

# **WETLAND MOSQUITO FAUNA OF TAMIL NADU**

**K. ILANGO**



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**Wetland Mosquito Fauna of Tamil Nadu**

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सत्यमेव जयते

**Zoological Survey of India  
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## INTRODUCTION

Wetland, by definition, is an interface between two ecologically non-mutual exclusive habitats, an aquatic and a terrestrial habitat, which includes ponds, lakes, rivers, hill-streams, rock-pools, estuaries, marshes, mangrove swamps, seas, and oceans. Wetlands can be either temporary or permanent, natural or man made, small such as the periphery of pools and ponds a few meters in length or as large as marshes, mangrove swamps several square km in area. Wetlands support the survival of a rich fauna and flora and provide the potential breeding grounds for many species of insects and other invertebrates, fish, residential and migratory birds and mammals. Because of their unique ecological characteristics, the wetland ecosystem represents as 'ecological window' that (i) it provides opportunity for taxonomists, evolutionary biologists, and population geneticists to study the variation of species in hybrid zones and edge effect; (ii) it offers a wealth of information for environmentalists and field biologists to work towards sustainable development; (iii) public health, veterinary and agricultural scientists need to work on prediction and prevention from the epidemics of insect borne diseases.

Wetlands may be regarded as 'water-logged wealth' which provides nurseries for fish and wild life, improve water quality, protect shore line, stabilize water supplies, moderate the effects of floods, recharge ground water aquifers and have aesthetic value. Invertebrates bred in wetlands play significant roles in nutrient recycling, primary and secondary consumers, food for wild life and indicators of ecosystem function (Keiper *et al.*, 2002). Wetlands also contribute to the stability of global levels of available nitrogen, atmospheric sulfur, CO<sub>2</sub> and methane. Riverine and lacustrine wetlands are estimated to be 160 times greater in economic value to society than an equal area of crop land (Mitsch and Gosselink, 2000). However, wetlands are also very important breeding grounds for mosquito species and for a wide variety of other lower Diptera. Adults of most mosquito species feed on plant-sap but their larvae and pupae are dependant on aquatic or wetland habitats. Most mosquito females need blood meals from warm blooded animals including human beings for their egg development and tend to migrate from their aquatic breeding habitats to animal sheds and human dwellings. As a results mosquitoes become potential carriers of many tropical diseases such as malaria, dengue, filariasis, and Japanese Encephalitis (JE).

The wetlands of India are exceptionally diverse comprising 2,167 natural habitats and 65, 253 artificial sites and constitute 0.47% of the geographical area (MOEF, 1990). The 'Directory of Indian Wetlands' brought out by the World Wide Fund for Nature- India (1993) includes 170 wetland ecosystems. For each data are provided on location, altitude, biogeographical province, type, description, climatic condition and vegetation, fauna and flora, and degree of disturbance, land use, conservation measures, economic and social value, research facilities

and references. In Tamil Nadu, the wetland ecosystem comprises more than 30 natural habitats and 20030 artificial areas, representing 1.6% of the geographical area of the state, and ranges from a 15 ha fresh water lake in Ooty, Nilgiri Hills at 2100 MSL to 25, 435 ha salt water swamp of Point Calimere and Vedaranyam in Tanjore district at 0-6 MSL.

Wetlands are increasingly under the pressure of natural and man made problems viz. population explosion, and of industrial growth, rural migration, urbanization, pollution, deforestation, environmental and climatic changes, drought and over flooding etc. These man-made (anthropogenic) as well as environmental factors tend to alter the wetland ecosystem, which in turn is responsible for the rapid growth of mosquito populations and thus spread of the diseases mentioned. For example, the incidence of rural malaria is reported in Rameshwaram Islands to be the highest in the state, in Tuticorin and Dindigul districts urban malaria is second only to Chennai and in Kaniyakaumari district there is a high prevalence of filariasis. The knowledge of the mosquito fauna and its associated wetland breeding habitats is far from complete. Hence this study was focused on making an inventory of mosquito fauna found in a wide range of wetland ecosystems and to assess them as vectors of human disease and the associated wetland ecosystems.

## **MATERIAL AND METHODS**

### **Study areas**

The area under study includes 8 districts: Kanyakumari, Tirunelveli, Tuticorin, Virudhunagar, Ramanadhapuram, Maduari, Dindigul and Theni in southern part of Tamil Nadu and constitutes 1/3 of the state geographical area. The study area is located between latitudes 8° 05' and 10° 05' N and longitudes 77° 30' and 79° 50' E. (Fig. 1). Physiographic features of the study area are so diverse that its southern tip is at the junction of the Indian Ocean, Arabian Sea and Bay of Bengal; its eastern part covers the coastal zones of the Gulf of Mannar and estuaries; its western part is surrounded by hills and ghats. For convenience, the study area is divided into 3 regions: (i) the island / coastal region comprising the Rameshwaram Island, part of Kanyakumari, Tuticorin, Ramanadhapauram districts (Figs. 2-7); (ii) the central part of inland plain including part of Tirunelveli, Virudhunagar, Dindigul and the entire Madurai district (Figs. 8-10); (iii) the western region close to and abutting the eastern slope of western ghats/ forests comprising western part of Kanyakumari, Tirunelveli, Virudhunagar and Dindigul districts and the entire Theni district (Figs. 11-13). The rivers Vaigai in north and Tamiraparani in south originate from the western ghats flow eastward through the plains and enter the Gulf of Mannar and hence the Bay of Bengal. The district headquarters of Maduari and Tirunelveli are located on the banks of the Vaigai River and the Thamiraparani River respectively.

### **Physiographic features**

Although the climatic condition is tropical monsoon throughout the year, the rainfall, soil

types, vegetation, forest cover differ markedly from north to south and west to east. The western region experiences both the southwest monsoon during June-September and the northeast monsoon during October-November whereas the central plains and coastal areas receive rains mainly during the northeast monsoon. Unlike the northern parts of India, there is no winter season here and the annual temperature in the western part ranges from min. 18° C and max. 25°C, while the central plains and coastal areas are usually hot throughout the year with min. 25° C and max. 45°C. Red-soil-type occurs in the western hills and ghats, either black or red soil-types in plains and alluvial soil interspersed with long sandy beaches in the coastal region. Because of the influence of both southwest and northeast monsoon rains, the vegetation and forest-cover are richer in the western region than the central and coastal regions. Tropical wet evergreen forests occurs on the upper reaches of the hills with scrub jungles mixed with degraded patches of deciduous forests in the lower hills. In plains and coastal areas, the natural vegetation is poor but the state forest department develops social and agro-forestry and other commercial plantation. In addition vast tracts of land used for agriculture crops like rice, banana, sugar cane, coconut etc along the river course of Vaigai and Tamiraparani increase green cover in plains and coastal areas.

### **Surveys undertaken, material collected and examined**

This project was originally envisaged for the entire state of Tamil Nadu but it was restricted subsequently to the areas as described which were surveyed from 1997 to 2001. Of the four surveys made, the first and second surveys were carried out to Kaniyakumari, Tirunelveli, Ramanadhapauram districts and Rameshwaram Islands during 1997-98 and 1998-99; the third survey was of Courtalam (Tirunelveli District), Virudhunagar and Tuticorin districts in 1999-2000; the fourth survey was of Theni, Dindigul and Madurai districts in 2000-01. In addition, mosquito species recorded by Christophers (1924) and Barraud (1934) from other than these study areas within Tamil Nadu were included to make a comprehensive inventory of the wetland mosquito fauna of the state. Adult mosquitoes were collected from human dwellings, cattle and goat-sheds while their pupae collected from the natural and man-made nearby wetlands were reared to adults. For the identification of mosquito species, Christophers (1933), Barraud (1934), Sirivanakarn (1976), Das et al., (1990) were used; the higher classification follows Harbach and Kitching (1995), Harbach (2004) and Reinert et al. (2004).

## **RESULTS AND DISCUSSION**

### **Mosquito taxonomy**

The current higher-level classification, taxonomic citation of species examined, their distribution, breeding sources and biology in relation to disease vector status are provided in that order. Species known from outside the limits of the study areas are marked with asterisks.

## SYSTEMATIC ACCOUNT

Order DIPTERA  
 Family CULICIDAE  
 Subfamily ANOPHELINAE  
 Genus *Anopheles* Meigen  
 Subgenus *Anopheles* Meigen

### 1 *Anopheles aitkeni* James\*

1903. *Anopheles aitkenii* James, in Theobald, *Mono. Cul.* 3 : 22. Type locality : Goa, India.

*Recorded* From Coimbatore, Maduari, Nilgiri and North Arcot districts.

*Distribution* : Occurs throughout the Oriental Region and also reported from New Guinea, Celebes, Java, Sumatra, Philippines, Lesser Sunda Islands, Borneo, Malaysia and Sri Lanka.

*Remarks* It is a wild species and breeds in small streams, springs, rock-pools in forests and jungle and in wells of plains. There is no evidence of it being a vector of human *Plasmodium* parasites. *Anopheles aitkenii* sensu lato is a group of 13 species and its varieties are treated as separate species. Further taxonomic study of *Anopheles aitkenii* s.l. is required (Harrison and Scanlon, 1975; Harbach, 2004).

### 2. *Anopheles culiciformes* Cogill\*

1903. *Anopheles culiciformes* Cogill, *J. Bombay Nat. Hist. Soc.*, 15 : 333. Type locality : North Kanara district, India.

*Recorded* From Nilgiri district.

*Distribution* : Occurs in the west coast of India especially from Goa to Malabar and Nilgiris.

*Remarks* : It is a forest species, breeding in tree holes, in jungle-pools. This species seems not to be a vector of human malaria parasites. *Anopheles culiciformes* s.l. includes *culiciformis* s.s., *sintoni* Puri and *sintonoides* Ho and needs further taxonomic study (Harrison and Scanlon, 1975).

### 3. *Anopheles gigas* Giles\*

1901. *Anopheles gigas*, Giles, *Entom. Month. Mag.*, 2 : 196. Type locality : Coonor, Nilgiri Hills, S. India.

*Recorded* From Nilgiri, Kodaikanal and Palani hills.

*Distribution* Occurs in India and Pakistan.

*Remarks* : It is a wild and hill species (above 6000 ft), breeding in fresh water springs and hill- streams. It is a complex 3 sibling species (Harbach, 2004) but it not known to be a vector of human malaria parasites.

#### 4. *Anopheles nilagiricus* Christophers new status

1924. *Anopheles lindesayi nilagiricus* Christophers, *Ind. Journ. Med. Res.*, **12** : 13 (as variety of *lindesayi*).  
Type locality: Nilgiri Hills, South India.

*Material collected and examined* : From the PWD Guest house near tributary of the river Vaigai, Periakulam, Theni District; 9.ii.2001; 1M, 3F.

*Recorded* : From Nilgiri and Madurai districts.

*Distribution* : Occurs in Nilgiri Hills, Anantapur and other plateaus in extreme southern India.

*Remarks* : Breeds in small clean pools with rocky-beds and cultivated gardens in hill tracts. It is not an efficient malaria vector. This species belongs to the *Anopheles lindesayi* species complex, which includes *An. nilagiricus* Christophers **status new**, hitherto treated as subspecies of *An. lindesayi* Giles, and two other closely related species viz., *An. mengalagensis* Ma, *An. wellingtonians* Alcock. This species complex needs further taxonomic study.

#### 5. *Anopheles interruptus* Puri

1929. *Anopheles interruptus* Puri, *Ind. Journ. Med. Res.*, **17** : 387 (as variety of *Anopheles annandale*). Type locality : Sukna, Darjeeling Dist., West Bengal, India.

*Material collected and examined* : From the PWD Guest house near tributary of the river Vaigai, Periakulam, Theni District; 9.ii.2001; 2F.

*Distribution* : Occurs in hill-tracts of North Eastern India and Sri Lanka. This is a new record for south India.

*Remarks* : Breeds in tree-holes in deep forests and wooded country. It is not recorded as malaria vector. This is one of the 4 closely related species recorded in India and further taxonomic study is required (Harbach, 2004).

#### 6. *Anopheles barbirostris* Van der Wulp

1884. *Anopheles barbirostris* Van der Wulp, *Notes from the Leyden Museum*, **4** : 248. Type locality : Mount Ardjoeno, East Java.

*Material collected and examined* : From houses and cattle-sheds near a fresh water pond, Kottaram village, 15 km E of Nagercoil, Kaniyakumari District; 17.xii.97; 1M, 1F; cattle-sheds close to rice-fields near Vaigai river in Kilmathur village 16 km W of Madurai; from a house and goat-sheds close to mine-pits in Narasingham 12 km E of Maduari; 14.ii.01; 14F.

*Recorded* : From Chennai, Chengleput, Coimbatore, Maduari, Nilgiri, North Arcot, South Arcot and Salem Districts.

*Distribution* Occurs throughout the Oriental Region including India, Pakistan, Bangladesh, Myanmar, Thailand, and Sri Lanka.

*Remarks* It is a wild and foothill species, breeding on the edges of lakes, ponds, wells, rice-fields. It is a vector of human malaria parasites and bancroftian filaria. *An. barbirostris* sensu lato is considered a complex of 13 species and needs further taxonomic studies (Harrison and Scanlon, 1975; Harbach, 2004).

### 7. *Anopheles nigerrimus* Giles

1900. *Anopheles nigerrimus* Giles, *Handb. Of Gnats or mosq.*, 1 : 161 (as variety of *hyrcanus*). Type locality : Kolkata, India.

*Material collected and examined* From cattle and goats-sheds close to rice-fields near Vaigai river in Kilmathur village 16 km W of Maudari; 15.ii.01; from the PWD Guest house, Pilavukkal dame, Watrap, Virudhanar Dist; 9.ii.2k; 1F.

*Recorded* From Chennai, Chengleput, Coimbatore, Madurai, North Arcot and South Arcot, Nilgiri and Tanjore districts.

*Distribution* : Occurs widely-in the Oriental Region and in the Philippines, Cambodia, Malaysia, Thailand, Indonesia and Vietnam.

*Remarks* Breeds in ponds, lakes, grassy pools and swamps. This species is not an efficient vector of human malaria parasites in India but it is reported as an important vector in Sumatra (Indonesia). *Anopheles nigerrimus* belongs to the subgroup Nigerrimus with 4 species of Hyrcanus group, which consists of 29 species some of them are vectors of malaria and other mosquito-borne diseases (Nguyen et al., 2000). This group requires further taxonomic studies in India.

#### Subgenus *Cellia* Theobald

### 8. *Anopheles jeyporiensis* James\*

1902. *Anopheles jeyporiensis* James, *Sci. Mem. Govt. India, n.s.*, 32. Type locality : Jeypore hill tracts. India.

*Recorded* From Coimbatore, Nilgiri, Salem and Madurai districts.

*Distribution* Occurs mainly in central, eastern and southern parts of India.

*Remarks* The breeding places are especially rice-fields, edges of lakes, streams. This species is considered an important malaria vector in south China.

### 9. *Anopheles varuna* Iyengar\*

1924. *Anopheles varuna* Iyengar, *Ind. Jour. Med. Res.*, 12 : 24. Type locality: Kolkata, India.

*Recorded* : From Chennai, Chengleput and South Arcot districts.

*Distribution* : Occurs only in the Oriental Region.

*Remarks* : The breeding habitats of the species are wells, stagnant fresh water ponds, slow running streams, rain water collections. Not much is known about its status as a vector of malaria in India but it is considered as a vector in Sri Lanka.

#### 10. *Anopheles culicifacies* Giles

1901. *Anopheles culicifacies* Giles. *Entom. Month. Mag.*, **12** : 197. Type locality : Hoshangabad. Madhya Pradesh, India.

*Material collected and examined* : From the houses and cattle-sheds close to Kottaram fresh water pond, 15 km E of Nagercoil town, Kaniyakumari Dist; 17.xii.97; from the cattle-sheds and indoors in Veeravandiyur village, 30 km west of Tirunelveli; 19.xii.97; 2F.

*Recorded* : From Chennai, Chingleput, North and South Arcot, Salem, Nilgiri, Coimbatore, Tiruchi and Madurai districts.

*Distribution* : occurs widely in India, Pakistan, Bangladesh, Myanmar and Sri Lanka.

*Remarks* : Breeds in a wide range of clean and fresh water habitats including streams, nullahs, sandy river-beds, freshly formed puddles, fallow rice-fields. *Anopheles culicifacies* is an important rural malaria vector in India and in Sri Lanka. It is a complex of more than 5 cyto-species (Subbarao 1998) but its individual species taxonomic status is still an enigma until each taxon is formally designated as suggested by Schmidt et al. (2001) and Krzywinski and Besansky (2003).

#### 11. *Anopheles fluviatilis* James

1902. *Anopheles fluviatilis* James. *Sci. Mem. Govt. India, n.s.*, **2** : p.31. Type locality : Jalpaiguri Dist. W. Bengal, India.

*Material collected and examined* Inside a hut located on the Gundaru Dam in the foot hills of the western ghats, 16 south west of Courtalam, Thirunelveli Dist; 5.ii.2k; 1F.

*Recorded* : From Chennai, Chingleput, North and South Arcot, Salem, Coimbatore, Nilgiri and Madurai districts.

*Distribution* : It is found throughout India.

*Remarks* : Breeds in stream beds, ponds, tanks and in slow-flowing water with vegetation and irrigation reservoirs. Commonly occurs in houses and cowsheds especially from the foothill areas and hilly-rocky tracts. It is an efficient vector of malaria. *An. fluviatilis* s.l. consists of the complex three cytospecies S, T and U (Subbarao et al., 1992). The formal taxonomic status of each species needs to be clarified.

## 12. *Anopheles minimus* Theobald\*

1901. *Anopheles minimus* Theobald, *Mono. Cul.*, 1 : 186. Type locality : Pokfulam, Hong Kong.

*Recorded* : From Madurai and Tanjore districts.

*Distribution* : This species occurs particularly in northeast and peninsular India and is recorded widely from China, Myanmar, Malaysia, Philippines, Lesser Sunda Islands, Java, Sumatra and Sri Lanka.

*Remarks* Breeding places include slow-running streams, springs, edges of swamps and paddy fields. This species is regarded as an important vector of malaria throughout its distribution and was a vector of lymphatic filariasis in China. *Anopheles minimus* is a complex of 3 species and belongs to *An. minimus* group (of the *Myzomyia* series of the subgenus *Cellia*). Other members included in this are *An. aconitus*, *An. fluviatilis* (see below) and *An. varuna* (Chen *et al.*, 2002)

## 13. *Anopheles karwari* James

1903. *Anopheles karwari* James, in *Theo. Mono. Cul.*, 3 : 102. Type locality : Karwar, Karnataka, India.

*Material collected and examined* From cattle sheds close to the seacoast and community pond in Kilakkarai town 25 km south east of Ramanathapuram dist. head qrs; 22.xii.97; 2F.

*Recorded* : From Nilgiri, Coimbatore and Tirunelveli districts.

*Distribution* : occurs widely in India, Pakistan, Bangladesh, Myanmar, Thailand, Malaysia and Sri Lanka.

*Remarks* Breeds in small open pools, weedy tanks and drains with free vegetation growth. The adults are found in cattle-sheds, human dwellings and feed readily on man. It is reported to be a poor malaria vector.

## 14. *Anopheles moghulensis* Christophers\*

1924. *Anopheles moghulensis* Christophers, *Ind. Jour. Med. Res.*, 12 : 296. Type locality : Deccan Plateaus.

*Recorded* From Coimbatore district.

*Distribution* Occurs only in the northeast and peninsular India.

*Remarks* Breeds in small rocky-pools and streams. Nothing is known about its status as a vector.

## 15. *Anopheles stephensi* Liston

1901. *Anopheles stephensi* Liston, *Ind. Med. Gaz.*, 36 : 441. Type locality : Ellichpur, Berars, M.P., India.

*Material collected and examined* : From houses, cattle-sheds in Vallam near Courtalam, Tirunelveli; 2.ii.2k; 19F; from goat-sheds and huts in Dindigul town; 13.ii.01; 2F.

*Recorded* : From Chennai city, Chengleput, North Arcot, Salem and Coimbatore districts.

*Distribution*: Occurs throughout India.

*Remarks* : It is primarily an urban mosquito species breeding in over-head tanks, wells, rain and other temporary water containers. This taxon is a complex of 3 sibling species and its type form from urban environment is an important malaria vector. Two varieties viz. the *intermediate* form and var. *mysorensis* from rural areas are considered to be a zoophilic (see Veradi *et al.* 2000). Further study is needed to resolve the taxonomic status of each taxon.

### 16. *Anopheles annularis* Van der Wulp

1884. *Anopheles annularis* Van der Wulp, *Notes from the Leyden Museum*, 4 : 249. Type locality : Mount Ardjoeno, East Java.

*Material collected and examined* : From houses and cattle-sheds close to Kottaram fresh water pond, 15 km E of Nagercoil town, Kanyakumari Dist; 17.xii.97; F.

*Recorded* : From Chennai, Chingleput, Coimbatore, North Arcot, South Arcot, Tanjore and Salem districts.

*Distribution* : occurs widely from India, Pakistan, Bangladesh, Myanmar, Thailand, Malaysia, Indonesia and Sri Lanka.

*Remarks* : This species is mainly a cattle-feeding mosquito, breeding in clean, weed grown stagnant waters, notably margins of lakes, ponds, rice-fields, river-beds and other fresh water ecosystems. It is not an efficient malaria vector. *Anopheles annularis* s.l. is a group of 4 species requiring further taxonomic study.

### 17. *Anopheles pallidus* Theobald\*

1901. *Anopheles pallidus* Theobald, *Mono. Culi.*, 1 : 134 (as variety of *An. fuliginosus*). Type locality : Sambalpur, Orissa, India.

*Recorded* : From Chennai, Chengleput, South and North Arcot, Coimbatore and Madurai districts.

*Distribution* : Occurs in northeast and peninsular India, and in Vietnam, Thailand, Sumatra and Sri Lanka.

*Remarks* Breeding places include margins of lakes, ponds, streams and rice-fields. It is not known as a malaria vector.

### 18. *Anopheles jamesii* Theobald

1901. *Anopheles jamesii* Theobald, *Mono. Cul.*, 1 : 134. Type locality : Quilon, S. India.

*Material collected and examined* : From PWD Guest house, Pilavukkal Dam (Watrap), foothills of western ghats, 60 km west of Virudhunagar, 9.ii.2K; 10F.

*Recorded* : From Chennai, Chengleput, North Arcot, Tanjore, Nilgiri and Madurai districts.

*Distribution* : Occurs mainly in north-eastern India through western and peninsular India and Sri Lanka.

*Remarks* : Breeds in lakes, ponds and in rain-pools, river beds, springs and surface-wells. It forms a group with 3 species. There is no evidence that this species is involved in the dynamics of malaria transmission.

### 19. *Anopheles splendidus* Koidzumi\*

1920. *Anopheles splendidus* Koidzumi, *Daiwan, Kenkyujo Hokoku*, 8 : 23, 32 and 55. Type locality : Taiwan.

*Recorded* : From Coimbatore, Nilgiri, Salem and South Arcot districts.

*Distribution* : Occurs in northeast, northwest and south India.

*Remarks* : The species breeds in jungle-streams, river-beds and clear fresh water pools and tanks. Not recorded as a malaria vector.

### 20. *Anopheles dravidicus* Christophers\* status revived

1924. *Anopheles dravidicus* Christophers, *Ind. Journ. Med. Res.*, 7 : 297 (as variety of *An. maculatus* Theobald). Type locality : Nilgiri Hills, South India.

*Recorded* : From Coimbatore, Nilgiri, Salem and South Arcot districts.

*Distribution* : Occurs in the hilly tracts of peninsular India and Sri Lanka.

*Remarks*: This species is essentially a stream and riverbed breeder and also occurs in a wide variety of fresh water habitats such as pools, springs, borrow-pits, lake margins and rice-fields. It is a member of the *Anopheles maculatus* Theobald species complex with 4 species, which comprises important malaria vector species in Southeast Asia.

### 21. *Anopheles elegans* (James)\*

1903. *Anopheles elegans* (James), in *Theobald Mono. Cul.*, 3 : 51 (as *Myzomyia elegans*). Type locality : Karwar, West Coast, India.

*Recorded* : From Coimbatore and Nilgiri districts.

**Distribution** : Occurs mainly in the western parts of India viz. Konkan, Coorg, Mysore, Malabar and Nilgiri.

**Remarks** : *Anopheles elegans* is a wild species, breeding in rocky-streams and rivers of deep jungle and forest. This species belongs to the Hackeri subgroup, which includes *elegans* (James), *hackeri* Edwards, *pujutensis* Colles, *sulawesi* Waktoedi and *sumatra* Peyton of Leucosphyrus group of Anopheles (Cellia). The Leucosphyrus comprises twenty species and two geographical forms and is taxonomically divided into three subgroups. The Leucosphyrus subgroup comprises two species complexes, the Dirus and Leucosphyrus (Peyton, 1989). The Leucosphyrus group includes several species that are important vectors of human and non-human primate *Plasmodium* especially in northeast India and in several countries of Southeast Asia. *An. dirus* Peyton and Harrison s.l. is a complex of seven species and has been studied extensively in Southeast Asia (Sallum, personal communication). There is an urgent need to study and revise this group from other parts of India for effective malaria control.

## 22. *Anopheles tessellatus* Theobald

1901. *Anopheles tessellatus* Theobald, *Mon. Cul.*, 1 : 175. Type locality : Taiping, Perak, West Malaysia.

**Material collected and examined** : From cattle/ goat-sheds close to the tributary of river Vaigai, Kilmathur 25 km west of Maduari; 15.02.01; 1F.

**Recorded** : From Nilgiri and Pondichery.

**Distribution** : This species has a wide distribution in India and other parts of the Oriental region viz. south China, Myanmar, Thailand, Philippines, Vietnam, Malaysia and Sri Lanka.

**Remarks** : It breeds in small pools, swamps, irrigation and seepage canals and dirty stagnant water and is known as a vector of malaria.

## 23. *Anopheles vagus* Dönitz\*

1902. *Anopheles vagus* Dönitz, *Zeit. f. Hyg.*, 12 : 80. Type locality : Forte de Kook. Sumatra.

**Recorded** : From Chengleput, South Arcot, Pondicherry, Tanjore and Nilgiri districts.

**Distribution** : Occurs widely in the Oriental and Australasian Regions.

**Remarks** Breeding places are pools, borrow-pits, puddles, hoof-prints etc. and also in grassy swamps, rice fields and brackish water. It is a suspected vector of malaria.

## 24. *Anopheles subpictus* Grassi

1899. *Anopheles subpictus* Grassi, *Atti d. R. Accad. Lincei*, 8 : 101. Type locality : Kolkata, India.

*Material collected and examined* : From cattle-sheds close to the sea-coast and a community pond in Kilakkarai town 25 km south east of Ramanathapuram dist. headqrs; 22.xii.97; 10; from houses and cattle-sheds, Vembanallur village, 8 km west of Sengottah, Thirunelveli Dist; 6.ii.2k; 11F.

*Distribution* : Occurs extensively in the Oriental and Australasian regions.

*Remarks* : Breeds in temporary collections of water, drains, pools, and other sources of fresh water storage. It feeds mainly on cattle but is known as a vector of malaria. This species comprises a complex of 4 species (Suguna et al., 1994) and needs further taxonomic studies.

### 25. *Anopheles sunaicus* Rodenwaldt

1926. *Anopheles sunaicus* Rodenwaldt, *Meded. Volks. Ned. Indie, D. 1* : 87 (as variety of *An. ludlowi*). Type locality : Sunda Islands, Java.

*Material collected and examined* From houses and huts near salt fields, Mappilaipuram Coastal village, Tuticorin Dist; 1.ii.2k; 4F; Udangudi village 60 km west Tuticorn Dist. head qrs; 3.ii.2k; 2F.

*Distribution* : Occurs throughout coastal parts of India including Andamans from the Oriental region and in Java, Sumatra, Borneo and Sulawesi. Although it is a common species reported along Indian coasts but it is reported for the first time in Tamil Nadu during the survey.

*Remarks* : Breeds in brackish water and saline swamps. It is an efficient malaria vector in coastal areas. *Anopheles sunaicus* is a complex of 3 cytospecies belonging to the Pyretophorous series which includes *An. indefinites* (Ludlow), *An. limosus* King, *An. litroralis* King, *An. ludlowae* (Theobald) and *An. parangenis* (Ludlow), *An. subpictus* Grassi and *An. vagus* Donitz in the Oriental Region and the six members of the *An. gambiae* Giles species complex in Africa (Linton et al., 2001).

Subfamily CULICINAE

Tribe Aedeomyiini

Genus *Aedeomyia* Theobald

### 26. *Aedeomyia venustipes* (Skuse)\*

1889. *Aedeomyia venustipes* (Skuse), *Proc. Linn. Soc. N.S.W.*, 3 : 1761 (as *Aedes*). Type locality : Elizabeth bay, Sydney, Australia.

*Recorded* From Tamil Nadu.

*Distribution* : Occurs commonly in southern India and in Sri Lanka and Australia.

*Remarks* : Habitats include pools, more usually those containing dense vegetation.

Genus *Aedes* Meigen

Subgenus *Aedimorphus* Theobald

27. *Aedes jamesi* (Edwards)\*

1914. *Aedes jamesi* (Edwards) *Bull. Ent. Res.*, 5 : 77 (as *Orchlerotatus*). Type locality : Colombo, Sri Lanka.

*Recorded* : From Tamil Nadu.

*Distribution* : This species is common in Sri Lanka and in peninsular India. It is unknown from other areas of India.

*Remarks* : It breeds in jungle-pools.

28. *Aedes pallidostratus* (Theobald)\*

1907. *Aedes pallidostratus* (Theobald) *M. C.* 4 : 410 (as *Culex*). Type locality : Peradeniya, Sri Lanka.

*Recorded* : From Tamil Nadu and other parts of peninsular India.

*Distribution* : Occurs widely throughout India and Sri Lanka.

*Remarks* : The habitats include open pools formed by rain or seepage; water-filled dykes, ditches, borrow-pits etc.

29. *Aedes pipersalatus* (Giles)\*

1901. *Aedes pipersalatus* (Giles) *M. C.* 2 : 316 (as *Stegomyia*). Type locality : Gonda, Uttar Pradesh.

*Recorded* : From Tamil Nadu and other parts of peninsular India.

*Distribution* : Occurs throughout India.

*Remarks* : It breeds in ground-pools, and water-filled ditches.

30. *Aedes stenoetrus* (Theobald)\*

1907. *Aedes stenoetrus* (Theobald) *M. C.* 4 : 395 (as *Culex*). Type locality : Maskeliya, Sri Lanka.

*Recorded* : From Coonoor in Nilgiri Hills, in Kodaikanal and Palani hill ranges.

*Distribution* : Known to occur in southern India and in Sri Lanka.

*Remarks* : It breeds in hill-streams and jungle-pools.

### 31. *Aedes syntheticus* Barraud\*

1928. *Aedes syntheticus* Barraud *Ind. J. Med. Res.*, **16** : 375. Type locality : Tavargatti, Mumbai, Maharashtra.

*Recorded* From the Anamalai Hills.

*Distribution* : Occurs only in the western and southern parts of India.

*Remarks* : Like *Aedes stenoetrus*, this species breeds in streams and pools in hilly areas.

### 32. *Aedes vexans* (Meigen)\*

1830. *Aedes vexans* (Meigen) *Syst. Bechr.* **6** : 241 (as *Culex* ). Type locality : near Berlin (Ruthe).

*Recorded* From the mountains in Tamil Nadu.

*Distribution* : Occurs throughout the World at altitude up to 3,000 m.

*Remarks* : This species breeds in natural pools.

Genus *Armigeres* Theobald

Subgenus *Armigeres* Theobald

### 33. *Armigeres obturbans* (Walker)

1860. *Armigeres obturbans* (Walker) *Proc. Linn. Soc. Lond.*, **4** : 91 (as *Culex*). Type locality : Amboyna, Moluccas.

*Material collected and examined* : From houses and cattle-sheds close to Murikulam pond, 2 km east of Nagerciol, and from huts in Mandaikkadu, Kaniyakumar district; 18.iii.99; 2F; from the PWD guest house close to Vaigai river tributary in Periakulam; 9.ii.01; 1F, 1M.

*Recorded* : From many parts of Tamil Nadu.

*Distribution* : Occurs commonly throughout India, Sri Lanka, Malaysia, Sumatra, China and Japan.

*Remarks* : It breeds in tree-holes, bamboos, domestic collections of water, including foul water.

Subgenus *Leicesteria* Theobald

### 34. *Armigeres annulitarsis* Leicester

1908. *Armigeres annulitarsis* Leicester *Cul. Malaya*, **99**. Type locality : Kuala Lumpur, Malaysia.

*Material collected and examined* : From the PWD guest house close to a tributary of river Vaigai in Periakulam, Theni district; 9.ii.01; 1M, 1F.

*Recorded* : From Nilgiri District.

*Distribution* : Occurs mainly in northeast and southwestern parts of India and in Malaysia, Thailand, Sumatra and Taiwan.

*Remarks* : It breeds in bamboo-stumps.

### 35. *Armigeres flavus* (Leicester)

1908. *Armigeres flavus* (Leicester) *Cul. Malaya*, 101 (as *Chaetomyia*). Type locality : West Malaysia.

*Material collected and examined* : From the PWD guest house close to the Vaigai River tributary in Periakulam; 9.ii.01; 9F, 4M.

*Recorded* : From many parts of Tamil Nadu.

*Distribution* : From forest areas in northeastern and southwestern parts of India, and in Malaysia, Thailand, Sumatra, Java and Borneo.

*Remarks* : Breeding places include bamboos, coconut-shells, pitcher-plants.

### 36. *Armigeres magnus* (Theobald)\*

1905. *Armigeres magnus* (Theobald) *Rec. Ind. Mus.*, 2 : 293 (as *Brevirhyncus*). Type locality : Sylhet, Bangladesh, India.

*Recorded* : From the western districts of Tamil Nadu.

*Distribution* : Similar to that of *Armigeres fluvas* except Thailand.

*Remarks* : It breeds in pitcher plants.

### Genus *Christophersiomyia* Barraud

#### 37. *Christophersiomyia thomsoni* (Theobald)\*

1905. *Christophersiomyia thomsoni* (Theobald) *Gen. Ins., Fam. Culicidae*, 18. (as *Stegomyia*). Type locality : N W Province, Pakistan.

*Recorded* : From Tamil Nadu.

*Distribution* : Occurs mainly in the plains of North West, North, East and South of India.

*Remarks* : The species breeds in tree-holes.

Genus *Diceromyia* Theobald38. *Diceromyia micropterus* (Giles)\*

1901. *Diceromyia micropterus* (Giles) *J. Bombay Nat. Hist. Soc.* **13** : 609 (as *Culex*). Type locality : Allahabad, Uttar Pradesh, India.

*Recorded* : From Tamil Nadu.

*Distribution* : Common in plains of India.

*Remarks* It breeds in tree-holes.

39. *Diceromyia agastyai* (Tewari and Hiriyan)\*

1992. *Diceromyia agastyai* Tewari and Hiriyan *Mosq. Syst.* **24** : 314, Type locality : Kannidatti, Ambasamudram, Tirunelveli District, Tamil Nadu.

*Distribution* : This species is known only from the type locality in Tamil Nadu.

Genus *Fredwardsius* Reinert40. *Fredwardsius vittatus* (Bigot)

1861. *Fredwardsius vittatus* (Bigot) *Ann. Soc. Ent. France*, **1** : 227 (as *Culex*). Type locality : Corsica.

*Material collected and examined* : From cattle-shed in Veeravandyur, 30 km west of Tirunelveli; 19.xii.97; 4F.

*Recorded* From Tamil Nadu.

*Distribution* Occurs throughout India and in the Mediterranean region and Africa.

*Remarks* It breeds in rock-pools, tree-holes and domestic collections of water.

Tribe *Aedini*Genus *Mucidus* Theobald41. *Mucidus scatophagoides* Theobald\*

1901. *Mucidus scatophagoides* Theobald, *M.C.*, **1** : 277. Type locality : Myigyan, Myanmar.

*Recorded* : From Tamil Nadu

*Distribution* Occurs widely in central and southern parts of India and in Sri Lanka, Myanmar and Africa.

*Remarks* The larvae live in open natural pools and are predaceous on other mosquito larvae.

Genus *Neomelaniconion* Newstead

42. *Neomelaniconion lineatopennis* (Ludlow)

1905. *Neomelaniconion lineatopennis* (Ludlow) *Can. Ent.*, **37** : 133 (as *Taeniorhyncus*). Type locality : Luzon, Philippines.

*Material collected and examined* : From the PWD Guest house close to the sea coast in Tuticorin; 2.ii.2k; 1F.

*Recorded* : From Tamil Nadu.

*Distribution* : Widespread from the Punjab to Assam and through peninsular India to Andaman Islands and from Sri Lanka, Myanmar, Malaysia, Philippines, Australia and Africa.

*Remarks* : Breeding habitats include open natural pools.

43. *Neomelaniconion oreophilus* (Edwards)\*

1916. *Neomelaniconion oreophilus* (Edwards), *Bull. Ent. Res.*, **4** : 357 (as *Ochlerolatus*). Type locality : Gharia, W. Himalayas.

*Recorded* : From the Nilgiri Hills.

*Distribution* : The commonest tree-hole breeding mosquito found in the Himalayas and Nilgiris in India.

44. *Neomelaniconion psedotaeniatus* (Giles)\*

1901. *Neomelaniconion psedotaeniatus* (Giles), *J. Bombay Nat. Hist. Soc.*, **13** : 607 (as *Culex*). Type locality : Naini Tal, Uttra Pradesh, India.

*Recorded* : From Tamil Nadu.

*Distribution* : Occurs throughout India and in Pakistan, Afghanistan, Myanmar and Sri Lanka.

*Remarks* : Habitats are tree-holes, rock-pools, drains and other artificial cisterns.

Genus *Ochlerotatus* Lynch Arribalzaga

Subgenus *Brucesharrisonius* Reinert

45. *Ochlerotatus greeni* (Theobald)\*

1903. *Ochlerotatus greeni* (Theobald), *M.C.*, **3** : 289 (as *Howardina*). Type locality : Peradeniya, Sri Lanka.

*Recorded* : From Tamil Nadu.

*Distribution* : Common in the forests in India and Sri Lanka.

*Remarks* : Breeding places are tree-holes and mambo-stumps.

**46. *Ochlerotatus inquinatus* Edwards\***

1922. *Ochlerotatus inquinatus* Edwards, *Ind. J. Med. Res.*, **10** : 267 : Type locality : Simla, India.

*Recorded* : From the Nilgiri Hills.

*Distribution* : Known to occur in western Himalayas and in Nilgiri Hills of southern India.

*Remarks* : It breeds in tree-holes.

**47. *Ochlerotatus macdougalli* Edwards\***

1922. *Ochlerotatus macdougalli* Edwards, *Ind. J. Med. Res.*, **10** : 271. Type locality : Diyatalawa, Sri Lanka.

*Recorded* : From Coonoor in Nilgiri Hills.

*Distribution* : Occurs only in southern India and Sri Lanka.

*Remarks* : Sources of breeding habitats include bamboos, rock-pools and rivers.

Genus *Rhinoskusea* Edwards

**48. *Rhinoskusea portonovensis* Tewari and Hiriyan\***

1991. *Rhinoskusea portonovoensis* Tewari and Hiriyan, *Mosquito Systematics*, **23** : 123. Type locality : Pitchavaram, south India.

*Distribution* : Known only from the type locality.

*Remarks* : It breeds in crab holes of the mangrove forests and the adults rest indoors.

Genus *Stegomyia* Theobald

**49. *Stegomyia aegypti* (Linnaeus)**

1762. *Stegomyia aegypti* (Linnaeus) *Hasselquist's Resise nach Palestina*, 470 (as *Culex*). Type locality : Egypt.

*Material collected and examined* : From houses in Kattunaikken street near Kanyiakumari township; 18.xii.97; 1 F; from huts in Mandaikkadu forest swamp 30 west of Nagerciol; 18.iii.99; 2F.

*Recorded* : From Chennai, Pondicherry, Karaikkal and Tuticorin.

*Distribution* : Occurs throughout the Indian Region and other tropical and subtropical areas.

**Remarks** : This species breeds in a wide variety of natural and artificial water containers but it is unusual to find its larvae in tree-holes or bamboo-stumps. It is the well-known vector of yellow fever in Africa and Latin America and of dengue fever in most parts of tropical and subtropical of the World.

#### 50. *Stegomyia albopictus* (Skuse)

1894. *Stegomyia albopictus* (Skuse) *Ind. Mus. Notes*, 3 : 20 (as *Culex* ). Type locality : Kolkata, India.

**Material collected and examined** : From bushes close to cattle-sheds in Kilakarai, 25 km southeast of Ramanathapuram; 22.xii.97; 2F.

**Recorded** : From many parts of southern India including Tamil Nadu.

**Distribution** : Known from the Indian states of West Bengal and Maharashtra, East and South East Asia, Madagascar, USA, Brazil, Italy, Arabia and France.

**Remarks** It breeds in bamboo-stumps. It acts as a vector of *Stegomyia aegypti* for dengue virus in sub urban areas in East and South East Asia.

#### Genus *Udaya* Thurman

#### 51. *Udaya subsimillis* Barraud

1927. *Udaya subsimillis* Barraud *Ind. J. Med. Res.* 14 : 552. Type locality : Sukna, Darjeeling dist., West Bengal, India.

**Material collected and examined** : From a goat-shed in Palani township; 12.ii.01, 1F.

**Recorded** : For the first time in southern India.

**Distribution** : Known from the type locality in Darjeeling dist., West Bengal and in Palani, Tamil Nadu, India.

**Remarks** : It breeds in hollow bamboos.

#### Genus *Verrallina* Theobald

#### 52. *Verrallina agrestis* Barraud\*

1931. *Verrallina agrestis* Barraud *Ind. J. Med. Res.* 19 : 613. Type locality : Nilgiri Hills, Tamil Nadu, India.

**Recorded** : From the Nilgiri district.

**Distribution** : Known only from Nilgiri Hills in Tamil Nadu and from Nagargali in Maharashtra State, India and not known from elsewhere.

**Remarks** : It breeds in streams.

**53. *Verrallina indicus* (Theobald)\***

1907. *Vē. indicus* (Theobald) *M. C. iv*, : 238 (as *Neomacleaya*). Type locality : Lahore, Punjab, Pakistan.

*Recorded* From Chennai in Tamil Nadu.

*Distribution* : Occurs throughout India and Pakistan and is not known elsewhere.

*Remarks* : It breeds in open pools, rain-filled ditches.

**54. *Verrallina pseudomediofasciatus* (Theobald)\***

1910. *Verrallina pseudomediofasciatus* (Theobald) *M.C. 5* : 489 (as *Skusea*). Type locality : Peradenya, Sri Lanka.

*Recorded* : From Chennai, Coimbatore and Nilgiri Hills.

*Distribution* : Occurs only in peninsular India and in Sri Lanka.

*Remarks* : It breeds in hill-streams and swamps.

**Tribe *Culicini***

**Genus *Culex* Linnaeus**

**Subgenus *Lutzia* Theobald**

**55. *Culex fuscus* Wiedemann**

1820. *Culex fuscus* Wiedemann *Dipt. Exot. 1* : 9. (Type locality : Ind. or non-existent.)

*Material collected and examined* : From houses and cattle-sheds close to a pool in Kilakarai town, 25 km southeast of Ramanathapuram; 22.xii.97; 2F, 3M; from a goat-shed in Palani township; 12.ii.01; 12 F, 3 M.

*Recorded* : From many areas of Tamil Nadu.

*Distribution* : Common over large part of Indian and Malaysia, Thailand, Philippines and southern China.

*Remarks* : Its breeding habitats include natural pools, shallow wells and domestic collections of water.

**56. *Culex raptor* Edwards**

1922. *Culex raptor* Edwards *Ind. J. Med. Res. 10* : 275. Type locality : Amritsar, Punjab, India.

*Material collected and examined* : From goat-sheds in Sirumalai Hills, ~500 m MSL, Palani hill ranges and from houses and cattle-sheds in Dindigult township; 13.ii.01, 10 M.

*Recorded* : From many areas of Tamil Nadu.

*Distribution* : Occurs commonly in many parts of India, except Assam and from Myanmar and southern China.

*Remarks* : The same breeding habitats as those for *Culex fuscanus*.

#### 57. *Culex vorax* Edwards

1921. *Culex vorax* Edwards *Bull. Ent. Res.* 12 : 327. Type locality : Tokyo, Japan.

*Material collected and examined* : From the PWD Guest house close to the tributary of river Vaigai in Periakulam, Theni district; 9.ii.01; 1F.

*Recorded* : From Combatore and Nilgiri Hills.

*Distribution* : Occurs mainly in mountainous localities in India and Japan.

*Remarks* : It breeds in natural-pools, shallow wells and domestic collections of waters.

#### 58. *Culex halifaxi* Theobald

1903. *Culex halifaxi* Theobald *M.C.* 3 : 231, Type locality : Dindings, West Malaysia.

*Material collected and examined* : From huts and houses close to brackish water, rice-fields in Trichendur township; 16.iii.99; 2F.

*Recorded* : from many parts of Tamil Nadu.

*Distribution* : Known from Assam in India and from Malaysia, Philippines, south China and Australia.

*Remarks* : It breeds in a wide range of habitats including rice-fields, pool of dirty water and other domestic water collections always with *Culex quinquefasciatus* Say.

#### Subgenus *Mochthogenes* Edwards

#### 59. *Culex iphis* Barraud\*

1924. *Culex iphis* Ind. *J. Med. Res.* 11 : 1279. Type locality : Nilgiri Hills, Tamil Nadu, India.

*Distribution* : Known only from the type locality.

*Remarks* : It breeds in rock-pools, ground-pools and tree-holes.

#### 60. *Culex khazani* Edwards

1922. *Culex khazani* Edwards *Ind. J. Med. Res.* 10 : 286. Type locality : Pudupadi, Kerala, India.

*Material collected and examined* : From the PWD guest- house in Courtalam, Tirunelveli dist., 6.ii.2k; 3M, 11F.

*Distribution* This species is known only from the western ghats of peninsular India.

*Remarks* : It breeds in tree-holes.

#### 61. *Culex malayi* (Leicester)\*

1908. *Culex malayi* (Leicester) *Cul. Malaya*, 184 (as *Aedes*). Type locality : Kuala Lumpur, Malaysia.

*Recorded* : Commonly from Tamil Nadu.

*Distribution* : It occurs commonly throughout India, Malaysia and southern China.

*Remarks* : It breeds in ground-pools.

#### Subgenus *Lophoceratomyia* Theobald

#### 62. *Culex minutissimus* (Theobald)\*

1907. *Culex minutissimus* (Theobald) *M. C.* 4 : 235 (as *Culiciomyia*) : Type locality : Peradeniya, Sri Lanka.

*Recorded* : From Tamil Nadu.

*Distribution* : It is common throughout India and also found in Celebes, Indonesia.

*Remarks* : The sources of breeding places are springs with rocky beds, pools in ravines and river-beds, artificial collections of water, and shallow wells.

#### 63. *Culex flavicornis* Barraud\*

1924. *Culex flavicornis* Barraud *Ind. J. Med. Res.* 12 : 45. Type locality : Nilgiri Hills, Tamil Nadu, India.

*Recorded* : From the Nilgiri Hills, Palani and Kodaikkanal hills in Maduari district of Tamil Nadu, not known from elsewhere.

*Remarks* : ground-pools, shallow wells and tree-holes.

#### 64. *Culex raghavanii* Rahman, Choudhury and Kalra\*

1968. *Culex raghavanii* Rahman, Choudhury and Kalra, *Bull. Ind. Soc. Mal. Com. Dis.* 28. Type locality : Coonoor, Nilgiris, Tamil Nadu.

*Distribution* : Known only from the type locality.

*Remarks* : It breeds in rock-pools containing decaying leaves.

Subgenus *Culiciomyia* Theobald

65. *Culex pallidothorax* Theobald\*

1905. *Culex pallidothorax* Theobald J. Econ. Biol. 1 : 32 (as *Culex*).

*Type locality* : India.

*Recorded* : In Tamil Nadu.

*Distribution* : Common in most part of India and in Sri Lanka, Malaysia, Thailand, southern China and Celebes.

*Remarks* : It breeds in tree-holes, bamboos, shallow wells, streams and rock-pools, swampy ground-pools, some times in foul water.

Subgenus *Culex* Linnaeus

66. *Culex epidesmus* (Theobald)

1910. *Culex epidesmus* (Theobald) Rec. Ind. Mus. 4 : 22 (as *Taeniorhyncus*).

*Type locality* Bhogaon, Purnea dist., Bihar, India.

*Material collected and examined* : From houses between paddy fields and brackish water near Trichendur township; 16.iii.99; 6F; from the PWD Guest house close to a tributary of river Vaigai in Periakulam, Theni district; 9.ii.01; 1F.

*Recorded* : From Tamil Nadu.

*Distribution* : Widespread from all parts of India and Sri Lanka but not known from other places. It is known as a vector of Japanese Encephalitis (JE) virus in parts of north India.

*Remarks* : It breeds in ground-pools.

67. *Culex bitaeniorhyncus* Giles

1901. *Culex bitaeniorhyncus* Giles J. Bombay Nat. Hist. Soc., 12 : 67.

*Type locality* : Trivandrum, Kerala, India.

*Material collected and examined* : From goat-sheds and houses in Palani township, Dindigul district; 12.ii.01; 2f; 2m.

*Recorded* : As a common species in Tamil Nadu.

*Distribution* : Common in India, Africa, Japan and Australia.

*Remarks* This species breeds in open weedy pools and other fresh water habitats. It is a proven vector of JE virus.

#### 68. *Culex cornutus* Edwards\*

1922. *Culex cornutus* Edwards *Ind. J. Med. Res.* 10 : 283.

*Type locality* : Tavargatti, Belgaum district, Karnataka, India.

*Recorded* : From Ennore, Chennai.

*Distribution* : Occurs in the western parts of India from Mumbai to southern India but not known elsewhere.

*Remarks* : It breeds in ground-pools, jungle-pools and fallow rice fields.

#### 69. *Culex sitiens* Wiedemann

1828. *Culex sitiens* Wiedemann *Aussereur. Zweifl. Insec.* 1 : 542.

*Type locality* : Sumatra.

*Material collected and examined* : From huts, houses, goat and cattle-sheds in Rameshwaram Isle. 10.iii.'97; 12 M, 2F.

*Recorded* : On the coasts of Tamil Nadu.

*Distribution* Common species on the seacoasts and islands of the Oriental, East African and Australasian Regions.

*Remarks* : It breeds in brackish pools near seacoasts and is a known vector of JE and Brugian filariasis.

#### 70. *Culex vishnui* Theobald

1901. *Culex vishnui* Theobald *M. C.* 1 : 355.

*Type locality* : Chennai, India.

*Material collected and examined* : From human dwellings in Madavapuram village near a community pond, Kaniyakumar township; 18.xii.97; 1F, 3M.

*Recorded* : From rice fields in many localities of Tamil Nadu.

*Distribution* It is a common species in India, Sri Lanka, from Mediterranean to China and Japan and New Guinea.

*Remarks* : It breeds in ground pools, rice-fields, salt marshes etc. It is a vector of JE virus in India, Sri Lanka, Thailand and Taiwan.

71. *Culex barraudi* Edwards\*

1922. *Culex barraudi* Edwards *Ind. J. Med. Res.* 10 : 284.

*Type locality* : Mahdopur, Punjab, India.

*Recorded* : From Karaikkal in Pondicherry and from Tanjore district in Tamil Nadu.

*Distribution* : It is known mainly from Punjab, Himachal Pradesh, and Tamil Nadu in India, and in Sri Lanka.

*Remarks* : It breeds in ground-pools and marshes.

72. *Culex tritaeniorhyncus* Giles

1901. *Culex tritaeniorhyncus* Giles *J. Bombay Nat. Hist. Soc.*, 13 : 606.

*Type locality* : Trivandrum, Kerala, India.

*Material collected and examined* : From cattle-sheds and houses close to a fresh water pond in Madavapuram village, Kanyakumari Township; 18.xii.97; 3F.

*Recorded* : It is known widely from Tamil Nadu.

*Distribution* : It is commonly found throughout India and its geographical distribution ranges from Mediterranean to China, Japan, Celebes and Africa.

*Remarks* : It breeds in ground-pools, rice-fields, salt-marshes and a wide variety of aquatic habitats. It is a well known vector of JE virus in the Oriental Region and is also known to transmit dengue virus and filarial parasites.

73. *Culex whitmorei* (Giles)

190. *Culex whitmorei* (Giles), *J. Trop. Med.* 7 : 367 (as *Tritaeniorhyncus*).

*Type locality* : Philippines.

*Material collected and examined* : From houses in Madavapuram close to a pond in Kanyakumari township; 18.xii.97; 1F, 1M; cattle-sheds in Murikulam village near lake, 2 km east of Nagercoil, from huts in Mandaikkadu swamp in Kanyakumar district; 2F. 3M.

*Recorded* : From Nilgiri Hills up to 2, 500m and many other localities of Tamil Nadu.

*Distribution* : It occurs widely in India, Sri Lanka, Malaysia, Philippines, West China and Japan.

*Remarks* : It breeds in paddy fields, and margins of ponds and lakes. It is a vector of JE virus in India and Sri Lanka.

#### 74. *Culex gelidus* Theobald

1901. *Culex gelidus* Theobald *M. C.*, 2 : 20.

*Type locality* : Selangor, Malaysia.

*Material collected and examined* : From huts, in Kottaram village, Suchindram wetlands near Nagerciol; 18.xii.97; 1M; from cattle-sheds and houses in Madavapuram close to a lake near Kaniyakumari township; 14.ii.01; 13F, 1M; from houses and cattle-sheds close to fresh water lake in Veeravandiyur, 25 km west of Tirunelveli; 19.xii.97; 4F, 11M; from cattle-sheds close to a community pond in Kilakari 25 southeast of Ramanathapuram; 22.xii.97; 2F, 2M; from the houses and goat and cattle-sheds near mine-pits and rice-fields, Narasingham, wetlands of Agriculture college campus, 30 km east of Maduari; 14.ii.01; 8F.

*Recorded* : From many parts of Tamil Nadu.

*Distribution* : It is a common species in India, Sri Lanka, Malaysia, Thailand, Philippines, southern China and Taiwan.

*Remarks* : It breeds in marshy tracts and weedy and ground-pools. It is a proven vector of JE virus in India, Sri Lanka, Thailand, Vietnam and Malaysia.

#### 75. *Culex mimeticus* Noe\*

1899. *Culex mimeticus* Noe' *Bull. Soc. Ent. Ital.* 31 : 240.

*Type locality* : Basilicata, Italy.

*Recorded* : From the hilly areas of Tamil Nadu.

*Distribution* : Common in hilly areas and highlands and occasionally in the plains of India and extends from Mediterranean to south China, Taiwan and Sri Lanka.

*Remarks* : It breeds in streams and pools.

#### 76. *Culex mimulus* Edwards\*

1915. *Culex mimulus* Edwards *Bull. Ent. Res.* 5 : 284.

*Type locality* : Sarawak, East Malaysia.

*Recorded* : From Tamil Nadu.

*Distribution* : It is a common species throughout India, Sri Lanka, Malaysia, Hong Kong and Australia.

*Remarks* : This species breeds in ground-pools.

77. *Culex nilgiricus* Edwards\*

1916. *Culex nilgiricus* Edwards *Bull. Ent. Res.* 6 : 358.

*Type locality* : Ootacamund, Nilgiri Hills, south India.

*Distribution* : It is known only from the type locality.

*Remarks* : It breeds in hill-streams and rock-pools.

78. *Culex vagans* Wiedemann

1828. *Culex vagans* Wiedemann *Aussereurop. Zweifl.* 1 : 545.

*Type locality* : Foochow, China.

*Material collected and examined* : From huts, houses close to brackish water, rice-fields in Trichendur Township; 16.iii.99; 4F.

*Recorded* : From many areas of Tamil Nadu.

*Distribution* : It is a common species throughout India and but less common in eastern parts of India, eastern China and Siberia.

*Remarks* : It breeds in ground-pools, marshes and pools in beds of streams

79. *Culex quinquefasciatus* Say

1823. *Culex quinquefasciatus* Say *J. Acad. Nat. Sci. Phila.*, 3 : 10.

*Type locality* : New Orleans, U.S.A.

*Material collected and examined* : From human dwellings, and cattle-sheds near Madavapuram pond, Kaniyakumari township, Marikulam pond 2 km east of Nagercoil of Kaniyakumari district; 17 and 18.xii.97; 2F, 1 M; Trichendur township; 16.iii.99; 10F, 5 M; Kilmathur, 12 west of Madurai; 15.ii.01; 11F; Dindigul township; 13.ii.01, 30F; Palani township; 12.ii.01; 15F, 10M.

*Recorded* This species is common throughout Tamil Nadu.

*Distribution* : It occurs throughout tropics and subtropics of the world.

*Remarks* : This species is the most common, domestic species occurring abundantly in houses and all types of human and animal shelters and also up to 2,000 m or more in the hills. Breeds in any type of aquatic habitat, ranging from fresh water to highly polluted, foul stagnant pools, ditches, septic tanks etc. It is one of the serious pests of human beings in the tropics and is an important vector of bancroftian filariasis in the Oriental Region, urban East Africa and N E Brazil and also of JE virus in Vietnam.

80. *Culex fuscocephalus* Theobald

1907. *Culex fuscocephalus* Theobald M. C. 4 : 420.

*Type locality* : Peradeniya, Sri Lanka.

*Material collected and examined* : From houses and cattle-sheds close to a community pond in Kilakarai 25 south east of Ramathapuarm; 22.xii.97; 1F, 2M.

*Recorded* : From many areas of Tamil Nadu.

*Distribution* : It occurs widely in India, Sri Lanka, Malaysia, Thailand, Philippines and south China.

*Remarks* : It breeds in ground-pools and rice-fields.

81. *Culex mimuloides* Barraud\*

1933. *Culex mimuloides* Barraud *Fauna Brit. Ind.*, 5 : 451.

*Type locality* : Nilgiri, Palani and Kodaikkanal Hills, south India.

*Distribution* : known only from the type localities.

*Remarks* : It breeds in streams and pools.

82. *Culex fuscifurcatus* Barraud\*

1933. *Culex fuscifurcatus* Barraud *Fauna Brit. Ind.*, 5 : 451.

*Type locality* : Ootcamund, Nilgiri Hills, south India.

*Distribution* : It is known only from the type locality.

*Remarks* : It breeds in streams and pools.

Tribe **Culisetini**Genus *Culiseta* Felt83. *Culiseta indica* (Edwards)

1920. *Culiseta indica* Edwards *Bull. Ent. Res.* 10 : 137.

*Type locality* : Gurdaspur dist. Punjab, India.

*Recorded* : From huts near a swamp in Mandaikkadu 30 km west of Nagercoil, Kaniyakumari dist.; 18.iii.99. 1F.

*Distribution* : Known mainly from northern India. This is a new record for Tamil Nadu

Remarks : This species, like other members of this genus, breeds in ground pools and hill-streams.

Tribe **Ficalbiini**

Genus *Ficalbia* Theobald

84. *Ficalbia chamberlaini* (Ludlow)\*

1904. *Ficalbia chamberlaini* (Ludlow) *Can. Ent.* **36** : 297 ( as *Mimomyiai*).

*Type locality* : Bayamban, Luzon, Philippines.

*Recorded* : Throughout Tamil Nadu.

*Distribution* : Occurs throughout India and Myanmar, Philippines and Sri Lanka.

*Remarks* It breeds in pools and ponds especially those containing vegetation.

Genus *Mansonia* Blanchard

Subgenus *Coquillettidia* Dyar

85. *Mansonia crassipes* (van der Wulp)\*

1892. *Mansonia crassipes* van der Wulp *Bijd. Fauna Mid. Sumatra, Dipt.*, 9. (as *Culex*).

*Type locality* : Soeroelangoen, Sumatra..

*Recorded* Occurs widely in Tamil Nadu.

*Distribution* : It has a wide distribution in India, Malaysia, Australia and Fiji.

*Remarks* : This species breeds in the roots of aquatic plants.

Subgenus *Mansonoides* Theobald

86. *Mansonia annulifera* (Theobald)

1901. *Mansonia annulifera* Theobald *M. C.* **2** : 183 (as *Panoplites*).

*Type locality* : Chennai, India.

*Material collected and examined* From cattle-sheds and indoors in Veeravandiyur village, 30 km west of Tirunelveli; 19.xii.97; 2F.

*Recorded* : Throughout Tamil Nadu.

*Distribution* It occurs widely in India, Malaysia, Thailand, Philippines and Sri Lanka.

Remarks : It breeds in the rootlets of floating vegetation in ponds and swamps. It is an important vector of Brugian filariasis.

### 87. *Mansonia indiana* Edwards

1930. *Mansonia indiana* Edwards *Bull. Ent. Res.* **21** : 54.

*Type locality* : Bandjaran, Java.

*Material collected and examined* : From goat-sheds near mine-pits in Narasingham, 12 km east of Madurai; 14.ii.01; 10F.

*Recorded* : From Coonoor in Nilgiri District.

*Distribution* : Occurs in India mainly from Assam, West Bengal, Tamil Nadu and Trivandrum.

*Remarks* : This species breeds in swamps and pools and is a known vector of Brugian filariasis.

### 88. *Mansonia uniformis* (Theobald)

1901. *Manonia uniformis* (Theobald) *M.C.* **2** : 180 (as *Panoptlites*).

*Type locality* : Quilon, India.

*Material collected and examined* : From houses and cattle-sheds near a lake in Veeravandiyur, 30 km west of Tirunelveli; 19.xii.97; 1F, 1M; from huts near a swamp in Mandaikkadu 30 km west of Nagercoil, Kanyakumari dist.; 18.iii.99; 2F.

*Recorded* : In many parts of Tamil Nadu.

*Distribution* : Occurs commonly throughout India and other parts of the Oriental Region and in Africa, Japan and Australia.

*Remarks* : This species breeds in swamps and pools and is a known vector of Brugian filariasis.

### Tribe Sabethini

#### Genus *Tripteroides* Giles

#### Subgenus *Rachinotomyia* Theobald

### 89. *Tripteroides aranoides* (Theobald)\*

1901. *Tripteroides aranoides* (Theobald) *M. C.*, **2** : 274 (as *Wyeomyia*).

*Type locality* : Taiping, Malaysia.

*Recorded* : From the Nilgiri Hills.

*Distribution* : Occurs mainly in the hilly areas of northeast, and southern India also Andaman Islands and in Myanmar, Thailand, Borneo, Java and Sri Lanka.

*Remarks* : The breeding places are tree-holes, bamboos and pitcher plants.

90. *Tripteroides affinis* (Edwards)\*

1913. *Tripteroides affinis* (Edwards) *Bull. Ent. Res.* 4 : 241 (as *Rachinotomyia*).

*Type locality* : Hakgala, Sri Lanka.

*Recorded* : From the Nilgiri Hills.

*Distribution* : Occurs in the hilly areas of south India and in Sri Lanka.

*Remarks* : Known to breed in tree-holes.

Tribe **Uranotaeniini**

Genus *Uranotaenia* Lynch Arrbalzaga

91. *Uranotaenia stricklandi* Barraud\*

1926. *Uranotaenia stricklandi* Barraud *Ind. J. Med. Res.*, 14 : 345. Balasum river, Darjeeling dist., West Bengal, India.

*Recorded* : From the Nilgiri Hills.

*Distribution* : Occurs mainly in northeast and southern India.

*Remarks* : Breeding places are streams and rivers.

Subfamily TOXORHYNCHITINAE

Genus *Toxorhynchites* Theobald

Subgenus *Toxorhynchites* Theobald

92. *Toxorhynchites minimus* Theobald\*

1905. *Toxorhynchites minimus* Theobald *J. Bombay Nat. Hist. Soc.* 16 : 237.

*Type locality* : Yatiyantota, Sri Lanka.

*Recorded* : From the Anamalai Hills of Coimbatore district.

*Distribution* : It has a restricted distribution in north Kanara and Anamalai hills of south India and in Sri Lanka and Sumatra.

*Remarks* It breeds in bamboos and tree holes.

### 93. *Toxorhynchites splendens* (Wiedemann)

1819. *Toxorhynchites splendens* Wiedemann *Zool. Mag.*, 3 : 2 (as *Culex* ).

*Type locality* : Java.

*Material collected and examined* : From cattle-sheds near a lake in Veeravandiyur, 30 km west of Tirunelveli; 19.xii.97, 1F.

*Recorded* : Throughout Tamil Nadu.

*Distribution* : Occurs commonly in most part of India and in Malaysia, Thailand, Philippines, Hong Kong and Sri Lanka.

*Remarks* : This species breeds in domestic collections of waters such as water butts, earthen jars close to human dwellings. Its larvae are known to prey upon the larvae of other mosquito species and are therefore used as a biological control agent of mosquitoes.

## CONCLUSION

*Current status of mosquito taxonomy in Tamil Nadu and India* : The wetlands surveyed for mosquito fauna comprise 8 districts in southern Tamil Nadu, which represents one third of the state geographical area. The number of mosquito species recorded from different types of wetlands of the state yields 40 taxa including 10 species of Anophelinae with 2 new records and 24 Culicinae with 3 new records and 1 Toxorhynchitinae. This inventory updates the mosquito fauna for the entire state of Tamil Nadu to 93 species from 85, and enhances anophelines species to 25 from 23, culicines to 66 from 60 and 2 toxorhynchitines (Fig.14B). Further the mosquito faunal surveys also include 10 vector species of human *Plasmodium* parasites, 7 of Japanese Encephalitis (JE), 2 of dengue, 2 of Bancroftian filariasis, and 4 of Brugian filariasis. Clearly further study is awaited to incorporate detailed morphological description and distribution of each species and their association with disease vector status.

The mosquito fauna in India presents a major taxonomic crisis and has not been revised since the monumental publication of Anophelinae by Christophers (1933) and of Culicine by Barraud (1934). The number of mosquito species known in India by 1934 was 288 with 43 anophelines, 240 culicines and 6 toxorhynchitines. With the 43 species of Anophelinae, 10 species regarded by Christophers as varieties and yet another 5 species reinstated from the synonymies by the South East Asia Mosquito Research Project were added subsequently amounting to 58 taxa. After the gap of 70 years or more, the total number of mosquito taxa now known from India is 320 species ([http://www.mosquitocatalog.org/countries/grid.asp?page=1&fld=species\\_name&ord=ASC](http://www.mosquitocatalog.org/countries/grid.asp?page=1&fld=species_name&ord=ASC)) since then Indian mosquito fauna has neither been revised, nor have been added new taxa to the existing ones. Given the vast geographical features and availability of more number of samples from different parts of India the Anophelinae fauna is expected to 2 or 3 times increase. For example, what Christophers (1933) considered

*An. leucosphyrus* as one species is now treated as one of the largest groups with 22 species in the subgenus *Cellia*, many of them are malaria vectors in the Oriental Region. A similar taxonomic problem is encountered with the species complex of *An. hyrcanus* (Nguyen *et al.* 2000) and *An. minimus* (Chen *et al.*, 2002).

Chromosomal variation and molecular techniques provided useful information on the population structure and gene flow between members of the species complex in *An. culicifacis*, and *An. fluviatilis* (Subbarao, 1998) and *An. subpictus* (Suguna *et al.*, 1994). These techniques considered by Schmidt *et al.* (2001) are not only expensive and time-consuming but also hardly serve for large-scale field studies, morphological markers therefore continue to be used immensely for differentiating members of *An. farauti* complex of sibling species. Knowledge on the taxonomy of other subfamilies and genera of mosquitoes found in India is too little known and remains neglected (Fig 14). The subgenus *Culex*, for example, contains a number of species as vectors of JE virus and species such as the Bancroftian filarasis vector, *Cx. quinquefasciatus*. Barraud in 1934 described 25 species of *Culex* s.s. which were increased subsequently to 49 species by a thorough taxonomic revisionary study by Sirivanakarn in 1976. A combination of molecular studies and morphological studies has led to resolve the systematic and phylogeny of some important mosquito vectors (Krzywinsky and Besansky 2003). Further taxonomic studies using both morphological description and molecular markers for all groups of mosquitoes found in India are urgently required to control the disease vectors.

*Impact of climatic and environmental factors on mosquito-breeding wetlands* : The environmental and climatic change on wetlands has impact on mosquito fauna and their associated transmission dynamics of parasitic and viral diseases. Deforestation, for example, in the Himalayan Terai, in Uttar Pradesh has caused *Anopheles minimus*, and *An. fluviatilis* to change from their forest-stream breeding habitats to agriculture fields. As a result the former disappeared and the latter became an efficient malaria vector (Walsh *et al.*, 1993). Climatic factors such as temperature, humidity, rain falls, surface water, wind, and drought control aquatic habitats, which in turn regulate the biology of development and survival of mosquitoes. Higher temperature shortens the aquatic life cycle of mosquitoes from 20 to 7 days and reduces time between emergence and oviposition as well as the time between successive ovipositions. Higher values of relative humidity (50 to 60 %) lengthen the life-span of mosquitoes. Temperatures in association with humidity modify the vectorial capacity of the mosquitoes and enable them to infect more people and propagate the diseases. Heavy rainfalls can change the breeding pools into streams while conversely drought conditions can turn streams into pools. The appearance of such opportunistic mosquito breeding sites some times precedes epidemics of vector-borne diseases (Martin and Lefebvre, 1995). It can be argued that the protection and conservation of wetlands is important because habitat changes as a result of environmental and climatic changes, industrialization, pollution and urbanization could lead to epidemics of mosquito-borne diseases.

## SUMMARY

The wetlands of India are exceptionally diverse natural resources, which support for the survival of numerous animal and plant species, have great aesthetic value and their rich biodiversity play a significant role for sustainable environmental development and economic growth of human society. Wetlands are habitats of many species of mosquito, which spread the serious tropical diseases malaria, dengue, Japanese Encephalitis (JE), filariasis thus causing mortality, morbidity and economic losses in India. For the management and effective control of such diseases, knowledge of mosquito fauna and their associated breeding habitats of different wetland ecosystems are prerequisites. The inventory of mosquito fauna in wetlands from 8 districts of southern Tamil Nadu, representing one third of the state geographical area, reveals 40 species including 2 new records of Anophelinae and 3 new records of Culicinae. The number of known species of mosquitoes in Tamil Nadu is now increased to 92 from 85, consisting of 25 species of anophelines, 65 culicines and 2 toxorhynchitines. For each species taxonomic citation is presented with details of samples collected and examined from the surveys, geographical distribution and biological information especially breeding habitats and disease vector status. A need for further taxonomic study for all groups of mosquitoes found in India is emphasized. The impact of environmental and climatic changes on mosquito fauna, mosquito-borne diseases and their associated wetland ecosystem is discussed.

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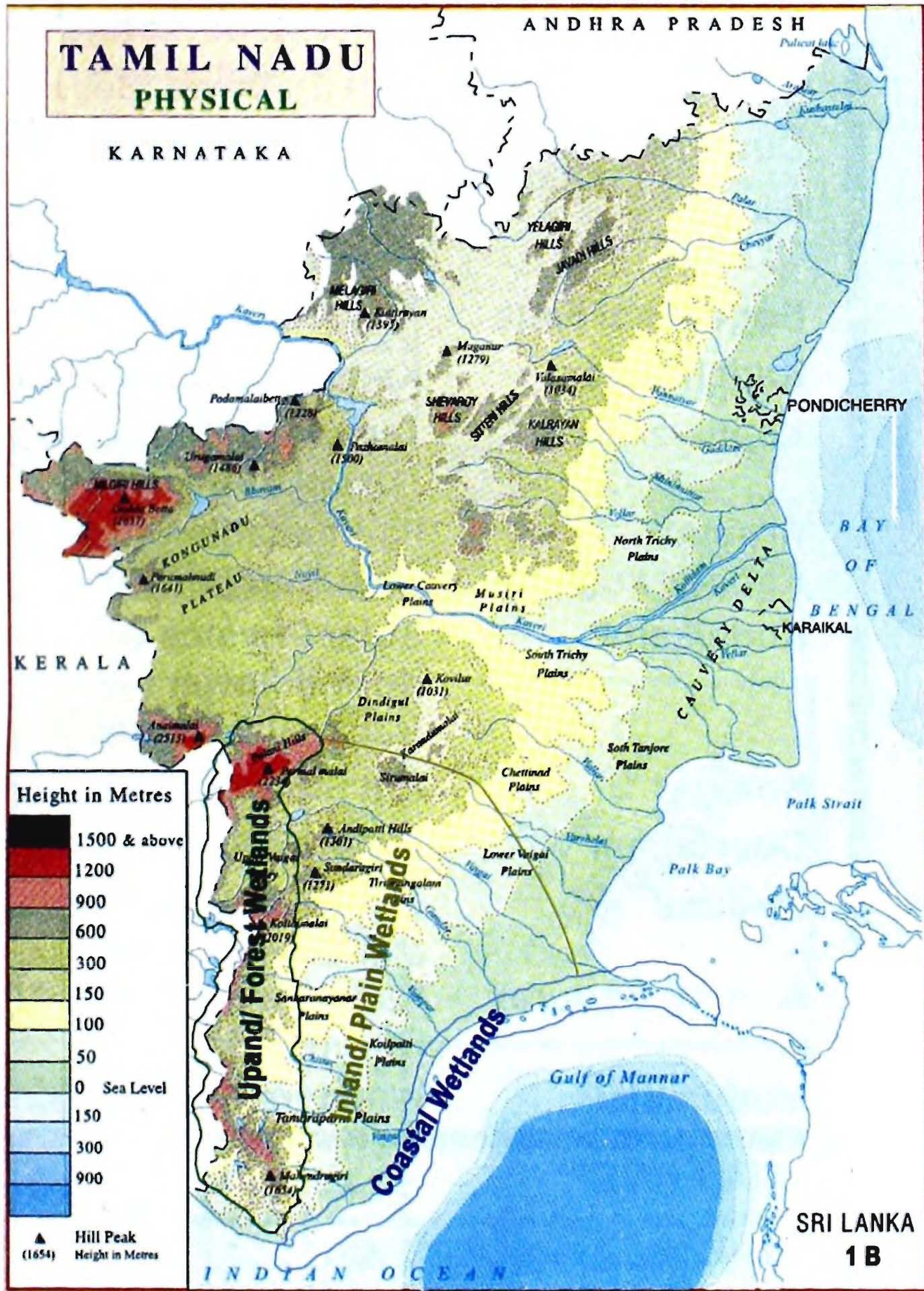


Fig. 1B. Outline Map showing the physical features of Tamil Nadu.



**Fig. 2.** (2A) Aerial view of the Rameshwaram Island photograph taken from island highest point, Gandamadana Parvatham showing the township and Gulf of Mannar. (2B) Entrance of the temple that leads to the bay. (2C) Where pilgrims taking holy dips. (2D) The Rameshwaram Island known for its malaria endemic has a permanent field station of Tamil Nadu Public Health department with which four party members of the ZSI joined during mosquito survey of the Island.



**Fig. 3. (3A)** Adult mosquitoes collected from the huts in Karayur, 6 km southeast of the Rameshwaram town. **(3B)** Immature stages of mosquitoes collected from the fresh water canal near Pamban, 13 km southwest of the Rameshwaram town.

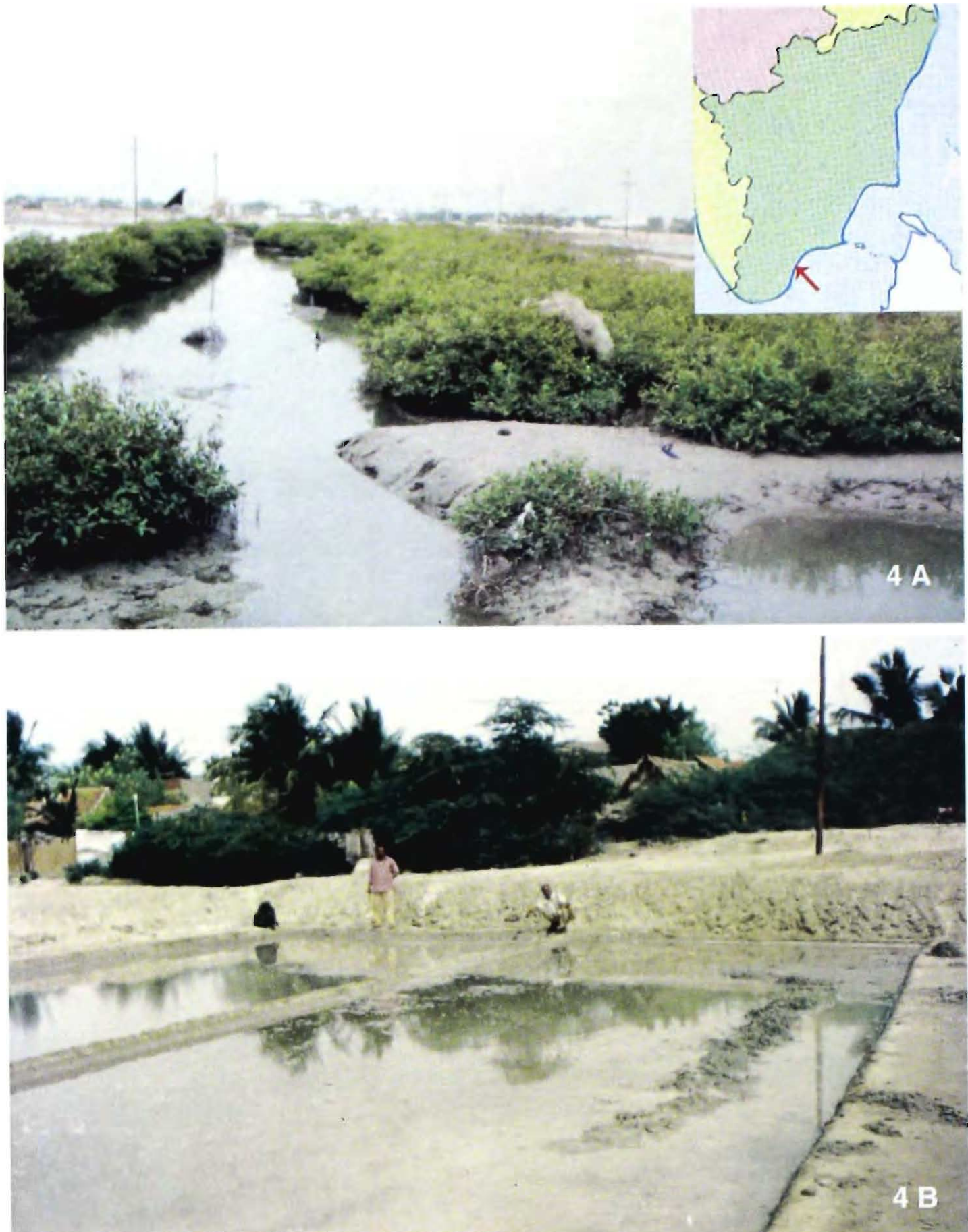
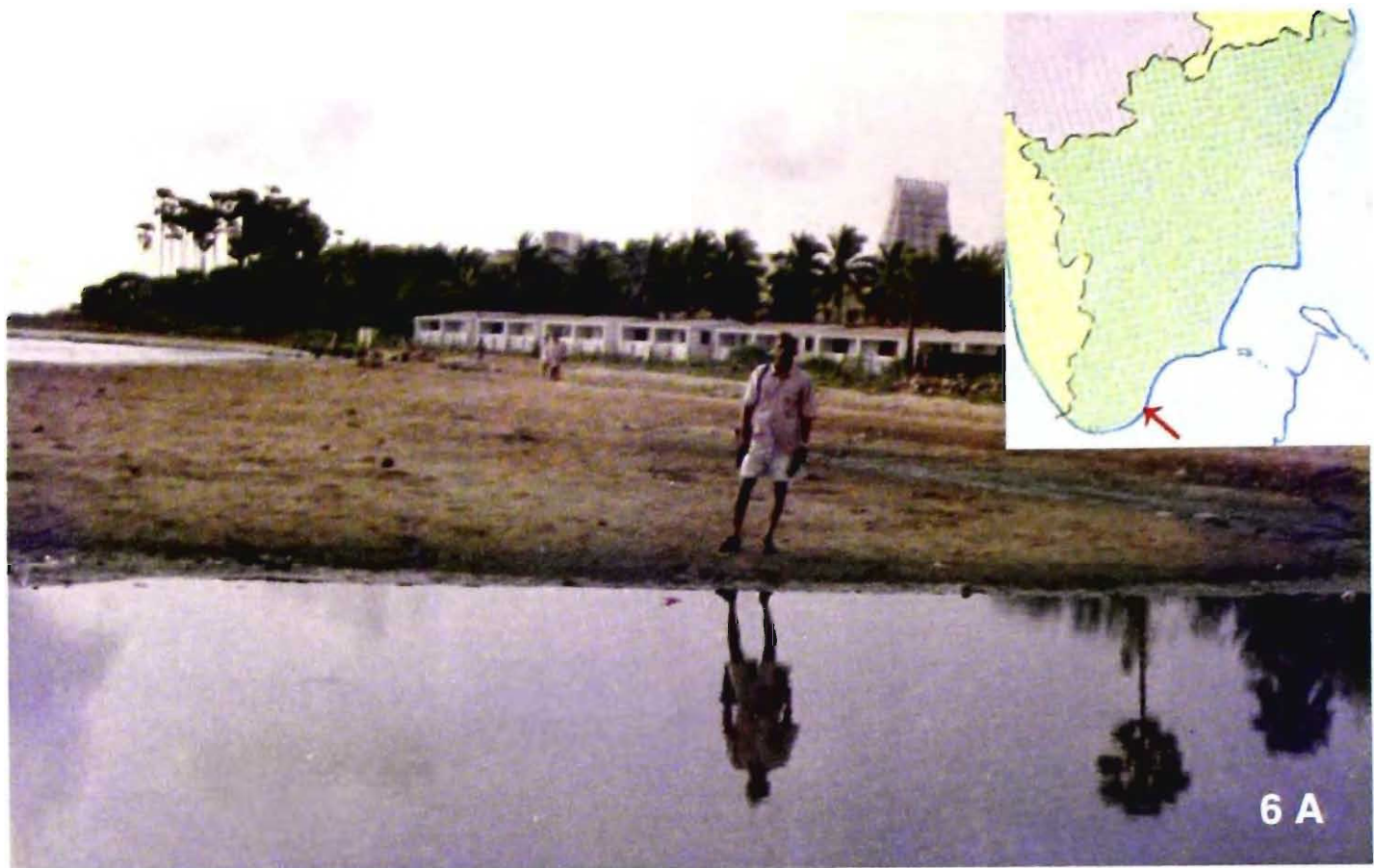


Fig. 4. (4A) Seawater surrounding mangrove shrubs leads to salt fields in Tuticorin. (4B) Salt fields - a potential breeding grounds for *Anopheles sundaicus* - examined for the presence of larvae in Tuticorin.



**Fig. 5.** (5A) Immature stages of mosquito collected from the water body close to Tuticorin township. (5B) The lake on the Tuticorin-Trichendur high way examined for mosquito larvae.



**Fig. 6.** (6A) Back water surrounded thatched houses near Trichendur township. (6B) Front view of an estuary at the base of Tamaraparani River near Kayalpattinam on the Tuticorin-Trichendur high way.



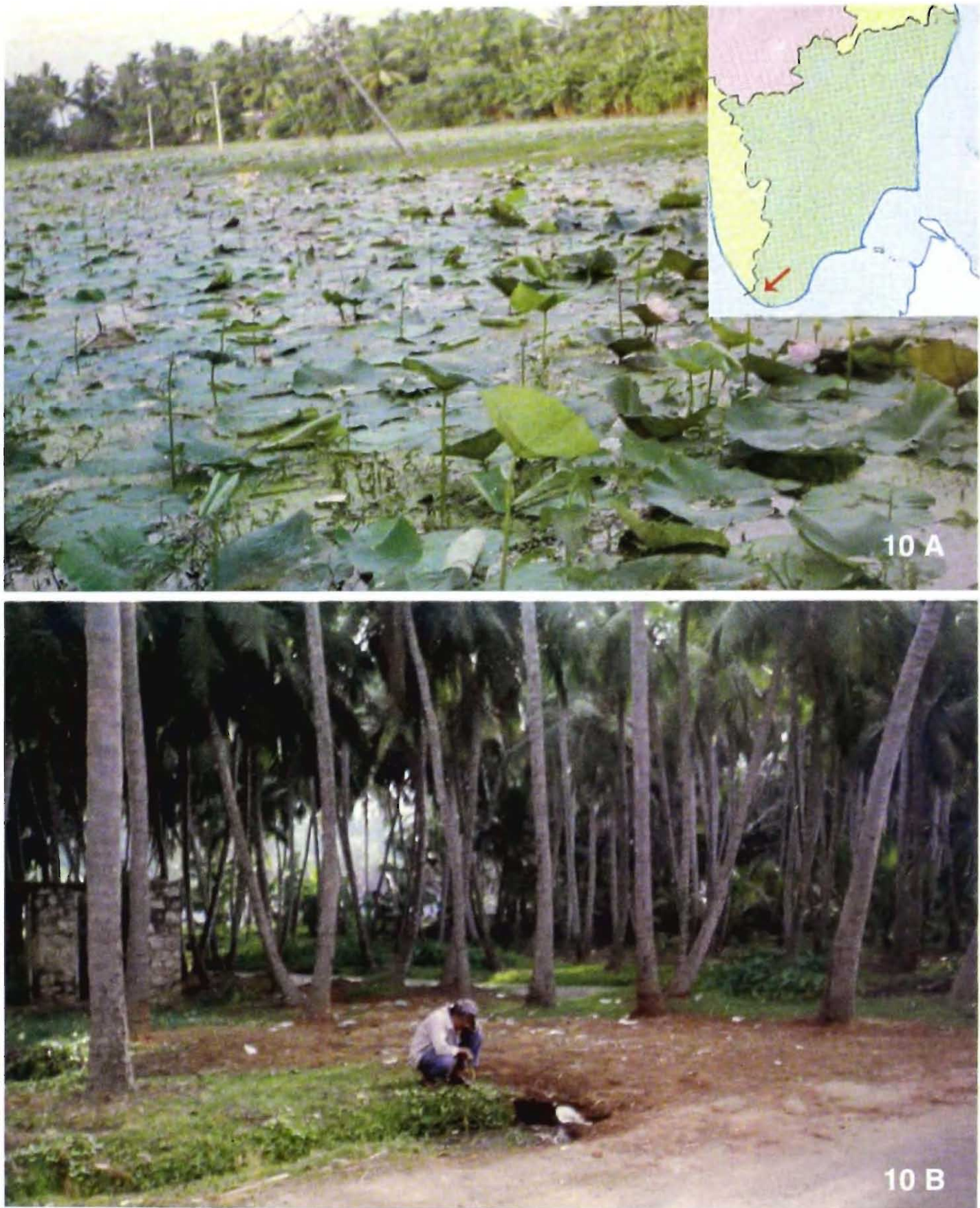
**Fig. 7.** (7A) Punnaikayal-the coastal village known for malaria endemic- is a major fish-landing site on the Tuticorin-Trichendur high ways. (7B) Immature stages of mosquitoes collected from the casuarinas-pit - a potential breeding ground of coastal mosquitoes in Punnaikayal village.



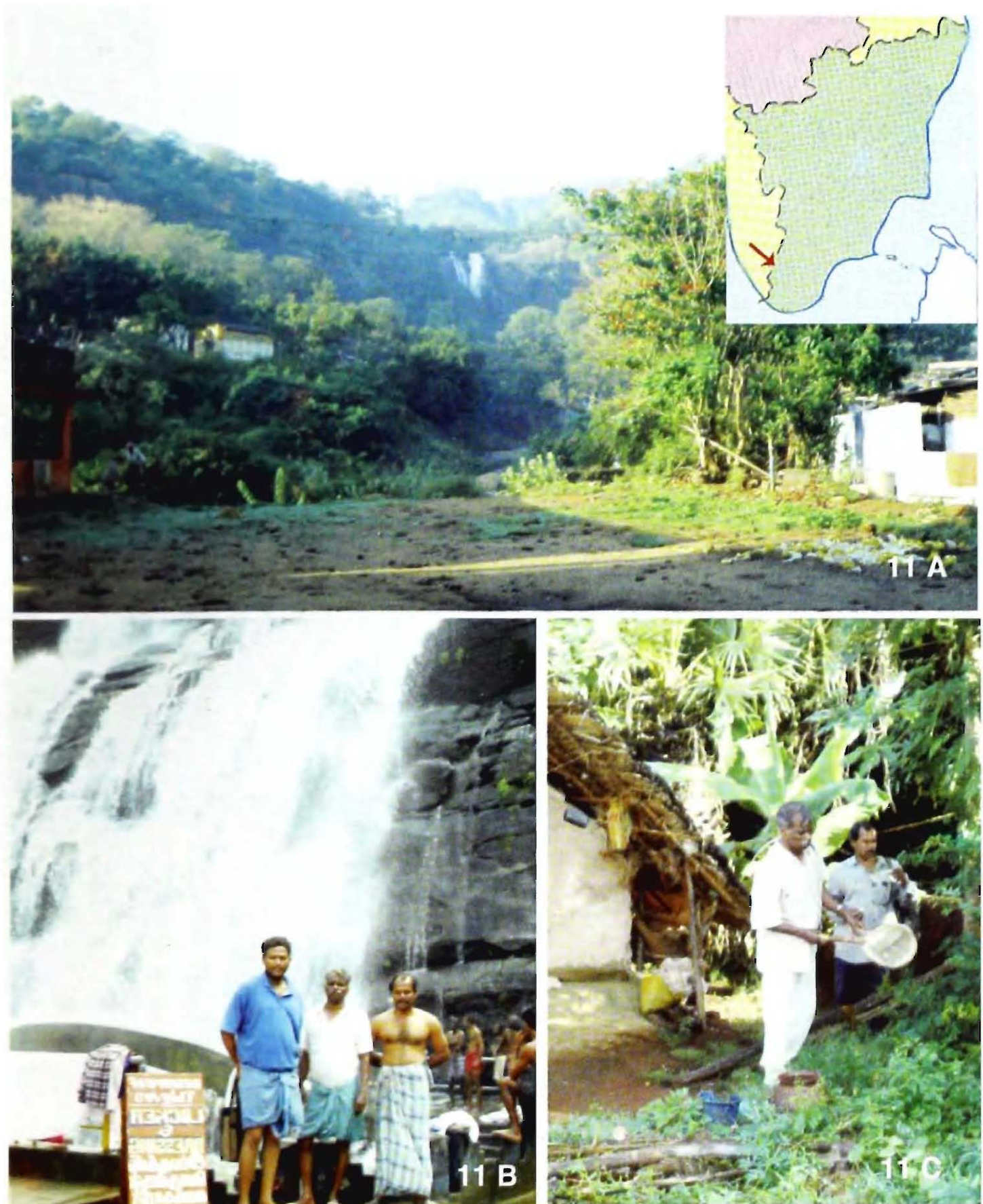
**Fig. 8. (8A)** Aerial view of the Suchinthram wetland on the high way of Nagerciol - Cape of Kanyakumari. **(8B)** Fresh water lake in Madhavapuram near Kanyakumari township examined for immature stages of mosquitoes.



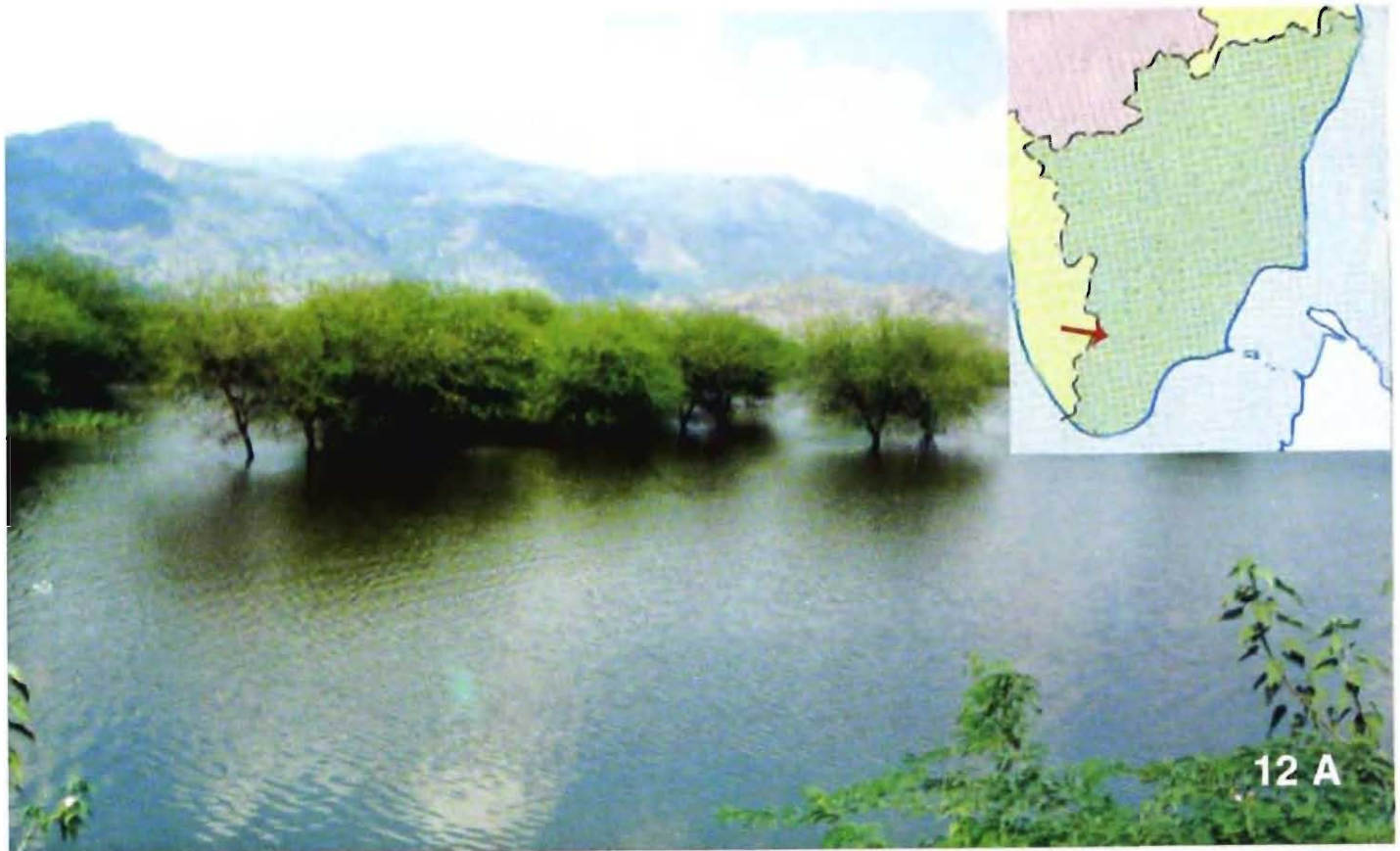
**Fig. 9.** (9A) Mine pits and its associated fresh water habitats in Kottaram village near Suchinthram wetland, which form an important breeding grounds for many species of *Anopheles* - examined for the presence of mosquito larvae. (9B) Immature stages of mosquitoes collected from the fresh water pond in Murikulam, 2 northeast of Nagercoil, Kanyakumari.



**Fig. 10.** (10A) A fresh water pond opposite to the railway station, Nagercoil, which provides a potential breeding ground for *Mansoni* mosquitoes. (10B) Bagavathipuram and its surrounding aquatic habitat in Mandaikkadu 35 km west of Kanyakumari District- an endemic focus of lymphatic filariasis where *Colocasia* sp. provides an ideal breeding ground for *Mansoni* sp. of mosquitoes.



**Fig. 11.** (11A) Aerial view of Courtalam water-falls, its surrounding forest cover in the western ghats and its township. (11B) A closer view of the courtalam waterfalls, which attract tourists and pilgrims throughout the year. (11C) Adult mosquitoes collected from the cattle-sheds, thatched huts and their hilly forest areas in Courtalam and Thenkasi.



**Fig. 12.** (12A) Aerial view of the Pilavukkal Dam (Watrap) situated 70 km west of Virudhunagar under the foothill of western ghats. (12B) Survey party engaged in mosquito collection from the cattle-sheds, houses, and PWD Guest house close to the dam-site.



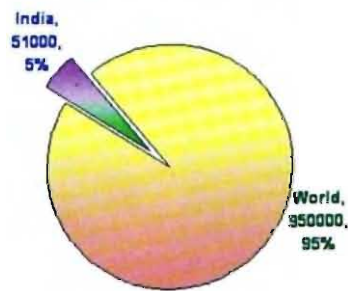
13 A



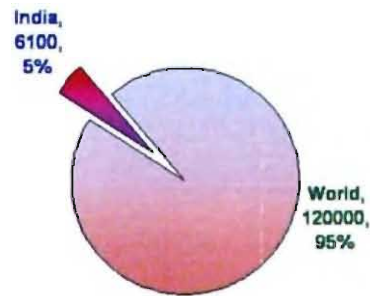
13 B

**Fig. 13. (13A)** Aerial view of the Gundaru water-dam (Sengottah) and its surrounding forest cover in the foothill of western ghats. Forest dwelling anophelines were collected from the huts and houses located closer to the dam-site. **(13B)** Chothupparai-dam constructed on the tributary of Vaigai River, which originates from the western ghats (in Periakulam, 80 km west of Madurai). Riverine and forest dwelling Anophelines were collected from the huts closer to dam-sites.

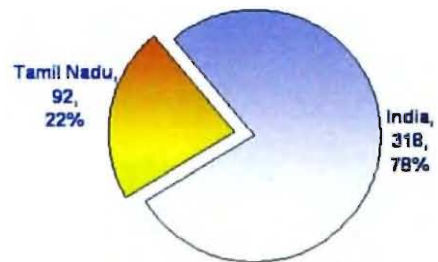
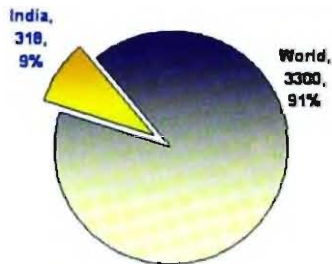
**Number of Insect species**



**Number of Diptera species**

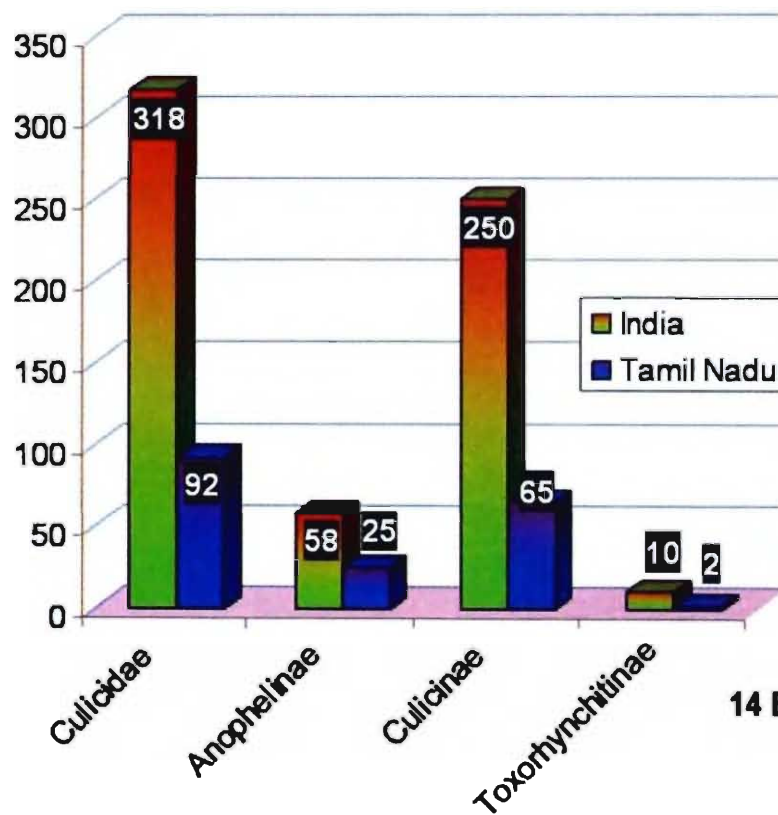


**Number of Mosquito species**



14 A

**Mosquito fauna of India and Tamil Nadu**



14 B

**Fig. 14. (14A).** Relative number of known species of Insect, Diptera and Culicidae (Mosquitoes). **(14B)** The number of known species of mosquitoes in India and Tamil Nadu.