Insect Pests of Fruit Trees and Grapevine

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By

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Preface

The present book describes the morphology, life history, symptoms of injury to the trees, and ways and means of controlling insect pests of fruit trees or grapevine. It is particularly useful to university instructors teaching respective courses, to students taking such courses, and to fruit or grapevine growers and other persons involved in the growing or protection of fruit trees or grapevine from insect pests. The authors are university professors with particular experience in the respective field under the conditions of Greece. The insect species covered, and the literature consulted and cited, are mainly from countries bordering the Mediterranean Basin, yet a considerable number of them concerns also other countries having the Mediterranean climate or a mild continental one. The book is not a review of the respective literature, yet, the more than 700 references cited are a rich source of additional useful information. Authorship priority has been adopted wherever possible.

To assist readers recognize many of the species treated, and some of the symptoms of injury they cause to the trees, more than 400 color photographs and other illustrations are included. Many of them are from a previous book in Greek, with a similar title, by the same authors, published in 1998 by Agrotypos S.A. The source of each figure is given in the respective legend.

At the beginning of each chapter there is a list of the species which frequently or occasionally infest the respective group of trees in Greece and certain other countries. A black square preceding the name of a species on the list indicates that the respective species is treated in some part of the book. The sequence of species in the text is the one shown on the lists, i.e. according to order and family, and in alphabetical order within each family. For insecticides and other plant protection products the internationally adopted common names of their active ingredients are used as a rule, instead of commercial names of specific formulations.

Throughout the text “larva” is used for all preimaginal stages, between the egg and the adult, of all species of insects, whether ametabolous, hemimetabolous or holometabolous. In larvae, the term “stadium” is used for the period of time between two consecutive molts, i.e the period of time spent in any given larval instar. Therefore, after hatching from the egg, the first-instar larva remains in the first stadium until it molts. Subsequently, it becomes a second-instar larva and remains in the second stadium until its second molt, and so on.

In the past several years, the European Parliament and the European Council have taken decisions and issued directives to be followed by member states, for the reduction of the hazard from the use of agricultural pesticides to human health and the environment, as well as for encouraging the development and application of integrated plant protection programs. Based on those instructions, member states should further develop and apply their national plans. A fairly recent such directive is 2009/128/EK of the 21st October 2009, completing several previous ones. Among the actions included in those directives are the setting of maximum allowed concentrations of pesticide residues in and on food and feed of plant and animal origin, and rules regarding the marketing, storing, and application of agricultural pesticides. Institutions and individual scientists advising growers should be familiar with such European directives and national rules and limitations. It is encouraging that in a number of European countries there has been a substantial reduction of the use of classical insecticides in fruit orchards, and an increase of the application of methods and means compatible with integrated pest control.

It is well known that the effectiveness of insect control is affected by a number of factors. If the fruit grower does not take those factors into account when planning or executing insect control, effectiveness may be limited. As such factors in each particular orchard, season, and case are beyond the control of the authors, neither the publisher nor the authors have any responsibility whatsoever for possible low effectiveness against the pest insects, or for possible injury to the trees, their products, or other living organisms by the measures and means recommended in this book, whether chemical or other. Especially for chemical measures it is essential to carefully read, apply the instructions and take the precautions written on the label of containers. State authorities, based on international experience and regulations, as well as on local experience and conditions, update at intervals the texts of labels, and in general the allowed uses of plant protection products, including their maximum allowable concentration in the spray liquid, and the minimum number of days to elapse between the last application and harvest, so as to avoid unacceptable residues on or in the harvested product. Therefore, label instructions and the advice of pertinent local agricultural advisers or other authorized persons should be the guide to fruit growers planning to apply insect pest control in their orchards. Consequently, specific insecticides and other plant protection products mentioned in this book as effective against certain injurious insects, should be taken only as examples of effectiveness in the past, and not as current recommendations.

M.E.T.

B.I.K.

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Introduction

The protection of fruit trees from phytophagous insects and other animal pests (mites, nematodes etc.) to be effective, economical and safe, should be done with the proper strategies, using methods and means that are applied in the right way, after knowledge and consideration of the various factors that affect it. There are three main strategies of control: the one by calendar or schematic, the directed or oriented, and the integrated one. Among the methods of control are the chemical (with classical or other insecticides), the biological, the biotechnical and certain other methods. The measures of control include chemical, cultural, mechanical, legal, and other.

a. **By calendar or schematic control.** Frequent insecticidal sprays are carried out based on certain dates, or according to certain vegetative stages of the trees, irrespective of the presence or population density of pest populations. Usually wide spectrum pesticides are used. The spray programs are usually planned by companies producing and selling pesticides, or by state central or regional plant protection and grower-warning stations and less often by other agencies or organizations. This strategy is the easiest and simplest in its application, therefore, it is widely followed. Usually more sprays are carried out than needed. This results in a high cost and especially adverse effects on the environment and the beneficial organisms in the orchard. Because of the frequent use of insecticides, certain insects after a shorter or longer period develop resistance to certain of them. Resistance makes this strategy often ineffective after a longer or shorter period of time, depending on the pest species and the insecticide.

b. **Directed or oriented control.** It is based mainly on instructions given to the grower by the regional plant protection warning services. It consists of the timely control of certain pest insects only when they are in the orchard, and if it is estimated that they constitute a hazard to the crop in the particular year or season. The decision regarding the time of control is taken after monitoring the insect population with the proper technique and also taking into account weather and other data. Attempt is made to protect beneficial organisms such as insectivorous parasitic insects and predatory insects and mites, through whose action the populations of a number of pest insects and mites are reduced.

When applying this strategy, the pesticides used are as much as possible effective against the primary pest species, but selective, so that they have the least harmful effect on the beneficial organisms and the environment.

c. **Integrated control.** In the last several decades, many definitions of integrated control or integrated pest management have appeared in the international literature. According to Kogan (1998), a respective survey recorded 64 definitions of integrated control, pest management or integrated pest management. The one adopted by an FAO panel of experts is: "Integrated pest control is a pest management system that, in the context of the associated environment and the population dynamics of the pest species, utilizes all suitable techniques and methods in as compatible a manner as possible and maintains the pest population at levels below those causing economic injury". Kogan (1998) points out certain weaknesses of this definition and suggests: "Integrated pest management (IPM) is a decision support system for the selection and use of pest control tactics, singly or harmoniously coordinated into a management strategy, based on cost/benefit analyses that take into account the interests of and impacts on producers, society, and the environment". In Article 3 of Directive 2009/128/EC of the European Parliament and of the Council of the European Union of 21 October 2009, "integrated pest management means careful consideration of all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products and other forms of intervention to levels that are economically and ecologically justified and reduce or minimise risks to human health and the environment. Integrated pest management emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms". According to another, generally accepted definition, integrated control or IPM is "a system of ecologically oriented management of the populations of organisms injurious to plants (insects, mites, fungi, viruses, weeds, etc.) which uses all suitable techniques and methods, in a combined way, so that the density of their population is kept at levels below those which could cause economic damage to the crop". A main aim of integrated control is the reduction of the use of those pesticides which are dangerous to the environment, the ecological (biological) balance and man on one hand, and the maximum use of methods other than chemical on the other (B. Katsoyannos and Koveos 1996). Integrated control does not necessarily use more than one method or technique of pest control. The number depends on the case. The most important requisites for integrated control to be applied properly are the following:

1. Knowledge of the bioecology of the primary and secondary pests of the tree and of their natural enemies, and especially the effective natural enemies.
2. Availability of control methods other than chemical.
3. Availability of a method for detecting the presence and for monitoring the populations of the various pests and the evolution of the injury they cause to the trees. Also, a method should be known for detecting the presence and progress of the population of beneficial insects and other organisms. The main methods or ways of following up insect populations are regular visual observations during winter and during the growing season, the knocking down (sondage) of insects and collection of them in special containers underneath, the sampling of plant parts (flowers, fruits, leaves, parts of twigs) to examine their degree of infestation, the caging in the field of infested plant parts to follow the development of the various stages of the life cycle of pest insects on them, the determination of the phenology of the pest insects on the basis of thermal summations (day-degrees) after a given date, and the use of effective insect traps. For the use of insect traps in fruit orchards see also B. Katsoyannos (1996a).
4. The setting of a "limit of tolerable population density" and a respective "intervention density" for every pest insect. The "limit of tolerable density" or "economic injury population level" (E.E.L.) is defined as the density of the insect population (or of the injury it causes) that if surpassed, the expected damage will be economically substantial. The "intervention density" or "intervention threshold" is the one at which control measures are taken, so that the E.E.L. is not surpassed. It is usually a little below the E.E.L., so that economic injury be avoided. To determine the above population densities, one has to take into consideration both the demands of the market (buyers), and other factors that may affect the level of insect populations, locally and with time. It is understood that the intervention density differs depending on the

intended method of control (see also Tzanakakis 1995).

5. The incorporation of the various elements and factors that participate in integrated control in a system that can function in practice. More specifically, there is need for cooperation between the participating scientists, technicians and growers. The integrated control strategy is a dynamic system of ideas, techniques and methods of plant protection, which to be applied in practice requires the fulfilment of the above-mentioned conditions. Methods applied in the strategy of integrated control are the following:

a. **Chemical method.** Selective insecticides are used, such that do not eliminate the beneficial entomophagous and acarophagous arthropods. If there is no available selective insecticide on the market for the particular case, and chemical intervention is necessary, a non selective insecticide of short residual action is used at the smallest dose possible, and applied on the right surface and at the right time, so that a selective effect is reached. Among the insecticides that are selective, or that can be used in a way that gives a selective result are the microbial ones, certain ones with hormonal action, and some organophosphorous or carbamate ones of short residual action.

b. **Biological methods.** In these methods natural enemies of the pest species are used, especially entomophagous insects and mites, entomoparasitic nematodes, entomopathogenic microorganisms (bacteria, fungi) and viruses. Some authors include in the biological methods the use of microbial insecticides. A recent example of successful biological control in Greece, has been the control of the citrus woolly whitefly *Aleurothrixus floccosus* with the introduction and release in citrus orchards of its parasite *Cales noacki* (P. Katsoyannos 1994a).

c. **Biotechnical methods.** In this category are included methods and techniques that take advantage of certain characteristics of insect behavior. Among them are insect traps, when used for direct insect control, i.e. for "mass trapping". Another method of special interest is the use of sex pheromones in "mating disruption", i.e. in preventing the sexes from meeting and mating. According to this method, we place in the orchard a number of pheromone dispensers (evaporators). The pheromone is diffused over the orchard and causes confusion and disorientation of the males of the pest species, which thus are unable to meet the females.

As a result the females lay infertile eggs. This method has been successful against certain moths which are serious pests of fruit trees and grapevine, such as the codling moth of apples (*Cydia pomonella*), the oriental fruit moth (*Grapholitha molesta*) and the European grape berry moth (*Lobesia botrana*). The review paper by Cardé and Minks (1995) regarding this method is worth consulting.

d. **Other methods.** There are also certain other methods that can be used in integrated control of fruit tree pests. The “sterile insect release” method is placed in the genetic methods of control by some authors, and in the biological ones by some others. The pest species is mass produced in specific installations, sterilized, and released in the specific area. The numerous sterile males released mate with unmated females of the natural pest population. The result is that most eggs to be laid give no progeny. The method is successful when applied over very large areas, but also in small but geographically isolated areas. It has been used successfully (alone or combined with other methods of control) against the Mediterranean fruit fly (*Ceratitis capitata*) in Israel, Mexico and elsewhere. The use of tree cultivars resistant to pests is usually placed in the cultural methods and means of control. The use of genetically selected races of beneficial organisms (resistant to pesticides) could well be included in the genetic methods, while the use of genetically modified insects or plants, with the use of genetic engineering could be considered as biotechnological methods of control. The use of genetically modified organisms, except difficulties of technical nature in their development, is confronted also with problems of social acceptance. In integrated control, where advisable, mechanical, cultural, and other measures are used.

The factors or conditions that affect the effectiveness of methods and measures of insect control are many. Some of them are: The knowledge of the identity of the pest insects, the degree of injuriousness, the degree of knowledge of the life history of the pests, that is of their way of life, of their development and behavior on the tree to protect, their way of life on other neighboring host-plants, cultivated or wild, the fluctuations of their populations, the likely development of resistance to certain insecticides, the proper application of control measures, and the need for simultaneous control of mites, fungi, bacteria or other plant pathogenic organisms of the given trees to protect.

With scientific progress in the field, the measures of insect control and the strategies through which they are applied change with time. In several European countries there has been a substantial reduction of the use of classical insecticides against pests of fruit trees. Instead, other measures have replaced them within the frame of integrated control. In this respect, the contribution of the European Commission has been great. Through respective directives to member states, and the enforced exchange of information between member states as well as between them and the Commission, the protection of plant pests is achieved with less and less hazard to the grower, the consumer of plant products, the general public and the environment. Such a directive is Directive 2009/128/EC of the European Parliament and the Council of the European Union of 21 October 2009. This Directive "establishes a framework to achieve a sustainable use of pesticides by reducing the risks and impacts of pesticide use on human health and the environment and promoting the use of integrated pest management and of alternative approaches or techniques such as non-chemical alternatives to pesticides". Within the provisions of this directive, but also according to previous regulations of the European Council, member states will establish national rules to achieve the reduction of pesticide use through integrated pest management and organic farming. Another Directive: 2009/127/EC also of 21 October 2009, modifies a previous one concerning the equipment for the application of agricultural pesticides. In addition to their properties, proper maintenance and frequency of inspection, instructions are given on the ways such equipment should be used so as to minimize spray drift that endangers humans, beneficial organisms and the environment.

In Greece, the Ministry of Rural Development and Food, formerly Ministry of Agriculture, is the state agency responsible for putting into force the EC directives concerning pest control in agriculture, through state legislation. Such legislation takes into account local conditions and local experience. In addition, regulations and instructions are addressed to scientists responsible for advising and supervising growers so that fruit pest control be applied within the desired framework. One of the crucial tasks of the Ministry's Plant Protection Service is the updating of the list of pesticides that are permitted for use on each specific crop or against specific pests. Persons involved in pest control and especially those advising the growers should consult those lists of pesticides permitted in the country. They can be found online in the website of the Hellenic Ministry of Rural Development and Food, "www.minagric.gr", in the menu "agricultural warning", and also in other websites such as "www.agrotypos.gr" where a regularly updated database of registered pesticides in Greece is provided, "www.farmacon.gr", and others. Also, in respective websites of other countries.

New knowledge may suggest recommendations regarding a new pesticide or, more frequently, the prohibition of a given one formerly used against a given species of insect or insects on specific fruit trees. The prohibition may concern not all but only certain ways or times of application of the given pesticide on a given species of fruit tree. Changes in the pesticides recommended for a specific use and prohibitions for certain of them are frequent. This is why we avoided recommending specific insecticides against most pest insects treated in the book. As a rule we mention only the chemical group or family of insecticides recommended in the past in the literature.

Persons involved in the protection of fruit trees from pest insects and other arthropods should keep in mind that in addition to its LD 50, volatility, stability under sunlight or humid conditions and other properties, additional factors may also affect the effectiveness of an insecticide in specific cases to the extent that it proves much more suitable against a certain pest insect than other members of the same chemical family. Therefore, mention of a given chemical may not be inappropriate in specific cases. However, as a rule the reader should not consider the insecticide(s) given in the text as the only effective ones, but rather as examples that refer to specific cases. Fruit growers should consult local farm advisers, other experts and respective information through the media, in order to apply the best insecticides recommended against specific pests in their area and case at each season.

Insects of pome trees

Homoptera

- *Stictocephala bulalus* (F.), Membracidae[1]
- *Tettigoniella viridis* (L.), Jassidae
- *Metcalfa pruinosa* (Say), Flatidae

Psyllids

- *Cacopsylla mali* (Schmidberger), Psyllidae

  Cacopsylla melaneura Foerster, Psyllidae
- *Cacopsylla pyri* (L.), Psyllidae
- *Cacopsylla pyricola* (Foerster), Psyllidae
- *Cacopsylla pyrisuga* (Foerster), Psyllidae

Aleyrodoidea (whiteflies)

  Siphoninus granati (Priesner and Hosni), Aleyrodidae
- *Siphoninus phillyreae* (Haliday), Aleyrodidae
- *Parabemisia myricae* (Kuwana), Aleyrodidae

Aphidoidea

  Anuraphis farfarae (Koch), Aphididae

  Aphis gossypii Glover, Aphididae
- *Aphis nerii* Boyer de Fonscolombe, Aphididae
- *Aphis pomi* De Geer, Aphididae

  Aphis pyri Boyer de Fonscolombe, Aphididae
- *Aphis spiraecola* Patch, Aphididae

  Dysaphis devecta (Walker), Aphididae
- *Dysaphis plantaginea* (Passerini), Aphididae
- *Myzus persicae* (Sulzer), Aphididae

  Piraphis pirinus (Ferrari), Aphididae

  Rhopalosiphum insertum (Walker), Aphididae

  Yezabura malifoliae Fitch, Aphididae
- *Eriosoma lanigerum* (Hausmann), Eriosomatidae
- *Eriosoma lanuginosum* (Hertig), Eriosomatidae
- *Aphanostigma piri* (Cholodkovsky and Mokrzecky), Phylloxeridae

Coccoidea (scale insects)

- *Aspidiotus nerii* (Bouché), Diaspididae

  Epidiaspis leperii (Signoret), Diaspididae
- *Lepidosaphes ulmi* (L.), Diaspididae
- *Parlatoria oleae* (Colvée), Diaspididae
- *Pseudaulacaspis pentagona* (Targioni -Tozzeti), Diaspididae

  Quadraspidiotus ostraeformis Curtis, Diaspididae
- *Quadraspidiotus perniciosus* (Comstock), Diaspididae

  Quadraspidiotus piri Licht., Diaspididae

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[1] On the list of species at the beginning of each chapter, certain names are preceded by a black square. They are the species treated in the respective chapter or in another part of the book. For the respective pages please consult the Taxa Index at the end of the book.

- *Saissetia oleae* (Bernard), Coccidae

  Pseudococcus viburni (Signoret), Pseudococcidae

Hemiptera

- *Calocoris fulvomaculatus* De Geer, Miridae
- *Calocoris norvegicus* Gmelin, Miridae
- *Calocoris trivialis* Costa, Miridae
- *Monosteira unicostata* Mulsant and Rey, Tingidae
- *Stephanitis pyri* (F.), Tingidae

  Rhaphigaster nebulosa Poda, Pentatomidae

Thysanoptera (thrips)

Taeniothrips inconsequens (Uzel), Thripidae
Taeniothrips meridionalis meridionalis Priesner, Thripidae
Thrips minutissimus L., Thripidae

Coleoptera (beetles)

Anisoplia sp., Scarabaeidae

- *Anomala ausonia* Erichson, Scarabaeidae
- *Anomala dubia* Scopoli, Scarabaeidae
- *Anomala vitis* F., Scarabaeidae
- *Epicometis hirta* (Poda), Scarabaeidae
- *Melolontha melolontha* L., Scarabaeidae

  Oxythyrea funesta (Poda), Scarabaeidae
  Popilia japonica Newman, Scarabaeidae
  Potosia aeruginosa Drury, Scarabaeidae
  Potosia angustata Germar, Scarabaeidae
  Rhizotrogus vernus Germar, Scarabaeidae
  Valgus hemipterus (L.), Scarabaeidae
  Agrilus sinuatus Olivier, Buprestidae
- *Capnodis tenebrionis* L., Buprestidae

  Chrysobothris affinis F., Buprestidae
  Cantharis obscura L., Cantharidae
  Apate monachus F., Bostrychidae
- *Sinoxylon sexdentatum* Olivier, Bostrychidae

  Teratolytta dives Brullé, Meloidae
  Cerambyx scopolii Fuessly, Cerambycidae
- *Byctiscus betulae* L., Attelabidae

  Haplorynchites caeruleus De Geer, Attelabidae
- *Involvulus cupreus* (L.), Attelabidae
- *Rhynchites (Coenorrhinus) aequatus* L., Attelabidae
- *Rhynchites aereipennis* Desbrochers, Attelabidae
- *Rhynchites bacchus* L., Attelabidae
- *Rhynchites lenaeus* Foerster, Attelabidae
- *Rhynchites pauxillus* Germar, Attelabidae
- *Rhynchites smyrnensis* Desbrochers, Attelabidae
- *Rhynchites versicolor* Costa, Attelabidae

  Anthonomus pedicularis L., Curculionidae
- *Anthonomus pomorum* L., Curculionidae

- *Anthonomus pyri* Kollar, Curculionidae
- *Anthonomus spilotus* Redtenbacher, Curculionidae
- *Curculio nucum* (L.), Curculionidae

  Magdalis barbicornis Latreille, Curculionidae

  Magdalis cerasi L., Curculionidae
- *Otiorrhynchus* spp., Curculionidae

  Phyllobius betulae F., Curculionidae

  Phyllobius oblongus (L.), Curculionidae

  Phyllobius pyri (L.), Curculionidae

  Polydrosus ponticus Faust, Curculionidae

  Ramplus pulicarius Herbst, Curculionidae
- *Scolytus amygdali* Guérin, Scolytidae

  Scolytus mali Becht., Scolytidae
- *Scolytus rugulosus* Mueller, Scolytidae
- *Xyleborus (Anisandrus) dispar* F., Scolytidae

  Xyleborus saxenesi Ratz., Scolytidae

Diptera (flies)

- *Apiomyia bergenstammi* (Wachtl), Cecidomyiidae
- *Contarinia pyrivora* (Riley), Cecidomyiidae
- *Dasyneura mali* Kieffer, Cecidomyiidae
- *Dasyneura pyri* (Bouché), Cecidomyiidae
- *Ceratitis capitata* (Wiedemann), Tephritidae

Lepidoptera (moths)

  Stigmella malella (Stainton), Stigmellidae

  Stigmella pyri (Glitz), Stigmellidae

  Stigmella pyricola Walker, Stigmellidae
- *Phyllonorycter blancardella* (F.), Gracillariidae
- *Phyllonorycter cerasicolella* (Herrich-Schaeffer), Gracillariidae
- *Phyllonorycter corylifoliella* (Haw.), Gracillariidae
- *Leucoptera malifoliella* (O.G. Costa), Lyonetiidae
- *Lyonetia clerkella* L., Lyonetiidae

  Conopia culiciformis L., Sesiidae
- *Conopia typhiaeformis* Borkhausen, Sesiidae
- *Synanthedon myopiformis* Borkhausen, Sesiidae

  Anthophila pariana Cl., Glyphipterygidae

  Agryresthia cornella F., Yponomeutidae
- *Yponomeuta malinellus* Zeller, Yponomeutidae
- *Yponomeuta padellus* (L.), Yponomeutidae

  Blastodacna putripenella Zeller, Cosmopterygidae
- *Anarsia lineatella* Zeller, Gelechiidae
- *Cossus cossus* L., Cossidae
- *Zeuzera pyrina* (L.), Cossidae

  Acleris variegana Denis & Schiffermueller, Tortricidae
- *Adoxophyes orana* Fischer von Rosslerstamm, Tortricidae

  Acrolita (Rhopobota) naevana Hübner, Tortricidae

  Ancylis selenana Gn., Tortricidae

- *Archips rosanus* L., Tortricidae
  Archips podanus Scopoli, Tortricidae
  Archips xylosteanus L., Tortricidae
- *Cacoecimorpha pronubana* Hübner, Tortricidae
- *Cydia pomonella* (L.), Tortricidae
- *Grapholitha molesta* (Busck), Tortricidae
- *Hedya nubiferana* Haw., Tortricidae
- *Hedya pruniana* Hübner, Tortricidae
- *Laspeyresia pyrivora* Danilevsky, Tortricidae
- *Ectomyelois ceratoniae* (Zeller), Pyralidae
- *Euzophera bigella* Zeller, Pyralidae
- *Vanessa polychloros* (L.), Nymphalidae
- *Aporia crataegi* (L.), Pieridae
  Eriogaster lanestris L., Lasiocampidae
  Malacosoma neustria L., Lasiocampidae
- *Saturnia pavonia* L., Saturniidae
- *Saturnia pyri* Schiffermueller, Saturniidae
- *Euproctis chrysorrhoea* (L.), Lymantriidae
  Orgyia antiqua L., Lymantriidae
- *Lymantria dispar* (L.), Lymantriidae

Hymenoptera

- *Palaeocimbex quadrimaculata* (O.F. Mueller), Cimbicidae
  Janus compressus F., Pamphiliidae
- *Caliroa cerasi* (L.), Tenthredinidae
- *Hoplocampa brevis* Klug, Tenthredinidae
- *Hoplocampa testudinea* Klug, Tenthredinidae

***Stictocephala bubalus* (F.)** *(Ceresa bubalus, Centrotus bubalus, Membracis bubalus)* **(Homoptera, Membracidae)**, comm. **buffalo treehopper**

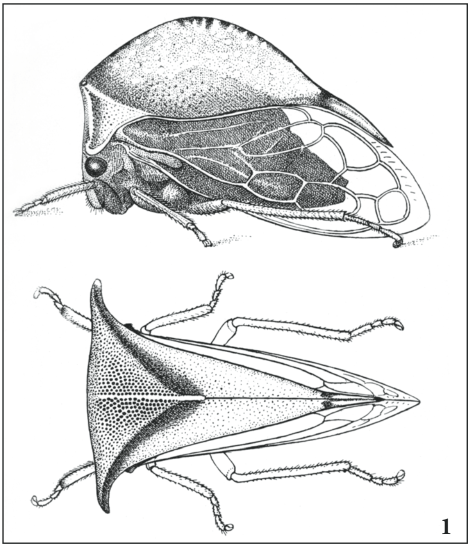
Adult. According to Balachowsky (1939), the body is pale green, with late-season individuals being brownish green. The average body length, from head to apex of the fore wing, is 10 mm. The shape of the body is characteristic. The pronotum is enormous, and along its middle forms a convex keel exceding the body in length and having a pointed processus terminalis. Seen dorsally, the pronotum widens laterally becoming triangular, and having a humeral horn on each side directed slightly backwards (Fig. 1). The wings are transparent, and the fore ones surpass the pronotum. The female has a strong contractile ovipositor able to cut through the bark of trees to insert the eggs.

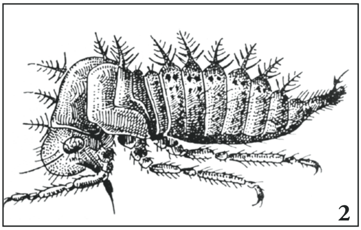
Egg. Whitish, 1.25-1.35 x 0.35-0.4 mm. The eggs, in small groups, are inserted in the subcortical layer of woody plants, mostly various fruit and forest trees. Pictures of such characteristic oviposition slits in shoots and twigs are given by several American and European authors such as Balachowsky (1939), Della Beffa (1961) and Kattoulas (1961) (Fig. 3).

Larva. The young larva is grey and 1-1.3 mm long. Along the dorsum of the thorax and of the abdomen it bears branched spines (Fig. 2). The grown larva is greenish or grey-green, bears also branched spines, is flat laterally, and is approximately as long as the adult.

Geographic distribution. North America and Europe.

Host plants. The larva does not harm trees. It is polyphagous, feeding on various herbaceous plants, such as leguminous ones, cotton, potato, carrot, beans and various other vegetables and weeds, as well as on ornamental plants such as dahlias and chrysanthemums. The injury to trees is due to the oviposition slits made by the ovipositing





Figs.1-3. *Stictocephala bubalus.* 1.Adult in side view above, and dorsal view below (x10). 2.Larva in side view (Balachowsly 1939). 3.Oviposition incisions in apple twig made by the adult female (Kattoulas 1961).

adult females to tree shoots and twigs (Fig. 3). Such injured trees are pome trees, stone fruit trees, grapevine, and many broad-leaved forest and amenity trees.

Life history and damage. It has one generation per year. It overwinters as an egg in the bark of shoots and twigs of various trees, in slits that the female makes with its ovipositor. In southern France (Balachowsky 1939) the larvae hatch in April and decend the trees to feed for approximately 3 months on herbaceous plants until mid-July, piercing and sucking their sap. After becoming adults and mating, the females fly to neighboring trees to insert their eggs, as mentioned above, in young, one- to two-year old trees, and one- to three-year-old shoots and twigs of older trees. The eggs are laid between the end of July and mid-October, but mostly in August to October. The lips of the slit almost close, and the eggs are not seen from the outside.

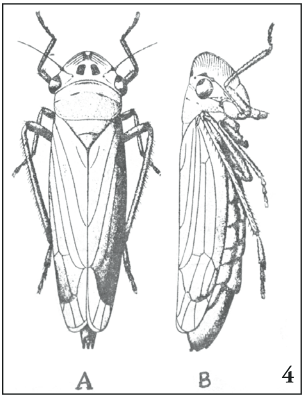
In central northern Greece hatching of the young larvae was observed mainly from mid-April to early May (Kattoulas 1961). In that region the larvae fed mostly on cotton and alfalfa growing under or very near trees. The larvae completed growth by mid-July, and adults were formed on the herbaceous hosts peaking in late July. The adult females flew mostly to apple and pear to oviposit. They selected shoots or twigs usually of small diameter and up to 3 years old. Before ovipositing, the female makes with its saw-like ovipositor a deep, 3 to 6-mm-long slit in the bark. The slit is approximately parallel to the shoot axis and in certain trees reaches or surpasses the cambium. In each slit the female inserts 7-14 eggs in one or two curved rows.

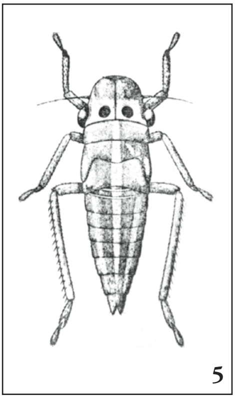
The oviposition slits made to the twigs of fruit trees and the formation of suberizing tissue around them by the plant, prevent the normal circulation of sap and the functioning of the twig which weakens. This affects the growth especially of young trees. In southern France damage was more important to young trees, and mainly in humid localities where adults concentrated in summer. Apple trees were more susceptible than pear ones (Balachowsky 1939). Larval feeding may sometimes also cause injury to herbaceous crops. When the larval population is dense, the loss of sap, together with tumors or lesions caused to the feeding sites result in limited growth and ultimate withering of the plants (Kattoulas 1961). Such injury was caused mostly to tender young cotton plants growing near fruit or other trees. In France, injury by larval feeding has been observed in chrysanthemums (Balachowsky 1939).

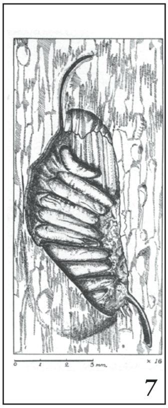
Control. To limit damage to young trees, the timely control of weeds under and near the trees is recommended, so that the larvae find no hosts to feed on and develop. In winter, at the time of pruning, removing of twigs bearing slits will reduce the overwintering insect population. No burning of those twigs is necessary, because in cut-off twigs the eggs are soon dehydrated (Bonnemaison 1961). To reduce spread of the insect to other areas, the transfer of nursery trees bearing oviposition slits should be forbidden. In the case that nearby cultivated herbaceous plants are damaged by larvae, timely sprays with a synthetic organic insecticide, preferably systemic, are recommended. Against weeds, timely ploughing is often sufficient.

***Tettigoniella viridis* L.** *(Cicadella, Tettigonia viridis),* **(Homoptera, Jassidae)**

Adult. According to Balachowsky (1941) the adult female is on average 9 and the male 5.5-6 mm long. The body is long and narrow and the head wider than the pronotum. The back of the body is green, the forewings dark green to blueish, while parts of the head, the legs and the ventral part of the body are yellow. There are two black spots in the median part of the vertex, between the two lateral ocelli (Fig. 4). Balachowsky (1941) gives pictures of adults and incisions made to pear and peach shoots housing the eggs.







Figs. 4-7. *Tettigoniella viridis.* 4.Adult female in dorsal and side view. 5.Larva in dorsal view. 6. Pear twig with numerous oviposition incisions (Balachowsky 1941). 7.Twig bark cut open to show the location of eggs (Kattoulas 1961).

Host plants. The larvae feed and grow on Gramineae, especially *Cyperus, Arundo, Juncus, Pragmites* growing in humid prairies, especially near lakes, pools and rivers. The adults oviposit in the stems of neaby woody plants, including fruit and amenity trees of such genera as *Malus, Pirus, Cydonia, Prunus, Crataegus, Alnus, Populus, Quercus, Salix, Ulmus* and *Rosa*.

Life history and damage. According to Balachowsky (1941) it completes one generation per year in France. It overwinters in the egg stage. The eggs are inserted by the females in shoots and twigs of the various trees and shrubs seen above, in a way similar to that of the eggs of *Stictocepala bubalus* (above). There are 12-15 eggs on the average per oviposition slit (Figs. 6,7). The larvae (Fig. 5) hatch from the eggs usually in April. The neonate ones are dark grey. They decend to the graminaceous hosts, where they complete growth in approximately 2 months. After mid-June only adults are found in the fields. They feed little and remain in the low vegetation until September when they mature sexually. The females gradually abandon the prairies and congregate in neaby localities with woody plants such as orchards, gardens, parks and plantations of broad-leaf trees and shrubs to oviposit inside the stems, shoots or one- to three-year old twigs. Oviposition is more intense from mid-October to mid-November. This leafhopper was studied also in Bulgaria by Malkoff (1904). Bonnemaison (1961) mentions that Frediani (1956) observed in Italy 3 generations per year of this leafhopper, the adults appearing in late May, late July, and end of September. Certainly this needs verification, including correct species identification.

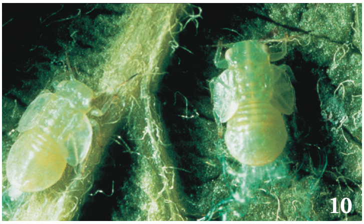
The injury caused by the oviposition slits in shoots of fruit trees, especially near humid localities may be serious, especially in young, up to three-year-old fruit trees. In such cases measures as against *Ceresa bubalus* (above) should be taken.

Cacopsylla mali (Schmidberger) (Homoptera, Psyllidae)

Adult. According to Balachowsky and Mesnil (1935) the males are 2.6 and the females 2.9 mm long. The general coloration is brown-red, but varies with the season and the individuals. The wings are transparent and exceed the end of the abdomen (Fig. 8).

Egg. It measures 0.4 x 0.16 mm. From whitish it turns yellowish or orange, and finally dark red (Fig. 9).

Larva. The young one is light yellow with red eyes and black vertical bands. In later instars it is uniformly greenish (Fig. 10).



Figs. 8-10. *Cacopsylla mali.* 8.Adult. 9.Eggs on the bark. 10.Last-instar larva on the underside of an apple leaf (photo A. Staub).

Geographic distribution. North and South Europe, the Balcans, Caucasus, Japan, Australia. Along the Mediterranean coast it is rare, while in central and northern Europe it is abundant and harmful.

Host trees. Mainly apple, and exceptionally pear, quince and *Sorbus* sp.

Life history and damage. It completes one generation per year. It overwinters in the egg stage on the bark of the shoots of the year, usually near buds. The larvae hatch in spring from April on, and attack buds, leaves, flowers and fruits. The adults are formed in May-June and oviposit in autumn (September to November) on the distal part of the shoots of the year. The eggs are partially inserted in the bark. According to certain authors (Balachowsky and Mesnil 1935 and references therein), the adults in summer migrate to other trees such as elm, and in autumn return to the apple orchards to oviposit. When the population density of this psyllid is high, normal bud development is adversely affected, and chlorosis, withering, petal fall, and drying of flowers, as well as abnormal fruit development may result. In addition, the honeydew excreted by the larvae and the resulting sooty mold, soil the fruits and add to the damage.

This psylla has many natural enemies, Hemiptera, Diptera, Coleoptera and Hymenoptera, and often the fungus *Entomophthora sphaerosperma* Fres.

Control. Satisfactory results have been reported by spraying the trees in late autumn to mid-winter with mineral or vegetable oils against the eggs. Such treatments may also kill aphid eggs, scale insects, and certain other insects that overwinter on the bark. Against larvae during the growing season, synthetic organic insecticides, fortified or not with a summer oil, are used. Whenever possible, it is advisable to combine the control of this psylla with that of codling moth.

Cacopsylla pyri **(L.)** (*Psylla pyri*) **(Homoptera, Psyllidae)**, comm. **pear psylla**

Adult. It resembles a small cicada (Fig. 11). The adult of spring and summer generations is 1.2-2.7 mm long, and of rust color, while that of the autumn generation, which overwinters, is larger and darker.

Egg. Oval, whitish or white-yellow (Fig. 12), with a terminal filament which is shorter than the egg width.

Larva. There are 5 larval instars. Their body is flat, yellowish, with light brown or dark brown spots (Fig. 13). During the first 4 stadia the larval body is covered by a drop of honeydew which the larva excretes. This honeydew reduces the efficacy of insecticidal sprays.

Host plants. Pear. This psylla is considered as the main pest of pear trees in Europe (Bués et al. 2000).

Life history and damage. In the Larissa area of central continental Greece 4-6 generations per year are reported (Broumas 1990) and in the neighboring Magnesia 5-6 (Stratopoulou and Kapatos 1992c). It overwinters as adult in protected sites on the trees, on fallen dead leaves, and in other sites of the orchard. In Magnesia, on trees of the cultivar Crystali (Tsaconica), a considerable percentage of the females that have overwintered matures reproductively and oviposits in February and March, with a peak the first 10 days of March. The larvae hatch when the mixed buds of the cultivar Crystali start developing (Stratopoulou and Kapatos 1992c). They enter the developing buds and feed by piercing and sucking the bases of young leaves and the flowers. Later they move to the leaves, where they settle and cover themselves with the droplets of honeydew they excrete. The maximum population of 4th and 5th instars aqpproximately coincides