), which is the typical parasite of various root aphids. Other example may be quoted in *Schizoneura* spp., or in *Forda* spp. In the latter case, where anholocyclic Central European species live on roots, they are infested here by the mentioned root aphids parasite *Paralipsis enervis* (NÈES); on the other hand, the South European holocyclic species live for a certain period in forest habitats, where, they are infested by other parasite complex.

In the studied groups there is quite a number of gallproducing aphids and those, which produce strong wax covers. The gall producing aphids are infested by more or less specialized parasite complex, similarly as root aphids, etc. The wax-producers, e. g. *Eriosoma lanigerum* (HAUSM.), *Stagona xylostei*, etc., are mostly omitted by the parasites and it seems that strong wax covers repel the aphidiid parasites in general.

5. Conclusions

On the ground of our studies the following situation in host $\times$ parasite relationship of the below quoted aphid groups has been ascertained:

a) Family *Lachnidae*. The parasite complex of this family is rather typical, the parasites do not infest other aphid groups. Each of the lachnid tribes is parasitised by typical group of parasites, monophagous or oligophagous.

b) Family *Chaitophoridae*. The aphidiid parasites represent strictly specialized group, the influence of polyphagous parasite species being nearly none. This group of parasites is composed from three complexes that represent parasites of the tribes *Periphyllini*, *Chaitophorini* and *Atheroidini*.

c) Family *Thelaxidae*. There is a strong influence of polyphagous parasites in the composition of parasite fauna of this aphid family. The mode of life of aphids seems to play a very important role in this case. From three subfamilies only the *Thelaxinae* have specialized parasite complex.

d) Family *Eriosomatidae* There are polyphagous species mostly represented as parasites of aphids of the *Eriosomatidae*, *Pemphiginae* and *Fordinae*, while specialized parasites are rare The holocyclic South European species of *Forda* have other parasite complex (on trees) than Central European species of this genus that are anholocyclic. The specific composition of the parasite fauna of all the family is remarkably poor, being probably caused by strongly developed wax covers, etc. in aphids of this family.

e) Families *Adelgidae*, *Phylloxeridae* Aphidid parasites have not been ascertained as yet It seems that the *Aphididae* do not parasitize these aphid groups at all

Summary

A review of aphidid parasites of aphid families *Lachnidae*, *Chaitophoridae*, *Thelaxidae*, *Eriosomatidae*, *Adelgidae* and *Phylloxeridae* in (Central) Europe and ecological characteristics of parasites are given

Zusammenfassung

Die Arbeit gibt eine Übersicht der *Aphididae* als Parasiten der Familien *Lachnidae*, *Chaitophoridae*, *Thelaxidae*, *Eriosomatidae*, *Adelgidae* und *Phylloxeridae* der *Aphidoidea* in (Zentral) Europa und eine ökologische Charakterisierung der Parasiten

Резюме

Работа дает обзор семейства *Aphididae*, как паразитов семейств *Lachnidae*, *Chaitophoridae*, *Thelaxidae*, *Eriosomatidae*, *Adelgidae* и *Phylloxeridae* подотряда *Aphidoidea* в (Центральной) Европе и экологическую характеристику паразитов

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