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Distribution, Hosts, Ecology and Biotic Potentials of Coccinellids of Pakistan

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Abstract: Coccinellids are the important natural enemies of aphids, scale insects, mealy bugs, mites etc. They had been used in classical biological control in the past. Recently they are being augmented or conserved for population reduction of pests in the concept of Integrated Pest Management. In Pakistan, 71 species of these predators are found in different ecologies associated with different pests. They have the potential to be used in oilseed crops, orchard and forest ecologies for the control of aphids and scale insects. In other habitats of their host pests these coccinellids have also some role to play. All these species have been documented along with their hosts, biology, ecology and biotic potential. Their use in different habitats has also been discussed in the prevalent Pakistani conditions.

Key words: Coccinellids, Pakistan, biological control

Introduction

Coccinellids commonly called ladybird beetles are the most attractive due to their bright colours. Individuals of a species often differ in color pattern. They are found in almost all the habitats. They have been considered good for fortune. Their forewings are modified to form hard and leathery elytra and have biting rather sucking mouthparts. They are semispherical and look like peas. Their color may be tan, black or red and spotted. About 3,500 species of these beetles have been reported from the world. Adults are most active during sunshine. They overwinter in unfavorable seasons mostly in the adult stage. They take shelter in crevices, cracks, under curled up leaves. Some may also rest in the shoot axils. Some time they congregate. Their food includes adelges, aphids, leafhoppers, lepidopterous borers, mites, scale insects and

white flies. Their real importance is in regulating the populations of different pests. Both adults and larvae can feed on their prey. When insect food is insufficient these coccinellids can feed on pollen and nectar. Frozen or dried aphids also serve as their food. Artificial diet can also be made by mixing honey, yeast and royal jelly. Their searching ability for prey is very high. They do not eat in winter and survive on reserve food.

Occurrence and hosts: There are 71 species of these predators in Pakistan (Ahmad, 1970; Alam *et al.*, 1969; Cheema *et al.*, 1980; CIBC, 1977, 1987; Ghani, 1963; Ghani and Cheema, 1973; Ghani and Muzaffar, 1974; Kazmi and Ghani, 1963, 1964; Mohyuddin, 1981; Mohyuddin *et al.*, 1982; Mughal *et al.*, 1985; Mustafa *et al.*, 1996; Naqvi *et al.*, 1981). Their hosts and distribution in Pakistan are given in Table 1.

Table 1: Distribution and hosts of coccinellids of Pakistan

01.	<i>Adalia bipilata</i> Hope on <i>Parlatoria oleae</i> (Colv.) (Diaspididae Hem). Quetta.
02.	<i>Adalia quadripilata</i> Hope on <i>Quadraspidotus perniciosus</i> Comst. (Diaspididae :Hom.). Northern Pakistan.
03.	<i>Adalia 4 pilata</i> Hope on <i>Adelges joshii</i> S.O & S. (Adelgidae : Hom.). Murree.
04.	<i>Adalia tetraspilata</i> (Hope) on <i>Adelges</i> spp. (Adelgidae : Hom.), <i>Quadraspidotus perniciosus</i> Comst. (Diaspididae : Hom.), <i>Dioryctria abietella</i> (Schiff.) (Pyralidae : Lep.). Murree.
05.	<i>Adalia</i> sp. on <i>Adelges joshii</i> S.O. & S. (Adelgidae : Hom.), <i>Chaitophorus</i> sp. (Aphididae : Hom.), <i>Quadraspidotus perniciosus</i> Comst. (Diaspididae : Hom.). Dir, Mardan, Swat, Tall.
06.	<i>Adonia variegata</i> Goetz on <i>Adelges joshii</i> S.O & S. (Adelgidae : Hom.), <i>Acyrtosiphon pisum</i> Harris, <i>Anuraphis helichrysi</i> Katt, <i>Aphis craccivora</i> Koch, <i>Macrosiphum granarium</i> (Kby), <i>Rhopalosiphum maidis</i> Fitch., <i>Schizaphis graminum</i> Rond., <i>Therioaphis trifolii</i> Monell (Aphididae : Hom.), <i>Haura</i> sp. (Asterolecaniidae : Hom.), <i>Drosicha mangiferae</i> (Green) (Margoridae : Hom.), <i>Dioryctria abietella</i> (Schiff.) (Pyralidae : Lep.), <i>Tetranychus atlanticus</i> Mcg., <i>Tetranychus</i> sp. (Tetranychidae : Acarina). Pakistan.
07.	<i>Afissa manderstjernae</i> Muls. on <i>Aphis gossypii</i> Glov., <i>Brachyudus</i> sp., <i>Capatophorus carduunus</i> Wlk. (Aphididae : Hom.). Northern Pakistan.
08.	<i>Alolocaria hexaspilata</i> Hope on <i>Quadraspidotus perniciosus</i> Comst. (Diaspididae : Hom.). Northern Pakistan.
09.	<i>Anisocalvia obversepunctata</i> Muls. on <i>Quadraspidotus perniciosus</i> Comst. (Diaspididae : Hom.). Northern Pakistan.
10.	<i>Ballia bayaderae</i> Muls. on <i>Adelges joshii</i> S.O & S. (Adelgidae : Hom.). Murree.
11.	<i>Ballia chrisophori</i> Muls. on <i>Adelges joshii</i> S.O & S. (Adelgidae : Hom.). Murree.
12.	<i>Ballia diannae</i> Muls. on <i>Adelges</i> spp. (Adelgidae : Hom.) Murree.
13.	<i>Ballia eucharis</i> Muls. on <i>Adelges joshii</i> S.O & S. (Adelgidae : Hom.), <i>Rhopalosiphum maidis</i> Fitch (Aphididae : Hom.), <i>Eucosma pyloniis</i> Meyr. (Eucosmidae : Lep.), <i>Dioryctria abietella</i> Schiff (Pyralidae : Lep.). Peshawar, Murree.
14.	<i>Berginus</i> sp. nr. <i>maindroni</i> Grov. on <i>Pulvinaria</i> spp. (Coccidae : Hom.), <i>Ferrisia virgata</i> (Ckll.) (Pseudococcidae : Hom.). Lahore.
15.	<i>Bumoides suturalis</i> F. on <i>Aleurocanthus husaini</i> Corbett, <i>Aleurocanthus woglumi</i> Ashby, <i>Aleurolobus barodensis</i> Mask, <i>Bemisia tabaci</i> Genn, <i>Neomaskellia</i> sp. (Aleyrodidae:Hom.), <i>Acyrtosiphon pisum</i> Harris, <i>Aphis craccivora</i> Koch, <i>Aphis fabae</i> Theobald, <i>Aphis gossypii</i> Glov., <i>Chaitophorus</i> sp., <i>Lipaphis pseudobrassicae</i> (Davis), <i>Myzus persicae</i> (Sulz), <i>Pterochloroides persicae</i> (Chol.), <i>Rhopalosiphum maidis</i> (Fitch), <i>Therioaphis trifolii</i> Monell (Aphididae : Hom.), <i>Hsui</i> sp., <i>Naiacoccus</i> sp. (Asterolecaniidae : Hom.), <i>Dialeurodes citri</i> Ashm., <i>D. elongata</i> (Doz.) (Dialeurodidae:Hom.), <i>Pyrrilla perpusilla</i> Wlk. (Fulgonidae:Hom.), <i>Centroccoccus insolitus</i> (Green), <i>Ferrisia virgata</i> (Ckll.), <i>Maconellicoccus hirsutus</i> (Green) (Pseudococcidae:Hom.), <i>Diaphorina citri</i> Kuw. (Psyllidae : Hom.), <i>Eutetranychus orientalis</i> (Klein), <i>Tetranychus atlanticus</i> Mcg., <i>Tetranychus</i> sp. (Tetranychidae : Acarina). Pakistan.
16.	<i>Catana parcesetosa</i> (Sic.) on <i>Aleurolobus barodensis</i> Mask., <i>Bemisia tabaci</i> Genn, <i>Neomaskellia</i> spp. (Aleyrodidae : Hom.), <i>Dialeurodes citri</i> Ash., <i>D. elongata</i> Doz. (Dialeurodidae: Hom.), <i>Ferrisia virgata</i> (Ckll.) (Pseudococcidae: Hom.). Pakistan.
17.	<i>Chilocorus bipustulatus</i> (L.) on <i>Parlatoria oleae</i> (Colv.), <i>Pulvinaria loralensis</i> (Rao), <i>Quadraspidotus perniciosus</i> Comst., <i>Salicicola kermanensis</i> (Lind.), <i>Tecaspis</i> sp. (Diaspididae : Hom.). Baluchistan.
18.	<i>C. bijugus</i> Muls. on <i>Adelges</i> spp (Adelgidae:Hom.) Swat.
19.	<i>Chilocorus infernalis</i> Muls. on <i>Adelges</i> spp. (Adelgidae : Hom.), <i>Chloropulvinaria polygonata</i> (Ckll.) (Coccidae : Hom.), <i>Cornimytilus afganensis</i> (Borch.), <i>Lepidosaphes afganensis</i> Borch, <i>Quadraspidotus perniciosus</i> Comst., <i>Tecaspis</i> sp., (Diaspididae : Hom.). Kashmir, Abbottabad, Swat.

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20. *Chilocorus nigritus* (F.) on *Aonidiella aurantii* (Mask.), *A. citrina* (Coq.), *A. orientalis* Newst., *Aspidiotus destructor* Sign., *Hemiberlesia lataniae* (Sign.), *Leucaspis coniferarum* Hall & Williams, *Parlatoria* spp., *Pinnaspis strachani* (Cooley), *Quadraspidiotus perniciosus* Comst., *Tecaspis* sp. (Diaspididae: Hom.). Murree, Rawalpindi.
21. *Chilocorus rubidus* Hope on *Eulecanium tiliae* (L.), *Lecanium* sp. (Coccidae: Hom.), *Parlatoria* sp., *Quadraspidiotus perniciosus* Comst. (Diaspididae: Hom.). Peshawar, Abbottabad, Parachinar.
22. *Coccinella 4-punctata* Potopp. on *Adelges* spp. (Adelgidae: Hom.). Murree.
23. *Coccinella 7 punctata* L. on *Acyrtosiphon pisum* Harris (Aphididae: Hom.), *Quadraspidiotus perniciosus* Comst. (Diaspididae: Col.), *Spilococcus* sp. (Pseudococcidae: Hom.), *Diaphorina citri* Kuw. (Psyllidae: Hom.): Northern Pakistan.
24. *Coccinella septempunctata* L. on *Aleurocanthus husaini* Corbett, *Aleurocanthus woglumi* Ashby, *Aleurolobus barodensis* Mask., *Bemisia tabaci* Genn., *Neomaskellia* sp. (Aleyrodidae: Hom.), *Acyrtosiphon pisum* Harris, *Aphis craccivora* Koch, *Aphis fabae* Theobald, *Aphis gossypii* Glov., *Chaitophorus* sp., *Lipaphis pseudobrassicae* (Davis), *Macrosiphum rosaeformis* Das., *Myzus persicae* (Sulz.), *Rhopalosiphum maidis* (Fitch), (Aphididae: Hom.), *Diaphorina citri* Kuw., (Psyllidae: Hom.), *Dialerodes citri* Ashm., *D. elongata* (Doz.) (Dialeuridae: Hom.), *Quadraspidiotus perniciosus* Comst. (Diaspididae: Hom.), *Pyrilla perpusilla* Wlk. (Fulgoroidea: Hom.), *Centroccoccus insolitus* Green, *Ferrisia virgata* (Ckll.), *Spilococcus* sp. (Pseudococcidae: Hom.). Pakistan.
25. *Coccinella undecimpunctata* L. on *Acyrtosiphon pisum* Harris, *A. craccivora* Koch., *Therioaphis trifolii* Monell (Aphididae: Hom.), *Pyrilla perpusilla* Wlk. (Fulgoroidea: Hom.), *Drosicha mangiferae* (Green) (Margaridae: Hom.) Peshawar, Mardan.
26. *Exochomus flavipes* (Thunb.) on *Aphis fabae* Theobald, *Rhopalosiphum maidis* Fitch, (Aphididae: Hom.), *Dactylopius confusus* Ckll. (Dactylopiidae: Hom.), *Parlatoria* sp. (Diaspididae: Hom.), *Ferrisia virgata* (Ckll.) (Pseudococcidae: Hom.), mites. Rawalpindi, Swat, Murree, Peshawar, Wah, Kohat, Hangu, Dir, Parachinar.
27. *Exochomus ? kiritschenkoi* Bar. on *Euclenia* sp. (Diaspididae: Hom.). Southern Baluchistan.
28. *Exochomus lituratus* Gorb. on *Adelges joshii* S.O. & S. (Adelgidae: Hom.), *Salicicola* sp. (Diaspididae: Hom.), *Dioryctria abietella* Schiff (Pyralidae: Lep.). Kashmir, Murree.
29. *Exochomus uropygialis* Muls. on *Adelges joshii* S.O. & S. (Adelgidae: Hom.). Murree.
30. *Evoina* sp. on *Acyrtosiphon pisum* Harris, *Therioaphis trifolii* Monell, *Aphis craccivora* Koch. (Aphididae: Hom.). Peshawar.
31. *Ghanus karachiensis* Ahmad on *Cercocarpus hibisci* Green (Coccidae: Hom.). Karachi.
32. *Halyzia sanscrita* Muls. on *Adelges joshii* S.O. & S. (Adelgidae: Hom.). Murree.
33. *Harmonia breiti* Mader on *Adelges* spp. (Adelgidae: Hom.), *Dioryctria abietella* Schiff. (Pyralidae: Lep.). Murree.
34. *Harmonia dimidata* Fab. on *Adelges* spp. (Adelgidae: Hom.), *Amritodus atkinsoni* Leth, *Idioscopus nagpurensis* Pruthi (Cicadellidae: Hom.). Lahore.
35. *Harmonia polita* Weise on *Planococcus citri* (Rissoo) (Coccidae: Hom.). Quetta.
36. *Hemiberlesia lataniae* Sign. on *Hsiu* sp. (Asteolecaniidae: Hom.), *Aspidiotus destructor* Sign., *Chloropulvanaria polygonata* (Ckll.) (Coccidae: Hom.). Karachi, Lahore, Northern Pakistan.
37. *Hyperaspis maindroni* Sic. on *Centroccoccus insolitus* (Green), *Naiacoccus* sp. (Pseudococcidae: Hom.) Northern Pakistan.
38. *Leis dimidiata* F. on *Acyrtosiphon pisum* Harris, *Aphis craccivora* Koch., *Therioaphis trifolii* Monell (Aphididae: Hom.), *Bemisia tabaci* Genn (Aleyrodidae: Hom.), *Eucosma pylonitis* Meyr. (Eucosmidae: Lep.), *Dioryctria abietella* Schiff, (Pyralidae: Lep.). Mardan, Murree, Swat, Peshawar.
39. *Menochilus sexmaculata* F. on *Adelges* spp. (Adelgidae: Hom.), *Aleurocanthus husaini* Corbett, *Aleurocanthus woglumi* Ashby, *Aleurolobus barodensis* Mask., *Bemisia tabaci* Genn., *Neomaskellia* sp. (Aleyrodidae: Hom.), *Acyrtosiphon pisum* Harris, *Aphis craccivora* Koch., *A. fabae* Theobald, *A. gossypii* Glover, *A. ruborum* Bor., *Chaitophorus* sp., *Lipaphis pseudobrassicae* (Davis), *Macrosiphum rosaeformis* Das., *Myzus persicae* (Sulz.), *Pterochloroides persicae* (Chol.), *Rhopalosiphum maidis* (Fitch), *Schizaphis graminum* (Kby), *Therioaphis trifolii* Monell, (Aphididae: Hom.), *Amritodus atkinsoni* Leth, *Evacanthus repexus* Dist., *Idioscopus nagpurensis* Pruthi (Cicadellidae: Hom.), *Quadraspidiotus perniciosus* Comst. (Diaspididae: Hom.), *Dialeurodes citri* Ash. *D. elongata* Doz. (Dialeuridae: Hom.), *Pyrilla perpusilla* Wlk. (Fulgoroidea: Hom.), *Drosicha mangiferae* (Green) (Margaridae: Hom.), *Centroccoccus insolitus* Green, *Spilococcus* sp. (Pseudococcidae: Hom.), *Diaphorina citri* Kuw. (Psyllidae: Hom.), *Dioryctria abietella* Schiff. (Pyralidae: Lep.), *Tetranychus orientalis* Mog (Tetranychidae: Acarina). Pakistan.
40. *Micraspis cardoni* (Weise) on *Amritodus atkinsoni* Teth (Cicadellidae: Hom.), *Quadraspidiotus perniciosus* Comst. (Diaspididae: Hom.), *Pyrilla perpusilla* Wlk. (Fulgoroidea: Hom.). Peshawar, Mardan.
41. *Nephus regularis* Sic. on *Nipaeococcus vastator* (Mask). (Pseudococcidae: Hom.). Rawalpindi.
42. *Nephus* sp. on *Metatetranychus japonica* (Mask.) (Coccidae: Hom.), *Nipaeococcus vastator* (Mask), *Planococcus robustus* (Mic.), *Saccicoccus sacchari* Ckll., (Pseudococcidae: Hom.). Multan, Rawalpindi, Peshawar.
43. *Oenopia pustulata* (Muls.) on *Aphis craccivora* Koch (Aphididae: Hom.). Rawalpindi.
44. *Oenopia sauzeti* Muls. on *Aphis gossypii* Glov., *Aphis craccivora* Koch, *Acyrtosiphon pisum* Harris, *Chaitophorus* sp., *Hyadaphis* sp., *Macrosiphum graminum* (Kby), *Macrosiphum rosaeformis* Das., *Rhopalosiphum maidis* Fitch., *Schizaphis graminum* Rond., (Aphididae: Hom.), *Aleurolobus barodensis* Mask., *Neomaskellia* sp. (Aleyrodidae: Hom.), *Evacanthus repexus* Dist (Cicadellidae: Hom.), *Tetranychus* sp. (Tetranychidae: Acarina) Northern Pakistan.
45. *Pharoscyrnus flexibilis* (Muls.) on *Aphis* sp., *Chaitophorus* sp., *Therioaphis trifolii* Monell, (Aphididae: Hom.), *Saissetia nigra* (Nietch.), *Lecanium* sp., *Chloropulvanaria polygonata* Ckll., *Coccus hesperidum* L., *Saissetia nigra* (Nietn.) (Coccidae: Hom.), *Nipaeococcus vastator* (Mask.), *Rastrococcus spinosus* Roh (Pseudococcidae: Hom.), *Aulacaspis tubercularis* Newst., *Chlorophilvanaria polygonata* (Ckll.), *Chrysomphalus aonidum* L., *Coccus hesperidum* L., *Nipaeococcus vastator* L. (Coccidae: Hom.), *Asterolecanium bambusae* (Boid.) , *Hsiu* sp. (Asterolecaniidae: Hom.), *Dactylopius confusus* Ckll. (Dactylopiidae: Hom.), *Andaspis kazimias* William, *Aonidiella aurantii* (Mask.), *A. citrina* Coq., *A. orientalis* (Newst.), *Aspidiotus destructor* Sign., *Aulacaspis tubercularis* Newst., *Chrysomphalus ficus* (Ashm.), *Corytoparlatoria opsis* sp., *Diapris echinocati* Bouche, *Fiorinia nerifolii* (Broche and Williams), *Genapartlatoria pseudaspidotus* (Lind.), *Hemiberlesia lataniae* (Sign.), *Leucaspis coniferum* Hall and Williams, *Lepidosaphes conchiformis* (Gmelin), *L. pallida* Green, *Odonaspis penicillata* Green, *Parlatoria crypta* Mck., *P. blanchardii* (Targ.), *P. ghanii* Hall and Williams, *P. oleae* (Colv.), *P. ziziphus* (Lucas), *Pinnaspis strachani* (Cooley), *Pulvanaria psidii* Mask., *Quadraspidiotus perniciosus* Comst., *Tecaspis* sp., *Temnaspidotus excisus* (Green) (Diaspididae: Hom.), *Cenopalpus pulcher* (C & F.) (Tenuipalpidae: Acarina), *Eutetranychus orientalis* (Klein), *Tetranychus atlanticus* Mog. (Tetranychidae: Acarina). Pakistan.
46. *Pharoscyrnus homi* Wse. on *Parlatoria crypta* (Mck), *P. blanchardii* (Targ.), *Pinnaspis strachani* (Cooley), *Tecaspis* sp. (Diaspididae: Hom.) Kaghan, Swat.
47. *Pharoscyrnus simmondsi* Ahmad on *Saissetia nigra* (Nietn.) (Coccidae: Hom.), *Aonidiella orientalis* Newst., *Parlatoria blanchardii* Targ. (Diaspididae: Hom.). Pakistan.
48. *Platynaspis saundersi* Cort. on *Acyrtosiphon pisum* Harris, *Aphis gossypii* Glov., *Aphis craccivora* Koch, *Aphis ruborum* Bor., *Chaitophorus* sp. (Aphididae: Hom.): Northern Pakistan.
49. *Pseudoscyrnus murrensis* Ahmad on *Aulacaspis* sp., *Tecaspis* sp., (Diaspididae: Hom.). Northern Pakistan

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50. *Pseudoscymnus simmondsi* Chapin and Ahmad on *Aonidiella citrina* Coq., *Ceroplastes actiniformis* Green, *Diaspis echinocacti* Bouche, *Pinaspis strachani* Cooley, *Temonospidiolus excisus* Green (Diaspididae: Hom.). Pakistan.
51. *Pullus coccidivora* Ayyar on *Chloropulvanarea plygonata* (Ckll.), *Coccus hesperidum* L (Coccidae:Hom.), *Icerya aegyptiaca* (Dougls) (Margarodidae: Hom.), *Ferrisia virgata* (Ckll.), *Nipaecoccus vastator* (Mask.), *Pulvanaria maxima* Green, *Rastococcus* sp., (Pseudococcidae: Hom.). Murree, Swat, Kashmir.
52. *Pullus guimeti* Muls. on *Acyrtosiphon pisum* Harris, *Aphis fabae* Theobald, *A. gossypii* Glover, *Aphis craccivora* Koch, *Macrosiphum graminum* (Kby), *Rhopalosiphum maidis* Fitch., *Shizaphis graminum* Rond. (Aphididae: Hom.), *Aspidiotus* sp. (Diaspididae: Hom.). Northern Pakistan.
53. *Pullus pyrochaltus* Muls. on *Eotetranychus cernus* (B&P) (Tetranychidae: Acarina). Northern Pakistan.
54. *Pullus* sp. on *Aphis gossypii* Glover, *Chaitophorus* sp. (Aphididae: Hom.). Peshawar.
55. *Rodolia fumida* Muls. on *Drosicha mangiferae* (Green), *D. stebbingi* Gr. (Margarodidae:Hom.). Peshawar, Dir.
56. *Rodolia guerinii* (Crotch.) on *Icerya seychelliarum* (Westw.) (Margarodidae: Hom.) Sargodha.
57. *Rodolia ruficollis* Muls. on *Icerya aegyptiaca* (Dougls) (Margarodidae:Hom.). Karachi.
58. *Scymnus fuscatus* Boh. on *Nipaecoccus vastator* (Mask.) (Pseudococcidae:Hom.). Rawalpindi.
59. *Scymnus quiemeti* Muls. on *Rhopalosiphum maidis* (Fitch), *R. pad* (L.) (Aphididae: Hom.). Peshawar.
60. *Scymnus nubilus* Muls. on *Acyrtosiphon maidis*, *A. pisum* Ratz, *Aphis fabae* Theobald, *A. craccivora* Koch, *A. gossypii* Glov., *Chaitophorus* sp., *Schizaphis graminum* Rond., *Theoraphis trifolii* Monell (Aphididae: Hom.), *Aspidiotus* sp. (Diaspididae: Hom.), *Eutetranychus orientalis* (Klein) (Tetranychidae: Acarina). Pakistan.
61. *Scymnus o-nigrum* Muls. on *Aspidiotus destructor* Sign. (Diaspididae: Hom.). Lahore.
62. *Scymnus* sp. on *Adelges joshii* S.O &S. (Adelgidae: Hom.), *Aleurocanthus husainii* Corbett, *Aleurocanthus woglumi* Ashby, *Aleurolobus barodensis* Mask., *Neomaskellia* sp. (Aleyrodidae: Hom.), *Aphis fabae* Theobald, *Chaitophorus* sp., *Eriosoma lanigerum* (Aphididae: Hom.), *Pulvinaria loralaensis* Rae, *Saissetia nigra* (Nieten), (Coccidae: Hom.), *Leucaspis coniferum* (Halls and William), *Tecaspis* sp. (Diaspididae: Hom.), *Eriococcus* sp., *Kiritshenkia sacchari* (Green), (Pseudococcidae: Hom.). Northern Pakistan.
63. *Simmondsius pakistanensis* Ahmad and Ghani on *Parlatoria oleaceae* (Colv.) (Diaspididae: Hom.), *Eriococcus* sp. (Pseudococcidae: Hom.). Murree, Kaghan.
64. *Stethorus gilvifrons* Muls. on *Brevipalpus* sp. (Tenuipalpidae: Acarina), *Eutetranychus cernus* (B.&P.), *E. oreintalis* (Klein), *Tetranychus atlanticus* MCG. (Tetranychidae: Acarina.) Northern Pakistan.
65. *Stethorus pauperculus* Weise on *Eutetranychus cernus* (B.&P.), (Tetranychidae: Acarina.) Northern Pakistan.
66. *Stethorus* sp. on *Aphis gossypii* Glov., *Myzus persicae* Sulz. (Aphididae: Hom.), *Tecaspis* sp. (Diaspididae: Hom.). Northern Pakistan.
67. *Sticholotis marginalis* Kapur on *Eriococcus* sp. (Pseudococcidae: Hom.). Murree.
68. *Sticholotis* sp. on *Andaspis kazimiae* Williams, *Chaitophorus* sp., *Leucaspis coniferum* Hall and Williams, *Parlatoria crypta* Mck., *Quadraspidotus permicoisus* Comst, *Pinaspis strachani* (Cooley) (Diaspididae: Hom.). Dir, Kaghan, Swat.
69. *Sumnius renardi* Wse. on *Coccus hesperidum* L. (Coccidae: Hom.), *Drosicha stebbingi* (Green). (Margarodidae:Hom.). Peshawar.
70. *Synia 6-spilota* Hope on *Chaitophorus* sp. (Aphididae: Hom.), *Luperus* sp. (Chrysomelidae: Col.). Northern Pakistan.
71. *Verania allardi* Muls. on *Pyrilla perpsilla* Wlk. (Fulgoroidea: Hom.). Mardan. Peshawar.

Biology and ecology of important species.

***Adalia tetraspilota* Hope:** It has three generations in a year. The life span of an adult is about 180 days. Mating occurs 2-3 days after emergence. Pre-oviposition period is 1 day. A female may lay 135 eggs and the incubation period is 3 days. Larval period lasts 10-11 days and pupal period is 15-16 days.

***Adonia variegata* Goeze:** It is widely distributed in Pakistan feeding on adelgids, aphids, scale insects and some lepidoptera. It is cosmopolitan in distribution. It overwinters from November to March and is multivoltine. Adults can live for about 270 days. Pre-oviposition period may be 3 days. A female may lay 310 eggs. Incubation period is 3-6 days, larval period is 8 days and pupal period lasts 5 days. An adult can consume 3, 23, 32 eggs, larvae, adult of red spider mite respectively.

***Brumoides suturalis* (F):** It is a general predator specially feeding on soft-bodied nymphs of aphids and mealy bugs and also scale insects, white flies and mites. It is a cosmopolitan species. An adult can consume 3, 23, 29 eggs, larvae and adults of red spider mite respectively. It was introduced into Bhopal against *Pyrilla* in 1942 with encouraging results (Ahmad, 1942).

***Chilocorus infernalis* Muls:** It is common coccinellid of Pakistan with wide distribution in the hilly areas (CIBC, 1977). It is important predator of scale insects. In winter it hibernates in the rolled, dried leaves, crevices of stem of plants. Its vertical distribution was similar regardless the diversity of adults (Ahmad *et al.*, 1999). Its larval period ranges between 18-21 days and pupal life is 7-11 days. Egg laying starts 47-61 days after emergence. Adults could live for 11 weeks depending on the food. Its first instar larva feed on eggs, body fluid of

nymphs and adults of female scales. The second instar larvae feed on the body fluid and can devour 1-3 second instar nymphs or adult females. A third, fourth- instar larvae and adults can eat 14, 34, 65 females of scale insects. Adults mate 3-8 days after emergence and mate repeatedly. It seems to concentrate in the lower canopy of trees rather upper. The lower part may be suitable for egg laying.

***Coccinella septempunctata* (L):** It is also cosmopolitan with wide distribution in Pakistan. At $21 \pm 1^\circ\text{C}$ and $70\% \pm 3$ R.H. Its adults and larvae can consume 60, 141 aphids / day on average and total development is completed in 18.7 days (Suhail *et al.*, 1999). The mature instars could consume more nymphs than young instars. According to Akram *et al.* (1996), it can consume 173 aphids per day. Microclimatic changes affect the aphid consumption.

***Exochomus flavipes* Thunb:** It is widely distributed all over the forests of Northern Pakistan. It has been recorded feeding on aphids and scale insects. It overwinters in adult stage, however, come out during sunny periods for basking. It seems to be multivoltine. Adult life may be around 220 days. Mating is repeated and may last 1-3 hours. A female may lay 45 eggs and incubation period is 6-7 days. The larval and pupal period is 16- 22 and 7-8 days respectively.

***Exochomus uropygialis* Muls:** It is widely distributed in Fir forests of Pakistan feeding on adelgids. It goes into hibernation by the end of November but in sunny days go for sun basking. There are 2 generations in a year. Hibernation may end by March. It seems to be univoltine. Adults may live for 320 days. Pre-oviposition period may be 2-3 months. Incubation period is 5- 8 days, larval life is 16-17 days and pupal period lasts for 7-8 days. A female may lay 150 eggs. Its eggs are

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spindle shaped and both ends are round. During summer adults can be seen on shoots of trees.

***Menochilus sexmaculata* (F.):** It is widely distributed in the country. A female lays 165 eggs with incubation period of 4-7 days. Larval period is 6 days and pupal life lasts 10-11 days. Its 3rd and 4th instar larvae are more voracious. Predatory potentials of females are higher than the males and laboratory-reared adult (Pirzada *et al.*, 1996). At Bahawalpur, *M. sexmaculata* first appeared in negligible numbers (0.2 per plant) during second week of September and were not observed later on. However, reappeared in second week of October (6.8/plant), started declining and was 1.59 in first week of November (Mustafa *et al.*, 1996).

***Pharoscyrnus flexibilis* Muls:** Ahmad and Ghani (1972) reported 35 species of coccids as its hosts while Kazmi and Ghani (1964) recorded its adults feeding on mites. It remains active all the year in the coastal and subcoastal areas and hibernates in other areas (CIBC, 1977). In the cooler areas it congregates in the dried leaves and pass winter as such. Some adults also die as a result of severe cold. In March, adults start dispersing. A female start egg laying 4-6 days after emergence and oviposition is maximum in 4th week and continues for 14 weeks. Maximum of 89 eggs per females could be laid. Adults could survive for 7-13 weeks. Its first instar larvae attack eggs, crawlers and newly settled instars, nymphs, body fluid of second instar nymphs and adult female. Its 3rd instar larvae could consume 3-4 instar nymphs or body fluid and 4-6 adult females. Egg development, first, second, third, fourth, pupal life at 25 °C is completed in 8,5,5,5,5,4 days with total developmental period of 32 days (Ghani and Ahmad, 1966).

***Pullus coccidivora* Ayyar:** It is widely distributed in the country and is a predator of scale insects and mealy bugs. It mates repeatedly 3-5 days after emergence. Oviposition starts 1-24 days after emergence. A female may lay 30-130 eggs during oviposition period of 18-153 days. The incubation period is 4-8 days, larval life 10-14 days and pupal life 3-5 days. Total development is completed in 19-26 days.

***Pullus guimetii* Muls:** It is a predator of scales. In the hilly areas of the country it resumes activity in June. It starts hibernation in October. At 25 °C the adults mate repeatedly 6-7 days after emergence. Mating lasts 22-43 days. Oviposition starts 12-20 days after emergence. Incubation period is 4-5 days. Larval instars and pupal period lasts 13-23 and 5-7 days respectively. Total development is completed in 23-26 days.

***Stethorus pauperculus* Wiese:** It is a specific predator of mites and is widely distributed in the country. Both larval and adult stages feed on mites. Larval colour varies from light black to brown. It is small rounded shaped. First instar larvae feeds on eggs and small nymphs. Its eggs are small and laid in clusters. Life cycle is completed in 3 weeks. A larva can eat 38,39,22 eggs, larvae and adults of red spider mites in 24 hours. Pupae are black, flattened and generally fastened to the upper side of leaves. In winter it hibernates in debris under the trees. They lay eggs on the lower surface of leaves. Eggs are whitish and elongated. They feed on all the stages of mites. The developmental period requires about a month. They may have 2-3 generations in a year.

Discussion

Insect control has mostly been undertaken through use of

insecticides. The use of pesticides has inherent disadvantages, as it is not environmentally friendly, therefore interest on biological control or biological based IPM is increasing continuously. In this context, little efforts have been made in the country. Now it is the need to exploit the natural enemies in this management concept. Despite extensive precautions, biological control, like all integrated pest management strategies, is not a panacea and also not risk-free. But that does not mean it should not be attempted. The consequences of inaction are far greater than the risks, as million of acres of rangeland, cropland, and wildlife habitat are affected each year by habitat disruption. No doubt biological control is difficult but sometimes it is the only practical approach. The importance of biological control in Pakistan has been discussed by Mohyuddin (1981). Most of the work is concerned with recording the natural enemies, their incidence, biology, ecology and host range. Some feeding studies are also reported. Little work has been done on mass rearing of these biotic agents and their utilization in the field.

Of the reported species of coccinellids some are aphidivorous (*Affisa manderstjernaee*, *Adonia variagata*), some are coccivorous (*Adalia quadripilota*, *Chilocorus* spp.), some are acarivorous (*Stethorus* sp.) and others are the general predators (*Coccinella* spp., *Brumoides suturalis*). This list seems to contain many species from the hilly areas of the country. The plains of Pakistan have not been either fully explored or not rich with coccinellid fauna as hilly areas. Further investigations may reveal some more species from this area. Control potentials of some of coccinellid predators of Pakistan have been explored by Anwarullah *et al.* (1966), Hamid (1983, 1984), Irshad (2001). Conserving *Suminius renardi* and *Rodolia fumida* controlled mango mealybug, *Drosicha stebbingi* in Lahore.

It is important to conserve their population through adjusting the chemical control as such that there is minimum effect on these natural enemies. This has been undertaken in cotton fields. A pre requisite of augmentative releases of natural enemies is the ability to produce the natural enemy in sufficient numbers at economic costs. Utilization of Coccinellids for biological control suffers in providing the sufficient numbers during initial period to have an impact on the pest population *Brumoides stururalis*, *Vernia allardi*, *M. sexmaculata*, *C. septumpunctata*, *C. undecimpunctata*. *Micraspis cardoni* are predators of some significance of sugarcane Pyrilla in NWFP (Mohyuddin *et al.*, 1982). *B. suturalis* found to be more abundant in non-sprayed areas of sugarcane in Mardan, Swabi. *M. sexmaculata* occurred regularly where no pesticides were applied. Khan *et al.* (1982) recorded *B. suturalis* feeding on *Aleurolobus barodensis* in NWFP. The population of *Catana parcesetosa* increases from March to May in sugarcane fields of Mardan and Peshawar. They can be shifted from maize and other adjoining crops to supplement the existing coccinellid populations for management of sugarcane pest (Mohyuddin *et al.*, 1982). Therefore it seems worthwhile to take advantage of these natural enemies in sugarcane plantations.

Few attempts on introduction of exotic coccinellid had also been undertaken. *Chilocorus kuwanae* Silv. was imported from Japan into Pakistan in 1959 and about 15,00 adults were released in Murree hills, Azad Kashmir, Parachinar and Baltistan against *Q. perniciosus*. It was not established in the released areas (Alam *et al.*, 1969). *C. infernalis* was collected from Murree hills and released in Parachinar and results were not monitored (Alam *et al.*, 1969). *B. suturalis* has been introduced into Bhopal (Ahmad, 1942).

Many gardeners consider coccinellids as sign of well being of

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their gardens. They are the most successful aphidivorous predators. They are heavy feeders during spring and fall. In USA *Hippodamia convergens* is sold @ 5.50 \$ per 1000. In the cotton fields in the world they feed on eggs and larvae of bollworms, other lepidoptera, aphids and *Scymnus* and *Stethorus* feed on mites. They mostly congregates therefore reduce the aphids population in patches.

Another area, which has promise is forest environment. Here, aphids, scale insects, and mealy bugs causing loss of wood mass damage to forest trees. However, little attention has been paid. When there are outbreaks of any pest, they can be effectively utilized. Fruit orchard is another habitat where they can take care of hoppers, scale insects, mealy bugs, and mites. Some outstanding results have been achieved in Pakistan by their utilization.

Coccinellid beetles should be released at night because at that time they will stay close and in the morning, when they are hungry, they will eat the aphids present over there. A predator also needs a lot of different aphids, which means a lot of different plants, and she needs a really good infestation. Therefore releases should be made in such periods when aphid population are abundant but they should not be allowed to cause economic loss. For this purpose a trap crop should be provided, wherever necessary. One strategy of aphid control is interplanting, which should, attract lady beetles and other predators naturally. Thus a natural balance would be available which would balance the population build up of aphids.

Interactions among predators can have substantial effect on the total impact of the predator complex. The combined predation rate of two predators could nearly be double the sum of their individual predation rates. Although most aphid species are attacked by several predator species, predator-prey theory has historically focused on interactions between individual prey and predator species. In biological control of aphids through predators in Pakistan these considerations must be given weight.

The potential of coccinellid in the control of different pests is quite promising in Pakistan. Currently a lot of emphasis is given to the judicious use of insecticides therefore, their potentials must be exploited to the maximum. They are important in oilseeds crops, however their population lags behind the population of aphids (major pest) therefore their argumentative releases in early season when aphid populations are low can give good results. This could be achieved either by rearing artificially or shifting from one field to another.

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