International Journal of Entomology Research
ISSN: 2455-4758
Impact Factor: RJIF 5.24
www.entomologyjournals.com
Volume 3; Issue 2; March 2018; Page No. 57-64

Diversity of praying mantids from Tilari forest, Chandgad, Kolhapur district of Maharashtra India

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Abstract
We present the first survey and diversity of praying mantis (Mantodea) from the Tilari forest and surrounding villages and provide the some natural images. Based on surveys and collection of praying mantis, results of 21 species were collected from four different targeting localities in Tilari forest, Chandgad. Of these 21 adult species of praying mantids, 8 species from major forest region, 6 species from Green Valley Park, 5 species from Swapnwel Point and 2 species from surrounding villages were obtained. The present data on collecting specimens and species diversity is very valuable information regarding Mantodea for Kolhapur district. The present research paper reveals that the study area is a rich diversity of order Mantodea, because there is a variety of insect species as a food of carnivorous insects and appropriate environmental conditions.

Keywords: diversity, mantodea, insect, carnivorous, Tilari

Introduction
Tilari forest is a part of Chandgad Tehsil. It is the one of rich vegetation, places in this Tehsil and covered by hilly region. This area is included in Western Ghats which is one of the well-known biodiversity hot spots in the world. The knowledge of insect diversity of Chandgad Tehsil is vaguely developed. Recently, some authors have published, their articles on different orders of insects namely, Nikam and More 2016 [1, 2], More and Nikam, 2016 [3, 4], More *et al.*, 2017 [5, 6, 7, 8, 9], Salunke and More, 2017 [10], Waghmare and Gaikwad, 2017[11] etc. Praying Mantids belong to order mantodea. They are predatory insects which are actively feeding on a variety of small insects such as other mantids. They are widely used among all insects for the keeping pests and they eat whatever they catch including both harmful and beneficial insects. A majority of species was found in tropical and semitropical habitat, but few in colder region. They are included in hemimetabolous insects and their life cycle completes in three stages viz. egg (ootheca), nymph and adult. The nymphal stage of mantid resembles to that adult, but there is only change in size, shape and color. They have a sedentary ambush style in habitat and lead cryptic life, often resorting to various forms of mimicry and mimesis. Because of this cryptic lifestyle they are difficult to collect and observe in the field. They are strictly predator by nature and feed on different types of insects, consisting of mantids and even small vertebrates Prete *et al*., (1999) [12]. There are about 2300 described species of praying mantids that belong to 434 genera which are distributed worldwide Ehrman, (2002) [13]. A total of 162 species of mantids under 68 genera and 6 families in India Mukherjee *et al*., (1995) [14], 52 species of praying mantids are found in Maharashtra Ghate and Ranade, (2002) [15]. Review of literature designates that a very compact information is available on state wise mantid fauna of India. Earlier some workers like Nadkerny (1965, 1974) [16, 17], Mukherjee and Hazra, (1983, 1985, and 1995) [18, 19, 20], Chaturvedi and Hegde (2000) [21], Ghate *et al.*, (2000 and 2001) [22, 23], Ghate and Ranade., (2002) [24], Sureshan *et al*., (2004) [25], Jadhav *et al*., (2006) [26] worked on mantids. The aim of this study is the understanding the diversity of praying mantids from the Tilari forest.

Materials and Methods
Praying mantids were collected from Tilari forest Chandgad, Maharashtra during the year 2015 to 2017. They were collected with the help of insect net and hand picking method in the morning and evening time. The photographs of collected specimens were taken by Canon PC 1560 Camera (Photo plate 1-8 and Images 1-67). Identification of those species was done by Mukherjee *et al*., (1995) [14], and standard research paper published by Ehrmann *et al*., (2015) [27].

3. Study Region
Tilari forest is one of the famous habitats for wild animals and tourism in Maharashtra, especially for the insects. The study area is covered with dense lush green, semi evergreen and mixed forest. It lies between (latitude 15° 45' to 16°3'N and longitude 74°1' to 74°27'E) and is situated 762 m above sea level. This forest area in Chandgad Tehsil receives more rainfall and here average rainfall is between 3000 to 4000mm/year. The rains appear moderate in September, with the irregular rainfall in October and November. The climate of this area is a very cool in the winter season, which is unbelievable like Mahabaleshwar. There is a very famous tourist spot named "Kille Pargad" and Swapnwel point near the Tilari forest area.

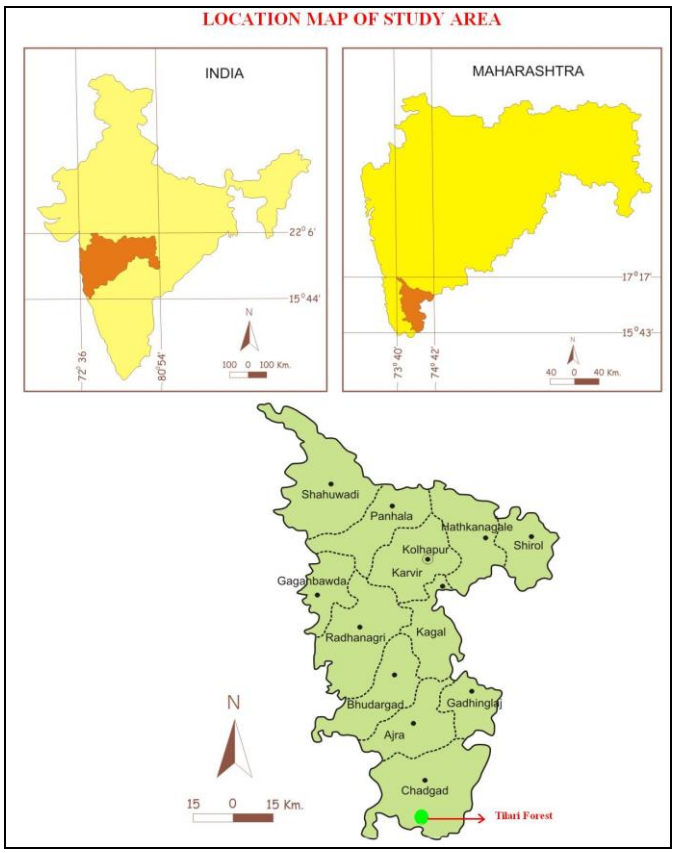


Fig 1: Location map of Tilar forest in Chandgad Tehsil, Kolhapur

4. Results

Four different localities wise species distribution in the Tilari forest and surrounding villages.

Major forest area

Major forest area is the very dense and full of mixed vegetation as compared to other parts of forest vegetation. Most of the species are collected from this study site.This area is represented by 8 species which are as follows, *Hierodula tenuidentata* Saussure, *Statilia nemoralis* Saussure, *Ambivia popa* Stal, *Mantis religiosa religiosa* Linne, *Creobroter apicalis* Saussure, *Aethalochroa ashmoliana* Westwood, *Deiphobella laticeps* Wood-Mason, and *Deiphobe infuscata* Saussure etc.

Green Valley

The green valley consists mostly of cultivated plants and short grasses. 6 species were obtained from this area, namely *Statilia maculata* Thunberg, *Hierodula unimaculata* Olivier, Tropidomantis (Eomantis) guttatipennis Stal, *Schizocephala bicornis* Linne, *Didymocorypha lanceolata* Fabricius, and *Humbertiella sp* etc.

Swapnavel Point

It is private property located 5 km away from Tlilar Nagar and its surrounding area is marked by very rich vegetation and covered with hilly region. This place yielded 5 species, namely, *Tenodera fasciata* Olivier, *Ephestiasula pictipes* Wood-Mason, *Gongylus gongylodes* Linne, *Acromantis sp*, and *Humbertiella sp* etc.

Surrounding villages

During the study period, we are covering two villages namely Kodali and Badraiwada located near the study area. These two villages yielded 2 species which are collected from the light source and grassland ecosystem namely *Humbertiella sp*, and *Amorphoscelis sp.*

Checklist of praying mantids from Tilari forest, Chandgad

Order: Mantodea
Family: Mantidae Latreille, 1802
Subfamily: Hierodulinae Br. de Wattenwyl, 1893
4.1. Genus: *Hierodula* Burmeister, 1838
4.1. 1 *Hierodula tenuidentata* Saussure, 1869 (Plate 1. Image 1 -5)
4.1.2 *Hierodula unimaculata* Olivier, 1792 (Plate 8. Image 67)
4.1.3 *Hierodula sp.* (Plate 1. Image 6 -8)
Subfamily: Solygiinae Giglio-Tos, 1919
4.2 Genus: *Deiphobe* Stal, 1877
4.1.4 *Deiphobe infuscata* Saussure, 1870 (Plate 2. Image 9 -12)
Subfamily: Mantinae Latreille, 1802
4.3 Genus: *Statilia* Stal, 1877
4.1.5 *Statilia maculata* Thunberg, 1784 (Plate 2. Image 13 -16)
4.1.6 *Statilia nemoralis* Saussure, 1870 (Plate 2 and 3. Image 17-20)
4.4 Genus: *Mantis* Linne, 1758
4.1.7 *Mantis religiosa religiosa* Linne, 1758 (Plate 6 and 7. Image 50-53)
4.5 Genus: *Deiphobella* Giglio-Tos, 1916
4.1.8 *Deiphobella laticeps* Wood-Mason, 1876 (Plate 8. Image 62 -66)
4.6 Genus: *Tenodera* Burmeister, 1838
4.1.9 *Tenodera fasciata* Olivier, 1792 (Plate 7. Image 55 -58)
Subfamily: Angelinae Beier, 1935
4.7 Genus: *Ambivia* Stal, 1877
4.1.10 *Ambivia popa* Stal, 1877 (Plate 4. Image 30 -32)
Subfamily: Schizocephalinae Saussure, 1869
4.8 Genus:*Schizocephala* Audinet-Serville, 1831
4.1.11 *Schizocephala bicornis* Linnaeus, 1758 (Plate 7. Image 54)
Family: Hymenopodidae Giglio-Tos, 1915
Subfamily: Acromantinae Br. de Wattenwyl, 1893
4.9 Genus: *Acromantis* Saussure, 1870
4.1.12 *Acromantis sp.* (Plate 3 and 4. Image 26 -28)
4.10 Genus: *Ephestiasula* Giglio-Tos, 1915
4.1.13 *Ephestiasula pictipes* Wood-Mason, 1879 (Plate 6. Image 45 -48)
Subfamily: Hymenopodinae Giglio-Tos, 1915
4.11 Genus: *Creobroter* Audinet-Serville, 1839
4.1.14 *Creobroter apicalis* Saussure, 1869 (Plate 4 and 5. Image 35 -42)
Family: Liturgusidae Giglio-Tos, 1915
Subfamily: Liturgusinae Giglio-Tos, 1915
4.12 Genus: *Humbertiella* Saussure, 1869
4.1.15 *Humbertiella sp.* (Plate 3. Image 21-22)
4.1.16 *Humbertiella sp.* (Plate 3. Image 23-25)
Family: Toxoderidae Saussure, 1869
Subfamily: Toxoderinae Saussure, 1869
4.13 Genus: *Aethalochroa* Wood-Mason, 1877

4.1.17 *Aethalochroa ashmoliana* Westwood, 1841(Plate 4. Image 29)

Family: Amorphoscelidae Stal, 1877

Subfamily: Amorphoscelinae Stal, 1877

4. 14 Genus: *Amorphoscelis* Stal, 1871

4.1.18 *Amorphoscelis sp.* (Plate 4. Image 33-34)

Family: Tarachodidae Giglio-Tos, 1917

Subfamily: Iridinae Westwood, 1889

4. 15 Genus: *Didymocorypha* Wood-Mason, 1877

4.1.19 *Didymocorypha lanceolata* Fabricius, 1798 (Plate 5. Image 43-44)

Family: Empusidae Burmeister, 1838

Subfamily:Empusinae Burmeister, 1838

4.16 Genus: *Gongylus* Thunberg, 1815

4.1.20 *Gongylus gongylodes* Linne, 1758 (Plate 6. Image 49)

Family: Iridopterygidae Giglio-Tos, 1919

Subfamily: Tropidomantinae Giglio-Tos, 1915

4.17 Genus: *Tropidomantis* Stal, 1877

4.1.21 *Tropidomantis (Eomantis) guttatipennis* Stal, 1877 (Plate 7 and 8. Image 59-61)

Images 1-8. 1 -5. *Hierodula tenuidentata;* 6 - 8. *Hierodula sp.*

Plate:2

Images 9-17. 9 -12. *Deiphobe infuscata ;* 13 - 16. *Statilia maculata ; 17- Statilia nemoralis*

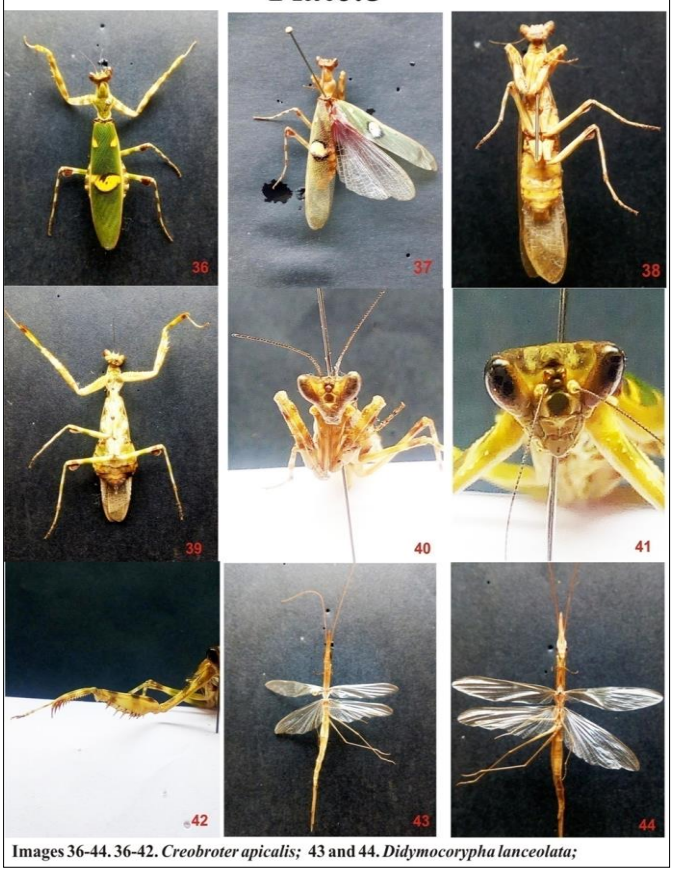
Plate:4

Images 27-35. 27 and 28- *Acromantis sp;* 29. *Aethalochroa ashmoliana; 30-32. Ambivia popa; 33 and 34- Amorphoscelis sp; 35-Creobroter apicalis*

Plate:3

Images 18-26. 18-20. *Statilia nemoralis;* 21 - 22. *Humbertiella sp; 23-25. Humbertiella sp; 26- Acromantis sp.*

Plate:5



Images 36-44. 36-42. *Creobroter apicalis;* 43 and 44. *Didymocorypha lanceolata;*

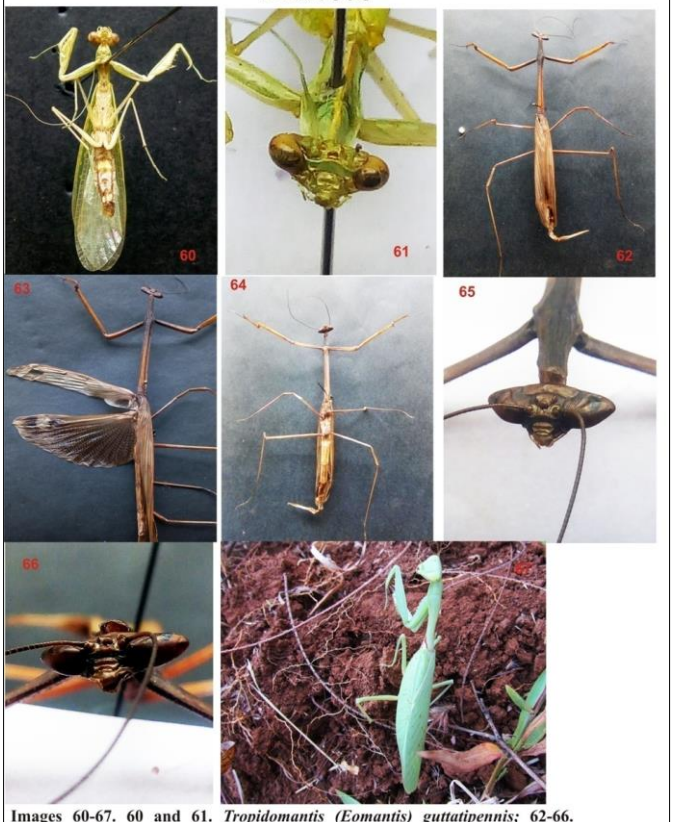
Plate:6

Images 45-51. 45-48. ***Ephestiasula pictipes;*** **49.** ***Gongylus gongylodes;*** **50 and 51.** ***Mantis religiosa religiosa***

Plate:7

Images 52-59. 52-53. ***Mantis religiosa religiosa;*** **54.** ***Schizocephala bicornis;*** **55-58.** ***Tenodera fasciata;*** **59.** ***Tropidomantis (Eomantis) guttatipennis***

Plate:8



Images 60-67. 60 and 61. ***Tropidomantis (Eomantis) guttatipennis;*** **62-66.** ***Deiphobella laticeps ;*** **67.** ***Hierodula unimaculata***

Table 1: Scientific checklist (Taxonomic groups up to families) from Tilari forest, Chandgad

Genus	Taxon	Family	Subfamily
Hierodula Burmeister, 1838	(3)	Mantidae Latreille, 1802	Hierodulinae Br. de Wattenwyl, 1893
Deiphobe Stal, 1877	(1)	Mantidae Latreille, 1802	Solygiinae Giglio-Tos, 1919
Statilia Stal, 1877	(2)	Mantidae Latreille, 1802	Mantinae Latreille, 1802
Humbertiella Saussure, 1869	(2)	Liturgusidae Giglio-Tos, 1915	Liturgusinae Giglio-Tos, 1915
Acromantis Saussure, 1870	(1)	Hymenopodidae Giglio-Tos, 1915	Acromantinae Br. de Wattenwyl, 1893
Aethalochroa Wood-Mason, 1877	(1)	Toxoderidae Saussure, 1869	Toxoderinae Saussure, 1869
Ambivia Stal, 1877	(1)	Mantidae Latreille, 1802	Angelinae Beier, 1935
Amorphoscelis Stal, 1871	(1)	Amorphoscelidae Stal, 1877	Amorphoscelinae Stal, 1877
Creobroter Audinet-Serville, 1839	(1)	Hymenopodidae Giglio-Tos, 1915	Hymenopodinae Giglio-Tos, 1915
Didymocorypha Wood-Mason, 1877	(1)	Tarachodidae Giglio-Tos, 1917	Iridinae Westwood, 1889
Ephestiasula Giglio-Tos, 1915	(1)	Hymenopodidae Giglio-Tos, 1915	Acromantinae Br. de Wattenwyl, 1893
Gongylus Thunberg, 1815	(1)	Empusidae Burmeister, 1838	Empusinae Burmeister, 1838
Mantis Linne, 1758	(1)	Mantidae Latreille, 1802	Mantinae Latreille, 1802
Schizocephala Audinet-Serv, 1831	(1)	Mantidae Latreille, 1802	Schizocephalinae Saussure, 1869
Tenodera Burmeister, 1838	(1)	Mantidae Latreille, 1802	Mantinae Latreille, 1802
Tropidomantis Stal, 1877	(1)	Iridopterygidae Giglio-Tos, 1919	Tropidomantinae Giglio-Tos, 1915
Deiphobella Giglio-Tos, 1916	(1)	Mantidae Latreille, 1802	Mantinae Latreille, 1802
17	21	08	13

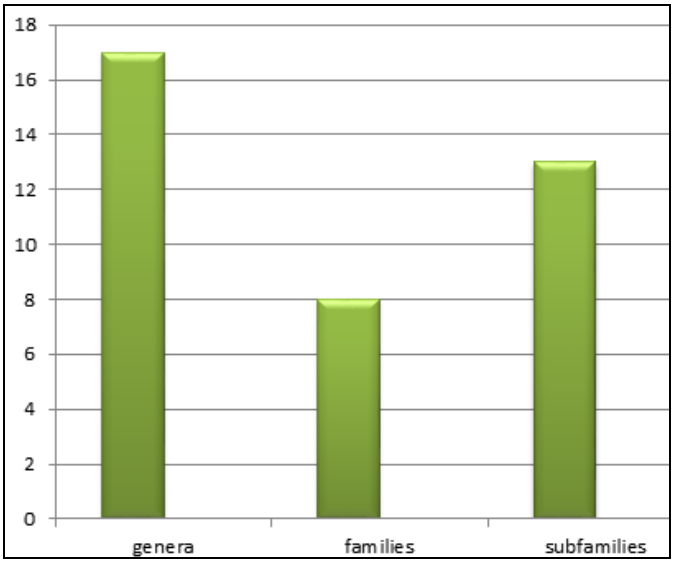


Fig 2: Checklist (distribution of taxonomic group up to families) from Tilari forest, Chandgad

5. Discussion

A total of 21 species of praying mantis which belong to 13 subfamilies of 8 families, and 17 genera were identified from different localities from Tilari forest and its surrounding villages (Table No. 1). We found 11 species of mantids which belong to family mantidae. The present investigation shows that the family mantidae is dominant and it represents 11 species which are namely *Hierodula tenuidentata* Saussure, *Hierodula unimaculata* Olivier, *Hierodula sp*, *Deiphobe infuscata* Saussure, *Statilia maculata* Thunberg, *Statilia nemoralis* Saussure, *Mantis religiosa religiosa* Linne, *Deiphobella laticeps* Wood-Mason, *Tenodera fasciata* Olivier, *Ambivia popa* Stal and *Schizocephala bicornis* Linnaeus etc. Of these, we have observed that, most of the species of this group were very common and they include following species like *Deiphobe infuscata* Saussure, *Statilia maculata* Thunberg, *Tenodera fasciata* Olivier, *Hierodula tenuidentata* Saussure, *Hierodula tenuidentata* Saussure, *Mantis religiosa* Linne, *Schizocephala bicornis* Linnaeus and *Hierodula sp*. It is noteworthy in this connection that the species *Statilia nemoralis* Saussure, *Ambivia popa* Stal and *Deiphobella laticeps* Wood-Mason are very uncommon in the study area. The above mentioned majority of all species were collected from different light sources in the study sites. The 3 species such as, *Creobroter apicalis* Saussure, *Ephestiasula pictipes* Wood-Mason and *Acromantis sp* belong to family Hymenopodidae. It is the second largest family among all families. The above mentioned 3 species of family Hymenopodidae were not common and they were obtained from light sources. During our complete study period, we observed the single species *Aethalochroa ashmoliana* Westwood is a very rare one in the study area which belong to family Toxoderidae and it was collected from the light source. The remaining species mentioned in the above checklist which are collected from different light sources from four different localities in the study area are very common.

In the previous and present century, most of the publications focusing on the diversity of praying mantids of Maharashtra and India have been published. The number of entomologist is continuously involved in their research on the order mantodea from Maharashtra state and other states of India are as follows:

Mukherjee *et al.*, (1995) [14] reported 17 species of parying mantids belongs to14 genera from Maharashtra. Chaturvedi and Hegde (2000) [21] reported 11 species of mantids from the Sanjay Gandhi National park, Mumbai, Maharashtra. Ghate and Ranade (2002) [24] recorded 29 species of mantids from Pune (Western Ghats) out of these 29 species, 12 species of mantids first recorded for Maharashtra. Sureshan *et al.*, (2004) [25] studied on mantid diversity from Pench National Park, Maharashtra and reported 9 species. Rao *et al.*, (2005) [28] have been recorded 26 species of mantids belonging to 23 genera from Andhra Pradesh. Jadhav *et al.*, (2006) [26] have been reported 5 species of mantids from Pench National Park. Vyjayandi (2007) [29] recorded 66 species of mantids from various geographical regions of Kerala. Sureshan (2009) [30] recorded 27 species belonging to 18 genera, 10 subfamilies

and 4 families from Orissa. Sureshan and Sambath (2009) [31] studied on the mantid fauna of Old Bihar and reported 25 species belonging to 21 genera, 16 subfamilies and 8 families. Koli *et al.*, (2011) [32] studied on the mantid fauna of the Chandoli National Park and reported 11 species belonging to 11 genera, 7 subfamilies and 3 families. Raut and Gaikwad (2017) [33] reported a *Tenodera fasciata* from western India. Recently, Mukherjee *et al.*, (2017) [34] have been reported 23 new records of mantodea from some states of India.

6. Summary

The present study indicates that a total of 21 species of praying mantids belonging to 17 genera, 13 subfamilies and 8 families were obtained in Tilari forest, area of Chandgad Tehsil. The following species namely, *Hierodula tenuidentata* Saussure, *Hierodula unimaculata* Olivier, *Deiphobe infuscata* Saussure, *Statilia maculata* Thunberg, *Schizocephala bicornis* Linnaeus, *Ephestiasula pictipes* Wood-Mason, *Creobroter apicalis* Saussure, *Humbertiella sp, Amorphoscelis sp, Didymocorypha lanceolata* Fabricius, *Gongylus gongylodes* Linne and *Tropidomantis (Eomantis) guttatipennis* Stal, *etc.* were obtained generally while others like *Statilia nemoralis* Saussure, *Mantis religiosa religiosa* Linne, *Deiphobella laticeps* Wood-Mason, *Ambivia popa* Stal, 1877, *Acromantis sp* and *Aethalochroa ashmoliana* Westwood etc.were uncommon and 3 species such as *Deiphobella laticeps* Wood-Mason, *Ambivia popa* Stal, 1877 and *Aethalochroa ashmoliana* Westwood are unique and rare in the Tilari forest. The species *Hierodula sp.* (Plate 1. Image 6-8) seems doubtful as its verification needs strongly.

7. Conclusion

During the collection period (2015 to 2017), the diversity of mantids in the study area is rich because of the rich diversity of insects as food sources of the predator insects (mantodea). The overall current study indicates that the majority of species was collected during the monsoon and winter season with different light sources. The present study provides new location of 21 species of mantids in Kolhapur district. The present information about praying mantids from Tilari forest, Chandgad may be useful because the mantid fauna of Maharashtra state are fairly well developed. There is a little knowledge about the diversity of a praying mantis available in other regions of Maharashtra state as compared to Western Maharashtra, so present publication provides important information about this group from the Tilari forest. Nonetheless, deep study of this order is very necessary to identify the population of praying mantids in Chandgad Tehsil as well as Kolapur district.

8. Acknowledgement

The authors are grateful to Dr. Phil Bragg expert on mantids from Derbyshire for his support and expert opinion. We are also thankful to Dr. H. V. Ghate, Modern College, Pune for identification and valuable suggestion and also thankful to the authorities of R. B. Madkholkar College, Chandgad for facilities.

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