Andrea Binazzi
Stephan Scheurer

ATLAS OF THE HONEYDEW PRODUCING CONIFER APHIDS OF EUROPE

www.aracneeditrice.it
info@aracneeditrice.it

via Raffaele Garofalo, 133 A/B
00173 Roma
(06) 93781065

ISBN 978–88–548–2508–6

1st edition: may 2009

CONTENTS

PREFACE

This small volume on such an interesting group of insects like aphids intends to give a detailed information on those forest aphid species which feed on conifers and are known to produce much more and better honeydew than others. In fact, that aphid honeydew is more searched and appreciated by bees and beekeepers for the "forest–honey" or "honeydew–honey" production.
This book achieved with the form of an atlas, clearly occupies an intermediate place between a scientific test and a field handbook and therefore it can be used either by natural scientists, students, biologists, entomologists, or by bee–keepers or apicultural forest technicians. Also public institutions like natural parks or offices for plant protection, nature conservation and green spaces management can be interested in.
Actually, by means of both the keys and the sheets of this atlas subdivided for each conifer–host genus, a correct identification of the aphid species is rather easy also by the not specialized reader with the only aid of a x 10 hand lens (but slide–mounted material is also recommended). Furthermore, basing on the single sheets given for each aphid species, enough information is available on the life cycles, biology and ecology of the species aimed to a more correct previsional knowledge of both their population dynamics (outbreaks) and honeydew flows in the European conifer forests and stands.
The sheets have been planned to include the whole information available on the treated aphid species. Each sheet has been accomplished in vertical or horizontal format and is subdivided in six sections or panels, i.e., 1.–"body length", 2.–"essential morphology", 3.–"host plants and ethology", 4.–"honeydew and ants", 5.–"life cyle" and 6.–"distribution".
Figures and data contained in panels 1 & 2 need to be verified and compared with mounted specimens on slide; the other panels give up–dated information referred to the year of publication of the atlas; the geographical distribution included in panel 6 is subdivied in simple "distribution" when related only to Europe or in "general distribution" when the species have a wider range.
For all of the symbols included in the different panels of the sheets four legenda are given, in sheet format: fig. 8 (main legenda for the aphid sheets of the atlas), fig. 9 (legenda for biological forms of aphids treated in the atlas), fig. 10 (legenda for life cycle patterns of aphids treated in the atlas) and fig. 11 (legenda for un– or little–known life cycle patterns of aphids treated in the atlas).
A list with explanation of the shortenings used in the keys is put at the beginning of the relative main chapter.
In the Appendix information is given on methods for the collecting, preservation and mounting of aphids whenever the necessity should arise for a correct identification of species.

Andrea Binazzi
Stephan Scheurer

ACKNOWLEDGEMENTS

Many thanks heartily are given to all the persons, colleagues, friends, forest operators, technicians ans beekeepers for all kind of co–operation and help in collecting aphids during our more than thirty years excursions.

We are particularly indebted to our colleague and friend Sebastiano Barbagallo (University of Catania) for his encouragement and precious advice.

INTRODUCTION

Among insects which are known to be the most impressive classis of animals as to the number of species and to the richness of morphs and bioecological patterns, aphids are a small but very interesting group of phytophagous organisms including at present about 5000 described entities. Aphids are very old insects, dating since the end of Triassic, about 200 millions of years ago (Heie, 1967), which have occupied the most of the temperate regions of the world exploiting almost the whole of the herbaceous and arboreal plants. Their life cycles are often as intricate as intriguing, usually enabling them to reach high population levels or outbreaks, under favourable conditions.

Aphids are small homopteran insects with weak teguments and rather low moving capability, compared with other groups of hexapods. Nevertheless, they became able to occupy successfully all the habitats of the vegetable kingdom owing to an high fertility which comes both from their cyclical parthenogenesis and high numbers of generation per year. Furthermore they have an high developing speed together with a periodical occurrence of alate morphs which are suitable to be easy transported by winds over wide areas and long distances spreading so their own populations.

As herbivorous (or phytophagous) organisms, aphids belong that sap–sucking group of insects which put their saliva inside the exploited tissues of the infested plants while feeding. But that saliva contains often phytopathogenic substances or viruses. As far as we know, plant phloem–sap is rich in sugars (e.g., sucrose, glucose, fructose, mannose) but poor in nitrogens or aminoacids (e. g., asparagin acid, glutamin acid, histidine, leucine) and also in secondary plant metabolits such as organic acids, vitamins and micro–elements. Sugars and aminoacids are essential for the growing of body so that aphids are obliged to ingest much food in order to provide themselves with enough proteins. In such a way, aphids excrete an huge amount of sugars with their honeydew. In addition, aphids can become harmful to the infested plants also when a lot of sooty mould fungi (Ascomycetes and Deuteromycetes species plurimae) develops copiously on their excreted honeydew. In fact, those fungi reduce or prevent the photosynthesis of the green parts.

MORPHOLOGY

The body of aphids has a length ranging from 1 mm up to 7,8 mm. The body is subdivided in 18 somites, six of which belong to head, three to thorax (pro–, meso– and metathorax) and nine to abdomen. Intersegmental sutures are more or less visible as well as the dorsal, and sometimes, ventral sclerotizations and pigmentation which can be more or less extended and marked. Aphid body has many appendages. Head bears the usually six–jointed antennae and the mouth pieces, while thorax bears the meso– and methathoracic wings (in the alate forms) together with the three pairs of legs. Furthermore, abdomen bears siphunculi and cauda on 5th tergite and at the distal end, respectively. The body of aphids is covered with a number of variously–shaped hairs or setae and tubercles arising from its tegument. It can bear also wax glands producing wax threads or powder.

The most of the conifer aphid species in the world belongs to Tribus **Eulachnini** in the Subfamily Lachninae of the Family Aphididae.

Tribus Eulachnini includes aphids having an oval– or pear–shaped body, as in Subtribus Cinarina, or a slender ed elongated body, as in Subtribus Eulachnina. The body colour in life varies from bronze to dark–brown or from light–orange to grey–bluish due to a frequent covering with a more or less thin waxy powder secretion. In some species several shades of green are present.

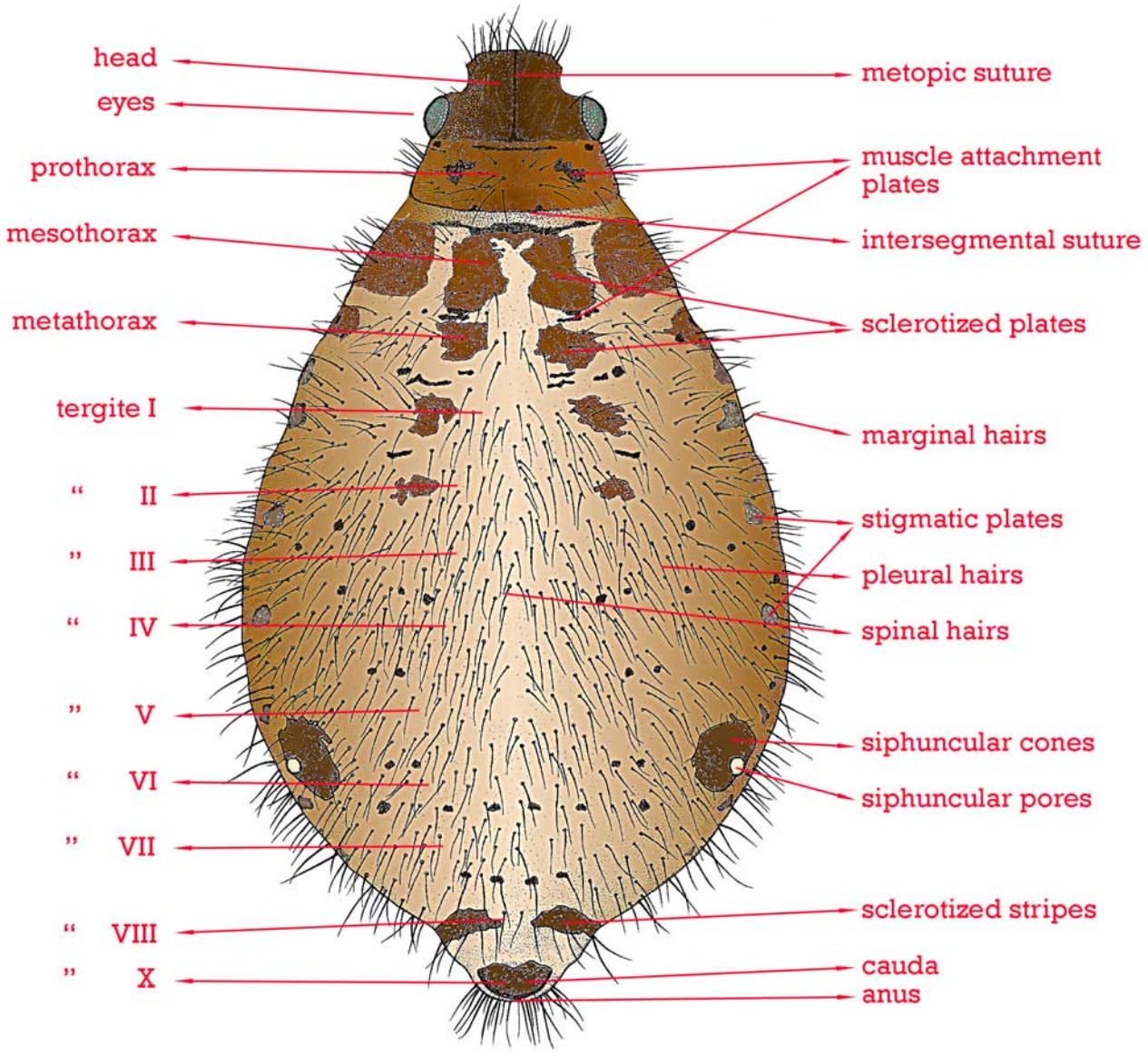

Fig. 1 – Morphology of the apterous body of an Eulachnini species belonging to *Cinara*.

The mouth apparatus (fig. 3) is made up of six parts corresponding to mandibles, maxillae and upper and lower lips (labrum and labium, respectively) modified for stinging and sucking. Both mandibles and maxillae are transformed in four thin and elongated stylets while labium is modified in a four– to five–jointed structure containing the four stylets as a groove.

BIOLOGY

Aphids include species reproducing by cyclical parthenogenesis, i.e., developing with a number of generations per year by wingless and winged virginoparous females alternating with one generation per year (usually in autumn) of anphigonic individuals (sexuales) which include apterous oviparous females and apterous or alate males. Cycles in which periodically the amphigonic generation appears, within one or two years, are named "holocycles" whereas, when that amphigonic generation is ever lacking and generations run continuously in parthenogentic way, cycles are named "an–holocycles". The latter biological way of life makes aphids more capable to reproduce and exploit and feed on a larger number of host plants in different habitats. Aphids can reach high population level in a short time as their newly born larvae can become adult within two weeks at least and each mature female can have an offspring of about 35–40 daughters at most. But usually many regulator causes such as biotic, abiotic and self regulating factors control the aphid populations in nature. In fact, departure of alatae, predation and parasitism by natural antagonists (e.g., Coccinellidae, Syrphidae, Chrysopidae, Aphidiidae, Raphididae) can reduce them drastically. In addition many other more or less important enemies can attack them such as other insects, spiders, lizards, birds (e.g., *Regulus* sp., *Parus* sp.) and fungi (*Entomophthora*).

Anyway, colonies are always able to defend themselves against enemies by secreting alarm pheromones from cones. In fact, those pheromones lead colonies to become restless and aphids to disperse and/or to drop underneath.

Fig. 2 – Alarm pheromone droplets secreted from cones (*Cinara confinis*).

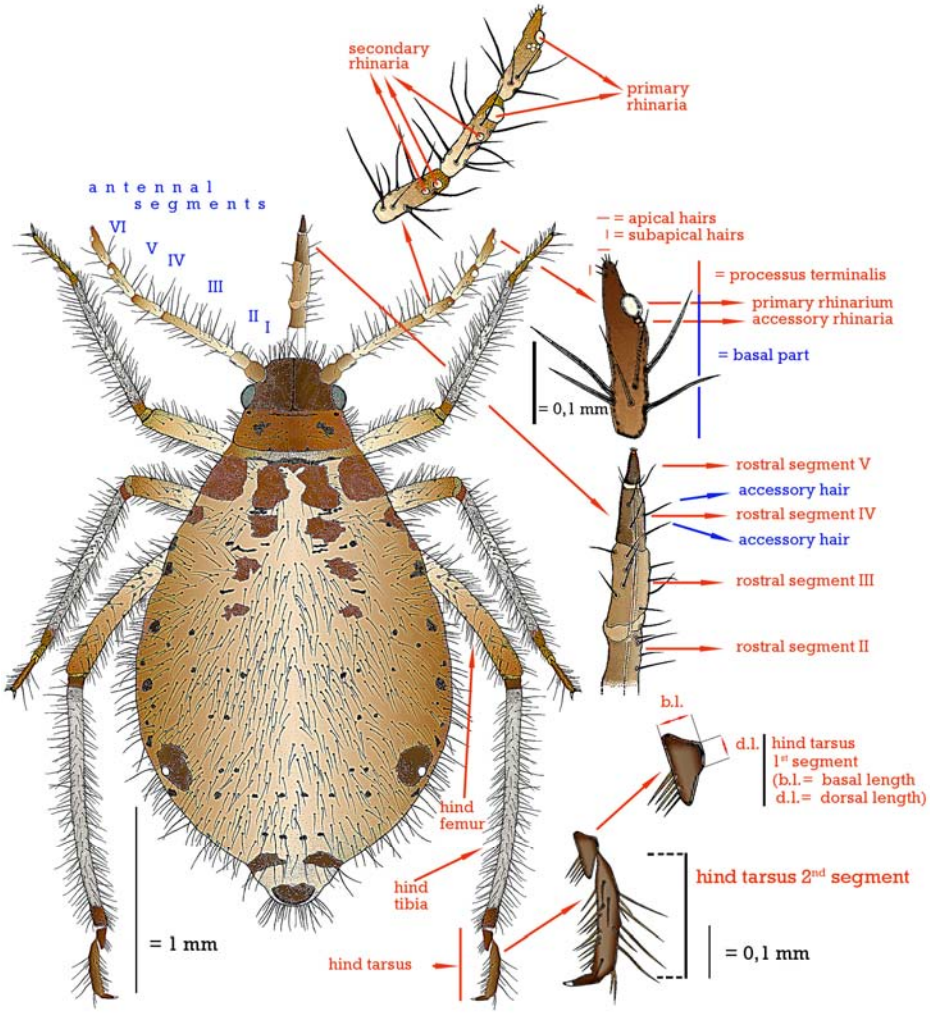

Fig. 3 – Morphology of the appendages of an aptera of *Cinara*.

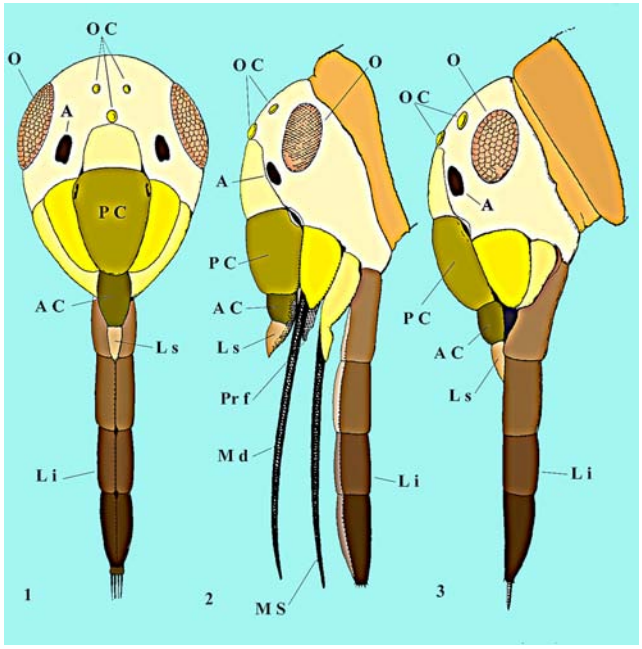

Fig. 4 – Homopteran mouth apparatus: 1, dorsal view; 2–3, lateral view (in 2, stylets are extracted from labium); A, antennal toruli; AC, anteclypeus; Ls, labrum; Li, labium; Md, mandibular stylets; MS, maxillar stylets; O, oculi; OC, ocelli; PC, postclypeus; Prf, prepharynx (after Grandi, 1966, modified).

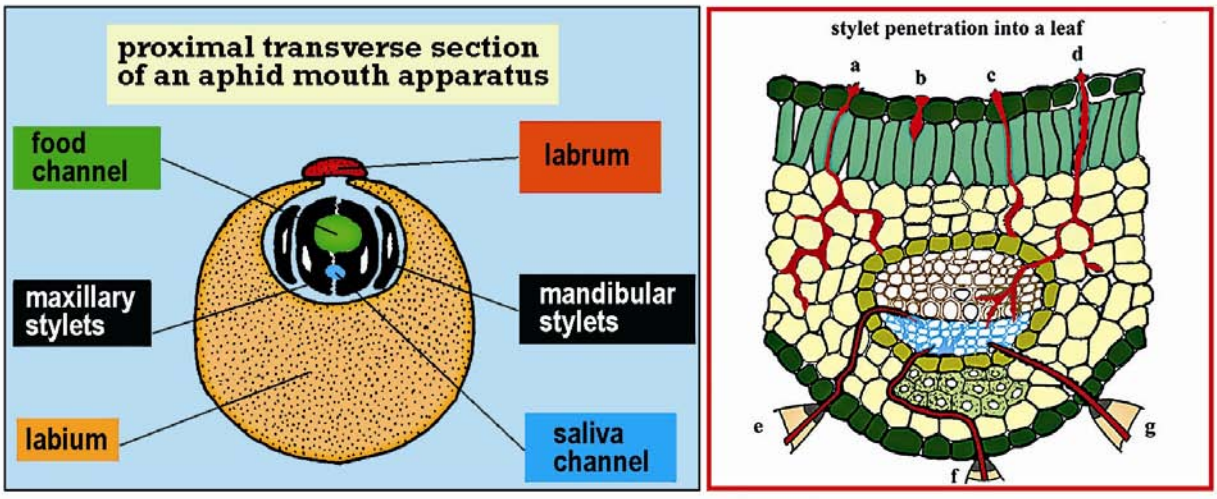

Fig. 5 – Left: inner structure of the mouth apparatus of an aphid (after Heie, 1980, modified); right: scheme of the stylet penetration into the exploited tissue of a leaf (after Pollard, 1973, redrawn).

Fig. 6 – A bee keeping an honeydew droplet from a cedar tree infested by *Cinara*.

Fig. 7 – A Bombinae species (Hymenoptera Apidae) keeping an honeydew droplet.

Fig. 8 – A colony of *Cinara kochiana* with some individuals excreting honeydew.

Tribus **Eulachnini** includes conifer feeding species showing one–year–lasting life cycles based on different numbers of generations which count up to ten per year.

The biological forms of Eulachnini are the following: –fundatrices and fundatrigeniae apterae (apterous viviparous females), –fundatrigeniae alatae (alate viviparous females), –sexuparae (apterous or alate viviparous females), –sexuales (apterous oviparous females, often with a white preanal ring, and apterous or alate males). Males appear once a year in autumn. Species of Eulachnini are monoecious, i.e., living their whole life cycle on the same host plant without changing of host plant genus.

ECOLOGY

Many Eulachnini species excrete honeydew as small droplets and because of that they are attended by ants which pick up and feed on their abundant or moderate honeydew.

The ant attendance on aphids can be compulsory (= compulsorily dependent) as, for example, in *Cinara piceicola*, *C. nuda*, *C. pini*, *C. acutirostris*, *C. kochiana*, or optional (= optionally dependent) as in *C. pruinosa*, *C. piceae*, *C. confinis*, *C. brauni*, *C. schimitscheki*, *C. laricis*), or rare (= independent).

All of the *Cinara* species visited by ants decrease progressively the quantity of the excreted honeydew ("hygiene service") but they increase the excretion frequency which anyway leads to the change of the honeydew composition. Furthermore, a lower stability of the colonies depends also on the increase of parasitation level by parasitiods (Aphidiidae). Ants defend aphids from adults and larvae of ladybirds (Coccinellidae) and hoverflies (Syrphidae). In such a way, some aphids appear to depend upon ant attendance and probably some others only occur where wood–ants exist (e.g., *C. piceicola*, *C. nuda*, *C. pini*, *C. kochiana*). Other species of aphids are independent from ant attendance (= independent myrmecophily) (e.g., *C. pilicornis*, *C. costata*, *C. pectinatae*, *C. pinea*, *C. pilosa*, *C. cuneomaculata*, *Eulachnus* ssp., *Schizolachnus pineti*).

But other insects pick up and feed on aphid honeydew such as bees and flies or others (i.e., ichneumons, tachinids, syrphids, social wasps, lacewings, ladybirds, etc.). In this regard, forest honeydew harvesting by bees is important for production of the so called "forest honey" which is highly regarded in many countries of Europe. Honeydew excreted by aphids is very rich in sugars (i.e., sucrose, fructose, glucose, melezitose, trehalose, raffinose and others) and this is, subsequently, a good source for bees. The proportion of these sugars as well as that of aminoacids in the conifer aphid honeydews is variable according to both conifer and aphid species. It depends also on the sites on the same plant where aphids settle as well as on the different concentrations of nutrients inside the tree phloem related to the different times of the vegetative season. Anyway, the more both phloem–sap and aphid honeydew are rich in sugars the more bees are attracted by that honeydew.

The most suitable forest honeydews for "forest honey" in Europe are known to originate mainly from *Abies alba*, *Picea abies, Larix decidua* and *Pinus sylvestris* (Carter & Maslen, 1982) but other conifer plants, with their sap–sucking insect equipment, can be a good source of "forest honey" (Kloft et al., 1985). Inside that insect equipment, Eulachnini can be regarded as the most important group of honeydew–producing aphids for the "forest honey".

The species of aphids listed below are known as the most suitable for the honeydew production and for its harvesting by bees in the conifer forests of Europe. Beekeepers know, that honeydew–honey cristallizes quickly in the hive, because of its richness in melezitose, and a good honeydew flow is expected to be a long lasting flow. For this reason, only a few of species are really important if singly considered while many other species can contribute all together to this aim.

The tribus Eulachnini in the system of insects

Phylum ARTHROPODA
Classis INSECTA
Ordo HEMIPTERA
Subordo HOMOPTERA
Sectio STERNORRHYNCHA
Superfamilia APHIDOIDEA

APHIDOIDEA VIVIOVIPARA
Familia Aphididae Latreille, 1802
Subfamilia Lachninae
Tribus **Eulachnini**

Conifers as hosts of Eulachnini within the system of Gymnospermae
Ordo Coniferales
(taxa as hosts of Eulachnini in Europe are in bold)

Divisio GYMNOSPERMAE
Ordo CONIFERALES
Familia Araucariaceae
Genus *Agathis*
" *Araucaria*
Familia Cupressaceae
Genus *Austrocedrus*
" *Callitris*
" *Calocedrus*
" ***Chamaecyparis***
" x ***Cupressocyparis***
" ***Cupressus***
" ***Juniperus***
" *Fitzroya*
" *Pilgerodendron*
" *Tetraclinis*
" ***Thuja***
" *Widdringtonia*
Familia Pinaceae
Genus *Abies*
" ***Cedrus***
" *Keteleeria*
" ***Larix***
" ***Picea***
" ***Pinus***
" *Pseudotsuga*
" *Tsuga*
Familia Taxodiaceae
Genus *Cryptomeria*
" *Metasequoia*
" ***Sequoia***
" *Sequoiadendron*
" ***Taxodium***