

INSECTS PRODUCING HONEYDEW EXPLOITED BY BEES IN GREECE

LOUKAS A. SANTAS

*Department of Agricultural Zoology and Entomology
University of Agricultural Sciences of Athens
Athens 301 - Greece*

SUMMARY

More than 65 % of the honey in Greece derives from honeydew of insects. In a research work, started in 1977 and continued until now, 32 species of insects have been identified which produce honeydew exploited by bees.

All these insects belong to the order Hemiptera : Homoptera and to the superfamilies Aphidoidea, Coccoidea, Psylloidea and Aleyroidea. Among these 32 species, the most important from the point of the honey production, are : The coccids *Marchalina hellenica* (Gen.) and *Physokermes hemicryphus* Dalm. and the aphids *Cinara confinis* (Koch.) *Cinara pectinatae* Nördl. and *Mindarus abietinus* Koch.

INTRODUCTION

Honeys are derived from flower nectar, from plants which have nectaries elsewhere (extrafloral nectaries) and from the honeydew.

« The utilisation of honeydew by bees has long been recognized and honeys derived from it have considerable economic value in some parts of the world » (AUCLAIR 1963).

From statistical data of honey market of the years 1975-1976 it is obvious that more than 65 % of honey production in Greece is based on honeydew. This honeydew honey according to the same statistical data, is derived from *Pinus* spp. (60 %) and *Abies* spp. (5 %) (SELIANAKIS 1978).

The honeydew honey has a low percentage of invert sugar (glucose and fructose) high percentage of saccharose and other polysaccharides high pH (4,8-5,1) and it shows no crystallization during the storage.

The main difference, between *Pinus* and *Abies* derived honey is based on the colour and flavour. Thus the *Abies*-honey is clear, and viscous and with good flavour while the *Pine*-honey is muddy and with inferior flavour (CODOUNIS 1962).

There is also a honeydew which seems to be excreted straight from plants and appears in very small quantities usually early in spring and some times late in autumn. At these times there is frequently lack of nectar and bees exploit this honeydew, but as this is excreted in low quantities and only for a short duration its contribution to honey production is negligible.

NICOLOPOULOS (1959) refers to about twenty plant species which seem to excrete directly honeydew. Recently three plants have been observed to give such honeydew which is exploited by bees, that is : *Abies* spp. which give honeydew during the spring, *Ceratonia siliqua* L. and *Quercus sessiliflora* Sm. in autumn. The honey derived from the honeydew of the two last plants is not good in quality and as reserves for the overwintering of the colonies, they create very serious problems to the beecolonies. This has been observed to the areas of Crete and Phokis and we have not concluded yet the explanation of this phenomenon. The whole subject is under investigation.

All honeydew producing insects belong to the order Hemiptera : Homoptera (Rhynchota). This group includes a large number of Coccoidea, all Aleyroidea and Psylloidea and most of the Aphidoidea and Cicadoidea (MAURIZIO, 1976).

Greek beekeepers often make use of abundant honeydew by bringing their hives at the proper season into host-plants which are infested by these honeydew producing insects.

Very little was known concerning these insects of Greece prior to study by NICOLOPOULOS (1965), SANTAS (1979 and 1981). In recent years a great deal of research has been done in Greece on the insects and some of the data which have accumulated are reported here.

METHODS

During the years 1977-1981 a country-wide survey was carried out in Greece (Fig. 1). The honeydew producing insects on which the bees were observed to forage, were collected and identified. Plant hosts of these insects were also collected and identified.

The survey was done in two steps : first extensive sampling of the plants to all migratory beekeeping areas in Greece was made to obtain information on the honeydew producing insects on which bees may forage, and second, detailed observations were carried out on the plants infested with honeydew producing insects to see bees to forage on honeydew.

The survey carried out in the main beekeeping areas and some times after information and suggestions of skilful beekeepers on biotopes which are used in the migratory and usual beekeeping areas.

These surveyed areas are :

1) North part of the Euboea island, Thassos island, Chalkidiki district and South East of Crete the main *Pinus*-honey producing areas, in August, September, October and March.

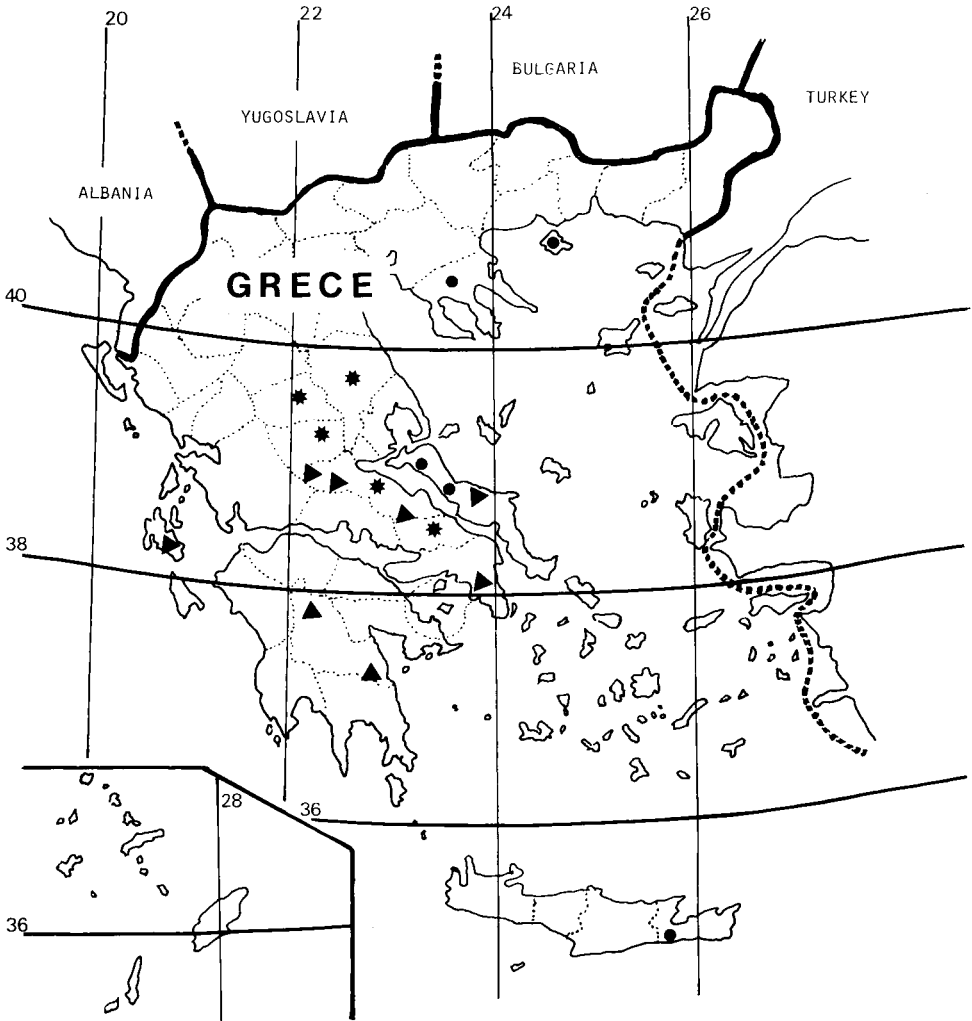


FIG. 1. — Areas on which surveys have been made.

- *Pinus* spp.
- ▲ *Abies* spp.
- ★ Valleys

2) The mountain of Parnis, Parnassos, Oiti, Tymphrystos Mainalon, Enos, Parnon and Ide, the main *Abies*-honey producing areas, in May and June.

3) The valleys of Phthiotis, Thessaly and Kopais the main glover and cotton producing areas.

The observations took place when the hives were in those places by the author and another skilful beekeeper.

The collected insects were transferred to the laboratory and some of them were identified by the author and other were sent to other specialists for identification. A quite large number of samples were sent to us by skilful beekeepers who had observed bees to forage on the honeydew.

In addition, attempts were been made to find out the contribution of each of the honeydew producing insects, in the honey production of Greece.

Thus a number of insects were found to produce honeydew exploited by bees. From these species many are probably not of great importance because the mere fact that some bees are found foraging on honeydew does not prove that they contribute significantly to the honey production.

RESULTS AND DISCUSSION

Thirty two species of insects producing honeydew were found to be exploited by bees in our country (Tabl. 1).

TABL. 1. — *Honeydew producing insects, useful to apiculture in Greece.*

Superfamily, Family Subfamily and Species	Host-Plants
Aphidoidea - Aphididae*	
Aphidinae	
1. <i>Acyrtosiphon pisum</i> Harr.	<i>Trifolium</i> sp.
2. <i>Aphis craccivora</i> Koch	<i>Trifolium</i> sp. <i>Medicago sativa</i> L.
3. <i>Aphis fabae</i> Scopoli	<i>Gossypium hirsutum</i> L.
4. <i>Aphis gossypii</i> Glover	<i>Gossypium hirsutum</i> L.
5. <i>Aphis pomi</i> De Geer	<i>Gossypium hirsutum</i> L.
6. <i>Brachycaudus cardui</i> (L.)	<i>Malus sylvestris</i> Miller
7. <i>Hyalopterus pruni</i> (Goeff.)	<i>Cydonia oblonga</i> Miller
8. <i>Myzus persicae</i> (Sulzer)	<i>Carduus</i> spp.
9. <i>Rhopalosiphum padi</i> (L.)	<i>Prunus dulcis</i> (Miller) D. A. Webb.
10. <i>Pterocomma populeum</i> (Kalt.)	<i>Prunus persica</i> (L.) Batsch
Thelaxinae	<i>Zea mays</i> L.
11. <i>Mindarus abietinus</i> Koch	<i>Populus</i> spp.
Phyllaphidinae	
12. <i>Callaphis juglandis</i> Goeze	<i>Abies cephalonica</i> Loud.
13. <i>Eucallipterus tiliae</i> (L.)	<i>Abies borisii - regis</i> Mattf.
Chaitophorinae	
14. <i>Chaitophorus leucomelas</i> Koch	<i>Juglans regia</i> L.
15. <i>Chaitophorus populeti</i> (Panz.)	<i>Tilia</i> sp.
Lachninae	
16. <i>Cinara confinis</i> (Koch)	<i>Populus</i> spp.
17. <i>Cinara palaestinensis</i> H.R.L.	<i>Populus</i> spp.
18. <i>Cinara pectinatae</i> (Nördl.)	
19. <i>Cinara close pini</i> .	<i>Abies cephalonica</i> Loud.
	<i>Abies borisii - regis</i> Mattf.
	<i>Pinus halepensis</i> Miller
	<i>Pinus silvestris</i> Miller
	<i>Abies cephalonica</i> Loud.
	<i>Abies borisii - regis</i> Mattf.
	<i>Pinus halepensis</i> Miller
	<i>Pinus silvestris</i> Miller

Pemphiginae	
20. <i>Prociphilus oleae</i> (Leach et Risso)	<i>Olea europaea</i> L.
21. <i>Prociphilus bumeliae</i> (Schrk.)	<i>Fraxinus</i> sp.
Coccoidea - Coccidae	
22. <i>Physokermes hemicryphus</i> (Dalm.)	<i>Abies cephalonica</i> Loud.
	<i>Abies borisii - regis</i> Mattf.
23. <i>Eulecanium sericeum</i> (Lind.)	<i>Abies cephalonica</i> Loud.
	<i>Abies borisii - regis</i> Mattf.
24. <i>Kermes quercus</i> (L.)	<i>Quercus</i> spp.
25. <i>Parthenolecanium corni</i> (Bch.)	<i>Prunus persica</i> (L.) Batsh.
	<i>Prunus armeniaca</i> L.
	<i>Crataegus</i> spp.
26. <i>Sphaerolecanium prunastri</i> (Fonsc.)	<i>Prunus dulcis</i> (Miller) D. A. Webb.
	<i>Prunus avium</i> L.
Margarodidae	
27. <i>Marchalina hellenica</i> (Gennadius)	<i>Pinus halepensis</i> Miller
	<i>Pinus silvestris</i> Miller
	<i>Pinus pinea</i> L.
	<i>Pinus brutia</i> Ten.
Psylloidea - Psyllidae	
28. <i>Euphyllura olivina</i> (Costa)	<i>Olea europaea</i> L.
29. <i>Cacopsylla</i> sp. (<i>crataegi</i> Schrk.)	<i>Crataegus</i> sp.
30. <i>Homotoma ficus</i> (L.)	<i>Ficus carica</i> L.
Aleyrodoidea - Aleyrodidae	
31. <i>Siphoninus phillyreae</i> (Haliday)	<i>Pyrus communis</i> L.
32. <i>Bemisia tabaci</i> Genn.	<i>Gossypium hirsutum</i> L.

(*) The classification of Aphidoidea has been based in some case on the work of R. J. Blackman (1980), and in some other cases on some other works.

This number is small compared with that found in central Europe (58 known) (KUNDEL and KLOFT, 1977).

These species may be divided into two groups. The first group comprises all those insects which have a great contribution to honey production in Greece. These are all the species which actually are exploited in Greece by beekeepers who transfer the hives to their biotopes. These are : *Marchalina hellenica*, *Physokermes hemicryphus*, *Cinara confinis*, *Cinara pectinatae*, and *Mindarus abietinus*.

The second groupe consists of those species which only partially contribute to honey production or those which are not very important to the honey production, being incidental foraged for the bees. These are the rest twenty seven species of Tabl. 1.

It is quite possible that this division does not give an accurate estimate of the importance of these species with respect to the honey production since the bees are capable of changing their forage if the principal source is not available. Nevertheless the five aforementioned species must be regarded as important source of forage for bees.

As it was estimated that the honeydew honey produced from the coniferous trees forests accounts for the 60-65 % of honey production in Greece while the contribution of broad-leaved trees and other host plants has not been estimated yet.

In our country, the different species of *Pinus* are the main host plants for the most important honeydew producing insects useful to honey production. The insects which produce honeydew on *Pinus* are : *M. hellenica*, *C. palaestinensis* and *C. close pini*. Taxonomically this species is not yet clear. Dr. G. REMAUDIERE of Inst. Pasteur, Paris, is on the way to make a detailed analysis. It will appear from our study that *M. hellenica* (Fig. 2, 3) is the main source of forage for the bees since 55-60 % of honey production in our country is from this scale insect (SANTAS, 1979).

This species is widely distributed in almost all pine forests all over Greece and supports the bulk of migratory beekeeping. The time of excretion of this insect is from June to following spring but the bees, depending on the area, forage on that honeydew in August, September, October and to a smaller extent in March and April (SANTAS, 1979, 1981).



FIG. 2. — A pine-twig infested by *Marchalina hellenica* (Genn.).

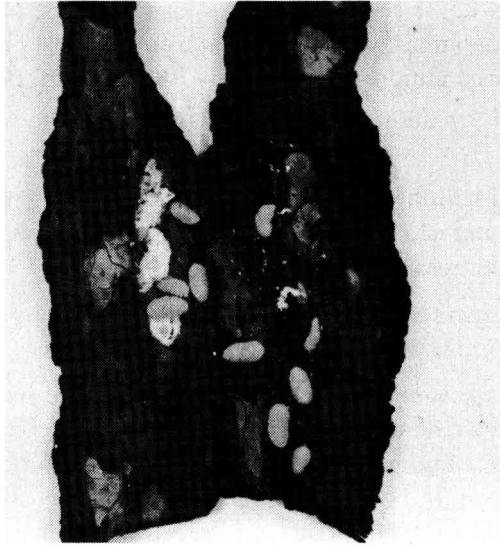


FIG. 3. — *Mature females of Marchalina hellenica* (Genn.) on pine-bark.

The exact contribution to honey production of *C. palaestinensis* and *C. close pini* is not known, as the infestation of *Pinus* by these aphids is not in large areas but in planches here and there.

Yet the infestation by these insects do not appear every year. This depends on the weather, entomophagous insects and other factors.

Second in importance as host-plants of honeydew producing insects are the different *Abies* species, as they contribute, 5-10 % of all the honey produced in Greece. The insects which produce honeydew on *Abies* trees are : The scales *Ph. hemicyphus*, *E. sericeum* and the aphids *C. confinis*, *C. pectinatae* and *M. abietinus*, with *Ph. hemicyphus* being the most important. The infestation of *Abies* trees by this scale appears more or less in large *Abies* forests. The beekeepers bring their hives to these *Abies* forests as most of the foraging is done in May-June and early July (SANTAS, 1981) but the exact time depends on the altitude of the forests and on the weather.

The scale *E. sericeum* appeared in patches on the *Abies* trees in the forest, although sometimes a whole tree may be infested. Nevertheless its contribution to honey production appeared to be negligible. The time of excretion of this insect was from October to June-July, but the bees exploit it only during May to July (SANTAS, 1981).

The aphids, *C. confinis*, *C. pectinatae* and *abietinus* appeared in our *Abies* forests, but their contribution to honey production is unknown. In some areas and in some years the population of one species is higher than the other two for some undetermined reasons.

It is known however that there are many factors, biotic and abiotic, which influence the population of insects, such as available host plants, parasites predators, altitude, weather conditions, etc. (URANOV, 1931; SMITH, 1935; PECHHACKER, 1977).

The time of excretion of these insects starts in May-June and continues until September.

In the years with high population of *C. confinis*, the honeydew is available in large quantities and can cover the leaves, twigs, trunks and even the ground under the infested *Abies* trees.

Since beekeepers know the irregularity in the appearance of these insects, they will survey the forage areas before transferring their hives in these areas.

Another forage area in Greece is the chestnut tree forests. The chestnut tree is a very well known honey plant and an important source of honeydew. This tree flourishes in late May and June and provides good forage for bees with nectar, pollen and honeydew. The honeydew is excreted by the *Myzocallis castanicola* which appears in high population levels in the underside of leaves. The production of honeydew is very abundant from May to July and later on.

There are some other forage areas with plants which do not form forests but which are scattered or are growing in clusters.

Among them the different species of *Populus* are planted in clusters for timber, along the roads or for windbreaks for ornamental reasons or scattered.

The most important species found in Greece are : *Populus canadensis* Moench, *Populus nigra* L., *Populus thevestina* Dode and *Populus alba* L. Besides pollen these trees provide bees honeydew in the spring. This honeydew is excreted by the aphids *Chaitophorus populeti*, *Chaitophorus leucomelas*, and *Pterocomma populeum*. The forage time is late May until early June. The quantity of honeydew honey produced is sometimes high but there are no accurate data on the contribution to honey production.

In the same group is the *Tilia* sp. which provides a good quality honey from nectar and honeydew. The honeydew is produced by the aphid *Eucallipterus tiliae* (L.) which lives in the underside of the leaves. This insect produces large quantities of honeydew in May and June. The *Tilia* sp. are scattered in the northern parts of the country.

On *Crataegus* spp., which are grown almost all over Greece two species of insects produce honeydew on which the bees have been observed to forage : the coccid *P. corni* and the psyllid *Psylla* sp. On *Fraxinus* sp. by the aphid *Prociphilus bumeliae* (Schrk.) large quantities of honeydew on which the bees forage are produced.

Honeydew is also produced on *Quercus* spp. by the coccid *Kermes quercus* (L.). The infestation on *Quercus* spp. by this insect was found to be very low.

Bees have also been observed to forage honeydew produced on cultivated trees, plants and weeds (Tabl. 1).

It is also worth mentioning the contribution of honeydew production from cotton, clover and maize.

The beekeepers transport their colonies to the cotton and clover plantations from July to August for the flowers. At the same time if there is a honeydew production, the bees forage on it. The honeydew in cotton plants is produced by *Aphis craccivora*, *Aphis fabae*, *Aphis gossypii* and *Bemisia tabaci* and in clover plants by *Acyrtosiphon pisum* and *Aphis craccivora*.

Generally in the case of cultivated plants, the farmers usually apply insecticides against those insects and for that reason there is no data on the accurate contribution to honey production.

ACKNOWLEDGMENTS

We wish to express our sincere thanks to Mr V. PAPAGEORGIU, président of « Melissokomiki » co-operative union of beekeepers associations and to all agriculturists and skilfull beekeepers for their help during this work.

Received for publication in August 1982.

RÉSUMÉ

LES INSECTES QUI PRODUISENT UN MIELLAT BUTINÉ PAR LES ABEILLES EN GRÈCE

Plus de 65 % de la production totale de miel en Grèce provient du miellat d'insectes. Une étude, commencée en 1977 et basée d'une part sur l'échantillonnage des insectes qui produisent un miellat exploité par les abeilles et d'autre part sur l'échantillonnage de leurs plantes-hôtes, a permis d'identifier 32 espèces d'insectes producteurs de miellat. Les prélèvements ont été effectués dans presque toutes les régions de Grèce. Tous ces insectes appartiennent à l'ordre des Hémiptères-Homoptères et aux superfamilles Aphidoidea, Coccoidea, Psylloidea et Aleyroidea.

Parmi les 32 espèces rencontrées les plus importantes du point de vue de la production de miel sont les coccides *Marchalina hellenica* (Genn.) et *Physokermes hemicyphus* (Dalm.) et les aphides *Cinara confinis* (Koch.), *Cinara pectinatae* (Nördl) et *Mindarus abietinus* Koch.

Il ressort de notre étude que *M. hellenica* est l'insecte producteur de miellat le plus important; c'est lui qui est à l'origine du miel de pin de Grèce. D'après les statistiques ce miel représente 55-60 % de la production globale du pays. *M. hellenica* se rencontre sur diverses espèces de *Pinus* et dans la plupart des forêts de pin de Grèce. Les sécrétions de miellat commencent en juin et se poursuivent jusqu'au printemps suivant, mais les abeilles le butinent essentiellement en août, septembre et octobre et, à un moindre degré, en mars et avril.

Les insectes qui vivent sur les diverses espèces d'*Abies* viennent en deuxième position avec une contribution de 5 à 10 % à la production annuelle de miel. Dans les forêts de sapins nous avons trouvé 5 espèces qui sécrètent du miellat, *Physokermes hemicryphus* étant la plus importante.

Au printemps les agriculteurs transhumant dans les forêts de sapins mais les abeilles n'exploitent le miellat qu'en mai, juin et début juillet.

ZUSAMMENFASSUNG

DIE HONIGTAUPRODUZIERENDEN INSEKTEN GRIECHENLANDS UND DIE AUSNUTZUNG DER WALDTRACHT DURCH BIENEN

Mehr als 65 % der gesamten Honigproduktion in Griechenland basiert auf Honigtau von Insekten. 1977 wurde eine Forschungsarbeit begonnen, die zum einen aus der Sammlung von honigtauproduzierenden Insekten, die von den Bienen besucht werden, bestand, zum anderen aus der Sammlung von Wirtspflanzen. 32 Arten von honigtauerzeugenden Insekten wurden identifiziert. Die Proben stammten aus fast ganz Griechenland (Fig. 1). Alle gefundenen Insekten gehören zu der Ordnung Hemiptera, Unterordnung Homoptera und zu den Familien Aphidoidea, Coccoidea, Psylloidea und Aleyrodoidea.

Unter den 32 gefundenen Arten waren die im Hinblick auf die Honigproduktion bedeutendsten : *Marchalina hellenica* (Genn.), die Schildlaus *Physokermes hemicryphus* (Dalm.), die Rindenläuse *Cinara confinis* (Koch.) und *Cinara pectinatae* (Nördl.) und *Mindarus abietinus* (Koch.).

Aus unseren Studien geht hervor, daß *Marchalina hellenica* das wichtigste honigtauerzeugende Insekt ist, von dem der Pinien-Honig in Griechenland stammt. Dieser Honig macht nach statistischen Angaben 55-60 % der gesamten Honigproduktion dieses Landes aus. Die Spezies *M. hellenica* kommt auf verschiedenen *Pinus*-Arten vor und wird in fast allen Pinienwäldern dieses Landes gefunden. Die Honigtausekretion beginnt im Juni und dauert bis zum nächsten Frühjahr, aber die Bienen sammeln davon nur im August, September, Oktober und in geringerem Maße im März und April.

Die zweitwichtigsten Insekten sind solche, die auf den verschiedenen *Abies*-Arten sitzen, da 5-10 % der jährlichen Honigproduktion des Landes vom Honigtau dieser Insekten stammt. In den Tannenwäldern fanden wir fünf Arten, die Honigtau produzieren. Unter ihnen ist *Physokermes hemicryphus* die wichtigste.

Die Imker transportieren ihre Bienenvölker im Frühjahr in die Tannenwälder, aber die Bienen sammeln den Honigtau nur im Mai, Juni und frühen Juli.

REFERENCES

- AUCLAIR J. L., 1963. — Aphid feeding and nutrition. *Annual Rev. of Entom.*, **8**, 439-490.
- BLACKMAN R. J., 1980. — Chromosome numbers in the Aphididae and their taxonomic significance. *Syst. Entomol.*, **5**, 7-25.
- CODOUNIS M., 1962. — La cristallisation du miel. Thèse Doct. Univ. d'Agric. d'Athènes, pp. 25-31 (in Greek).
- KUNKEL H. und KLOFT W., 1977. — Fortschritte auf dem Gebiet der Honigtau - Forschung. *Apidologie*, **8** (4), 369-391.
- MAURIZIO A., 1976. — How Bees make honey. In CRANE, E., *Honey a comprehensive survey*, p. 94, London.

- NIKOLOPOULOS Chr., 1965. — *Morphology and biology of the species Marchalina hellenica (Gennadius) (Hemiptera : Margarodidae : Coelestomidiinae)*, 31 pp. Athens (in Greek).
- NIKOLOPOULOS Chr., 1959. — Apicultural flora of Attica, pp. 21-23. Athens (in Greek).
- PECHACKER H., 1977. — Über die Auswirkung von Umwelteinflüssen auf die Populations-Entwicklung der Physokermes-Arten. *Apidologie*, **8** (4), 451-457.
- SANTAS L. A., 1979. — *Marchalina hellenica* (Gen.) an important insect for apiculture of Greece, Apimondia XXVII Inter. Congr. Athens, pp. 419-422 Apimondia Publishing House, Bucharest, Romania.
- SANTAS L. A., 1981. — Insects useful to apiculture in Greece. XXIIth Intern. Congr. of Apiculture held in Acapulco-Mexico on 23-29 Octob. 1981 (in press).
- SELIANAKIS G. V., 1978. — Greek apiculture in the regime of Europeans Community, p. 13. Athens (in Greek).
- SMITH H. S., 1935. — The role of biotic factors in the determination of population densities. *J. econ. Ent.*, **28**, 873-898.
- URANOV B. P., 1931. — Insects and climate. *Trans. Ent. Soc. London*, **79**, 1-247.