# Chapter 3

## AN OVERVIEW OF INSECT DIVERSITY OF WESTERN GHATS WITH SPECIAL REFERENCE TO KERALA STATE

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## Introduction

India, with its diversified ecosystems ranging from the snow-clad boreal forests in the Himalayas and tropical evergreen forests along the Western and Eastern Ghats, to the dry deserts of Rajasthan is considered to be one of the mega diversity countries. Of the various ecosystems, the Eastern Himalayas and the Western Ghats are known to harbour rich biodiversity. The latter is acclaimed as one of the 25 biodiversity 'hot-spots' of the world and thus occupies a critical position in the global biodiversity scene (Myers *et al.*, 2000).

The Western Ghats mountain range comprises of a series of hills running almost parallel to the west coast of Indian subcontinent from Tapti river in southeastern Gujarat to Kanyakumari in south Tamil Nadu. The 'ghats' descend steeply to the coastal plains on the west but merge rather gently through a series of hills in the Deccan plateau in the east. The western slopes receive rainfall of about 2000 mm per year and support luxuriant evergreen forests while the eastern slopes, which come under the rain shadow area harbour moist and dry deciduous types of vegetation. The area covers 1,59,000 km$^2$ with elevation ranging from sea level to 2,695 m.

Kerala State, located between 8$^0$4$'$ and 12$^0$48$'$N and 74$^0$52$'$ and 77$^0$37$'$E is known for its rich biological resources on account of availability of a variety of ecological niches and habitats ranging from high forests, valleys, plains and coastal areas. Geographically, the State can be broadly divided into three zones *viz*., highland (area lying above 75 m ASL), midland (area lying between 75 to 8 m ASL) and lowland comprising of areas situated below 8 m ASL. The highlands are formed by the Sahya Mountains of the Western Ghats along the eastern boundary, which are almost continuous except for a few gaps of varying width at certain locations. The Palakkad gap, which is the largest, has a width of 24-30 km. On its north are the Nilgiri Mountains and in the south are the Anamalais which has the highest peak, Anamudi situated at a height of 2695 m.

Kerala is bordered along its western side by the Arabian Sea. As a result, the State has a long shore area. This region, which is narrow having a width of 7 to 8 km, constitutes the lowlands. It constitutes roughly about 10% of the total geographical area of the State. The population of lowlands is very high compared to the other areas. The area lying between the highland and the shoreline is the midland, which roughly constitutes about 42% of the total geographical area. The valleys of the hill ranges, which have an altitude ranging from 300-600m ASL, belong to this. In the north, the Chaliyar River and the Nilambur valley separate the Kunda-Niligiri Mountains from Wayanad plateau located north to the Palakkat gap. Areas north to Palakkat gap belongs to Malabar comprising of the Districts Malappuram, Kozhikkode and Kannur. These areas are characterised by laterite belts, which are 10 to 60 m in altitude. South of Palakkad gap are the areas extending from Kochy to Thiruvanathapuram.

The climate of Kerala is generally tropical with high rainfall and humidity, which in turn

supports a luxuriant flora and fauna. The important vegetation types of this region are the tropical rain forests, tropical moist deciduous forests, tropical dry deciduous forests, montane shola forests, riparian forests, forest plantations, grasslands as well as agro ecosystems comprising of paddy, banana, vegetables and plantation crops such as arecanut, coconut, rubber etc.

Because of heavy population pressure, many patches of natural vegetation in Kerala are under threat. Of the total area of 38863 km$^2$, 10336 km$^2$ are forests. Incidence of fire, invasion by weeds, indiscriminate lopping of trees for fodder and firewood, introduction of plantations of exotics, establishment of hydro-electric and irrigation projects, encroachment as well as cattle grazing are the major disturbances to the forest ecosystems in this region. The agro ecosystem is also subject to disturbances due to filling of paddy fields, adoption of modern agricultural practices leading to large-scale application of chemical fertilizers and pesticides and fouling of wetlands. As a result, the microhabitats of many groups of organisms are affected which has tremendous implications on their survival. At present, we do not have any information on the species found in various ecosystems and their habitat preferences. For the conservation and sustainable utilisation of biodiversity, data pertaining to local biota is very important. Because of the large variety of species and diversified roles, insects have great significance both ecologically and economically. Although several surveys have been made on insects found in various ecosystems in Kerala, data generated for several groups still remains to be compiled. An account of the current status of research pertaining to the insect fauna of Kerala is presented here.

## Brief summary of work so far carried out on the insect fauna of Western Ghats of Kerala

A strict differentiation into forest insects is not possible since insects found in other environments are also found in forests. Documentation of the Indian insect fauna has been initiated with the establishment of the British rule. Amateurs who made faunal surveys at various locations did much of the earlier works and either studied the material or passed them to experts in Europe. The results of these surveys are contained in the 'Fauna of British India' series. Since most of the above surveys were made in areas, which were easily accessible, or in areas close to human settlements, many locations particularly in formidable areas have been either poorly covered or not covered at all. Also, the intensity of sampling was low as indicated by data generated by subsequent workers especially of the Zoological Survey of India, various Universities and Research Institutions. For instance, in the Fauna of British India series on Moths, Vol. IV, Hampson (1896) described 1136 species from this region, out of which only 8 species were recorded as from Kerala. In contrast, he recorded 128 species from Nilgiris in the adjoining State of Tamil Nadu and 378 species from the neighboring island Sri Lanka (Ceylon). The common features exhibited in the geological and climatological features of Nilgiris and Sri Lanka with different parts of Kerala predict

rich pyralid fauna in this region. However, the inadequate surveys carried out in this part of the country are primarily responsible for the scanty records of these moths from Kerala as indicated by the number of species recorded in the subsequent studies by Hampson himself (Hampson, 1908, 1912, 1917, 1919, 1920, 1930) and by other workers (Meyrick, (1936-1937); Bleszynski (1961, 1964, 1970 a, b; Amsel (1968); Bradley (1969); Munroe and Mutuura (1969,1971); Arora and Mandal (1974); Roesler (1969) as well as Pajni and Rose (1978). As a result of these studies, about 500 more species have been added to the list of pyralids described by Hampson in 1896. Same is the case with other groups of insects such as Hymenoptera, Coleoptera, Isoptera, Thysanoptera, Hemiptera, Odonata and Collembola.

Several estimates on the fauna have been made from time to time. As per an estimate by Menon (1965), there could be about 50,000 insect species in India. According to a recent estimate by Varshney (1997), 59,353 species of insects belonging to 619 families, constituting merely 6.83 % of the world insect fauna, have been so far reported from India. The number would have been high but for the poor coverage of various ecosystems particularly the forest, which are known to be storehouses of great diversity. The estimate of insect species from Kerala is roughly 6,000 species (Nair and Easa, 1997). Most of the information generated by various workers lies scattered in the literature. In the absence of consolidated information on the fauna, no reasonable evaluation of the faunal specialties of the different regions is possible. It was in this context that an attempt was made herein to consolidate available data on various insect groups. Information generated for various groups is briefly summarized below.

**Protura**

Prabhoo (1972 a,b; 1975) listed 10 species belonging to the families Eosentomidae, Protentomidae and Acerentomidae, which included five new species.

**Collembola**

Prabhoo (1971 a, b) conducted detailed investigations on the Collembola of Kerala, describing sixty new species belonging to the families Neanuridae, Hypogastruridae, Onychiuridae, Anuridae, Brachystomellidae, Isotomidae, Entomobryidae, Neelidae and Sminthuridae.

**Odonata**

Fraser, Rao and Lahiri, Prasad and Kulkarni, Radhakrishnan, Emilyamma and Lakshminarayana have made valuable contributions to this group. Fraser in his 3 volume treatises on the odonates of the Indian sub continent gave a more or less detailed account of the fauna of Kerala. He (Fraser, 1933) described twenty new species of the family Platystictidae. In the next year (Fraser, 1934), he described thirteen new species of the family Gomphidae. Later, in 1936, he described seventeen new species belonging to the families Corduligastridae, Libellulidae and Aeschnidae. Rao and Lahiri (1982) conducted a preliminary study of the odonates of Silent Valley

and New Amarambalam reporting twenty-three species. Prasad and Kulkarni (2001) described thirty new species belonging to eight families. In the same year, Radhakrishnan and Lakshminarayana surveyed the Nilgiri Biosphere Reserve reporting eighty-eight species from the area. Emilyamma and Radhakrishnaan (2002) worked on the odonates of Parambikulam Wildlife Sanctuary recording twenty-five species and subspecies belonging to eighteen genera and five families. They also prepared a systematic database of this group in Kerala listing one hundred and thirty seven species under seventy-nine genera and twelve families (Radhakrishnan and Emilyamma, 2003). Asaithambi and Manickavasagan (2002)described five new species belonging to Gomphidae and Libellulidae.

**Plecoptera**

Zwick (1981) described six new species belonging to the family Perlidae.

**Orthoptera**

Hebard (1929) and Henry (1940) studied Acrididae. Shishodra and Kulkarni (2001) described twenty-seven new species belonging to Acrididae. Chopard (1969) described twenty-three new species belonging to the families Gryllidae, Gryllotalpidae, Myrmecophilidae, Pteroplistidae and Scleropteridae. Shishodra and Vasanth (2001) described five new species of Tettigonidae and two new species of Gryllidae. Cherian (1985) recorded six species of Orthoptera from the Idukki Hydal area. During 1979-'80, four faunistic explorations were conducted in the Silent Valley National Park wherein thirty-three species of Orthoptera have been recorded of which one was new (ZSI, 1986).

**Phasmida**

Two species have been described *viz.*, the leaf insect *Phyllium crurifolium* Audinet-Serville (Phyllidae) and the stick insect *Phasmida* sp. (Phasmidae).

**Dermaptera**

Burr (1910) has described eight new species belonging to Pygidicranidae, Forficulidae and Labiduridae.

**Dictyoptera**

Fourteen species belonging to the families Cryptoceridae, Blattidae, Mantidae and Empusidae have been described from Kerala which included the extremely rare woodroach *Dicellonotus* sp. which breed in rotting wood in wet evergreen forests. Cherian (1985) recorded two species of Dictyoptera from the Idukki Hydal area.

**Isoptera**

Fifty-six species of termites belonging to the families Hodotermitidae, Kalotermitidae, Rhinotermitidae and Termitidae have been reported from Kerala. Bose (1984) described

32 new species belonging to the families Kalotermitidae and Rhinotermitidae. Chhotani (1970) and Verma (1983, 1984 a, b; 1986) described six new species of the families Kalotermitidae, Rhinotermitidae and Termitidae. Bose (1975), Thakur (1981) and Varma (1990) have recorded several species of termites affecting forest trees from Kerala.

**Psocoptera**

Over thirty species of psocids have been listed from Kerala by Menon (1939). They belonged to the families Lepidopsocidae, Psoquillidae, Amphientomidae, Caeciliidae, PseudocaeciliidaeAmphipsocidae, Stenopsocidae, Peropsocidae, Archipsocidae and Psocidae.

**Siphunculata**

Four species of importance in public health, belonging to the family Pediculidae have been reported.

**Hemiptera**

Distant (1904, 1906, 1908, 1910, 1916, 1918) made detailed studies on the Hemiptera describing seventy-four new species. Dworakowska (1980, 1981 a, b; 1992 a, b) described twenty-seven species of leaf hopers; Dash and Viraktamath (1998, 2001) fifteen species; Viraktamath (1998), Viraktamath and Wesley (1988) seventy-four species; Maicykutty and Usha (1995, 1996, 1997, 2002) nineteen species and Abdulla (1984) nine species.

The whiteflies were studied by Meghnathan and David (1994) describing sixty-four species and Sunderaraj and David (1993) eight species; Tirumalai (2001), thirty-nine species. Thirumalai and Radhakrishnan (1999) studied the aquatic Hemiptera of Kasargode listing fifty-eight species. Tirumalai *et al.* (2003) prepared a synoptic list of Gerromorpha from Kerala listing one hundred and twenty eight species under forty-four genera and five families. Coccidae have been studied by Rai (1984) and species of economic importance have been listed by Fletcher (1920) and Nair (1978). Mathur (1975) studied Psyllidae listing out species of economic importance. Hollis and Martin (1993) revised the genus *Padukia* and made some generic transfers. During 1979-'80, four faunistic explorations were conducted in the Silent Valley National Park wherein thirty-nine species of Hemiptera (six new) and two species of Homoptera (both new) have been recorded (ZSI, 1986). Cherian (1985) recorded six species of Hemiptera from the Idukki Hydal area.

**Thysanoptera**

Ananthakrishnan and Sen (1980) described one hundred and twenty one species of the family Thripidae. Later, Bhatti and Ananthakrishnan (1972 a, b; 1976) and Ananthakrishnan and Varadarasan (1978) described several new species of the family Merothripidae and of the gall forming thrips. Rai (1984) described three species of the family Phloeothripidae and Bhatti (2000) two species of the family Aeolothripidae.

**Neuroptera**

Only a few species are reported from Kerala and there has not been any exhaustive study of this group.

**Coleoptera**

With regard to Coleoptera, excellent faunal treatises have been prepared by Horn (1905) who described fifteen new species from Kerala; Gahan (1906), also on Cerambycidae; Fowler (1912) on Cicindelidae, describing fifteen species; Jacoby (1908) as well as Maulik (1919) on Chrysomelidae describing thirty one species and sixteen species respectively; Andrews (1929) on Carabidae describing six species; Arrow (1931) on Scarabaeidae describing forty-eight species; Rai (1984); Mukherjee (1986) on Gyrinidae describing thirteen species; Biswas (1986) on Staphylinidae describing eighteen species from Silent Valley; Biswas and Chatterjee (1986) on Scarabaeidae describing twenty nine species and twenty seven species respectively. During 1979-'80, four faunistic explorations were conducted in the Silent Valley National Park wherein one hundred and twenty eight species of Coleoptera have been recorded. This included ten new species (ZSI, 1986). Stebbing (1914) and Beeson (1941) made an excellent treatment of economically important Coleoptera of the Indian subcontinent, which contained reference to species found in Kerala. The former contained references to thirteen species recorded from Kerala and the latter, forty-three species. Mathew (1982) conducted a survey of timber beetles of Kerala in which he recorded about one hundred species of beetle borers belonging to the families Cerambycidae, Bostrychidae, Lyctidae, Curculionidae, Scolytidae, Brenthidae, Platypodidae and Anthribidae affecting commercially important timber species in the State. He (Mathew, 1985) also made a report of the coleopteran predators of various timber beetles from Kerala. Cherian (1985) recorded nine species of Coleoptera from the Idukki Hydal area.

**Diptera**

Brunetti, Cherian, Joseph and Parui, and Singh and Ipe have made major contribution to this group. Details of taxa described by various authors are as follows: Brunetti (1912, 1920, 1923) described fifty-three species belonging to Tipulidae, Psychodidae, Mycetophagidae, Simulidae, Asilidae and Syrphidae. Culicidae was studied by Barraud (1934) who described forty-one species, Hiriyan *et al.* (2003) twenty-one species and Christophers (1933) sixteen species. van Emden (1965) described twenty species of Muscidae; Singh and Ipe (1973) thirty six species belonging to Agromyzidae; Joseph and Parui (1981, 1986, 1990) sixty nine species of Asilidae and Nandi (2002) eleven species of Sarcophagidae. Cherian (2002), and Drew and Reghu (2002) recorded thirty-nine and twenty-one species of Tephritidae. The latter from the Nilgiri Biosphere Reserve area contained eight new species.

Cherian (1985) in a study on the insect diversity in the Idukki Hydel Project reservoir

## Table 1. Details of taxa described by various workers

| Family | Name of contributor | Details of taxa described/ recorded |
|---|---|---|
| Ichneumonidae | Sudheendrakumar (1986, 1993)<br>Mohamed (1977-1980)<br>Beevi *et al.* (2000) | 7 species<br>3 species<br>7 species |
| Braconidae | Sumodan and Narendran (1990)<br>Narendran *et al.* (1994, 2002)<br>Narendran and Rema (1996)<br>Beevi *et al.* (2000)<br>Sudheendrakumar (1986,1993) | 5 species<br>11 species<br>3 species<br>8 species<br>3 species |
| Chalcididae | Mani *et al.* (1974); Narendran (1976, 1985 b, 1986, 1987 a, b, 1994, 1996)<br>Joseph *et al.* (1970 a, b; 1973 a, b, 1976)<br>Mohamed (1977-1980)<br>Beevi *et al.* (2000)<br>Sudheendrakumar (1986, 1993) | 23 species;<br>55 species<br>43 species<br>7 species<br>(5 species) |
| Torymidae | Joseph (1954)<br>Narendran (1994)<br>Narendran and Sureshan (1988)<br>Abdurahiman and Joseph (1967a, b; 1975 a, b; 1976) | 3 species<br>58 species<br>8 species<br>11 species |
| Eurytomidae | Mani *et al.* (1974)<br>Narendran (1994)<br>Narendran and Padmasenan (1989, 1991) | 3 species<br>40 species<br>5 species |
| Pteromalidae: | Sureshan and Narendran (1990, 1994 a, b; 1997)<br>Beevi *et al.* (2000) | 167 species<br>8 species |
| Encyrtidae | Mani *et al.* (1974)<br>Beevi *et al.* (2000)<br>Hayat *et al.* (2003) | 4 species<br>3 species<br>1 species |
| Eupelmidae | Narendran (1996)<br>Narendran and Anil (1995)<br>Narendran and Sheela (1996)<br>Beevi *et al.* (2000) | 6 species<br>10 species<br>2 species<br>2 species |
| Eulophidae: | Surekha and Narendran (1992, 1993)<br>Beevi *et al.* (2000) | 5 species<br>8 species |

| Family | Name of contributor | Details of taxa described/ recorded |
|---|---|---|
| Scelionidae | Mani and Sharma (1982)<br>Beevi *et al.* (2000)<br>Narendran (1998)<br>Narendran *et al.* (2001 a, b)<br>Rajmohana and Narendran (2001a, b) | 26 species<br>12 species<br>4 species<br>3 species<br>3 species |
| Trichogrammatidae | Beevi *et al.* (2000) | 2 species |
| Mymaridae | Beevi *et al.* (2000) | 6 species |
| Proctotrupidae | Rajmohana and Narendran (1996) | 4 species |
| Diapriidae | Rajmohana and Narendran (1999, 2000 a, b; 2001a, b) | 7 species |
| Ormyridae | Narendran (1999 a)<br>Narendran *et al.* (1990) | 7 species<br>1 species |
| Platygastridae | Mani and Sharma (1982)<br>Beevi *et al.* (2000)<br>Ushakumari (2002) | 3 species<br>3 species<br>20 species |
| Tetracampidae | Narendran and Ramesh Babu (1996) | 6 species |
| Chrysididae | Bingham (1903) | 6 species |
| Scoliidae | Bingham (1903) | 7 species |
| Mutillidae | Bingham (1903) | 1 species |
| Formicidae | Suresh *et al.* (1999)<br>Sheela and Narendran (1998) | 12 species<br>4 species |
| Eumenidae | Bingham (1903)<br>Suresh *et al.* (1999) | 3 species<br>4 species |
| Pompilidae | Bingham (1903) | 9 species |
| Vespidae | Suresh *et al.* (1999) | 2 species |
| Sphecidae | Bingham (1903)<br>Sudheendrakumar (1984) | 6 species<br>44 species |
| Colletidae | Suresh *et al.* (1999) | 1 species |
| Halictidae | Narendran *et al.* (2000) | 1 species |
| Megachilidae | Suresh *et al.* (1999) | 3 species |
| Anthophoridae | Suresh *et al.* (1999) | 3 species |
| Apidae | Bingham (1903)<br>Suresh *et al.* (1999) | 11 species<br>7 species |

complex made special atternpts to study three dipteran families *viz*., Tephritidae, Agromyzidae and Chloropidae. He reported fifteen species of Tephritidae representing 9.4%; fourteen species of Agromyzidae representing 10.8%; and ten species of Chloropidae representing 5% of the known species in India. Radhakrishnan (2002) prepared an inventory of Tephritidae of Nilgiri Biosphere Reserve recording thirty-five species under twenty-five genera and four subfamilies of which, nine species were new to science and four genera as new records for India. Radhakrishnan (2002) further studied this group at Eravikulam National Park listing nine species under nine genera and two subspecies.

**Lepidoptera**

Hampson (1894, 1895, 1896), Meyrick (1936- 1937), Talbot (1947) and Wynter-Blyth (1957) have made excellent contributions on the butterflies and moths of this region. Subsequently, several workers like Bleszynski (Crambidae), Francy (Noctuidae), Hampson (Moths), Larsen (Butterflies), Mathew (Moths and Butterflies), Meyrick (Microlepidoptera), Munroe (Pyralidae), Radhakrishnan (Moths and Butterflies), Rahmathulla (Geometridae), Roesler (Phycitidae), Menon (Moths) and Wynter-Blyth (Butterflies) have worked on the taxonomy and ecology of various groups of Lepidoptera. These authors have reported several new taxa from this area which included five species of Hepialidae, two species of Arbelidae (Hampson, 1892); one hundred and sixty six species of Noctuidae (Hampson, 1894); twenty species of Arctiidae and eight species of Pyralidae (Hampson, 1896); one hundred and sixty three species of Noctuidae (Francy, 2000); hundred and forty species of pyralids (Mathew and Menon, 1984) and seventeen species of bagworms (Mathew and Nair, 1986). With regard to butterflies, thirty-seven species have been reported by Wynter-Blyth (1957); fifty three species (twenty-two species of Papilionidae, twenty species of Pieridae; two hundred and ninety nine species (from the Nilgiri Biosphere Reserve) by Larsen (1987, 1988); forty four species by Radhakrishnan and Lakshminarayana (2001); one hundred and eighteen species (from Periyar Tiger Reserve) by Jaffer Palot *et al*., (1997) and over ninety species by Mathew (1990) and Mathew *et al*. ( 1998)(from Silent Valley National Park). Cherian (1985) thirty-five species of Lepidoptera from Idukki Hydal project area. Sreekumar and Balakrishnan (1998) studied the butterflies of Adirappally area reporting forty-four species. Investigations by Mathew and Mohanadas (2001) indicated survival of very specialised insect community in the extremely harsh climatic conditions of the montane shola forests of Munnar and Wayanad. Of the butterflies recorded by them, 11 were endemic and 5 having protected status. In another study on the insect fauna of New Amarambalam, Mathew (2002) recorded 860 species of insects belonging to 13 orders. The fauna contained a high proportion of rare and endemic species particularly of Lepidoptera. Of the 133 species of butterflies recorded, 28 were having high conservation value being either rare or endemic.

**Trichoptera**

Higler (1992) studied Trichoptera describing thirty-seven new species belonging to the

families Xiphocentronidae, Hydropsychidae, Molannidae, Leptoceridae, Philopotamidae and Rhyacophilidae.

**Hymenoptera**

The Fauna of British India series on Hymenoptera Bingham (1903) has given a good coverage of various hymenopteran groups. Subsequent to the publication of the Fauna Volume, various workers such as Abdurahiman and Joseph (1967 a, b; 1975 a, b); Hayat *et al.* (2003); Joseph *et al.* (1973 a, b; 1976); Narendran (1986, 1992); Narendran and Joseph (1975); Narendran and Sureshan (1989); Narendran and Sheela (1995); Sudheendrakumar (1990, 1993, 1994), Sudheendrakumar and Narendran (1985) and Wiebes (1980) have made valuable contributions to our knowledge of this group of insects. Besides updating the taxonomy of various families, these workers have described a large number of new genera and species from Kerala mostly from the forests. An account of some new descriptions of taxa by various authors under major hymenopteran groups is summarised in Table 1.

Recently, Sudheendrakumar and Mathew (1999) conducted a faunal survey of the macro Hymenoptera of the Parambikulam Wildlife Sanctuary reporting one hundred and eight species of hymenopterans belonging to fifteen families under fifty six genera (Binoy *et al.*, 1999). The families Sphecidae, Formicidae, Pompilidae and Apidae contained maximum number of species. Of the various species recorded, seven genera and eleven species are new reports for Kerala. The evergreen forests had the highest diversity followed by moist deciduous forests and teak plantations.

## Conclusions

Because of the characteristic ecoclimatic conditions, the Western Ghats fauna is very unique comprising of elements drawn from different biogeographic zones, which have evolved, into characteristic 'species groups' over years of isolation. This has been shown in studies carried out at Silent Valley. A major share of the moths collected from this area had close resemblance to the Malaysian fauna, although significant differences have been noted by CAB (London) between specimens collected from Silent Valley and Malaysia, suggesting endemism due to geographical isolation. In addition to the above, occurrence of species having Palaearctic and Afro-tropical affinities has also been noted (Mathew, 1990). The proportion of rare and endemic species was also very high. It may be mentioned here that in a study of the Lepidoptera of Silent Valley, about 30% of the material collected could not be identified as the systematics of many groups is still in a preliminary stage and it may turn out that many species collected could be new. Similarly, phenetic variations have also been noted in species collected from Silent Valley and elsewhere in Kerala: for example, the arctiids, *Cyme gratiosa, Asura obsoleta* and *Cyana bianca* collected from different geographical regions were distinct. It is obvious that we are only just beginning to understand the vast diversity of insects that we possess in our forests.

## Genetic diversity within species

Because of the greater variety of habitats and host variability compared to the more uniform agricultural systems, we might expect incidence and perpetuation of greater genetic diversity within species in forest ecosystems. However, we know practically nothing about the genetic diversity existing within species of insects present in forest ecosystems. Existence of different host races of the bagworm *Pteroma plagiophleps* Hamp., a minor pest of tamarind which became a serious pest of forest plantations of *Paraserianthes falcataria* in Kerala in 1977 and of the avenue plantings of *Delonix regia* about two and a half years later has been suspected (Nair and Mathew, 1988). Occurrence of light and darker forms of the larvae of the teak defoliator *Hyblaea puera* Cramer in the same population is well known, but its significance is not understood. In the use of parasitic and predatory insects in biological control, even minute differences in strains are very important. Aspects of genetic diversity within species will come to light only when species-specific population studies are initiated.

## Conservation implications

The economic and ecological significance of various insects is not yet worked out except in a few cases. Because of their number and diversified habits, insects play important roles in the sustenance of natural ecosystems. Information pertaining to biodiversity and biological attributes of insects is very important in conservation programmes.

## Suggestions for future course of action

### Need for more intensive study of fauna

Conservation of biodiversity will be meaningless without knowing its components. The insects so far reported from the Western Ghats represent only a fraction, since several forest habitats in this area still remain unexplored. Even with material collected in previous surveys, a major share still remains to be identified due to lack of taxonomic expertise in various groups. Of the twenty-nine insect orders, only a few orders like Lepidoptera, Hymenoptera and Coleoptera have been studied in any greater details. Even in these cases, many families have not been fully studied. Therefore, serious efforts are needed to study the species found in different habitats and their role in the ecosystem particularly with regard to lesser-studied groups such as the soil insects (Protura, Collembola), Diptera, Neuroptera, Plecoptera, Hemiptera etc. Due to deforestation, conversion of natural forests to plantations and with more subtle changes to the forest climate and flora as a result of human activities, the species and genetic diversity of insects is being continuously eroded. But we however, have no systematic record on these changes. As has already been stated, such information is needed for the conservation and sustainable utilization of biodiversity. Lack of taxonomic expertise, financial assistance, neglect from administrators and forest managers etc., are some of the reasons for not being able to undertake comprehensive research on forest insect biota. Preparation of a database on insects so far reported from various parts of

the Western Ghats and preparation of a master plan to study the various groups are few major aspects that need to be considered.

Information on the biota is a prerequisite for undertaking appropriate conservation strategies and this has been emphasized in the Convention on Biological Diversity (CBD) held in 1992. Documentation of biodiversity is the primary requisite for biodiversity conservation and therefore, in order to develop scientific conservation strategies, it is necessary to develop taxonomic skill. With the degeneration of taxonomic expertise in the current century, taxonomic investigations are at cross roads. It is the responsibility of administrators, environmentalists and all concerned with biodiversity conservation, to take necessary steps to document the existing biodiversity.

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