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The current status of pistachio pests in Iran

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SUMMARY – The injurious pests of pistachio orchards could be classified into three groups based on economic damage and distribution in Iran. The first group contains the major pests which are distributed throughout the main pistachio-producing areas and usually cause significant loss on pistachio yields by either attacking pistachio leaves, fruits or twigs. These include: (i) the common pistachio psylla, *Agonoscena pistaciae*; (ii) the pistachio twig borer, *Kermania pistaciella*; and (iii) the pistachio bugs, *Acrosternum heegeri*, *Acrosternum millieri*, *Apodiphus amygdali*, *Brachynema germari*, *Brachynema segetum*, *Lygaeus pandurus*. The second group comprises phytophagous insects and mites which are locally important pests like, the pistachio fruit moth, *Recurvaria pistaciicola*; the pistachio leaf hopper, *Idiocerus stali*; the pistachio scale insects including: the pistachio twig and fruit scale, *Pistaciaspis pistaciae*, the pistachio trunk and branch scale, *Melanaspis inopinata*; the pistachio bark beetle, *Hylesinus vestitus*; the pistachio leaf borer, *Ocneria terebinthina*; the pistachio common mites, *Tenuipalpus granati*. The third group contains the phytophagous insects and mites which are only minor pests. However, under certain conditions they occur as local injurious pistachio pests, e.g., the pistachio leaf-rolling psyllid, *Megagonoscena viridis*; the pistachio root beetle, *Capnodis cariosa hauseri*; the pistachio weevil, *Polydrosus davatchii*; the pistachio eriophyid mites, *Aceria* (= *Eriophyes*) *pistaciae* and *Aceria* (= *Eriophyes*) *stephanii*; the pistachio fruit hull borer, *Arimania komaroffi*; the carob moth, *Apomyelois* (= *Ectomyelois*) *ceratoniae*; pistachio leaf miner, *Stigmella promissa*; pistachio soft scale, *Anapulvinaria pistaciae*; pistachio spherical scale, *Eulecanium rugulosum*; pistachio Noghi scale, *Salicicola pistaciae*; pistachio seed wasp, *Eurytoma plotnikovi* and pistachio seed chalcid, *Megastigmus pistaciae*.

Key words: Pistachio pests, *Pistacia vera*.

RESUME – "Situation actuelle des ravageurs du pistachier en Iran". Les ravageurs des vergers de pistachiers pourraient être classifiés en trois groupes en se basant sur les dommages économiques qu'ils causent et leur distribution en Iran. Le premier groupe est formé par les grands ravageurs qui sont répartis sur les principales zones productrices de pistachiers et causent habituellement des pertes significatives aux rendements des pistachiers en attaquant soit les feuilles, les fruits ou les rameaux. Parmi eux : (i) le psylle commun du pistachier, *Agonoscena pistaciae* ; (ii) le kermès des rameaux du pistachier, *Kermania pistaciella* ; et (iii) les punaises du pistachier, *Acrosternum heegeri*, *Acrosternum millieri*, *Apodiphus amygdali*, *Brachynema germari*, *Brachynema segetum*, *Lygaeus pandurus*. Le deuxième groupe comprend des insectes et acariens phytophages qui sont, localement, des ravageurs importants, tels que la teigne du fruit du pistachier, *Recurvaria pistaciicola* ; la sauterelle des feuilles du pistachier, *Idiocerus stali* ; les cochenilles du pistachier qui comprennent : la cochenille des rameaux et fruits de pistachier, *Pistaciaspis pistaciae*, la cochenille du tronc et des branches du pistachier, *Melanaspis inopinata* ; le scarabée de l'écorce du pistachier, *Hylesinus vestitus* ; la tordeuse des feuilles de pistachier, *Ocneria terebinthina* ; les téosintes communs du pistachier, *Tenuipalpus granati*. Le troisième groupe comporte les insectes et acariens phytophages qui ne sont que des ravageurs de moindre importance. Cependant, sous certaines conditions, ils deviennent des ravageurs locaux nuisibles du pistachier, par exemple le psylle de l'enroulement des feuilles du pistachier, *Megagonoscena viridis* ; la capnode des racines du pistachier, *Capnodis cariosa hauseri* ; le charançon du pistachier, *Polydrosus davatchii* ; les acariens ériophyides du pistachier, *Aceria* (= *Eriophyes*) *pistaciae* et *Aceria* (= *Eriophyes*) *stephanii* ; la mineuse de la coque du fruit du pistachier, *Arimania komaroffi* ; la pyrale des caroubes, *Apomyelois* (= *Ectomyelois*) *ceratoniae* ; la mineuse des feuilles du pistachier, *Stigmella promissa* ; la cochenille molle du pistachier, *Anapulvinaria pistaciae* ; la cochenille sphérique du pistachier, *Eulecanium rugulosum* ; la cochenille Noghi du pistachier, *Salicicola pistaciae* ; la guêpe des semences du pistachier, *Eurytoma plotnikovi* et le chalcis des semences du pistachier, *Megastigmus pistaciae*.

Mots-clés : Ravageurs du pistachier, *Pistacia vera*.

Introduction

Pistachio is the major agricultural product in Iran. Insects attack every part of this plant throughout its growth period. The control of the pistachio pests is often an exceedingly complex problem. However, the use of chemicals for insect control is not economic since this method has also not been effective and the problem has become more serious year after year. Nevertheless, many of the insect and mite pests of pistachio can be very effectively controlled by using agricultural applications, introduction and

conservation of natural enemies and some very easy and simple methods. However, particular information about the biology, ecology, behaviour and other aspects of entomophagous insects and their insect hosts in pistachio orchards is needed. Undoubtedly such knowledge is important to the successful manipulation of the beneficial species in a pest management system. Insect pests have been the main problem for Iranian pistachio growers during the last 60 years. Numerous phytophagous insects and mites attack pistachio trees. These pests may be economically classified into three groups comprising major and minor as well as an intermediate group including phytophagous insects and mites which may be considered as locally important pests. This paper focuses on the three groups of pistachio pests in Iran. These pests are found in the pistachio orchards throughout the country. Definitely more phytophagous insects attack pistachio trees, but they do not cause significant damage in the pistachio plantations. The present information is compiled from several research projects that were conducted on different features of the pistachio pests by the author over several years.

Widespread pistachio key pests

This group of pistachio pests are found almost always throughout the main pistachio-producing areas and usually induce significant damage on pistachio yields by either attacking pistachio leaves, fruits, branches or twigs every year. These insects generally reproduce heavily from early spring and the control applications against them is usually difficult due to their biological and ecological features.

The common pistachio psylla, *Agonoscena pistaciae* Burckhardt & Lauterer (Hemiptera: Psylloidea: Rhinocolinae)

Pistachio psylla was first reported on wild and cultivated pistachio trees in Iran by Kiriukhin (1946). This author suggested that the number of a *Psylla* species is limited by an encyrtid parasitoid, but he added that a jassid *Idiocerus stali* is the most injurious pest in all the pistachio-growing regions of Iran. Later, Davatchi (1958) indicated that control of *I. stali* by chemicals was followed by a change in the pest status and occurrence of the pistachio psyllid. Now, the common pistachio psylla, *A. pistaciae* is the most serious insect pest of cultivated pistachio trees and is distributed throughout all the pistachio-producing regions in Iran. The control of this pest relies almost exclusively on pesticides, however the tendency of *A. pistaciae* to develop resistance against insecticides has been clearly observed since the early 1950s. Usually the population rapidly increases from early spring. However, the presence of high population densities of psyllid nymphs and adults causes severe problems in kernel development and subsequently bud drop and defoliation occurs, therefore it causes significant economic losses. For this reason, psyllid infestations have received particular attention from pistachio-growers, who insist on spraying to reduce the psyllid damage. Mehrnejad (1998) showed that the common pistachio psylla has two seasonal forms. The winter-form psyllids appear in early October and emigrate towards the overwintering shelters. They are larger with generally darker forewings with brown shading in the cells and pigmented veins. The female ovaries are undeveloped at the time of emergence. The winter-forms attack pistachio trees in the late winter and early spring, feed on swollen buds, young leaves and shoots and establish the summer-form generation. The insect lays her eggs mainly on the upper surface of the pistachio leaves, but egg laying on the petiole of soft leaves and young succulent plant shoots was observed as well. Eggs are embedded in plant tissue by a very delicate pedicel. Feeding and ovipositing of the psyllids, either winter- or summer-forms, on the stem's tissues or on the base of buds of pistachio trees has not yet been observed. Both stages (nymphs and adults) produce huge amounts of a paste-consistency honeydew that turns to white solid granules immediately after secretion. This species develops and reproduces in the wide range of temperature, and produces several generations during the growth season. Information on the status of the psyllid's natural enemies in the pistachio-growing area of Iran is being considerable, the available information show natural control is exhibited by Encyrtidae, Coccinellidae, Chrysopidae, Anthocoridae, Phytoseiidae, Anisidae and Erythreidae. The most recent research on the parasitoid *Psyllaephagus pistaciae* showed that this wasp is a valuable biological control agent for the common pistachio psylla (Mehrnejad, 1998).

The pistachio twig borer, *Kermania pistaciella* Ams. (Lep.: Oinophilidae)

The insect overwinters as fully developed larvae inside the twigs. The larvae emerge in the middle of March and walk around to find a proper site for pupation, they spin a cocoon on the twigs' surface and

pupate inside the cocoon. The period for larvae emergence lasts about 40 days, but the adult population usually rises to a peak when the pistachio flower clusters are fully developed. The moth lays eggs on the flower clusters and the newly hatched larva penetrates into the cluster tissue. The earliest damage appears in the young succulent clusters when the whole cluster turns black and falls off the trees. The larvae bore a tunnel in the cluster towards the twigs and live there for about ten months. The pest causes fruit drop and the infested twigs do not grow well. The insect has one generation a year. Several egg and pupal parasitoid wasps are reported as natural enemies of this species. The natural parasitization ratio reaches up to 50% in the most pistachio plantations of the country (Mehrnejad, unpublished data).

Stink and sucking bugs that attack pistachio

In Iran, several species of hemipteran bugs have been reported as pistachio pests. These hemipterans attack pistachio fruits during the growing seasons, either on young fruits or later when they feed on the pistachio kernel. The stink bugs, e.g., *Acrosternum heegeri*, *Acrosternum millieri*, *Apodiphus amygdali*, *Brachynema germari*, *Brachynema segetum*, which all belong to the family Pentatomidae, are abundant and serious pests of pistachio nuts in the pistachio plantation areas of the country. Moreover, the seed bug, *Lygaeus pandurus* (Lygaeidae) has also been reported (Samet and Akbary, 1974). These native bugs are widely distributed throughout the pistachio-growing regions of Iran. Like many other stink bugs these species are general feeders and have been associated with crops such as; *Brassica napus* L., *Gossypium herbaceum* L. and deciduous trees, e.g., *Amygdalus communis* L., *Elaeagnus angustifolia* L., *Malus domestica* Borkh., *Pistacia vera* L., *Pistacia mutica* Fisch. & Mey., *Prunus domestica* L., *Punica granatum* L., *Vitis vinifera* L. They may also be found on uncultivated plants and weeds like; *Alhagi camelorum* fisch., *Anabasis cf. Brachiata* Fisch. & Mey, *Peganum harmala* L., *Seidlitzia rosmarinus* Ehrenb., *Zygophyllum atriplicoides* Fisch. & Mey, and *Zygophyllum fabago* L. especially in wintertime and early spring in the forest areas as well as outside or inside of the pistachio orchards. Dispersal of adults is often correlated with drying of weed hosts in late spring. These insects are known as the important pests of pistachio and cause severe damage to pistachio nuts throughout the season, from early spring to the time of harvest.

Very young and immature nuts may be attacked by either adult or nymph of bugs in the spring, causing epicarp lesion followed by nut drop. Piercing of the soft-shelled pistachios by the stylets of stink and sucking bugs causes necrotic lesions on the hull (epicarp and mesocarp) in the early season, a phenomenon termed epicarp lesion (Bolkan *et al.*, 1984). This injury leads to desiccation and dropping of the damaged nuts from the trees due to peroxidase activity in wounded pistachio fruits (Bostock *et al.*, 1987). The damage usually declines as the shell begins to harden. However, epicarp lesion is considered as one of the important problems in pistachio orchards in Iran. As shells mature and the kernel begins filling in midsummer, the stink bugs feed on the developing kernel through the shell, causing kernel necrosis or deformity up to harvest time. Kernel necrosis symptoms usually caused by pentatomid bugs are the indented brown to black spots on the kernel surface. These may be found on any part of the kernel but usually occur in the area close to the stem end and along the split line of the shell. Furthermore, it was found that all the six bug species act as a vector for transmission of a fungal pathogen, *Nematospora coryli* in pistachio nuts (Ershad and Barkhordary, 1974b). *Nematospora coryli*, an ascomycete yeast is an important causal agent of the diseases transmitted exclusively by hemipteran bugs (Ershad and Barkhordary, 1974a, 1976; Michailides and Morgan, 1990). This disease was called 'Massu' by the native pistachio growers of the Kerman province, with symptoms characterised by a wet, smelly, decayed and slimy appearance of the pistachio kernel, and resembled symptoms of 'stigmatomycosis'. The levels of stigmatomycosis usually increase by the kernel developing period and the damage rises during August and September, but amount of infection usually depends on weather and environmental conditions. Therefore, during a bug outbreak situation, heavy damage in pistachio yield results. Considerable knowledge of several species of pistachio bugs and their relation to epicarp lesion, kernel necrosis and stigmatomycosis in pistachio nut has been developed over the past few years, and these problem are also widespread throughout the pistachio plantations of the country. However, our understanding of bugs in the pistachio orchards is still incomplete. Because of their wide host-range, adult dispersal habits and diverse habitats, this group of pistachio pests are generally difficult to control. Egg parasitoids, particularly *Trissolcus* spp. and *Ooencyrtus telenomicida*, have been collected from most species of stink bug eggs in the Kerman province (H. Hashemi-Rad, pers. comm.). Our knowledge about these parasitoids is not yet sufficient to predict their efficiency in the pistachio orchards. Apart from the above bugs, several species of pentatomid bugs, e.g., *Carpocoris* sp. and *Dolycoris* sp. attack pistachio nuts, furthermore two mirid bugs, e.g., *Campylomma* sp. and *Megacoelum* sp. have been reported as

pests of pistachio fruits in spring (Hashemi-Rad and Safavi, 1996). Our knowledge shows that all the above bugs species are capable of inducing epicarp lesion on young pistachio fruits in field condition.

Localised key pests

The second group comprises phytophagous insects and mites which are locally important pests. Some times they appear as a key pest in a small plantation but these species are considered as the minor pistachio pests overall.

The pistachio fruit moth, *Recurvaia pistaciicola* Danil. (Lep.: Gelechidae)

This insect causes serious damage in old pistachio trees, where there is good site and safe shelter for the overwintering larvae under the trunk and large branches' bark. The insect hibernates as a fully developed larvae, and the adults emerge during the pistachio flowering period in the early spring. The moth lays its eggs on the very young pistachio flower cluster and on the tiny fruits. This species has two generations per year in the pistachio orchards of Iran. In the first generation, the young larvae penetrate the tiny pistachio fruits and feed on the embryo at the base of nuts, then the larva moves to other fruits. The injured fruits stop growth, turn brown and subsequently fall off the tree. Each larva destroys several young fruits until full development, then leaves the pistachio cluster and walks to old branches and trunk in late of May and early June. The larvae spin white silken cocoons under the bark and remain inactive, but the colour gradually changes to green until pupation time in the middle of August. Alternatively, the full-grown larvae may make nest around the trees' collar base and under the dried leaves and weeds on the ground (Samet, 1984). The second generation appears in early August and the moth attacks pistachio nuts. The larvae usually feed on the fruits soft skin (mesocarp). It causes black and brown wide spots on the shell surface due to faeces produced by the larvae. In the split nuts, the larvae feed on pistachio kernels as well, and the damaged fruits generally become susceptible to fungal and mould infection.

The pistachio leaf hopper, *Idiocerus stali* Fieb. (Hem.: Jassidae)

The pistachio leaf hopper was the most serious pest in all the pistachio-growing areas of Iran about 50 years ago (Davatchi, 1958), but its position was replaced by the common pistachio psylla, *Agonoscena pistaciae*, because of heavy insecticide application. At present, the jassid hopper is not a common pest throughout the country, but is considered as a local injurious pistachio pest. Moreover, it is usually abundant in the pistachio orchards adjacent to wild pistachio (e.g. *Pistacia mutica*). The pistachio leaf hopper is considered as an important pest in the forest and mountainous areas, where *Pistacia mutica* are grown. The insects overwinter as the adult stage in the pistachio orchards and under the bark of trees, under dried weeds and leaves and in the cracks of walls. The adults appear on the trees in the late winter and early spring and feed on the swollen buds. The pest first causes damage to flower clusters, new fleshy shoots, petioles and leaf mid veins by laying eggs. The hoppers embed their eggs in the plant tissues. The hopper nymphs feed on young parts of pistachio plants, but prefer the fruit clusters, and the young fruits consequently fall-off from trees. The pistachio leaf hopper secretes a heavy amount of liquid honeydew, contaminating the aerial parts of the plants with a wet and sugary material, and a mould infection occurs subsequently. The insect has one generation per year. At high populations, the hopper may cause heavy damage to pistachio trees and a significant reduction in yield occurs.

The pistachio scale insects. The pistachio twig and fruit scale, *Pistaciaspis pistaciae* Archan. (Hem.: Diaspididae)

This is a narrow and elongate scale and one of the most widely distributed and destructive scales in the pistachio orchards. It attacks both planted and wild pistachio trees, and has three generations per year. The broods of the first generation infest the twigs, fruits cluster base and leaf petioles, but in subsequent generations, the young nymphs move towards pistachio leaves and nuts. The infested foliage and nuts turn yellow and purple about the areas where the scales are feeding. The infested nuts are relatively smaller, ripening is delayed, and the kernel is not fully developed. Severe damage may kill the branches and twigs. This insect overwinters as an adult under its scale on the pistachio twigs.

The pistachio trunk and branch scale, *Melanaspis inopinata* Leonardi (Hem.: Diaspididae)

The grey, circular scale with a black center occurs on pistachio trunk and branches and bears one generation a year. This polyphagous diaspid attacks pistachio, rose, apple, plum, pear and walnut trees. The insect causes a general weakness in the plant, and in the case of heavy infestation, the buds fail to open in the early spring. The pistachio Noghi scale, *Salisicola davatchii* Bala. & Kauss. (Diaspididae), the pistachio spherical scale, *Eulecanium rugulosum* Arch. (Coccidae), the pistachio soft scale, *Anapulvinaria* (= *Pulvinaria*) *pistaciae* Boden. (Coccidae) are found in a few pistachio plantation areas, and the status of these species are not of economic importance now. Wherever the scale insects occur in the pistachio orchards, different species of predatory insects such as ladybirds (Coccinellidae) and parasitoid wasps are found feeding on them.

The pistachio bark (twig borer) beetle, *Hylesinus* (= *Chaetoptelius*) *vestitus* Mulsant & Rey (Col.: Scolytidae)

This is an old pest of the pistachio-growing areas of the world (Davatchi, 1958). The beetle has one generation per year. The adult beetle was known as the destructive stage, since they attack pistachio trees in early May and penetrate into the young pistachio twigs through feeding on the fruit buds and bore a short tunnel towards the twig's centre. An adult beetle usually destroys one bud by drilling the twig in the leaf base or terminal buds, however about 10% of adults may feed upon more than one bud to start the tunnel (Farivar-Mehin, 1983). The adult beetles remain in these so called feeding tunnels until late October and then emerge to locate dead and damaged pistachio trees or branches for reproduction. During the autumn and winter period the beetle reproduces in pruned, damaged and weakened pistachio branches by digging a hole into the bark and boring a double sided tunnel under the bark. This period may extend to early spring, and both male and female beetles participate to prepare the site for egg laying. The female lays its eggs on both sides of the tunnel and the larvae bore galleries by feeding under the bark. The adult generally emerges early the following May and attacks healthy pistachio trees. At present, the pistachio bark beetle is under control, by removed of damaged branched by growers and keeping the pistachio orchards in vigorous condition. It can be found in orchards adjacent to villages, where the workers use pistachio branches as fuel-wood.

The pistachio leaf borer, *Ocneria terebinthina* (Lep.: Lymantriidae)

This insect is a whitish moth, there are several black spots in a line across its front wings. The adults appear in pistachio orchards in early spring and lay their eggs in a batch on both upper and lower surfaces of the pistachio leaves. The young caterpillars feed on the leaf parenchyma and upper epidermis, they produce large skeletonised patch and brown spots on the pistachio leaves, although the old larvae leave only the mid-vein. The caterpillar is yellowish, and bears red and black tubercles from which long black hairs protrude. This species has several generations throughout a year and hibernate in the pupal stage in the soil near the trunk collar and under the dried leaves and weeds as well as inside crevices on the tree trunk.

The common pistachio mites, *Tenuipalpus granati* Sayed (Acari: Tenuipalpidae)

This species attacks pistachio, pomegranate and grapevine plants. The mite overwinters in the adult stage, near the base of buds and under the bud scales, but it can also be found in crevices on the plant branches and twigs. It has several generations per year, and does not weave a silken web on the leaf or fruit. The eggs are reddish and are laid around the mid- and sub-veins of pistachio leaves. The larvae and nymphs are red to orange colour but the adults turn to pale orange with numerous tiny black spots. In heavy infestations, fruit buds may drop and kernel development can be stopped. Severe damage may occur by defoliation in the late summer. This species is heavily attacked by predatory mites belong to the Phytoseiidae and Ascidae, as well as by the coccinellid beetles.

Minor pests

This group comprises the phytophagous insects and mites which are only minor pistachio pests. Because of their rare occurrence, these insects are not considered important pests of pistachio trees. However, under certain conditions they occur as injurious pistachio pests, although they are distributed in a limited area.

The pistachio leaf-rolling psyllid, *Megagonoscena viridis* (Baeva) (Hem.: Psylloidea)

This psyllid develops on pistachio leaves and is univoltine. The insect hibernates and aestivates in the egg stage, and the psyllid nymphs appear in early spring when the new shoots emerge and the fresh leaves appear. The infested leaves roll because of the insect feeding and the psyllid nymphs develop in the shelter. The adult psyllid emerges in early summer and deposits a batch of elongated pink eggs in the angle between bud and twig of pistachio trees.

The pistachio root beetle, *Capnodis cariosa hauseri* Ob. (Col.: Buprestidae)

This pest causes severe damage in infested trees and the affected plants would be subsequently destroyed. Farivar-Mehin (1997) reported that the completion of one generation takes more than two years and the beetle overwinters in the larval stage, although the adult stage was also found in sheltered places during the winter. The adults generally appear in spring and summer. The newly hatched larva penetrates into tree trunks just beside the trunk collar and bores the trunk and roots of pistachio trees. The adult may feed on pistachio and pine leaves. The insect significantly prefer to attack the weakened trees for egg laying and larval development.

The pistachio weevil, *Polydrosus davatchii* Hoffman (Col.: Curculionidae)

The adult weevil attacks pistachio trees immediately after bud-break and feed on swollen buds in the early spring. The larvae is not assumed as a pistachio pest due this species is not to feed upon the aerial parts of the pistachio trees in larva stage. Little information is available on the biology of this species.

The pistachio eriophyid mites, *Aceria* (= *Eriophyes*) *pistaciae* Nalepa and *Aceria* (= *Eriophyes*) *stephanii* Nalepa (Acari: Eriophyoidea)

These species live on all the aerial parts of pistachio trees. The adult mites overwinter under the bud scales. The mites are active in the spring while the plant green parts are fresh and fleshy. *Aceria pistaciae* has an average density of <21 mites on a cluster of either flower or fruit, causes fruit dropping in the early spring and some leaf deformation in June. Heavy infection causes deformation on twigs, buds, leaves and flower clusters, with the male flowers modified and female flowers not fertilised. *Aceria stephanii* cause leaf deformation, e.g., rolling of pistachio leaflets over the upper surface (Mehrnejad and Daneshvar, 1991a,b). Furthermore, the eriophyid mite, *Tegonotus* sp. was found on pistachio leaves (Mehrnejad, unpublished), but our knowledge on this species is limited.

The pistachio fruit hull borer, *Arimania komaroffi* Ragonot (Lep.: Pyralidae)

The biology of this species has been studied by Samet (1985). The adult moths first appears in the pistachio orchards in early spring and lay their eggs in a bunch on the tiny and fresh pistachio fruits. The larvae spin web as well as bore into the young fruits, and the infested fruits fall off the trees. The second generation adult moth appears in August and September, and their offspring feed on the fruit hull (epicarp and mesocarp), in addition spinning web web around the infected nuts. The insects hibernate in the pupal stage and produce two generations in a year.

The carob moth, *Apomyelois* (= *Ectomyelois*) *ceratoniae* (Zeller) (Lep.: Pyralidae)

The carob moth was found as a pest of pistachio kernels in the field and in storage (Mehrnejad, 1993, 1995). Basically, the carob moth is the major pest of pomegranate fruits in Iran, however it occurs in the pistachio orchards adjacent to pomegranate plantations. The moth attacks pistachio orchards in early summer when the early split pistachio nuts appear, hence this insect needs an alternative host in the spring. Otherwise, in absence of an alternative host, the carob moth is not able to establish and develop in the pistachio-growing areas. The carob moth lays its egg inside the cracks of pistachio hull or under the nut-shell of split fruits. The infestation increases as hull cracks coincide with the ripening and harvesting period. The larvae do not feed on the fruit hull but develops only on the pistachio kernel. They usually enter the kernel via cracks of splitting line, but about 10% penetrate inside the nuts through the fruit stem. Larval damage to the fruits facilitates mould development that spoils the nuts. The maximum insect population was found in September and October in contaminated pistachio orchards. It is recommended that the pistachio nut must be harvested immediately after ripening. Since pistachio has been developed extensively as a monoculture product, and the carob moth is not capable of establishing in pistachio plantations without spring hosts (e.g., pomegranate, fig), the insect is not known as a serious pest of pistachio nuts in Iran.

The pistachio leaf miner, *Stigmella promissa* Stgr. (Lep.: Stigmellidae)

The insect feeds on the leaf parenchyma and causes irregular black spots on the leaves, and several larvae may attack one leaflet. This species has one generation per year. The pistachio plants which suffer drought are generally susceptible to the pistachio leaf miner.

The pistachio seed wasp, *Eurytoma plotnikovi* Nikol. (Hym.: Eurytomidae)

The larva feeds on the pistachio kernel and overwinters inside the infested nuts in the pistachio orchards either on the trees or on the ground. The adult wasps appear in May-June and lay a single egg inside the young fruits. The damaged fruits stop development and dries out. The larvae remain inside the nuts over the year and turns to the pupa in the early spring. The insect is univoltine.

The pistachio seed chalcid, *Megastigmus pistaciae* Walker (Hym.: Torymidae)

The biology of this species is very similar to *Eurytoma plotnikovi*, but this species has two generations a year. The above two pistachio seed wasps have been serious pests of pistachio nuts in the past, but they are no longer considered important pests in 95% of pistachio orchards. Removing all the nuts after harvest time are the effective means of control to prevent the hibernating larvae from producing any adult wasps in spring.

The pistachio long-horned beetle, *Calchaenesthes oblongmaculatus* (Guerin) (Col.: Cerambycidae)

There are several polyphagous long-horned beetles recorded on pistachio trees although they are not considered pistachio pests. Recently, *Calchaenesthes oblongmaculatus* was observed on pistachio trees (*P. vera*) in a limited pistachio growing area (H. Hashemi-Rad, pers. comm.). Primary studies showed that the insect immigrated from the forest area where *Pistacia mutica* are grown. The beetle damage on pistachio trunk and branches is serious, but the contaminated area is on a small-scale.

In the early spring, several other insects attack pistachio trees and cause minor damage to plants, e.g., the cotton bollworm, *Helicoverpa armigera* Hubner, feed on young soft shelled pistachio fruits; the pistachio bud moth, *Telphusa pistaciae* Sattler; the pistachio thrips, *Thrips pistaciae* Yak. and *T. iranicus* Yak.

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