

Biodiversity of Hoverflies (Diptera: Syrphidae) of the Protected Areas of Goa



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Anooj S. S.



भा.कृ.अनु.प.-केंद्रीय तटीय कृषि अनुसंधान संस्थान
(भारतीय कृषि अनुसंधान परिषद)
ओल्ड गोवा ४०३ ४०२, गोवा, भारत



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Biodiversity of Hoverflies (Diptera: Syrphidae) of the Protected Areas of Goa

INTRODUCTION

Hoverflies are ecologically important group of insect which has diverse habitat preference. Hover flies or flower flies (Diptera: Syrphidae) are one of the largest family in true flies. The adults are often brightly coloured and many species mimics bees many wasps (Golding et al. 2005). The adults are generally found near flowers and are important pollinators of wild and cultivated flora. The larvae have diverse habitat preferences *viz.* predatory, saprophytic, saproxylic and phytophagy. Larval stages are reported from diverse niches like aphid colonies, ant nest, trees sap runs, waterfalls (in tree holes/bamboo/leaf axils of bromeliads), bulbs/rhizomes, rotting plant materials and wood near streams and ponds etc. (Sorensen et al. 1995; Sommaggio 1999; Stubbs and Falk 2002; Rojo et al. 2003) With such diverse feeding habit and habitat requirements, their diversity is an indication of a healthy ecosystem.

Worldwide they have been used to study health of forest ecosystems, especially those with ample tree canopy structure. Further there is an increasing trend of classifying many rare syrphids as requiring conservation status globally. For example *Blera fallax* or the pine hoverfly, a rare species of hoverflies associated with mature pine tree in northern and central Europe is listed as critically endangered in the red list by the IUCN.

Presently 6,107 species of hoverflies under 209 genera reported Worldwide (Pape and Evenhuis, 2013 and Miranda et al. 2013). Around 493 hoverfly species of 107 genera in 14 Tribes and 3 Subfamilies can be currently considered valid in the Indian subregion, of the Oriental biogeographical region (Ghorpade 2014). 131 species of hover-flies, of 49 genera in 10 Tribes and 3 Subfamilies have so far been recorded from the southern Indian sub-continent (Ghorpade 2019). Out of which Goa is represented by just two Species in 2 genera in 2 tribes and 2 subfamily (Ghorpade 2019) which shows the poor filed work in Goa. Unlike many other states where there had been basic classical taxonomy work by the then British colonial era taxonomists; in Goa such works are less due to the Portuguese settlement. Till date, there is no proper research work on the diversity of hoverfly of Goa. Given

the relevance of Goa, gap of the Western Ghats in speciation, it is quite probable that many new species of syrphids awaits discovery from Goa, especially from the undisturbed natural vegetation and hence Protected Areas could serve as the best survey sites. Further the study on diversity of this group of flies in Protected Areas of Goa will help in finding out the locations which need special attention and will also help to find out rare syrphid flies which can be considered as future candidates of species requiring conservation efforts.

The checklist, key, distribution map and field guide of hoverflies of Goa which will be produced out of the study will be of immense value for natural history and conservation efforts in Protected Areas of Goa

This project aims to bridge the knowledge gap about hoverfly fauna of Protected Areas of Goa with the following objectives:

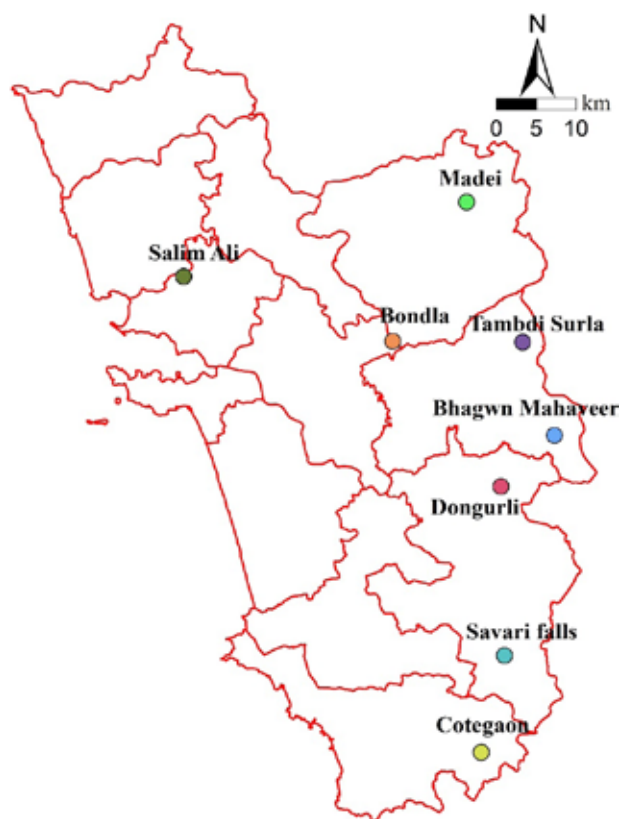
1. Collection and taxonomic identification of hoverflies from various Protected Areas of Goa
2. Description/redescription of new/known species of hoverflies of Protected Areas of Goa
3. Identification of specified habitat/location in the protected areas which houses rare hoverflies of conservation and ecological value
4. Preparation of checklist, taxonomic key, distribution map and field guide for the hoverflies in Protected Areas of Goa

MATERIALS AND METHODS

Study area

Survey and collection of hoverflies were carried out in seven protected areas of Goa.

1. Bhagwan Mahavir National Park & WLS
2. Bondla WLS
3. Choroa Island (Salim Ali Bird Sanctuary)
4. Cotigaon WLS
5. Madei WLS
6. Netravali WLS.
7. Mollem WLS



Peak seasons of wetness (especially the period of monsoon breaks) and peak season of flower blooming were targeted to conduct the opportunistic surveys.

Specimen collection and handling

Collections were mainly done using an aerial net and the specimens were collected in 99% ethyl alcohol with proper label data including the GPS coordinates and habitat details. Relaxing of specimens were done by placing the specimen over cotton soaked in 1:1:1 solution of ethanol, ethyl acetate and water followed by pinning, labelling (with location and habitat data). Then specimens were dried under incandescent bulb in ant proof facility and stored in cabinets.

Collection permit

Collection of specimens were done in the protected areas with bonafied permit from the competent authority of the Goa Forest Department (No-2-66-WL-Research Permission-FD-Vol. VI/5317 dated 28.02.2023, Deputy Conservator of Forest, OSD (Head Quarters), Panaji, Goa).

Observations

Field observations recorded included the location, GPS co-ordinates, habitat and date of collection. Microscopic observations were made using Leica M 80 stereozoom microscope.

Photographic documentation

Laboratory photography was done using Leica MC 170 HD mounted on Leica M 80 stereozoom microscope. Field photography of habitat was done using Canon 600D DSLR camera. The plates were prepared with help of adobe photoshop CS5 software.

Identification of specimens and descriptions

Species identification was done based taxonomic keys (Brunetti,1923, Ghorpadé,1994, Thompson & Ghorpadé, 1992) and also comparison with type materials were done. Description of the species identified was carried out along with illustrated colour photograph.

Voucher specimens

The voucher specimens are currently housed at ICAR-CARI, Old Goa which will be subsequently submitted to NBAIR, Bengaluru and ZSI, Kolkata.

Habitat study

Specified habitat/location in the protected areas with ample hoverflies diversity which indicated an ecological value were identified during the field surveys. The rarity of the species harboured, the number of species found and number of species with habitat peculiarity was used as a parameter for spotting such locations.

Distribution map

The species distribution map was prepared using QGIS with inputs from the specimen label data especially the GPS co-ordinates

Survey team at various Protected Areas of Goa



Bondla WLS



Crocodile Lake (Bondla)



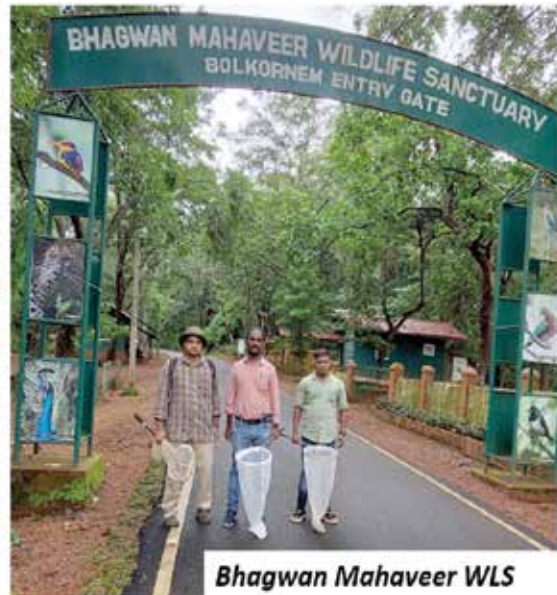
Cotegaon WLS



Netravali WLS



Mhadei WLS



Bhagwan Mahaveer WLS

Surveyed habitat areas



Riverine



Dry streams with marsh



Pond



Riverine



Pandanus growth



Garden - Bondla

RESULTS AND DISCUSSION

A total of 19 species of hoverflies in 14 genera in 5 tribes and 2 subfamilies have been reported from periodic surveys and collection done in various protected areas of Goa from March 2023 to March 2024. Out of the 19 species of hoverflies reported here, 17 species and 12 genus are new record for Goa. The list of species along with the distribution, habit and habitat details is furnished in table 1.

Table1. List of species in Protected Areas of Goa

No	Species	Location (*See table legend)	Habitat M:Marsh G:Garden R:Riverine Gr: Grass/ weeded boundaries	Habit	S:New species to Goa G:New genus to Goa P: Past record exists
SUBFAMILY ERISTALINAE					
Tribe Eristalini					
1	<i>Eristalinus arvorum</i> (Fabricius)	Bo,C	G,M,R	Saprophytic	S, G
2	<i>Eristalinus obscuritarsis</i> (deMeijere)	Bo	M	Saprophytic	S, G
3	<i>Phytomia crassa</i> (Fabricius)	Bo,C	G,M,R	Saprophytic	P
4	<i>Phytomia argyrocephala</i> (Macquart)	C	R	Saprophytic	S
Tribe Milesiini					
5	<i>Syritta orientalis</i> Macquart	Bo,C,N,M	G,M,R,Gr	Saprophytic	S, G
6	<i>Xylota</i> sp	M	R	Saproxylic	S,G
SUBFAMILY SYRPHINAE					
Tribe Bachhini					
7	<i>Melanostoma orientale</i> (Wiedemann)	M	Gr	Predatory	S,G
8	<i>Melanostoma univittatum</i> (Wiedemann)	M	Gr	Predatory	S,G

Tribe Paragini					
9	<i>Pandasyopthalmus</i> cf. <i>rufocinctus</i> (Brunetti)	Bo	M	Predatory	S, G
10	<i>Serratoparagus crenulatus</i> (Thomson)	Bo,C, Bm, N, M	M,R,Gr	Predatory	S, G
11	<i>Serratoparagus serratus</i> (Fabricius)	N,Bo	R	Predatory	S, G
Tribe Syrphini					
12	<i>Allobaccha apicalis</i> (Loew)	Bo,Bm	M,R	Predatory	P
13	<i>Allobaccha amphithoe</i> Walker	M	R	Predatory	S
14	<i>Allobaccha</i> sp1	M,Bo,Bm	R	Predatory	S
15	<i>Asarkina incisuralis</i> (Macquart)	M	R	Predatory	S,G
16	<i>Asiobaccha</i> cf. <i>nubilipennis</i> (Austen)	C,M	R	Predatory	SG
17	<i>Dideopsis aegrota</i> (Fabricius)	N,C,Bm	R	Predatory	S, G
18	<i>Episyrphus viridaureus</i> (Wiedemann)	N,Bo,C, Bm	G,M,R	Predatory	S, G
19	<i>Ischiodon scutellaris</i> (Fabricius)	Bo	M	Predatory	S, G

***Bm**:Bhagwan Mahavir National Park & WLS, **Bo**: Bondla WLS, **C**:Cotigaon WLS, **M**:Madei WLS and **N**: Netravali WLS

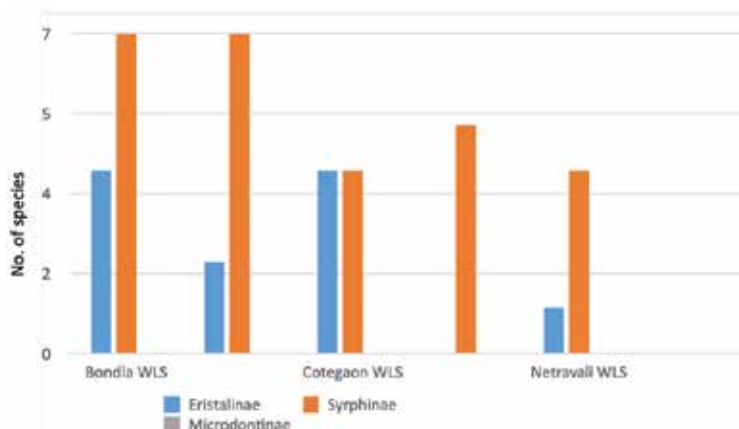


Fig 1. Subfamily wise species distribution in various protected areas of Goa

Table 2. Distribution of hoverflies in various protected areas

	Species	Subfamily	Habit
Bondla WLS			
1	<i>Eristalinus arvorum</i> (Fabricius)	Eristalinae	Saprophytic
2	<i>Eristalinus obscuritarsis</i> (deMeijere)	Eristalinae	Saprophytic
3	<i>Phytomia crassa</i> (Fabricius)	Eristalinae	Saprophytic
4	<i>Syritta orientalis</i> Macquart	Eristalinae	Saprophytic
5	<i>Pandasyopthalmus</i> cf. <i>rufocinctus</i> (Brunetti)	Syrphinae	Predatory
6	<i>Serratoparagus crenulatus</i> (Thomson)	Syrphinae	Predatory
7	<i>Serratoparagus serratus</i> (Fabricius)	Syrphinae	Predatory
8	<i>Allobaccha apicalis</i> (Loew)	Syrphinae	Predatory
9	<i>Allobaccha</i> sp1	Syrphinae	Predatory
10	<i>Episyrphus viridaureus</i> (Wiedemann)	Syrphinae	Predatory
11	<i>Ischiodon scutellaris</i> (Fabricius)	Syrphinae	Predatory
Madei WLS			
1	<i>Syritta orientalis</i> Macquart	Eristalinae	Saprophytic
2	<i>Xylota</i> sp	Eristalinae	Saproxylic
3	<i>Melanostoma orientale</i> (Wiedemann)	Syrphinae	Predatory
4	<i>Melanostoma univittatum</i> (Wiedemann)	Syrphinae	Predatory
5	<i>Serratoparagus crenulatus</i> (Thomson)	Syrphinae	Predatory
6	<i>Allobaccha amphithoe</i> Walker	Syrphinae	Predatory
7	<i>Allobaccha</i> sp1	Syrphinae	Predatory
8	<i>Asarkina incisuralis</i> (Macquart)	Syrphinae	Predatory
9	<i>Asiobaccha</i> cf. <i>nubilipennis</i> (Austen)	Syrphinae	Predatory
Cotegaon WLS			
1	<i>Phytomia crassa</i> (Fabricius)	Eristalinae	Saprophytic
2	<i>Eristalinus arvorum</i> (Fabricius)	Eristalinae	Saprophytic
3	<i>Phytomia argyrocephala</i> (Macquart)	Eristalinae	Saprophytic
4	<i>Syritta orientalis</i> Macquart	Eristalinae	Saprophytic
5	<i>Serratoparagus crenulatus</i> (Thomson)	Syrphinae	Predatory
6	<i>Asiobaccha</i> cf. <i>nubilipennis</i> (Austen)	Syrphinae	Predatory
7	<i>Dideopsis aegrota</i> (Fabricius)	Syrphinae	Predatory
8	<i>Episyrphus viridaureus</i> (Wiedemann)	Syrphinae	Predatory
Bhagwan Mahavir National Park & WLS			
1	<i>Serratoparagus crenulatus</i> (Thomson)	Syrphinae	Predatory
2	<i>Allobaccha apicalis</i> (Loew)	Syrphinae	Predatory
3	<i>Allobaccha</i> sp1	Syrphinae	Predatory

4	<i>Dideopsis aegrota</i> (Fabricius)	Syrphinae	Predatory
5	<i>Episyrphus viridaureus</i> (Wiedemann)	Syrphinae	Predatory
Netravali WLS			
1	<i>Syritta orientalis</i> Macquart <i>Dideopsis aegrota</i> (Fabricius)	Eristalinae	Saprophytic
2	<i>Serratoparagus crenulatus</i> (Thomson)	Syrphinae	Predatory
3	<i>Serratoparagus serratus</i> (Fabricius)	Syrphinae	Predatory
4	<i>Episyrphus viridaureus</i> (Wiedemann)	Syrphinae	Predatory
5	<i>Dideopsis aegrota</i> (Fabricius)	Syrphinae	Predatory

KEYS TO THE GENERA AND SPECIES OF SYRPHIDAE IN PROTECTED AREAS OF GOA

One of the key character to identify the family is the presence of a spurious vein at the wing that bisects the radio median cross vein (Fig 2.). There are about 493 species of 107 genera and 3 subfamilies of syrphids in the Indian sub-region (Ghorpade, 2014). The below furnished taxonomic key deals with common genera and species with emphasis southern Indian fauna mainly. The following Fig 2 and 3 illustrates some of the key characters that are of use in running the taxonomic key. It is to be noted that the key also includes few other species which are common to India. This has been included for easy running of the dicotonomous keys. The genus and species of Goa are highlighted in the key.

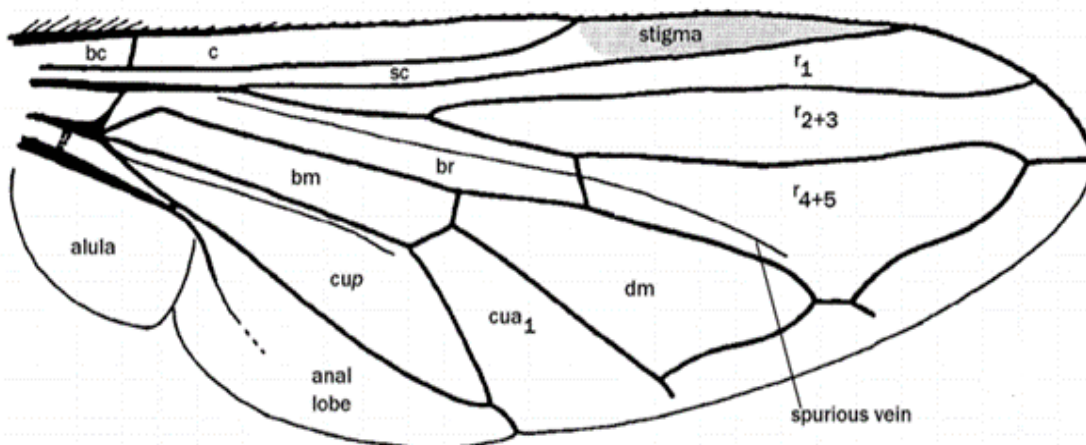


Fig. 2 Cells of wing, dorsal view. bm – Basal medial cell; bc – Basal costal cell; br – Basal radial vein; c – Costal cell; cua1 – Anterior cubital cell; cup – Posterior cubital cell; dm – Discal medial cell; r1, r2+3, r4+5 – Radial cells; sc – Subcostal cell. Figure taken from Thompson et al (2014).

Key to the subfamilies in Syrphidae

1. Postpronotum pilose 2
Postpronotum bare **Syrphinae**
2. R4+5 with spur, oral margin not notched Microdontinae
R4+5 without spur, oral margin notched **Eristalinae**

Key to the genera in the subfamily Eristalinae

1. Cell r1 open at wing margin 2
Cell r1 petiolate, closed before reaching wing margin 6
2. Arista bare 3
Arista conspicuously plumose Others
3. Marginal cell closed *Milesia* Latreille
Marginal cell open 4
4. Face not cut away below antennae, distinctly angled outer side of the first posterior cell *Eumerus* Meigen
Face more or less distinctly cut away below antennae, outer side of the 1st posterior cell not distinctly angled 5
5. Hind femora conspicuously incrassate and with row of short rigid spines below *Syritta* Lepeletier & Serville
Hind femora thickened but much less conspicuously incrassate with no spines below *Mesembrius* Rondani
6. Vein R4+5 straight or nearly so, not sinuate 7
Vein R4+5 moderately to strongly sinuate 8
7. Marginal cell closed, 4th vein strongly recurrent at tip, katepimeron pilose ... *Volucella* Geoffroy
Marginal cell open, apical portion of 4th vein strongly divergent from wing-border, body short, stout, abdomen rounded or shortly ovate *Graptomyza* Wiedemann
8. Katepimeron pilose; sclerites frequently partly pilose 9
Katepimeron, anepimeron pilose on posterior half, meron and metepisternum all bare. 10
9. Postalar tuft absent; non metallic flies . *Eoseristalis* Kanervo (Note-Common species: *arbustorum* (Lin.))
Postalar tuft present; metallic green to purple flies others
10. Eyes with dark maculae or vittae, anepimeron with triangular area ventral to wing base pilose; post alar pale tuft present 13
Eyes unicolours, anepimeron with triangular area ventral to wing base pilose; post alar pale tuft absent 11

11. Meron bare posteroventrally, without pile anterior or ventral to spiracle; eye pilose, wing bare..... *Eristalis* Latreille
(Note-Common species: *tenax* (Lin.)
Meron pilose posteroventrally with pile anterioventrally to spiracles, eyes bare, wing partly microtrichiose 12
12. Frons with strong rugose area dorsal to antennae, maleholoptic *Phytomia* Guerin-Meneville
Frons not rugose, male dichoptic others
13. Eyes faciate and punctate..... *Eristalodes* Mik.
(Note-Common species-*paria* (Bigot))
Eyes punctate *Eristalinus* Rondani

Key to the genera in the subfamily Syrphinae

1. Face having a central Knob or else arched or produced cone like and not at the upper mouth edge. only..... 2
Face flat or retreating (i.e. not arched, nor with a central knob; rarely produced at upper mouth edge); being from the prominence of the frons down to the mouth almost parallel with the eye margin 8
2. Face arched not hollowed below frontal prominence, more or less yellow
.Paragus Latreille
Face hollowed below frontal prominence produced again to central knob or to upper mouth edge or to both 4
4. Pale markings on head, thorax, scutellum or abdomen 5
Wholly dark species without pale markings other
5. Abdomen not conspicuously constricted 6
Abdomen conspicuously constricted others
6. Wholly aeneous or black face and scutellum..... 7
Face partly yellowish others
7. Front tarsi and tibia simple *Melanostoma* Schiner
Front tarsi and tibia dilated others
8. Anterior flat portion of mesopleuron with long fine hairs present..... 9
Anterior flat portion of mesopleuron with bare or microscopic pubescence .
12
9. The extreme posterior margin of wings with minute sclerotized dots and hypopleuron haired below spiracles 10
Extreme posterior margin of wings with no minute sclerotized dots 11
10. Mesonotum anteriorly without collar of longer hairs, subscutellum fringe

- well developed, abdomen non petiolate, terga 3 & 4 orange-yellow with sub-basal and apical black fasciae, Metasternum haired *Episyrphus* Matsumura Mesonotum anteriorly with a collar of longer hairs, subscutellum fringe absent/weakly developed, abdomen petiolate and club shaped, terga 3 & 4 not coloured as above, Metasternum bare *Asiobaccha* Violenovitch
11. Abdomen not petiolated, Eyes haired or bare; hypopleuron bare; posteriomedian apical angle of hind coxa with a tuft of strong hairs;.....
Parasyrphus Matsumura
Abdomen petiolate and club shaped, Eyes bare; hypopleuron haired; posteriomedian apical angle of hind coxa without tuft of strong hairs
Allobaccha Curran (in part)
 12. Mesonotum anteriorly with a distinct, complete or incomplete collar of long hairs 13
Mesonotum anteriorly without such a collar of hairs 15
 13. Dark, transverse vitta in middle which may extend to wing base, apical third of wing hyaline, Hypopleuron bare; hind coxal hair tuft present, wings with broad*Dideopsis* Matsumura
Wings entirely hyaline or differently, variable, darkened, Hypopleuron haired; hind coxal hair tuft absent 14
 14. Abdomen margined and usually broad, if narrow then tergite 2 and 3 not petiolate, humerus bare, metasternum haired, laterotegite bare, lower face produced and oral cavity elongate*Asarkina* Macquart
Abdomen distinctly petiolate and club shaped, Humerus haired posteriorly, metasternum bare, laterotegite haired, , lower face not produced *Allobaccha* Curran (in part)
 15. Entirely unmargined abdomen 16
Abdomen at least faintly margined on terga 2 to 5 18
 16. Male sternum 9 with posteroventral emargination and a distinct ligula, hind coxal hair tuft absent. Upper and lower sternopleural hair patches at least narrowly joined posteriorly; lateral mesonotal margin dark, if yellowish then the demarcation from the dark dorsum not distinct; terga 2 to 4 with yellow spots which are not rectangular in shape or terga 3 and 4 with fasciae; eyes bare or haired *Epistrophe* Walker
Male sternum 9 without posteroventral emargination or ligula, sternopleural hair patches distinctly separated posteriorly or reduced or even absent; lateral mesonotal margin bright yellow, sharply demarcated from dark dorsum; . 17
 17. Abdomen shorter than wings, large species with fairly broad abdomen;

- subscutellar fringe normal, metasternum haired, tergum 9 of male normal; not wider than abdomen, male terminalia small *Allograpta* Osten Sacken
- Abdomen (at least in male) cylindrical and elongated, longer than wing, Small, more slender species with; subscutellar fringe absent or present only laterally; metasternum haired or bare; male tergum 9 wider than abdomen, enlarged; male terminalia large, globose . *Sphaerophoria* Lepeletier & Serville
18. Metasternum haired 19
Metasternumbare 21
19. Hind coxal hair tuft absent; eyes bare or very rarely sparsely haired 20
Hind coxal hair tuft present; eye distinctly haired, though sometimes sparsely others
20. Sternopleural hair patches joined posteriorly; lateral mesonotal margin bright yellow, distinctly demarcated from darker dorsum; pleuron with bright yellow areas..... *Citrogramma* Vockeroth
Sternopleural hair patches distinctly separated posteriorly; lateral mesonotal margin dark, if yellowish then dull and not distinctly demarcated from darker dorsum; pleuron dark without any with yellow areas..... *Eupeodes* Osten Sacken
21. Hind coxal hair tuft present..... 22
Hind coxal hair tuft absent..... 23
22. Sternopleural hair patches separated posteriorly; tergum 2 with narrow yellow or grey fascia which may be interrupted in some specimens Eyes densely haired *Betasyrphus* Matsumura
Sternopleural hair patches joined posteriorly; tergum 2 with a pair of well separated yellow spots, eyes bare or very rarely haired *Syrphus* Fabricius
23. Eyes bare; antenna with segment 3 only two times as long as broad; abdomen flat and slightly convex dorsally, slightly but distinctly margined. Lateral mesonotal margin bright yellow, distinctly demarcated from dark dorsum; sternopleural hair patches separated posteriorly... *Ischiodon* Sack
Eyes usually haired, at least sparsely, if bare, then antenna porrect, segment 3 at least 3 times as long as broad, abdomen strongly convex dorsally, very strongly margined, male frons strongly swollen, eyes with distinctly large facets on upper one half, wing microtrichia greatly reduced, basal half and allula almost bare, wing vein R4+5 distinctly though very weakly dipped in to cell R4+5, terga 3 & 4 with a pair of oblique or lunate pale spots *Scaeva* (Fabricius)
(Note-Common species: *latimaculata* (Brunetti))

Keys to the common species under selected genera in the subfamily of *Eristalinae*

Key to the common species of *Syritta* Lepeletier & Serville

1. Abdominal spots in male on 2nd and 3rd segments definitely separated by a moderately wide median black stripe, hind femora with a moderately narrow complete orange ring at base; a more or less Incomplete ring or streak of varying width on under side near middle. *pipiens* (Linnaeus)
Abdominal spots in male on 2nd and 3rd segments normally united to form two complete bands, or at most the dividing black line is very narrow or incomplete, (In specimens with entirely black femora the abdominal spots are more widely separated.) Hind femora normally wholly black, but sometimes very narrowly pale at extreme tip, and occasionally just perceptibly so at extreme base; frequently with upper side practically wholly black, and basal half (or thereabouts) below brownish or orange; with or without an additional streak at middle of underside (as in *pipiens*) *orientalis* Macq.

Key to the common species for *Eristalinus* Rondani

1. Eyes stripped 2
Eyes spotted, irregularly coloured or unicolourous 3
2. Four conspicuous black stripes on yellow thorax; third abdominal segment mainly or wholly black others
Four indistinct black stripes on thorax dull yellowish-grey with, third abdominal segment with mainly yellowish *taeniops* (Wiedemann)
3. Eyes spotted with irregular dark markings 4
Eyes unicolours others
4. Black or aeneous species 5
Black and yellow species 7
5. Abdomen uniformly aeneous without spots *anenus* (Scopoli)
Abdomen with grey or whitish spots 6
6. Abdominal spots obliquely placed *obliquus* (Wiedemann)
Abdominal spots transversely placed *laetus* (Wiedemann)
7. Femora all orange or brownish orange *arvorum* (Fabricius)
Femora black; tip more or less pale 8
8. Yellowish-white tarsi (nearly to tips); abdomen comparatively shorter, more ovate-conical *quinquestriatus* (Fabricius)
Black tarsi, at most pale at base; abdomen comparatively longer and narrower, more elongate conical *obscuritarsis* (de Meijere)

Key to the common species of *Phytomia* Guerin-Meneville

1. Hind femora with a conspicuous tooth below near tip *crassus* (Fabricius)
Hind femora unarmed 2
2. Arista bare *errans* (Fabricius)
Arista very distinctly plumose on basal half 3
3. Thorax with a broad black transverse band across middle; wings brownish or yellowish about the middle and base, femora unicolorous, varying from light brown to blackish; hind pair never tawny on basal half and dark on apical half *argyrocephalus* (Macquart)
Thorax blackish, with pubescence close, black, yellowish or reddish anteriorly; wings nearly clear, a distinct blackish-brown suffusion in middle of anterior border and to some extent at base, femora wholly quite black; hind pair with short, stiff, bristly hair *zonatus* (Fabricius) ,

Key to the common species under selected genera in the subfamily of Syrphinae

Key for the common species of *Melanostoma* Schiner

1. Face in profile with two distinct small bumps *orientale* (Wiedemann)
Face in profile forming a single only, being nearly straight above and below this point *univittatum* (Wiedemann)

Key for the common species of *Paragus* Latreille

1. Scutellum with a serrate posterior margin 2
Scutellum with a smooth posterior margin others
2. First abdominal tergum nearly all black, especially behind transverse ridge, only narrowly reddish on posterior margin; wing nearly completely bare, hyaline, with only a few scattered microtrichia apically; fore femur without black markings, even at base *yerburiensis* Stuckenberg
First abdominal tergum extensively reddish medially, not black (partially in some specimens) behind transverse ridge; fore femur variably black or not at all 3
3. Forefemur wholly brownish yellow and white, with no black markings; hind tibia with very little or no dark brown, Large species, antenna longer than face *auritus* Stuckenberg
Forefemur at least basally brownish black or black; hind tibia with dark brown subapical annulus Smaller species antenna as long as face 4
4. Hind femur yellow, with narrow dark Brownish annulus Wing hyaline, never suffused with yellowish brown; mesonotal pile short; abdomen with black hairs sparse and very inconspicuous *serratus* (Fabricius)

Hind femur almost entirely dark brown Wing suffuse yellowish brown at least in costal cells; mesonotal pile long; abdomen with many conspicuous, reclinate black hairs *crenulatus* Thomson

Key to the common species of *Episyrphus* Matsumura

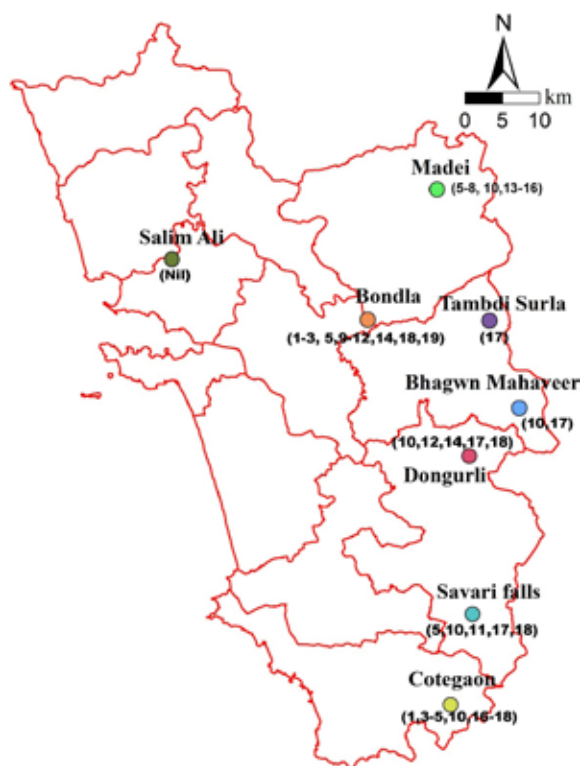
1. Sterna each with a black spot in center, or immaculate... *balteatus* (De Geer)
Sterna 2 & 3, at least, with complete or incomplete black subposterior fasciae..... *viridaureus* (Wiedemann)

Key to the common species of *Allobaccha* Curran

1. Scutellum black; pleurotergite haired; pleuron black at most with posterior mesopleuron yellow; prescutum, between yellow humerus and notopleural callus black2
Scutellum at least partly yellow; pleurotergite bare; pleuron with yellow markings also on sternopleuron and pleurotergite; humerus, notopleural callus and lateral prescutum between them yellow others
2. Face with at least lateral areas partly yellow, humerus haired;; anterior mesopleuron bare; posterior mesopleuron at least partly yellow pollinose; alula medium in size with posterior margin straight.....3
Face black and at most sparsely white pollinose on lateral areas, humerus bare; anterior mesopleuron haired; pleuron entirely black; alula large with posterior margin weakly rounded, not straight *saphirina* (Wiedemann)
3. Wings with apical dark spot wider than marginal cell; female frons with pale pollinose spots subtriangular, shorter, placed at some distance away from the anterior ocellus, male with pale hairs on frontal triangle long, longer than black hairs on lunular callus; yellow markings on posterior mesopleuron and notopleuron dull yellow, not contrasting sharply with black areas of pleuron and mesonotum (sternopleuron black, at most with some short white hairs on upper margin)dull yellow of notopleuron rarely extending above on prescutum *apicalis* (Loew)
Wings with apical dark spot narrower than marginal cell, appearing as an extension of stigma; female frons with pale pollinose spots distinctly elongate, almost reaching anterior ocellus: male with pale hairs on frontal triangle shorter, at most as long as black hairs on lunularcallus; yellow markings on posterior mesopleuron and notopleuron contrasting sharply with black areas of pleuron and mesonotum (upper sternopleuron usually also bright yellow); bright yellow of notopleuron extending distinctly above on prescutumothers

* Note: Numbers 1-19 represented in the map denotes the corresponding species furnished in table 1

Fig 4. Distribution map of Hoverflies of Protected Areas of Goa*



HABITAT STUDIES

The habitats/locations which harboured good syrphid population due to its unique ecological characters are listed below

Bondla WLS: Habitat to be focused for conserving syrphid diversity: Marshes with luxuriant *Pandanus* growth near the Crocodile Lake.

The pandanus growth in the marshes supported many saprophytic species like *Eristalinus arvorum* (Fabricius), *Eristalinus obscuritarsis* (deMeijere), *Phytomia crassa* (Fabricius), *Phytomia argyrocephala* (Macquart) and *Syritta orientalis* Macquart. Predatory syrphids like *Pandasyopthalmus* cf. *rufocinctus* (Brunetti), *Serratoparagus crenulatus* (Thomson), *Serratoparagus serratus* (Fabricius) and *Allobaccha apicalis* (Loew). Further the thick pandanus vegetation acted as a protective enclosure for the syrphids from predation by many insectivorous birds and disturbances by movement of big mammals.



Cotegao WLS : Riverine with luxuriant growth of Willow-leaved water croton (*Homonoia riparia*) near to the Astragal Gate.

This vegetaion provided good canopy hideouts and nectar for many predatory syrphids. The water source also supported saprophytic species like the *Eristalinus arvorum* (Fabricius), *Phytomia crassa* (Fabricius), *Phytomia argyrocephala* (Macquart) and *Syritta orientalis* Macquart.



Madei WLS: Wet rivernine patch with climbers and rotting wood and dense canopy and under growt at the start of the path which lead to the Chidamber falls and Bat cave.

Tha habita was densely vegetated and moist with lots of climbers which grow over the stream. The rotting wood and branches supported abundant population of saproxylic species *Xylota* which is otherwise uncommon. This small patch harboured many interesting species like



Allobaccha amphithoe Walker, *Asarkina incisuralis* (Macquart) and *Xylota* sp which was only recorded from the spot in the entire study. Further it is to be noted the location is on the periphery and shares border with private agricultural land and hence needs specially attention to prevent any kind of encroachment or disturbance.

Bhagwan Mahavir WLS: Semi evergreen patch with reiverine vegetation and with raised natural levee of streams at Dongurli, about 3Km from Kaelm Round Forest Office.

The habitat remains wet even during month of March when other nearby habitats remain dry. Further the raised natural levee of streams which are moist often act as a microhabitat for many syrphids especially the species in the genus *Allobaccha*. There had also been a abundant aphid population in vegetation on the deltaic formations of the streams which supported good number of predatory hoverflies like *Serratoparagus crenulatus* (Thomson), *Allobaccha apicalis* (Loew), *Episyrphus viridaureus* (Wiedemann) and *Dideopsis aegrota* (Fabricius).



Species diagnosis

1. *Eristalinus arvorum* (Fabricius)

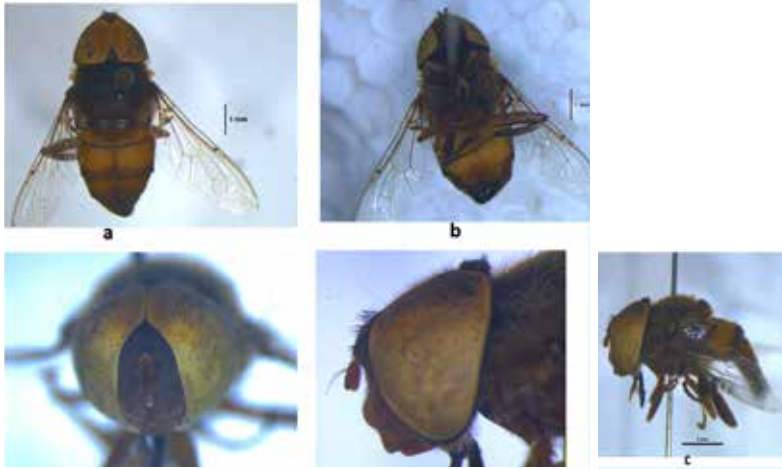


Fig 1. *Eristalinus arvorum* (Fabricius) a.habitus, b. ventral, c. lateral. d. face, e. facial profile

Diagnosis: Arista bare, eyes never striped; either spotted, irregularly marked or unicolorous, eyes spotted, or with irregular dark markings, eyes in male contiguous (presumably so in tabanoides, in which male is unknown). Black and yellow species. Second, 3rd and 4th segments never all orange, the markings never rectangular; arcuate whitish bands normally present, femora normally all orange or brownish orange.

2. *Phytomia argyrocephala* (Macquart)

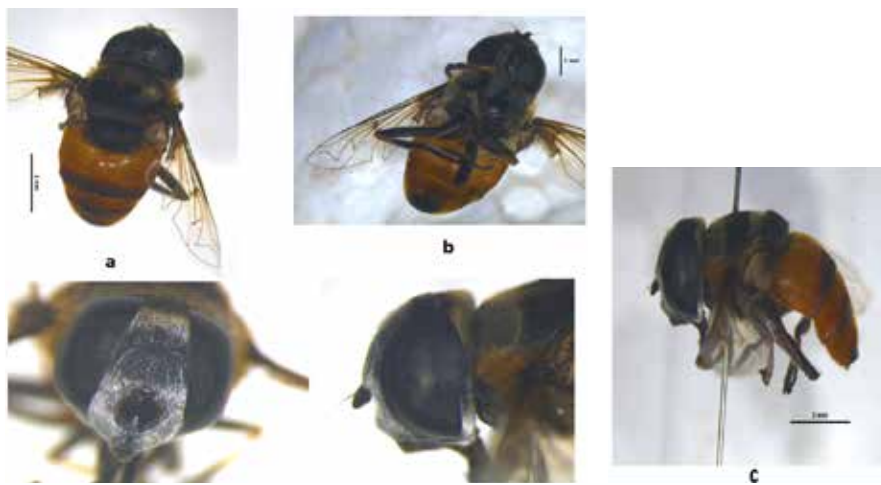


Fig.2 *Phytomia argyrocephala* (Macquart) a.habitus, b. ventral, c. lateral. d. face, e. facial profile

Diagnosis: Hind femora unarmed. Arista very distinctly plumose on basal half. Basal half of wing not black, normally at most only (with central and anterior part also more or less) a little tawny-brown. Femora unicolorous, varying from light brownish to blackish; hind pair never tawny on basal half and dark on apical half; Thorax with a broad black transverse band across middle; wings brownish or yellowish about the middle and base

3. *Syritta orientalis* Macquart



Fig.3 *Syritta orientalis* (Macquart) a.habitus, b. ventral, c. lateral. d. face, e. facial profile

Diagnosis: Variable species especially regards colour of hind femur and tergum. Well sclerotised spurious vein present, and cone-shaped subbasal spina on the posteroventral surface of hind femur, spina minute in female, only one long white seta basally of the row of black posteroventral setae before apex. Male has tergum 4 in dorsal view about as wide as tergum 3, with greatest width about 1/3 on the posteroventral of tergal length from posterior margins; side margins from this point and to posterior margin slightly concave; colour violet-black with yellow-brown strip of integument posteriorly, and anterolateral areas of tomentum on the posteroventral very restricted in size.

4. *Serratoparagus crenulatus* (Thomson)



Fig.4 *Serratoparagus crenulatus* (Thomson) a. habitus, b. ventral, c. lateral. d. face, e. facial profile

Diagnosis: Scutellum yellow apically and with a serrate posterior margin; eye with alternating fasciae of thick opaque white and thin translucent pale pile. First abdominal tergum extensively reddish medially, not black (partially in some specimens) behind transverse ridge; fore femur variably black or not at all. Wing suffuse yellowish brown at least in costal cells; hind femur almost entirely dark brown; mesonotal pile long; abdomen with many conspicuous, reclinate black hairs

5. *Dideopsis aegrota* (Fabricius)



Fig.5 *Dideopsis aegrota* (Fabricius) a.habitus, b. ventral, c. lateral. d. face, e. facial profile

Diagnosis: Moderately sized. Hypopleuron bare; hind coxal hair tuft present; wing with broad, dark, transverse vitta in middle which may extend toward wing base, apical third of wing hyaline

6. *Episyrphus viridaureus* (Wiedemann)



Fig.6 *Episyrphus viridaureus* (Wiedemann) a.habitus, b. ventral, c. lateral. d. face, e. facial profile

Diagnosis: Metasternum haired: mesonotum anteriorly without collar of longer hairs: subscutellar fringe well developed. Abdomen not petiolate, terga 3 & 4 orange-yellow with sub-basal and apical black fasciae. Anterior mesonotal collar of hairs absent; terga 2 & 4 without black median vitta; frons only with two black spots above antennae. Sterna 2 & 3, at least, with complete or incomplete black subposterior fasciae

7. *Ischiodon scutellaris* (Fabricius)



Fig.7 *Ischiodon scutellaris* (Fabricius) a.habitus, b. ventral, c. lateral. d. face, e. facial profile

Diagnosis: Black and yellowish coloration. Legs yellowish brown. Lateral mesonotal margin bright yellow, distinctly demarcated from dark dorsum; sternopleural hair patches separated posteriorly

8. *Melanostoma orientale* (Wiedemann)

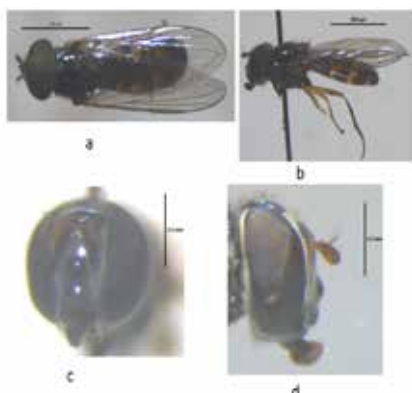


Fig.8 *Melanostoma orientale* (Wiedemann) a. habitus, b. lateral, c. face, d. facial profile

Diagnosis: Small species with blackish brown shining abdomen with yellow lateral spots on the terminal tergites. Distinguished from the closely resembling species by two distinct facial bump in profile.

SUMMARY

A total of 19 species of hoverflies in 14 genera in 5 tribes and 2 subfamilies have been reported from periodic surveys and collection done in various protected areas of Goa from March 2023 to March 2024. Out of the 19 species of hoverflies reported here, 17 species and 12 genus are new record for Goa. Out of the 19 species recorded 13 are predatory 5 are saprophytic and one is saproxylic in larval feeding behaviour.

Maximum number of species (11) was recorded from Bondla WLS, followed by Madei WLS (9). Diverse habitat viz. Marshes with luxuriant *Pandanus* growth, lake ecosystem, riverine ecosystem and garden land with ornamental flowers was the main reason for such higher number of syrphid in Bondla. The Wet riverine patch with climbers and rotting wood and dense canopy and under growth occurring in Madhehi also supported good syrphid species. This habitat in Madei WLS was the only habitat where a saproxylic species (*Xylota*) was recorded. Madhehi WLS had the maximum number (5) of unique species recorded from a single location. I.e. *Asarkina incisuralis* (Macquart), *Allobaccha amphithoe* Walker, *Melanostoma orientale* (Wiedemann), *Melanostoma univittatum* (Wiedemann) & *Xylota* sp were recorded only from Madhehi WLS. *Serratoparagus crenulatus* (Thomson) was the most common species which was recorded from all the protected areas followed by *Sritta orientalis* Macquart and *Episyrphus viridaureus* (Wiedemann).

The habitat study revealed that the following habitats with ample hoverfly diversity needs to be focused for conservation: Marshes with luxuriant *Pandanus* growth at Crocodile Lake in Bondla WLS, wet riverine patch with climbers and rotting wood and dense canopy and under growth at the start of the path which lead to the Chidamber falls and Bat cave in Madei WLS, riverine with luxuriant growth of Willow-leaved water croton (*Homonoia riparia*) near to the Astragal gate, Cotegaon WLS and Semi evergreen patch with riverine vegetation and with raised natural levee of streams at Dongurli, Bhagwan Mahvir WLS.

This study had brought to light the hitherto less known syrphid diversity of Goa; by raising the number of species reported from Goa, from the previously known two species to now 19 species. The species list, distribution map and taxonomic keys presented here will be of much use for further detailed explorations in Goa.

Hoverflies of Protected Areas of Goa (Pictorial Guide)



1. *Eristalinus arvorum*



2. *Eristalinus obscuritarsis*



3. *Phytomyia crassa*



4. *Phytomyia argyrocephala*



5. *Syrirta orientalis*



6. *Xylota* sp



7. *Melanostoma orientale*



8. *Melanostoma univittatum*



9. *Pandasyopthalmus* cf. *rufocinctus*



10. *Serratoparagus crenulatus*



11. *Serratoparagus serratus*



12. *Allobaccha apicalis*



13. *Allobaccha amphithoe*



14. *Allobaccha sp1*



15. *Asarkina incisuralis*



16. *Asiobaccha cf. nubilipennis*



17. *Dideopsis aegrota*



18. *Episyphus viridaureus*



19. *schiodon scutellaris*

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