

HYMENOPTEROUS BIOPESTICIDES AND THEIR PRELIMINARY BIOCONTROL POTENTIAL FROM WESTERN MAHARSHTRA INCLUDING GHATS

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ABSTRACT

Hymenopterous parasitoids are biopesticides scattered in the environment which develop on pest insects and kill them. The use of pesticides leads tremendous pressure on various ecosystems causing pest resistance, secondary pest outbreak, pest resurgence, pollution, health hazards and destruction to ecocycles. Hence, biopesticides (parasitoids) play a very crucial role in pest control and keeping environment ecofriendly. A total of 96 hymenopterous parasitoids belonging to 6 prominent families namely, Ichneumonidae, Braconidae, Chalcidae, Eulophidae, Trichogrammatidae and Aphelinidae were recorded parasitizing and killing various insect pests both from plain and forest (Western Ghats) ecosystems. The family Braconidae was dominant over others by the number of individuals (39) parasitizing pest insects. Second dominant family was Ichneumonidae with 36 species followed by Eulophidae, Trichogrammatidae, Chalcidae and Aphelinidae by the numbers 7, 7, 6 and 1 respectively. The results also indicated that 84 species of parasitoids were common, 12 rare and parasitized and killed more than 40 species of insect pests.

Key words: Diversity, Hymenoptera, Biopesticides, Biological pest control

INTRODUCTION

Hymenopterous parasitoids are biopesticides scattered in the environment which develop on pest insects and kill them. The use of pesticides leads tremendous pressure on various ecosystems causing pest resistance, secondary pest outbreak, pest resurgence, pollution, health hazards and destruction to ecocycles. Hence, biopesticides (parasitoids) play a very crucial role in pest control and keeping environment ecofriendly. In population dynamics estimation of number of species is one of the important task. For sampling the specialized insects such as parasitoids and predators requires basic knowledge of biological peculiarities. The parasitoids are usually specific for one or closely related group of insects. Therefore, they are

restricted to, and dependant on an individual of host species. The reproductive rates are also related to the availability of their hosts. Parasitoid sampling is thus, the process of sampling of pest species. Hence, the survey and diversity of parasitoids has tremendous importance in biological pest management. It is estimated that there are about 2, 50, 000 species of the parasitic hymenoptera in the world (Gupta, 1988).

In past, survey and diversity of hymenopterous parasitoids have been attempted by Thompson (1944, 1953, 1954), Chatterjee & Swarup (1961), Sathe (1986a, b), Sathe (1987a, b), Sathe et.al. (1986), Sathe (1992), Goulet & Hubner (1993), Noyes (1995), Sood et.al. (1995), Sathe & Jadhav (2001), Sathe et. al. (2003), Sathe

(2004), Sathe & Chougale (2006), Chougale & Sathe (2008), Sathe (2014), etc. The present study will be helpful for understanding the distribution and ecology of parasitoids and their role as a biopesticides for controlling insect pest ecofriendly of the region

MATERIALS AND METHODS

Diversity, survey and preliminary biocontrol potential of hymenopterous parasitoids on important crop insect pests from agro and forest ecosystems were conducted at Kolhapur, Sangli and Satara districts from the years, 2011 - 2013 by visiting agro and forest ecosystems of various tahsils including Ghats fortnightly and collecting larvae by one man one hour search method from the field. The field collected material was screened for parasitoids/ cocoon formation in the laboratory $27 \pm 1^{\circ}\text{C}$, 75-80% RH and 12 hr photoperiod.

Cocoons of hymenopterous parasitoids were also collected from the field for parasitoid emergence. Adults emerged from host insects were identified by consulting appropriate keys and literature (Towens et.al., 1961; Wilkinson, 1928 a, b; Mason, 1981; Goulet & Hubner, 1993; Noyes, 1995; Sathe, 2014; etc. The per cent parasitism of hymenopterous parasitoids have been recorded by counting larvae parasitized out of 100 by screening field parasitized pest larvae.

RESULTS

The results recorded in table 1 and figs 1-7 indicated that a total of 96 hymenopterous parasitoids (biopesticides) were recorded on various insect pests both from plain and forest (western Ghats) ecosystems belonging to 6 prominent families namely, Ichneumonidae, Braconidae, Chalcidae, Eulophidae, Trichogrammatidae and Aphelinidae (Fig. 7).

Table -1 : List of Hymenopterous parasitoids(biopesticides) from Kolhapur, Sangli and Satara districts of Western Maharashtra including Ghats

Sr. No.	Species	Host record	Distribution	Occurrence
FAMILY : ICHNEUMONIDAE				
1.	<i>Banchopsis ruficronis</i> Cameron*	<i>Helicoverpa armigera</i> (Hubn.)	K, S, Sa	Common
2	<i>Charops charukeshi</i> S. & D.*	<i>Spilosoma obliqua</i> (Walk)	K, S, Sa	Common
3	<i>Charops patmangiri</i> S. & D.*	<i>Thiocidas postica</i> (Walk)	K, S, Sa	Common
4	<i>Charops</i> sp.	<i>T. postica</i>	K, S, Sa	Common
5	<i>Charops</i> sp.	<i>Vilrachola iscolartes</i> (Fabr.)	K, S, Sa	Common
6	<i>Campoletis chlorideae</i> Uchida*	<i>H. armigera</i> <i>Spodoptera litura</i> (Fabr.)	K, S, Sa	Common
7	<i>Diadegma argenteopilosa</i> (Cameron)	<i>S. litura</i> <i>Spodoptera exigua</i> (Hubn.)	K, S, Sa	Common
8	<i>D. fenestralis</i> (Cameron)	<i>H. armigera</i>	K, S, Sa	Common
9	<i>D. trichoptilus</i> (Cameron)	<i>Exelastis atomosa</i> (Wal.)	K, S, Sa	Common
10	<i>D. trochanterata</i> Morlay	<i>Dichocrocis puntiferalis</i> (Guenee)	K, S, Sa	Common
11	<i>D. vulgari</i> Morlay	<i>S. exigua</i>	K, S, Sa	Common
12	<i>D. recini</i> R. and K.	<i>D. puntiferalis</i>	K, S, Sa	Common
13	<i>Diatora lissonota</i> Viereck*	<i>Achea janata</i> (Linn.)	K, S, Sa	Common
14	<i>Ecthromorpha</i> sp.	<i>Mythimna separata</i> Fab.	K, S, Sa	Common
15	<i>Eriborus trochanteratus</i> (Morley)	<i>H. armigera</i>	K, S, Sa	Common
16	<i>E. sinicus</i> Holm.	<i>Tryporira insertulus</i> Wlk	K, Sa	Common
17	<i>Enicospilus</i> sp.*	<i>H. armigera</i> <i>S. litura</i>	K, S, Sa	Common
18	<i>Goryphus chaitshri</i> S. & D.	<i>Erias vitella</i> Fab.	K, S	Common
19	<i>G. nursei</i> (Cam.)	<i>E. vitella</i>	K, S, Sa	Common

Table -1 : List of Hymenopterous parasitoids(biopestisides) from Kolhapur, Sangli and Satara districts of Western Maharashtra including Ghats

Sr. No.	Species	Host record	Distribution	Occurrence
20	<i>Goryphus sp.</i>	<i>E. vitella</i>	K, S, Sa	Common
21	<i>Itoplectes narangae</i> Ashmead*	<i>Chilo suppressalis</i> (Hampson)	K	Common
22	<i>Isotima javensis</i> Rohwer	<i>Acigona steniella</i> (Hampson)	K	Common
23	<i>Netelia ephippata</i> Smith*	<i>Achea janata</i> Linn.	K, S, Sa	Common
24	<i>Netelia sp.</i>	<i>A. janata</i> Linn.	K, S, Sa	Common
25	<i>Netelia sp.</i>	<i>M. separata</i>	K, S, Sa	Common
26	<i>Perilissus cingulator</i> (Morley)*	<i>Athalia proxima</i> (Klug)	K, S, Sa	Common
27	<i>P. testaceus</i> (Morley)	<i>Leucinodous orbonalis</i> Guenee	K	Common
28	<i>Pimpla turionellae</i> (Linn.)	<i>Ostrinia kashmirica</i> (Moore)	K, S, Sa	Common
29	<i>Pristomerus euzopherae</i> Viereck	<i>Euzophera perticella</i> Reg.	K	Common
30	<i>Pristomerus valnerator</i> Pan.	<i>Phthorimaea operculella</i> Zeller	K, S, Sa	Common
31	<i>Xanthopimpla cera</i> Cam.	<i>Scirpophaga nivella</i> Fab.	K, Sa	Common
32	<i>X. nursei</i> Cameron*	<i>Sylepta derogata</i> Fab.	K, S, Sa	Common
33	<i>X. punctata</i> F.	<i>Chilo partellus</i> (Swin.)	K, S, Sa	Common
34	<i>X. stemator</i> Cameron	<i>C. partellus</i>	K, S, Sa	Common
35	<i>Xanthopimpla sp.*</i>	Paddy borers	K, S, Sa	Common
36	<i>X. transversalis</i> Voll.	Jamun borer	K, Sa	Common
FAMILY : BRACONIDAE				
37	<i>Cotesia flavipes</i> (Cameron)	<i>C. partellus</i>	K, S, Sa	Common
38	<i>C. chilonis</i> Munakata	<i>C. partellus</i>	K, S, Sa	Common
39	<i>C. sesamae</i> Cameron	<i>Sesamae inferens</i> (Walker)	K, S	Common
40	<i>C. ruficrus</i> (Haliday)	<i>H. armigera</i>	K, S, Sa	Common
41	<i>C. glomeratus</i> (Linn.)	<i>Peiris brassicae</i> Linn.	K, S, Sa	Common
42	<i>C. orientalis</i> C. & N.	<i>E. atosoma</i>	K, S, Sa	Common
43	<i>C. diurnii</i> C. & R.	<i>E. atosoma</i>	K, S, Sa	Common
44	<i>C. meghrangini</i> S. & D.	<i>E. atosoma</i>	K, Sa	Common
45	<i>C. shri</i> S. & Ing.	<i>Erias fabia</i> Stoll	K, S	Rare
46	<i>C. suvarni</i> S. & Ing.	<i>S. inferens</i>	K, Sa	Rare
47	<i>Meteorus dichlomeridis</i> Wilkinson	<i>S. obliqua</i>	K, S, Sa	Common
48	<i>M. spilosomae</i> M. & R.	<i>S. obliqua</i>	K, Sa	Common
49	<i>Apanteles angaleti</i> Muesebeck*	<i>Pectinophora gossypiella</i> Saun.	K, S	Common
50	<i>A. prodeniae</i> Viereck	<i>S. litura</i>	K, S, Sa	Common
51	<i>A. blateatae</i> Lal	<i>S. derogata</i>	K, S	Common
52	<i>A. creatonoti</i> Viereck	<i>T. postica</i>	K, S, Sa	Common
53	<i>A. baoris</i> Wilkinson*	<i>Pernara mathias</i> Fab.	K, S, Sa	Common
54	<i>A. bosei</i> Bhatnagar	<i>Amsacta moori</i> (Butl.)	K, S, Sa	Common
55	<i>A. colemani</i> Viereck	<i>P. gossypiella</i>	K, S, Sa	Common
56	<i>A. earterus</i> Wilkinson	<i>Erias insulana</i> (Boisduval)	K, S, Sa	Common

Table -1 : List of Hymenopterous parasitoids(biopesticides) from Kolhapur, Sangli and Satara districts of Western Maharashtra including Ghats

Sr. No.	Species	Host record	Distribution	Occurrence
57	<i>A. plutellae</i> Wilkinson	<i>Plutella xylostella</i> (L.)	K, S, Sa	Common
58	<i>A. papilionis</i> Viereck*	<i>Papilio demoleus</i> Linn.	K, S, Sa	Common
59	<i>A. ruidis</i> Wilkinson*	<i>A. janata</i>	K, S, Sa	Common
60	<i>A. subandinus</i> Blanchard	<i>P. operculella</i>	K, S, Sa	Common
61	<i>A. schoenobi</i> Wilkinson	<i>Scirpophaga insectulus</i>	K, S, Sa	Common
62	<i>Agathis indica</i> G. & B.	<i>S. obliqua</i>	K, S, Sa	Common
63	<i>Bracon bravicornis</i> Wesmeal	<i>E. fabia</i> , <i>E. insulana</i> (Boisd)	K, S, Sa	Common
64	<i>B. chinensis</i> Bhatnagar	<i>S. inferens</i>	K, S, Sa	Common
65	<i>B. hebator</i> Say	<i>Erias</i> sp.	K, S, Sa	Common
66	<i>B. gelechiae</i> Ashmead	<i>H. armigera</i>	K, S, Sa	Common
67	<i>B. greeni</i> Ashmead	<i>Erias</i> sp.	K, S, Sa	Common
68	<i>Microplitis maculipenis</i> (Szepligeti)	<i>A. janata</i>	K, S, Sa	Common
69	<i>Chilonus blackburni</i> Cameron	<i>H. armigera</i>	S, Sa	Common
70	<i>C. heliope</i> Gupta	<i>H. armigera</i>	K, S, Sa	Rare
71	<i>Dolichogenidea mythimna</i> S. & B.	<i>M. separata</i>	K, S, Sa	Common
72	<i>D. exiguvi</i> S. & B	<i>S. exigua</i>	K, Sa	Common
73	<i>Glyptapanteles malshri</i> S. & I.	<i>P. xylostella</i>	K, S	Common
74	<i>Rhigoplitis pahadi</i> S. & I.	Tomato caterpillar	K, S, Sa	Rare
75	<i>Stenobracon occulatus</i>	<i>C. partellus</i>	K, S, Sa	Common
	FAMILY : CHALCIDAE			
76	<i>Brachymeria euploaeae</i> (Westwood)	<i>D. punctiferalis</i>	K, S, Sa	Common
77	<i>B. lasus</i> Walker	<i>Erias</i> sp.	K, S, Sa	Common
78	<i>B. tachardiae</i> Cameron*	<i>S. derogata</i>	K, S, Sa	Rare
79	<i>B. nephantidis</i> Gahan*	<i>Erias</i> sp. <i>Nephantidis serinopa</i> (Meyrick)	K, Sa	Common
80	<i>Dirhinus giffardi</i> Silvestri	<i>Dacus cucurbitae</i> , Coquilett <i>D. dorsalis</i> Hendel	K, S, Sa	Rare
81	<i>D. luzonensis</i> Rohwer	<i>D. cucurbitae</i>	K, S, Sa	Rare
	FAMILY : EULOPHIDAE			
82	<i>Tetrastichus ayyari</i> Rohwer	<i>Acigona steniela</i> (Hampson)	K	Common
83	<i>T. israeli</i> (M. & K.)	<i>Chilo infuscatellus</i> Sneller	K, Sa	Rare
84	<i>T. ophiusae</i> Crawford*	<i>A. janata</i>	K, S, Sa	Rare
85	<i>T. pyrillae</i> Crawford	<i>P. purpusilla</i>	K, Sa	Rare
86	<i>T. radiatus</i> Waterson	<i>Diaphorina citri</i> K.	K, S, Sa	Rare
87	<i>T. sokolowski</i> Kurdjumoy	<i>P. xylostella</i>	K, S, Sa	Rare
88	<i>Trichospilus pupivora</i> Ferr.*	<i>S. litura</i> <i>S. derogata</i>	K, S, Sa	Common

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Sr. No.	Species	Host record	Distribution	Occurrence
FAMILY : TRICHOGRAMMATIDAE				
89	<i>Trichogramma achaeae</i> N. & N.	<i>P. gossypiella</i>	K, S, Sa	Common
90	<i>T. brasilensis</i> (Ashmead)	<i>Erias</i> sp.	K, S, Sa	Common
91	<i>T. chilonis</i> Ishi	<i>C. infuscatellus</i> <i>P. gossypiella</i>	K, S, Sa	Common
92	<i>T. chilotraeae</i> N. & N.	<i>C. infuscatellus</i> <i>Erias</i> sp.	K, S, Sa	Common
93	<i>T. evanscens</i> Westwood*	<i>Papilio demolelus</i> Linn.	K, S, Sa	Common
94	<i>T. japonicum</i> Ashmead	<i>C. suppressalis</i>	K, S, Sa	Common
95	<i>T. minutum</i> Riley*	<i>A. janata</i>	K, S, Sa	Common
FAMILY : APHELINIDAE				
96	<i>Aphelinus gossypii</i> Timberlake*	<i>Aphis gossypii</i> Glover	K, S, Sa	Common

* = Found in Western Ghats
K=Kolhapur, S=Sangli, Sa=Satara.

The family Braconidae was dominant over others by the number of individuals (39) parasitizing and killing eggs/larvae/pupae of pest insects. Second dominant family was Ichneumonidae by the number collected (36) followed by Eulophidae (7), Trichogrammatidae (7), Chalcidae (6) and Aphelinidae (1). The results recorded in table 1 also indicated that 84 species of parasitoids were common and 12 rare in the region. Out of 96 species of hymenopterous parasitoids 23 were found in forest (Western Ghats) ecosystems. The most potential parasitoid *Campoletis chlorideae* (Uchida) was parasitizing 50-62% larvae of *Helicoverpa armigera* (Hubn.) and *Spodoptera litura* (Fab.) both in agro and forest ecosystems.

Fig-1. *P. mathias* containing braconid larvae in body



Fig. 2. Braconid larvae coming out from caterpillar body



Fig. 3. *Dolicogenidea mythimna* adults



Fig. 4. *Charops charukeshi* adult female



Fig. 6. *C. charukeshi* Cocoon

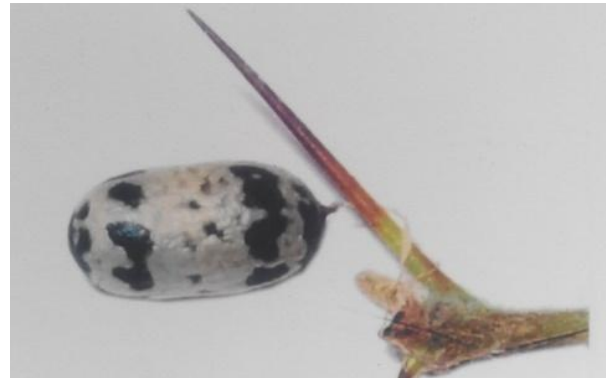


Fig.5. *D. mythimna* Cocoon colony

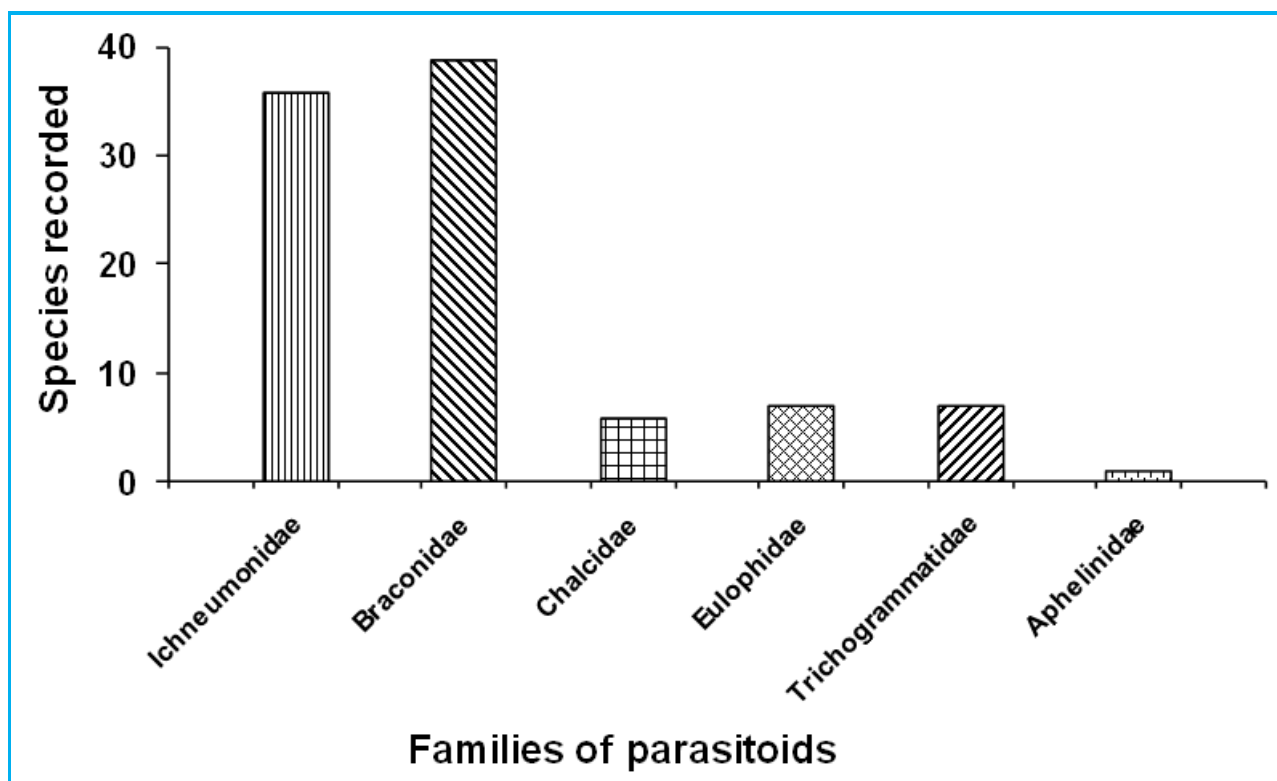


Similarly, the genus *Charops* was potentially causing higher mortalities (10% - 32%) in lepidopterous caterpillars. The potential genera found in both agro and forest ecosystems were *Diadegma*, *Xanthopimpla*, *Cotesia* and *Apanteles*

DISCUSSION

According to Gupta (1988) parasitic hymenoptera contain 60,000 species of Ichneumonidae and 40,000 species of Braconidae from the world as biopesticides but, very little attention is given except the work of Sathe and Gupta and their co-workers cited in references. *Apanteles glomeratus* (Linn.) has been reported for first time in Maharashtra by Sathe & Jadhav (2001) on *B. mori* during the year 1996. However, it was very first parasitoid recorded on *Pieris brassicae* L. in 1602 (Thompson, 1944; Chatterjee & Swarup, 1961).

Fig. 7 : Occurrence of parasitoid species from Western Maharashtra



According to Sood et.al. (1995) *A. glomeratus* begins to parasitize *P. brassicae* from second fortnight of March. This gregarious endoparasitoid killed the host larvae in the fifth instar and remained associated till early May and caused mortality ranging from 3.9 to 23.6 % with peak parasitization in the second week of April. The maximum mortality recorded in *P. brassicae* by the Sood et. al. (1995) was 40 %.

Sathe (1987b) made a survey of natural enemies of *Spodoptera litura* (Fab.) on groundnut crop from Kolhapur. He reported 10 hymenopterous parasitoids parasitizing *S. litura*. Natural enemies of *Spodoptera exigua* (Hubn.) from Kolhapur have been recorded by Sathe et. al.(1987). They reported a total of 13 hymenopterous parasitoids on *S. exigua*. In 1992 Sathe prepared index of hymenopterous parasitoids and pest insects from entire Maharashtra.

A survey of Braconid pest biocontrol agents from Southern Maharashtra have been conducted by Sathe (2004). Out of 37 species of Braconids listed, the genera *Cotesia* and *Apanteles* were dominant while, the genera *Microplitis*, *Rhigoplitis* and *Glyptapanteles* were represented by a very small number of species. From the genus *Cotesia*, 10 species, from *Apanteles* 13 species and from genera *Rhigoplitis*, *Glyptapanteles* and *Microplitis* only a single species was reported. *Glyptapanteles* was found confined to Kolhapur region (heavy rain fall) while, *Apanteles ruidis* was found in Solapur region (low rain fall). The most abundant species of the region were *C. flavipes*, *C. orientalis*, *C. ruficrus*, *C. glomeratus*, *A. prodeniae*, *A. angaleti*, *A. plutellae*, *Meterous dichomeridis* and *Bracon* spp.

Sathe and Chougale (2006) reported 10 hymenopterous parasitoids on *Helicoverpa armigera* (Hubn.) from Kolhapur. Similarly, Chougale and Sathe (2008) prepared the index of 26 Ichneumonid parasitoids and their host (pest) insects from Sangli district. In the present study it was observed that the family Braconidae was dominant by the number of individuals collected (39) followed by Ichneumonidae(36),

Eulophidae(7), Trichogrammatidae(7), Chalcidae(6) and Aphelinidae(1). In all, 96 hymenopterous parasitoids have been reported as biopesticides for more than 40 insect pests both from agro and forest (Western Ghats) ecosystems of Western Maharashtra. Out of which 84 species were common and 12 rare. The species *Tetrastichus ayyari*, *Pristomerus euzopherae*, *Perilissus testaceous*, *Isotima javensis* and *Itopectes narangae* were confined to the Kolhapur region. Biological control will not progress on a large scale without basis knowledge of diversity, availability in the nature and ecology. The present data will add great relevance designing biological control programs for various insect pests reported in the text.

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