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The invasive aphid *Pterochloroides persicae* (Cholodkovsky, 1899) (Hemiptera: Aphidoidea: Lachninae) recorded on important fruit trees in Kashmir Valley, India

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Abstract: *Pterochloroides persicae* (Cholodkovsky, 1899) is reported here for the first time from the Kashmir Valley. The aphid is seen to infest almond, peach, plum orchards in the region. Monitoring of the pest was carried out in the peach and almond fields of the Central Institute of Temperate Horticulture (CITH) during the years 2014–2016. Seasonality and bio-rational management practices of the pest are discussed.

Keywords: Aphid, bio-rational, natural-enemies, pest, *Pterochloroides persicae*, seasonality.

Aphids are among the most destructive insect pests on cultivated plants in temperate regions (McGavin 1993). They passively feed on the sap of phloem vessels in plants, creating lack of vigor along with frequent transmission of various viruses to their hosts (more than 50 aphid species are cited to be vectors; (Robert & Bourdin 2001). Though enemies of farmers and gardeners these represent a highly successful group of organisms on planet earth (Blackman & Eastrop 1994; Piper 2007). About 4,702 species are known globally (Remaudiere & Remaudiere 1997), among which 1,015 species occur in the oriental region and 653 species belonging to 208 genera have been reported from India, with a major portion (310 species) being reported from the northeastern region of India (Agarwala & Ghosh 1984, Verma & Das 1992; Ghosh & Singh 2000; Ghosh & Ghosh 2006). Among globally known aphids, around 250 species are dependent on agriculture and forestry species (Blackman & Eastrop 1994; Aphid Species File 2016), 51 species have been found to affect more than 31 species of agricultural crops from the Kashmir Division (Jammu & Kashmir, India) (Bhagat 1986a,b). Aphids represent a dominant and economically important group of insects from the region.

During the present study, the alien invasive aphid *Pterochloroides persicae* (Cholodkovsky, 1899) of temperate crops is reported here for the first time from the Kashmir Valley. From India, the species was previously reported sporadically only from the states of Himachal Pradesh and Punjab, on peach (Bindra & Bakhetia 1970; Mann et al. 1979). Review of the pest status, biology and control measures are provided here. The sporadic appearances of the species in the valley

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suggest that it has not flourished in the region yet but considering the economic importance, its presence in the region should be taken seriously and immediate measures for its control and regional quarantine should be enforced.

Materials and Methods

Specimens were collected by hand picking method. Weekly observations on aphid population were recorded using standard University of California, integrated pest management (UC IPM) sampling protocols for aphids. The weather parameters used are relative to the place and not exact and were procured from the regional metrological department. Taxonomic analyses were conducted using Olympus SZX16 stereo zoom microscope. For digital images, ProgRes0 CapturePro v.2.8.0. evolution digital camera was used on the same microscope with Combine ZP-Montage software. Later, images were cleaned with Adobe Photoshop CS6. The collected material has been deposited in the Biosystematics Laboratory of the Central Institute of Temperate Horticulture (CITH–Srinagar) for future reference.

Results and Discussion

Distribution: *Pterochloroides persicae* also called brown peach aphid, woody aphid, clouded peach bark aphid, cloudy-winged peach aphid depends on its host plants *Prunus* spp. (almond, apricot, peach) and Citrus species (Ciampolini et al. 1997). The species is well documented with distributional records available for many regions (Blackman & Eastrop 1994; Ateyyat & Abu-Darwish 2009; Knowledge Bank-Plantwise 2015). The species is persistent (Liotta & Maniglia 1993), serious (Kairo & Poswal 1995), invasive (Ciampolini et al. 1997; Bounfour et al. 2005) with distributional records suggesting gradual extension towards the eastern Mediterranean and central Asia (Kairo & Poswal 1995).

Damage: *Pterochloroides persicae* feeds on the brunch cortex (phloem), which results in general weakening of the young fruit trees, withered branches and reduced yield (Stoetzel 1994). The species is not listed as transmitting a virus (Chan et al. 1991) but healthy densities result in premature fruit drop, leaf curling, an irregular curvature of twigs, stunted growth and sooty mold fungal growth development, due to excessive honey dew production (Mann et al. 1979; Hondru et al. 1986). The species does not depend on attendance by ants for its survival as it can efficiently eject its honeydew but ants are seen collecting existing honeydew deposits (Talhouk 1977). Although polyphagous, peach is the most preferred host plant of the aphid, with regards to its enhanced fecundity and developmental rates, peach is also considered as the best suited host plant for its mass rearing. The species is most prolific in its rates of reproduction at 20^0C temperature (Khan et al. 1998). The colonies constantly move away from exposed areas of sun and actively move on the trees but spread to neighbouring trees is seen to be very poor (Mann et al. 1979).

Not much is known about the natural enemies of the aphid with *Chrysoperla carnea*, *Coccinella undecimpunctata*, *Pauesia antennata* and *Coccinella algerica* as other alien invasives are considered as most promising bio-control agents of the pest (Mirabzadeh et al. 1998; AbdRabou 2008; Rakhshani et al. 2005; Mdellel & Kamel 2012). Entomopathogenic fungi against the species include *Beauveria bassiana* (Hypocreales, Cordycipitaceae); *Metacordyceps liangshanensis* and *Metarhizium anisopliae* (Hypocreales, Clavicipitaceae) (Tsinovskii & Egina 1972). Yeast, vegetable oil, mineral oil, potassium sulphate + detergent have been trialed successfully against the control of the species (El-Salam 2001; Braham et al. 2007). Several chemicals at different concentrations and varying compositions have also been successfully used against the aphid: Dimecron (phosphamidon) or diazinon, Etiol, Anthio (formothion) and Lebaycid (fenthion) at 0.2% concentration (Velimirovic 1997); 0.05% of malathion and phosalone (Mann et al. 1979); Confidate® (Imidaclorpid) and Chlorcyrin® (Chlorpyrifos and Cypermethrin) (Ateyyat 2008); Patron® (diflubenzuron) and Trivap® (Cyromazine) as biorational insecticides (El-Salam 2001; Ateyyat & Abu-Darwish 2009); ULV sprays of dimethoate and monocrotophos applied at rates of 135 and 100 g a.i./ha, respectively, and 0.025% high-volume sprays of chlorpyrifos, dimethoate, leptophos, monocrotophos, oxydemetonmethyl, permethrin, phosalone and quinalphos (Sandhu & Sohi 1978); non-specific insecticides parathion, dimethoate, mevinphos and acephate along with the addition of some wetting agent (Ciampolini & Martelli 1980). Use of Phosalone has also been advocated (Sandhu & Sohi 1978) for its effectiveness and for being harmless to non target insects.

Biology: The life-cycle of the species is complex, having alteration of parthenogenetic and sexual generations, apterous and alate forms exhibited and persistently overlapping. Anholocyclic and holocyclic means of life cycle of the species from Lebanon was detailed by (Talhouk 1977). Holocyclic populations with sexual phase in autumn have only been observed

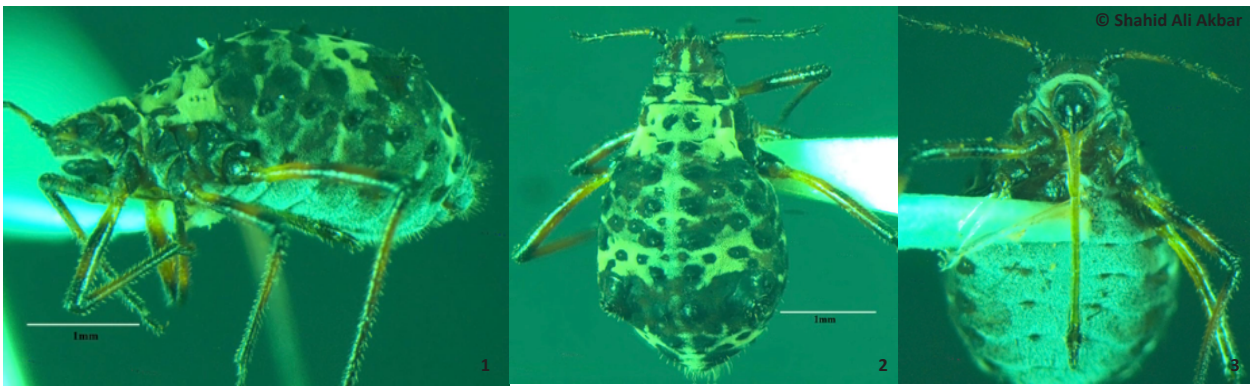
in cooler regions with oviparous females very similar to apterous viviparous females, except for their larger size (Archangelsky 1917; Wieczorek et al. 2013). Environmental conditions predominately influence population dynamics of the species with 18 overlapping generations reported in a year (Darwish et al. 1989); however fewer offspring's are produced per female in the winter than in summer (Velimirovic 1977). It takes 66–82 hr, 64–80 hr and 144–152 hr for the first, second and third instar to complete development; 16–48 hr, 122–280 hr and 8–24 hr for the pre-oviposition, oviposition and post-oviposition periods. 17–55 nymphs/female are raised in the entire reproductive life with an estimated reproductive rate of 4.51 nymphs/female per day (Velimirovic 1977; Darwish et al. 1989). Khan et al. (1998) reported 4-instars with eight days nymphal period and affirmed that average life span of the aphid is 41 days.

***Pterochloroides persicae* (Cholodkovsky)**
***Lachnus persicae* Cholodkovsky, 1899: 472**
(Images 1–9)

Material examined: CHT-IC/NPDF/B1-3, India: Kashmir, Srinagar, CITH, 33.59^{0}N & 74.50^{0}E, 1,500m, 122 Apterous viviparous and 32 Alate viviparous females, 10.v.2014, 12.x.2014, 21.iii.2015, 17.v.2015, 11.viii.2015, 11.iv.2016, 16.v.2016, 28.v.2016, 09.vi.2016, 21.xi.2016, coll. G. Mahendiran and S.A. Akbar.

Description: Apterous viviparous and alate viviparous females are the most conspicuous form in the colony, when fully grown these are large in size, having morphometric ranges of body length and width as 3.75–4.00 mm and 2.61–2.70 mm respectively; color dark brown to black with some white patches, dorsum of abdomen with a double row of large tubercles (Images 1–3); antennae six segmented; forewing with large distinctive dark patches and long rostrum easily demarcates the species from other con-generic members (Images 4–9). Sexual forms (oviparous females and males) although previously reported, have only recently been detailed and described by Wieczorek et al. (2013).

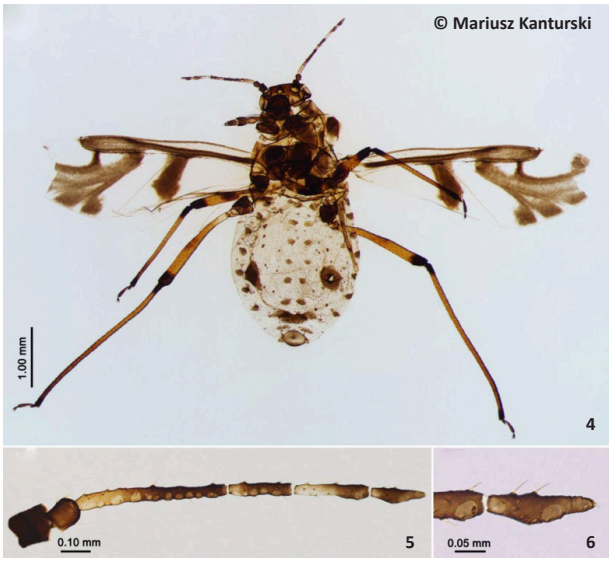
Seasonality (Images 7–22): Periodic monitoring of the aphid was carried in non-native peach and almond fields of the Central Institute of Temperate Horticulture (CITH) during 2014–2016 growing seasons. CITH is situated at 33.59^{0}N and 74.50^{0}E at an altitude of 1,640m. Eggs were initially sighted from the second week of November with few nymphs also present but infrequent in occurrence (Image 10). These eggs are mostly laid on the stems and are light brownish in colour but change to dark brownish to blackish-brown in colour with time. These eggs cover the entire surface of branches and twigs and are easily sighted (approximately 600–750 eggs/10cm^2) (Image 11). These eggs are comparatively bigger and thicker shelled than other aphid eggs. The aphid overwinters in the egg stage and these eggs begin to hatch from the first week of March. By the middle of March almost 70–80 % of the overwintering eggs are hatched. Newly emerged nymphs are most frequently sighted from the second week of March; moving upwards towards the small twigs for feeding (Image 12). These grow and attain full maturity and start to produce young ones from the second week of April (approximately one month from the date of hatching) (Image 13). First noticeable population build up of the species is observed during the second week of May with several batches of 45–60 individuals easily seen along the underside of tree trunks. Alate forms are mostly seen from the beginning of the second week of May (Image 14). Population density peaks in the month of May and decreases towards the latter half of the month and



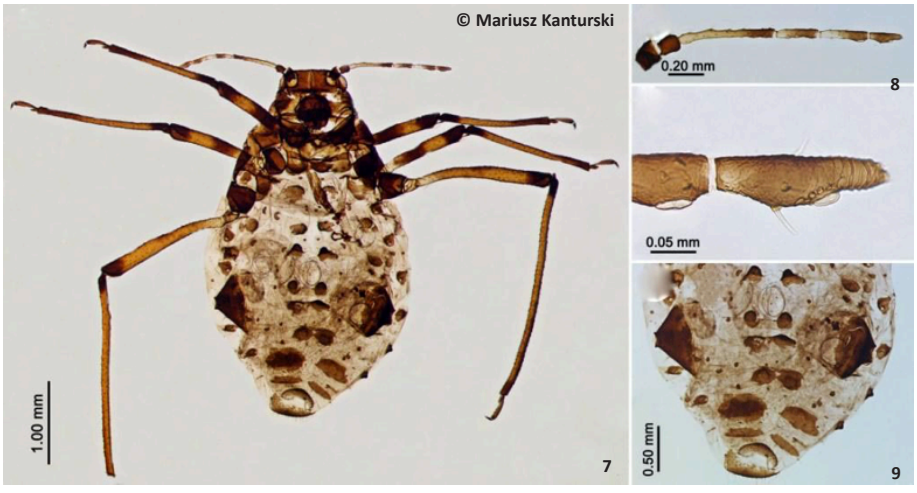
Images 1–3. *Pterochloroides persicae* - viviparous female: 1 - Body in lateral view; 2 - Body in dorsal view; 3 - Head in full-face view (not to scale).

more in the early weeks of June. The species gradually becomes inconspicuous during the early weeks of July. The second population build up starts towards the end of July. The population of the species gradually increases in the month of August along with the appearance of a few alate forms. These alates, however, are most conspicuous during the latter half of August, concurring with dispersal and an increased degree of infestation of other trees and evident presence of several coccinellids availing opportunities for egg laying. Second noticeable population build up of the species becomes most palpable during the latter half of October, with the underside of tree trunks occupied by the species along with large areas of blackened soil surface near the tree trunks (Images 15–17). The population of the species continues to increase in September and in the early weeks of October; however a drastic decline in the population occurs in the month of December. Longevity of females ranges from 41–60 days during which she lays several nymph batches (35–43 nymphs per female).

Probably six to eight generations of the aphid species are prevalent in a season from the region; however, ambiguous numbers observed could not be concluded and confirmed. The species was most prolific during the months of April, May, September and October with the population density of late season generation much higher compared with the early season. Mean average temperature recorded during the early season months (April, May) was 12^{0}C with maximum and minimum temperatures been 18.6^{0}C max and 8.6^{0}C min; dew point of 12^{0}C, precipitation of 31.0mm and wind speed of 9km/hr. Mean average temperature of 16^{0}C with maximum and minimum temperatures of 8^{0}Cmax and 23^{0}Cmin; dew point of 17^{0}C, precipitation of 10.0mm and wind speed of 89km/hr for the late season (September, October, November). The aphid was seen most prolific at mean temperature of 20–22 ^{0}C. The species was seen to be active at temperatures as low as 3^{0}C. There exists a definite relationship between the temperature and the population dynamics of the species, however in an open system with multiple environmental factors no definite correlation was confirmed. The species can be used as an ideal model for the concept of adaptive phenotypic plasticity (Halkett et al. 2004) which states the investment in sexual reproduction to be proportional to winter severity and forecasting climate predictability; however any definite inference on the subject is beyond



Images 4–6. *Pterochloroides persicae* - Alate viviparous female: 4 - Slide depicting dorsal row of spines and Infuscated wing; 5 - 3-segmented antennae; 6 - 6th antennal segment setae.



Images 7–9. *Pterochloroides persicae* - Apterous viviparous female: 7 - slide depicting dorsal row of spines; 8 - 3-segmented antennae; & 6th antennal segment setae; 9 - stout siphunculus.

Images 10–15. *Pterochloroides persicae* seasonality
10 - Oviparous females and freshly laid brown eggs; 11 - dark black diapausing eggs on branch; 12 - newly emerged stem mothers; 13 - a month old apterous viviparous female giving birth to young one and formation of new summer colony; 14 - Alate forms start to appear from second week of May; 15 - fully grown summer colony.

Images 16–18. Peak incidence and spray effects
16–17 - Sooty mold formation by honey dew secretion of aphids, appears as petroleum burning marks; 18 - membrane disintegration of aphids on spraying.

the scope of this paper and would require much more information. The aim of this review is to encourage understanding of this fascinating aspect of aphid biology and to promote more studies in this direction.

Several safe chemical combinations were used (Neem seed kernel extract-NSKE, Neem plant extract; Soyabean, Oliver, Rosemary Lavender oils; MetOH extract of *Crocus sativus*, *Spilanthes ciliate*, *Datura stramonium*, *Juglans regia* and Vim gel soap solution) at various concentrations against *Pterochloroides persicae*. Days after spray (DAS) data showed that all the combinations were prolific against the invasive species. Data recorded seven days after spray showed that in the beginning all the treatments provided cent percent control of the

Images 19–21. Insect association of *Pterochloroides persicae*
19 - *Adalia tetraspilota* nymphs feeding on the pest; 20 - Syrphid fly grub feeding on the pest; 21 - unidentified parasitic hymenoptera ovipositing on aphids.

pest; after 15 days pest population remained minimal in rosemary oil + soap solution (@ 0.1ml+10ml /litre of water) whereas negligible resurgence was observed in other combinations which also subsided to zero in following weeks. These chemicals were responsible for causing membrane disintegration on contact and the repellant nature of the spray also dispersed the surviving aphids (Image 18). The data generated is under evaluation for further use and recommendation. Some of the prominent coccinellids found associated with the aphid during the study were *Hippodamia variegate* (Goeze, 1777), *Oenopia conglobata* (Linnaeus, 1758), *Priscibrumus uropygialis* (Mulsant, 1853) and *Adalia tetraspilota* (Hope, 1831). Several un-identified parasitoids, syrphids, *Vespa* sp. were also seen frequently associated with the nymphs and adults of the alien species (Image 19–21). The aphid was also seen predominately attended by *Formica sanguinea* Latreille, 1798 for its honey dew.

References

AbdRabou, S. (2008). Mass production, releasing and evaluation of the Lady Beetle, *Coccinella undecimpunctata* (Coleoptera: Coccinellidae), for control of aphids in Egypt. *Archives of Phytopathology and Plant Protection* 41: 187–197.

Agarwala, B.K. & A.K. Ghosh (1984). A checklist of Aphididae of India. *Records of Zoological Survey of India, Occasional Paper* 50: 1–71.

Aphid Species File (2016). http://aphid.speciesfile.org/Common/basic/Taxa.aspx? Taxon Name ID = 1159459 accessed on 7 May 2016.

Archangelsky, P.P. (1917). On the biology of Pterochloroides persicae Chol. Reports of Turkestan Entomological Station, Tashkent, 70pp.

Ateyyat, M.A. (2008). Evaluation of some insecticides against the Peach Trunk Aphid, *Pterochloroides persicae* (Cholodkovsky) (Homoptera: Lachnidae), on peach in Jordan. *IOBC/WPRS Bulletin* 37: 19–27.

Ateyyat, M.A. & M.S. Abu-Darwish (2009). Short communication. Insecticidal activity of different extracts of *Rhamnus dispermus* (Rhamnaceae) against Peach Trunk Aphid, *Pterochloroides persicae* (Homoptera: Lachnidae). *Spanish Journal of Agricultural Research* 7(1): 160–164.

Bhagat, R.C. (1986a). Aphid pests of fruit trees and their natural enemies in Kashmir Valley, India. *Indian Journal Agricultural Sciences* 56(7) 532–534.

Bhagat, R.C. (1986b). On aphid pests of fruit trees and their natural enemies in Kashmir Valley, India. *Indian Agriculturist* 30(3) 229–235.

Bindra, O.S. & D.R.C. Bakhetia (1970). The chemical control of the Peach Stem Aphid, *Pterochlorus persicae* (Cholodkovsky). *Journal of Research, Punjab Agricultural University* 7: 48–51.

Blackman, R.L. & V.F. Eastrop (1994). *Aphids on the World's Trees. An Identification and Information Guide*. CABI, Wallingford, UK, 476pp.

Bounfour, M., F. Jebbour & J. Wadjinny (2005). Biological traits of invasive insect species harmful to Moroccan agriculture, pp. 95–100. In: Plant protection and plant health in Europe: introduction and spread of invasive species, held at Humboldt University, Berlin, Germany.

Braham, M., P. Edison & N. Ncira (2007). Efficacy of koalin, spinosad and malathion against *Ceratitis capitata* in Citrus orchards. *Bulletin on Insectology* 60(1): 39–47.

Chan, C.K., A.R. Forbes & A. Raworth (1991). Aphid-transmitted viruses and their vectors of the World. Agricultural Canada Research Branch Technical Bulletin, 216pp.

Ciampolini, M. & M. Martelli (1980). Appearance in Italy of the Peach Trunk Aphid *Pterochloroides persicae* (Cholodk.). *Bollettino di Zoologia Agraria e di Bachicoltura* 14: 189–196.

Ciampolini, M., I. Farnesi & A. Capella (1997). The spread of the woody aphid of *Prunus* (*Pterochloroides persicae*). *Informatore Agrario* 53: 105–107.

Darwish, E.T.E., M.B. Attia & M.O. Kolaib (1989). Biology and seasonal activity of giant Brown Bark Aphid *Pterochloroides persicae* (Cholodk.) on peach trees in Egypt. *Journal of Applied Entomology* 107: 530–533.

ElSalam, S.A.A. (2001). Toxicity and biochemical effects of some safe alternative materials against *Pterochloroides persicae* Chlod. Individuals (Order Homoptera: Fam. Aphididae) on peach trees. *Egyptian Journal of Agricultural Research* 79: 1387–1397.

Ghosh, A.K. & L.K. Ghosh (2006). *The Fauna of India and Adjacent Countries: Homoptera, Aphidoidea.* Zoological Survey of India, Calcutta, 244pp.

Ghosh, L.K. & R. Singh (2000). Biodiversity of Indian Insects with special reference to Aphids (Homoptera: Aphididae). *Journal of Aphidology* 14: 113–123.

Halkett, F., R. Harrington, M. Hulle´, P. Kindlmann, F. Menu, C. Rispe & M. Plantegenest (2004). Dynamics of production of sexual forms in Aphids: theoretical and experimental evidence for adaptive "coin-flipping" plasticity. *The American Naturalist* 163(6): 113–125.

Hondru, N., G. Mărgărit & I. Popa (1986). A new aphid pest of fruit orchards *Pterochloroides persicae* Cholodkovsky (Homoptera Aphidina Lachnidae). *Analele Institutului de Cercetări pentru Protecţia Plantelor* 19: 151–154.

Kairo, M.T.K. & M.A. Poswal (1995). The brown peach aphid, *Pterochloroides persicae* (Lachninae: Aphididae): prospects for IPM with particular emphasis on classical biological control. *Biocontrol News and Information* 16: 41–47.

Khan, A.N., I.A. Khan, M.A. Poswal & S. Ahmad (1998). Mass rearing/culturing of brown peach aphid, *Pterochloroides persicae* (Kholodkvoskii) (Lachninae:Aphididae) under laboratory condition. *Sarhad Journal of Agriculture* 14:355–368.

Knowledge Bank-Plantwise (2016). http://www.Plantwise.org/KnowledgeBank/Map/GLOBAL/Pterochloroides_persicae/ accessed on 10 May 2016.

Liotta, G. & G. Maniglia (1993). Variations in infestations of the almond tree in Sicily in the last fifty years. *Acta Horticulturae* 373: 277–285.

Mann, G.S., D. Singh & A.S. Dhatt (1979). Chemical control of *Pterochloroides persicae* (Cholod.), a sporadic pest of peach and almond in Punjab. *Indian Journal of Agricultural Sciences* 49: 895–897.

McGavin, G.C. (1993). *Bugs of the World*. Infobase Publishing, 550pp.

Mdellel, L. & B.M. Kamel (2012). Prey consumption efficiency and fecundity of the Ladybird Beetle *Coccinella algerica* Kovàr (Coleoptera: Coccinellidae) feeding on the Giant Brown-bark Aphid, *Pterochloroides persicae* (Cholodkovsky) (Hemiptera: Lachninae). *African Entomology* 20: 292–299.

Mirabzadeh, A., A. Sahragard & M. Azma (1998). Functional response of *Chrysoperla carnea* Steph. larvae to *Pterochloroides persicae*, *Uroleucon* (Urol.) *cichorii* and *Aphis craccivora*. *Seed and Plant* 14: 29–34.

Piper, R. (2007). *Extraordinary Animals: An Encyclopedia of Curious and Unusual Animals*. Greenwood Press. 6–9pp.

Rakhshani, E., A.A. Talebi, P. Stary, S. Manzari & A. Rezwani (2005). Redescription and biocontrol information of *Pauesia antennata* (Mukerji) (Hym., Braconidae, Aphidiinae), parasitoid of *Pterochloroides persicae* (Chol.) (Hom., Aphidoidea, Lachnidae). *Journal of the Entomological Research Society* 7(3): 59–69.

Remaudiere, G. & M. Remaudiere (1997). *Catalogue of the World's Aphididae*. Paris, 426pp.

Robert, Y. & D. Bourdin (2001). Aphid transmission of potato viruses, pp. 195–225. In*:* Loebenstein, G., P.H. Berger, A.A. Brunt & R.H. Lawson (eds.). *Virus and Virus-Like Diseases of Potatoes and Production of Seed- Potatoes*. Kluwer, Dordrecht, Netherlands.

Sandhu, G.S. & A.S. Sohi (1978). Highvolume and ultralowvolume spraying for the control of peach stemaphid in Punjab. *Pesticides* 12: 15–17.

Stoetzel, M.B. (1994). Aphids (Homoptera: Aphididae) of potential importance on Citrus in the United States with illustrated keys to species. *Proceedings of Entomological Society Washington* 96: 74–90.

Talhouk, A.S. (1977). Contribution to the knowledge of almond pests in East Mediterranean countries. VI. The sapsucking pests. *Zeitschrift fur Angewandte Entomologie* 83: 248–257.

Tsinovskii, Y.P. & K.Y. Egina (1972). The use of Entomophthora fungi in the control of aphids, pp. 73–94. In. The pathology of insects and mites: Patalogiya nasekomykh i kleshchei.

UC IPM Home page (2016). http://www.ipm.ucdavis.edu/ accessed on 10 May 2017.

Velimirovic, V.A. (1977). Contribution to the study of peach aphid *Pterochloroides persicae*. *Zastita Bilja* 28(1): 3–7.

Verma, K.D. & S.M. Das (1992). The Aphididae of north-west India (with special reference to Aphids of Jammu and Kashmir State). Ashish Publication House, New Delhi, i–viii+171pp.

Wieczorek, K., M. Kanturski & L. Junkiert (2013). The sexuales of Giant Black-bark Aphid, *Pterochloroides persicae* (Hemiptera, Aphidoidea: Lachninae). *Zootaxa* 3626(1): 094–098.

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