

# 2

## SURVEY OF NATURAL RESOURCES

[Botanical Survey of India, Zoological Survey of India, Forest Survey of India]

### Survey of Flora

#### Botanical Survey of India

Botanical Survey of India (BSI) was established in 1890 with the basic objective of carrying out floristic surveys. During the successive plan periods, its functions have been gradually expanded. The objectives and perspectives of Botanical Survey of India were thoroughly reviewed in 2002 by the subcommittee constituted by the Programme Advisory Committee for Botanical Survey of India and Zoological Survey of India.

#### Primary Objectives

- Exploration, inventorisation and documentation of phytodiversity in general and protected areas, hotspots, fragile ecosystems and sacred groves in particular and publication of National, State and District Floras.
- Monitoring Phytodiversity to evaluate the qualitative changes in species rich and sensitive areas; *ex situ* conservation of critically threatened taxa in botanical gardens.



**Fig 1.** *Sarauia aramata* – an ornamental species found in North East

- Identification of species with traditional economic uses and preparation of protocols for their conservation and sustainable utilization.
- To complete a National database of plant species, herbarium specimens, live specimens, illustrations, relatives of cultivated species and economically important species.



**Fig 2.** *Trapa bispinosa* – an aquatic plant with edible fruits

### **Secondary Objectives**

- Survey, Inventorisation and documentation of non-flowering plants.
- Monographic studies on selected plant groups
- Qualitative and quantitative study of the diversity of selected economically useful species.
- Capacity building in plant taxonomy through refresher and post M.Sc. certificate courses.
- Environment impact assessment of areas assigned for study to BSI.
- Develop and maintain botanical gardens, musea and herbaria.



**Fig 3.** *Tacca* sp. – a rare plant with attractive inflorescence growing in Arunachal Pradesh

### **Major activities of the BSI during the year :-**

#### ***Botanical Exploration and Inventorisation of Phytodiversity***

Thirty three field/exploration/collection tours were undertaken by circle officers and units of BSI covering different districts of different states and protected areas, sanctuaries, fragile ecosystems including wetlands of Andaman & Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Goa, Gujarat, Himachal Pradesh, Maharashtra, Madhya Pradesh, Orissa, Rajasthan, Sikkim, Uttaranchal, Tamil Nadu, Uttar Pradesh and West Bengal. More than 17,500 specimen have been collected including lower groups of plants viz. Algae, Fungi, Lichens, Bryophytes and Pteridophytes. About 3,028 specimens belonging to 1,155 species were identified by different circles/units of BSI. Seven herbarium consultation tours were undertaken in connection with the revisionary studies.



**Fig 4.** Cacti in blooms

**Data collection and compilation :** National Database : Preparation of content, layout and design development of website for BSI has been completed. Suitability of the software called Botanical Research and Herbarium Management System (BRAHMS)

from Oxford University was studied. A total of 18,820 herbarium data sheets were prepared for the family Orchidaceae, Beberidaceae, Menispermaceae, Ranunculaceae, Resedaceae including type specimens. 9,365 data sheets entered into the computer using BRAHMS.

Prepared 155 index cards for ethnobotanical information, 467 herbarium specimens and five museum specimens of ethnobotanical and medicinal importance were collected from field tours undertaken in Jalpaiguri and Darjeeling districts of West Bengal and Sambalpur districts of Orissa. Out of these 93 specimens were identified during the year.



**Fig 5.** The endemic and rare pitcher plant *Nepenthes khasiana* growing luxuriantly away from its natural habitat

**Environmental Impact Assessment :** Project report on ‘Human River Irrigation Project’, Chandrapur district, Maharashtra has been submitted to the Ministry. Twelve projects were proposed for EIA studies .

**Funded and Collaborative Projects :** Eighteen field tours were also undertaken in connection with the funded projects. Assessment of 21 protected areas including Biosphere Reserves, National Parks and Wild Life Sanctuaries of India funded by Ministry in States of Himachal Pradesh, Uttaranchal, Jammu & Kashmir, Andaman & Nicobar Islands, Chhattisgarh, Madhya Pradesh, Assam, Karnataka, Arunachal Pradesh, Bihar, West Bengal, Rajasthan, Andhra Pradesh are in progress and manuscripts will be finalized soon.

Nine All India Co-ordinated Projects on Taxonomy (AICPTAX) are in progress at Northern Circle-Dehradun, Central Circle-Allahabad, Eastern Circle-Shillong and Southern Circle-Coimbatore.

Nine collaborative projects funded by different funding agencies are in progress. First phase of Bio-prospecting of biological wealth using Bio-technical tools was completed.

**Herbarium maintenance:** Different circles/units of BSI mounted 4,536 herbarium specimens of which 685 were remounted. Stitching, labeling, pasting, etc of 2,917 specimens completed. 1,907 specimens were identified and 2,668 specimens were incorporated in different herbaria of BSI. 1356 specimens were sent on loan and 220 specimens received on exchange. One hundred twenty six type photographs were received from Kew.

### *Documentation of Phytodiversity*

**National Flora:** Manuscripts of family Bromiliaceae, Cannaceae, Menyanthaceae, Buddlejaceae, have been completed. Families Urticaceae, Polygonaceae, Orchidaceae, Solanaceae, Ebenaceae, Cactaceae, Podostomaceae, Lauraceae, Acanthaceae, Basellaceae and Aspleniaceae are in different stages of progress. Fifty three species were studied for the National Flora under the families Urticaceae (06 species), Orchidaceae (10 species), Solanaceae (04 species), Smilacaceae (01 species), Ebenaceae (08 species), Cactaceae (10 species), Lauraceae (05 species), Acanthaceae (02 species) and Aspleniaceae (07 species).



**Fig 6.** A beautiful orchid of eastern Himalayas

**State Flora/Regional Flora:** Work on Flora of Uttar Pradesh initiated and a checklist of 90 families from Ranunculaceae to Apiaceae containing 260 genera and 820 species was prepared. 321 species have been completed for Flora of Cold Desert Vol. II (Dicot) and Flora of Kerala. Identification keys to 23 tribes, 105 genera, 217 species, seven varieties updating of their nomenclature of the family Poaceae for Flora of Nagaland Vol. IV have been completed. Key to species of 10 genera under Asteraceae of Flora of Jammu & Kashmir Vol. II was completed. Species reference cards were prepared for 55 and 28 genera of families Poaceae and Asteraceae respectively for Flora of Uttaranchal. 300 species have been finalized for Flora of Karnataka and manuscripts prepared for families Asteraceae (25 species), Lauraceae (25 species), Fabaceae (60 species) and Cesalpinaceae (40 species). 29 species belonging to families Saxifragaceae, Eriocaulaceae, Marantaceae, Convolvulaceae and Zingiberaceae were completed. Manuscripts of Acanthaceae was finalized for Flora of West Bengal.

**District Flora :** One hundred and ninty species have been completed under Flora of Pune district.

**Wetlands :** In connection with studies on ecology and floristic diversity of eight different wetlands of the state of Maharashtra, Bihar, Uttar Pradesh, Himachal

Pradesh and West Bengal, 159 species including macrophytes and phytoplankton were identified. Works on angiospermic flora of Adisoi, Ashidab & Barbila Wetlands of West Bengal were completed and submitted.

**Protected Areas :** Botanical Survey of India is surveying 21 protected areas in the states of Orissa, Maharashtra, Karnataka, Goa, Nagaland, Meghalaya, Madhya Pradesh, Sikkim, Jharkhand, West Bengal and Andaman & Nicobar Islands which include 13 Wildlife Sanctuaries, Six National Parks, one Biosphere Reserve and one Reserve Forest. The flora of Bandhabgarh National Park was completed. The Survey has given special emphasis on lower groups of plants. Northern Circle, Dehradun & Central Circle, Allahabad were declared as centres for Bryophytes and Lichens respectively.

**New Discoveries :** Seven species and two varieties have been described as new to science:

- *Combretum sanjappae* Chakrab. & G. S. Lakra
- *Cryptocarya praetervisa* Gang., Chakrab. & Chauhan
- *Antidesma bhargavae* Chakrab. & Balakr
- *Glochidion jarawae* Chakrab. & Balakr
- *Glochidion zeylanicum* Trimen var. *paucicarpum* Chakrab. & Balakr
- *Spongiocarpella purpurea* (Li) Yakolev var. *lhonakia* D. Maity & Chauhan
- *Gmelina thothathriana* A. Rajendran & P. Daniel
- *Ceropegia mannarana* Umamaheswari & P. Daniel
- *Anoectochilus narasimhanii* Sumathi *et. al.*



**Fig 7.** *Anoectochilus narasimhanii* Sumanthi

Eight species have been recorded for the first time from India, two species *Argemone ochroleuca* Sweet and *Melhania incana* Heyne ex Wight & Arn. recorded for the first time from Maharashtra and an endemic species *Asplenium auritum* Sw. rediscovered after 100 years from Kerala.

### **Conservation**

Germplasm of 65 species of rare, endangered, wild relatives of ornamentals, medicinally important plants has been conserved, multiplied and maintained in different gardens of Botanical Survey of India. 180 species of orchids have been maintained in Experimental Garden and National Orchidarium, Yercaud. Another 304 species collected for *ex-situ* conservation and maintained. Out of these, 18 species of

rare/threatened, 74 medicinally or economic important species and 85 ornamental plant species are introduced.



**Fig 8.** Toothbrush orchids - common in Sikkim

### ***Bioperspective Assessments***

- Isolation and identification of secondary metabolites from two *Bauhinia* species completed. Partial chemical screening of three medicinal plant species of family Rubiaceae were completed.
- Spores of Thelypteroid ferns and seeds of *Ruelia tuberosa* blue and white-flower variants were studied under Scanning Electron Microscope (SEM)
- Collected write ups, photographs on plant fossils for the new bay 'Plant & fossil' for Industrial Section-Indian Museum, Botanical Survey of India for placing in the gallery.
- Three orchid species, have been cultured and successfully transferred from laboratory to garden under micropropagation of rare, endangered and threatened species of North-East India.
- A committee was set up to look into the restoration procedure of Watt's ledge and textile fabrics of India in 18 volumes at Industrial Section, Indian Museum, Botanical Survey of India.
- BSI participated in a joint expedition to "Study the Jarwa tribes of Andaman Islands" jointly organized by Andaman administration, Janajati Vikas Samity, Directorate of Tribal Welfare, Andaman & Nicobar Administration, Port Blair and report submitted.
- Creation of virtual herbarium was initiated by scanning of all specimen of Dilleniaceae in BSI, Southern Circle (MH) on a pilot scale and CD-ROM prepared.



**Fig 9.** *Pterocarpus santalinus* (Red sanders) – endemic to Eastern Ghats

- Algal collections of Prof. Uma Maheswar Rao of Botany department, Andhra University have been received by Central National Herbarium under the scheme of procurement of Collections of Eminent Scientists of the country. The family of late Prof. E. Govindarajalu of Presidency College, Chennai has been approached to donate his personal collections which consists of many Type Specimens.
- Participated in the joint expedition to Dibang Valley, Arunachal Pradesh, for collecting plant specimens.
- Nomenclature of 80 plant species in different bays in Industrial Section, Indian Museum, Botanical Survey of India has been checked and updated. Completed new write ups of 70 jars of plant specimens.



**Fig 10.** An orchid of floriculture potential found in Sikkim

### ***Publications***

The following books and journals were published during the year

- Bulletin of Botanical Survey of India, Vol. 43.
- Floristic Diversity and Conservation Strategies in India, Vol. IV.
- Floristic Diversity and Conservation Strategies in India, Vol. V.

- Flora of Mizoram, Vol. I.
- Flora of Gulf of Mannar.
- Flora of Palamau district, Jharkhand.
- Vanaspati Vani-Vol. 11 (In Hindi).
- Brochures of BSI, IBG and Catalogue of scientific publication of BSI 2002-2003.
- Scientists of Botanical Survey of India published 50 research papers in different Indian Journals, two in foreign journals, 30 research papers communicated to different Indian and foreign journals. Popular scientific articles have been published in Hindi (18), English (13) and regional languages (01).

### **Other Activities**

BSI provides services not only to various scientific and academic institutions but also to students, teachers, scientists and general public.

- Four hundred and sixty six books, 403 Indian Journals, 91 foreign journals, 71 departmental and 46 non-departmental reports, newsletters, and brochures have been added to the libraries of Botanical Survey of India.
- A large number of BSI scientists attended various conferences/symposia/workshops/training in the country.
- BSI & its associated circles participated in many exhibitions.
- Essay writing, debates, painting competitions, sit & draw competitions, quiz contests, film shows and exhibition for school children and general public were organized on World Environment Day, International Biodiversity Day, Wild Life week and *Van-mahotsav*.



**Fig 11.** Staghornfern (*Platycterium alcicorne*) - endemic to Manipur

## **Survey of Fauna**

### **Zoological Survey of India**

The Zoological Survey of India (ZSI), a premier institute under the Ministry has been undertaking survey, exploration and research leading to the advancement of knowledge on the exceptionally rich faunal diversity of the country since its inception in 1916. With its headquarters at Kolkata and sixteen Regional Stations located in

different parts of the country, ZSI in recent years, has reoriented its plan of work by grouping the survey and studies under five major programmes, viz. 1) Fauna of States, 2) Fauna of Conservation areas, 3) Fauna of Important Ecosystems, 4) Status Survey of endangered species and 5) Ecological Studies. Besides these, the ongoing Fauna of India programme was also continued.

Seventy Nine extensive faunal surveys were undertaken in different States/Union Territories including important ecosystems and some selected conservation/protected areas. Two Surveys were undertaken for the determination of the status of some endangered species. The scientists of the department also participated in a multidisciplinary survey in Andaman and Nicobar Islands for the studies on animals associated with *jarwas*. Besides, several short duration intensive surveys for ecological studies were also undertaken. Detailed taxonomic studies were carried out on the material collected during these as well as earlier surveys. Ecological studies including status survey of endangered animals were continued. Besides, studies on some other projects like documentation of some important faunal groups were also continued.

The National Zoological collection was further enriched by the addition of 14,642 Specimens belonging to 1,107 species including 31 species new to science.

In addition to above major activities, identification and advisory services were rendered to 204 individuals or institutions in India and abroad. One training course was organized under Training and Extension programme. The ZSI Scientists participated in three training courses abroad.

Publications brought out during the year include three volumes of Fauna of India, one volume (2 parts) of the periodical Records of Zoological Survey of India, 12 'Occasional Papers', one volume of the 'Memoirs of ZSI' five documents on the 'Fauna of conservation areas', three documents of 'Fauna of Important Ecosystem', two issues of 'State Fauna' and six special publications.

## **Faunal Explorations and Surveys**

### ***Ecosystems***

**Tropical Rainforest :** Two extensive surveys were conducted of Western Ghats in Goa and Maharashtra.

**Himalayan :** *Ladakh Cold Desert* – One extensive survey was carried out in cold desert areas of Ladakh. *Shivalik Hills* – Two extensive surveys were conducted in Shivalik Hills of Uttaranchal.

**Wetlands :** Four extensive surveys were conducted in Nalsarovar, Gujarat, Subarnarekha River, Jharkhand; Madehpura-Bhagwanpur, Bihar and Gandhi Sagar, Himachal Pradesh.

**Mangroves :** Three extensive surveys were conducted in Ernakulam, Kannur and Kozhikode districts of Kerala.

**Estuarine :** Three extensive surveys were conducted in Vamsadhra Nagavali, Andhra Pradesh, Kottayi, Kerala and Backwater of Kerala State.

**Marine/Coastal :** Two surveys, one to Kerala Coast and another of Gulf of Kutch, Gujarat, were carried out.

### ***Conservation Areas***

**National Parks :** Surveys were conducted for the faunal diversity in Sanjay Gandhi National Park, Maharashtra, Bannerghatta, Karnataka, Ranthambhore, Rajasthan, Corbett, Uttaranchal, Pin Valley and Hemis, Himachal Pradesh, Hazaribagh, Bihar and Bandhavgarh and Madhya Pradesh.

**Biosphere Reserve :** Pachmarhi, Madhya Pradesh and Gulf of Mannar, Tamil Nadu were surveyed.

**Wildlife Sanctuaries :** Bethuadahari, West Bengal and Bagmara and Saipung, Meghalaya were surveyed.

### ***States and Union Territories***

Under this programme, 41 surveys were conducted in several districts of Andhra Pradesh, Arunachal Pradesh, Chhattisgarh, Goa, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Uttaranchal and Uttar Pradesh.

### ***Ecological/Status Surveys***

Two faunal explorations for the status survey of arboreal mammals and Indian edible Swiftlet *Collocalia unicolor* (Jerdon) were conducted in North Bengal and Sindhudurg District of Maharashtra respectively.

### ***Multidisciplinary Surveys***

One extensive survey was conducted for the study of animals associated with Jarwas.

## **Research Work**

### ***Identification of New Taxa***

Detailed taxonomic studies carried out during the year resulted in the discovery of a total of 31 new species. It includes three species of mites from Antarctica.



**Fig 12.** Spotted deer (*Axis axis*)

Ner mathelminthes : Dorylaimida – 6 species

Anthropoda : Insecta : Hymenoptera – 11 species

Anthropoda : Insecta : Diptera: Chloropidae – 10 species

Arthropoda : Arachnida : Acarina – 3 species

Chordata : Pisces : Synbranchidae – 1 species

### ***Taxonomic Studies***

The research works carried out on fauna collected from different States, conservation areas and other ecosystems are as follows.

### ***Fauna of India***

The following three volumes were published during the period under report:

Diptera : Chloropidae

Diptera : Sarcophagidae

Reptilia, Vol II : Sauria

Beside these, one volume of Scolytida is under processing for publication.



**Fig 13. Sambar deer at Ranthambore National Park**

### ***Fauna of States***

Details of the number of specimens collected and species identified (in parentheses) based on the collections made from different States are given in Table-1.

### ***Fauna of Conservation Areas :-***

#### **Biosphere Reserves :**

**Pachmarhi, Madhya Pradesh :** Fourteen examples belonging to six species of Odonata, 3 examples pertaining to three species of Hemiptera, 107 examples consisting of 31 species of Lepidoptera, 108 examples comprising two species of Acarina and 101 examples belonging to 13 species of Pisces were studied and identified.

**Table - 1****Major Groups of Animals Collected**

(Total number of specimens and species in parenthesis)

States surveyed	Protozoa	Rotifera	Nematoda	Annelida	Bryozoa	Odonata	Isoptera	Hemiptera	Lepidoptera	Coleoptera	Orthoptera
Andaman & Nicobar Is.	—	—	—	20(12)	—	—	—	—	—	—	—
Andhra Pradesh	12(12)	—	—	242(21)	—	—	—	115(28)	—	—	95(12)
Bihar	—	—	—	200(3)	—	—	—	—	—	—	—
Gujarat	—	—	21(9)	—	—	—	—	—	—	—	—
Madhya Pradesh	—	—	—	—	—	3(2)	—	7(4)	19(7)	—	—
Maharashtra	—	—	—	71(2)	—	20(3)	—	—	—	—	—
Manipur	—	—	—	—	—	—	—	31(7)	—	124(12)	—
Mizoram	—	—	—	—	—	—	—	20(6)	—	—	—
Rajasthan	—	—	—	—	—	—	426(7)	—	—	—	—
Tamil Nadu	—	3(3)	—	13(1)	—	—	—	—	—	1476(29)	—
Uttar Pradesh	—	—	—	71(1)	78(3)	170(17)	—	—	—	—	—
Uttaranchal	—	—	—	—	—	—	10(5)	66(13)	15(13)	—	45(5)
West Bengal	—	—	—	250(8)	—	—	—	—	—	—	—

States surveyed	Diptera	Hymanoptera	Arachnida	Crustacea	Chilopoda	Molusca	Pisces	Amphibia	Reptilia	Mammalia
Andhra Pradesh	—	—	260(32)	30(2)	—	—	—	—	—	—
Arunachal Pradesh	—	—	105(12)	—	—	—	—	—	—	—
Assam	—	—	—	—	—	—	170(31)	—	—	—
Gujarat	—	10(2)	—	—	—	—	—	—	—	—
Himachal Pradesh	—	—	—	—	—	—	14(3)	—	—	—
Karnataka	—	—	17(3)	176(6)	—	15(2)	3846(37)	130(10)	—	—
Kerala	—	16(6)	—	—	—	43(2)	—	—	—	39(5)
Madhya Pradesh	—	—	—	—	—	—	—	29(1)	—	—
Maharashtra	—	—	13(6)	—	3(1)	—	15(2)	—	—	—
Nagaland	—	—	—	—	—	—	37(7)	—	7(2)	—
Tamil Nadu	22(5)	—	—	27(9)	—	—	986(20)	—	—	—
Uttaranchal	—	—	—	326(5)	—	—	—	—	—	8(2)





**Gulf of Mannar, Tamil Nadu :** Fourteen examples comprising 8 species of Porifera and 20 specimens belonging to 12 species of Coelenterata (Corals) were studied and determined.

#### **National Parks :**

**Pench, Maharashtra :** One hundred and fifty eight specimens pertaining to 9 species of Thysanoptera, 10 specimens belonging to 10 species of Odonata, 19 specimens comprising eight species of Arachnida, 55 specimens belonging to two species of Scorpionida, two specimens consisting of two species of Cladocera, 18 specimens pertaining five species of Mollusca, 201 specimens comprising 14 species of Pisces and three specimens belonging to two species of Mammalia were studied and recognized.

**Tadoba, Maharashtra :** Eight specimens belonging to 2 species of Odonata, 12 specimens consisting of 4 species of Cladocera, one species of Myriapoda, One species of Chilopoda, 12 specimens belonging to 5 species of Mollusca and 11 examples pertaining to 4 species of Pisces were studied and determined.

**Sanjay Gandhi, Maharashtra :** Four examples pertaining to one species of Chilopoda were studied and identified.

**Bannerghata, Karnataka :** Five specimens belonging to 5 species of Rotifera and 6 specimens comprising 6 species of Cladocera were studied and recognized. Twenty one specimens pertaining to one species of Oligochaeta and one species of Amphibia were studied and determined.

**Corbett, Uttar Pradesh :** Twenty specimens belonging to 6 species of Lepidoptera and 5 specimens consisting of one species of Hymenoptera were studied and recognized.

#### **Tiger Reserve :**

**Melghat, Maharashtra :** Twenty five specimens belonging to 24 species of Odonata, 24 specimens consisting of 10 species of Cladocera, 4 examples pertaining to 4 species of Arachnida: Aranae and 262 examples belonging to 10 species of Pisces were studied and identified.

#### **Wildlife Sanctuaries :**

**Betuadahari, West Bengal :** A total of 1,132 specimens belonging to 11 species of Oligochaeta were studied and recognized.

**Avalam, Kerala :** Fourteen examples comprising 10 species of Odonota were studied and identified.

#### ***Fauna of Important Ecosystems***

##### **Tropical rainforest/Western Ghats :**

**Kerala :** Two hundred and eighty six examples belonging to 28 species of Odonota, 14 examples consisting of 6 species of Hymenoptera and 372 examples pertaining to 17 species of Pisces were studied and determined.

**Karnataka :** 17 specimens comprising seven species of Odonata were studied and identified.

**Freshwaters :**

**Nalsarovar, Gujarat :** Nine specimens pertaining to 6 species of Pisces were studied and determined.

**Nathsagar, Maharashtra :** Seventy Nine specimens consisting of 14 species of Mollusca, 44 specimens belonging to 9 species of Crustacea and 6 specimens belonging to 3 species of Pisces were studied and recognized.



**Fig 14.** Painted stork (*Mycteria leucocephala*)

**Subernrekha River, Jharkhand :** A total of 139 specimens belonging to 43 species of Pisces were studied and identified.

**Western Doon Wetland :** Twenty nine examples consisting of 15 species of Lepidoptera, 40 examples comprising 3 species of Hymenoptera and 12 examples belonging to 4 species of Pisces were studied and determined.



**Fig 15.** Wild buffaloes at Kaziranga National Park

**Govind Sagar, Himachal Pradesh :** Three examples pertaining to one species of Annelida and 24 specimens belonging to 5 species of Pisces were studied and recognized.

**Pong Dam, Himachal Pradesh :** Twenty specimens belonging to 3 species of Amphibia were studied and identified.

### **Estuarine :**

**Krishna Estuary, Andhra Pradesh :** Two hundred and thirty seven specimens belonging to 12 species of Crustacia, 86 specimens pertaining 13 species of Mollusca and 502 specimens consisting of 43 species of Pisces were studied and determined.

**Vamsadhara Nagavali, Andhra Pradesh :** Thirty seven examples belonging to 5 species of Crustacea were studied and identified.

### **Himalayan :**

**Cold Desert Ladakh :** Six specimens pertaining to 3 species of Annelida and 20 specimens consisting of 3 species of Lepidoptera were studied and recognized.

### **Shivaliks :**

**Uttaranchal :** A total of 32 specimens belonging to 32 species of Lepidoptera and 64 examples pertaining to 34 species of Pisces were studied and determined.

### **Desert :**

**Thar Desert, Rajasthan :** Eleven specimens belonging to 11 species of Isoptera were studied and identified.

### **Marine/Coastal :**

**Andhra Pradesh Coast :** Forty seven specimens comprising four species of Porifera and 56 specimens pertaining to 31 species of Mollusca were studied and determined.



**Fig 17. *Rusa aristotelis* Male**

**Chennai Coast :** Forty four specimens consisting of seven species of Porifera and 62 specimens belonging to 16 species of Pisces were studied and recognized.

**Kerala Coast :** Three hundred and twenty seven specimens comprising 6 species of Mollusca and 131 specimens pertaining to 16 species of Pisces were studied and identified.

**Gulf of Kutch :** A total of 68 examples belonging to 14 species of Coelenterata: Sclerectinia were studied and determined.



**Fig 16.** Andaman Day Gecko (*Phelsuma andamanese*)

### ***Ecological Studies***

Work was continued on the following projects :

- Faunal Succession in a newly emerged Nayachar Island at Sunderban delta.
- Impact of some heavy metals on the soil micro-fauna in reclaimed wetlands embankments of Kolkata.
- Ecology of East Calcutta Wetlands
- Faunal diversity of Zooplankton and Benthos in Kerala backwaters.

The project on 'faunal diversity of floodplain wetlands of southern West Bengal' was completed.



**Fig 18.** Pack of wild dog (*Cuon alpinus*)

### ***Other Studies***

- Checklist of Indian Mammals (Completed)
- Endemic Mammals of India (Completed)
- Endemic land and freshwater Molluscs (Completed)

- Endemic freshwater fishes of India
- Upgrading of the list of rare, threatened and endangered birds of India.

### **Identification and Advisory Services**

The ZSI continued to render identification and advisory services free of cost to research and teaching institutes in India and abroad, Central and State Government/Agencies, Non-governmental organizations, industries and individuals on zoological matters. During this period 204 enquiries pertaining to different groups of fauna were attended to.

### **Development of National Zoological Collection**

The ZSI, which is a national repository of Zoological specimens, maintains the collection of a large number of identified examples of species belonging to almost all groups of animals of the country. The National Zoological Collection was further enriched by 14,642 specimens belonging to 1,107 species including 31 new species.

### **Training and Extension**

Twelfth training course on the Collection and Preservation of Insects and Mites of Economic Importance was held at Headquarters Office from 10<sup>th</sup> to 16<sup>th</sup> December'02.

### **Publications**

The following publications were released during the period under report:

#### **Fauna of India**

- Diptera :Chloropidae
- Diptera : Sarcophagidae
- Reptilia (Sauria)
- Records of Zoological Survey of India - Vol. 100 Part-1 and part 2
- Records of Zoological Survey of India - Occasional Papers
- A Check list of the Scale Insects and Mealybugs of South Asia
- India Seashells (Part-1) Polyplacophora and Gastropoda
- Index catalogue and Bibliography of Protozoan Parasites from Indian fishes
- Faunal Diversity of Aquatic Insects in freshwater wetlands of South Eastern West Bengal
- The Ecology and faunal Diversity of two flood plain Ox-Bow Lakes of South Eastern West Bengal
- Endemic Land Molluses of India
- A Catalogue of Experimental studies on Grasshopper Chromosomes in India

- Bibliography of the Indian Estuaries, Lagoons and Backwaters
- Checklist of Mammals of India
- Endemic Birds of India
- Endemic Mammals of India
- Memoirs of Zoological Survey of India : Volume-19, 2002
- A Monograph on Plant Inhabiting Predatory Mites of India
- Geographical Distribution of Odonata of Eastern India
- Bibliography of Indian Zoology : Vol. 31



**Fig 19.** Indian one-horned rhino

#### **Fauna of Conservation Areas**

- Vertebrate Fauna of Chankaka-Dampara Wildlife Sanctuary Orissa
- Faunal Diversity of Gulf of Mannar Biosphere reserve
- Nilgiri Biosphere Reserve – Conservation Area Series 11
- Sanjay Gandhi National Park – Conservation Area Series 12
- Eravikulam National Park – Conservation Area Series 13

#### **Fauna of Ecosystems**

- Fauna of Renuka Wetland
- Fauna of Ujani Wetland
- Fauna of Godawari Estuary

#### **State Fauna**

- Fauna of West Bengal Part 10 & 11
- Fauna of Tripura Part 1

## **Special Publications**

- Threatened Mammals of Kerala
- Lesser Known Animal Resources of India
- Handbook – Indian Amphibians
- Field Guide on Grouper & Snapper Fishes of A & N Island
- Ecosystems of India (for ENVIS Centre, ZSI)
- Envis Newsletter Vol.8

**Sales of Departmental Publications:** Rs. 5.00 Lakh (approx.)

## **Computerisation/Data Base Development**

The database on National Zoological Collection encompassing all groups (Protozoa to Mammalia) are entered in the computers of Headquarters. During the period, the data entry on the insects, lower invertebrates and Pisces were under process. A total of 1,45,000 entries were made

## **Other Activities**

- World environment day and Wildlife week were celebrated at ZSI Hq. Kolkata.
- Laboratory facilities and guidance were provided to a number of scientists, both from the country as well as from abroad in the laboratories of Headquarters and Regional Stations.
- Participation in Training Courses: Scientists and Staff of ZSI participated in several Training courses in different parts of the country.
- The Director ZSI attended several high level meetings/conferences in different parts of the country/abroad and delivered lectures/keynote addresses or presided over technical sessions. A large number of ZSI scientists also attended various Conferences/symposia/Workshops in the country and presented their paper or acted as faculty members.

## **Forest Survey of India**

Forest Survey of India (FSI), an organization of Ministry is engaged in generating information and database on Forest cover and forest resources in the country besides providing training, research and extension. Forest Survey of India (FSI) was established on June 1, 1981 as successor to “Pre-investment Survey of Forest Resources” (PISFR), a project initiated in 1965 by Government of India and sponsored by FAO and UNDP. The main objective of PISFR was to ascertain the availability of raw material for establishment of wood based industries in selected areas of the country. Further, the National Commission on Agriculture (NCA), in its report in 1976, recommended the creation of a National Forest Survey Organisation for collection of data on scientific lines through country-wide comprehensive forest resources survey at regular intervals. Consequently, PISFR was reorganized as FSI. After a critical review of activities undertaken by FSI, Government of India, in 1986, redefined its mandate in order to make it more purposeful and relevant to the needs of the country.

## **Objectives of FSI**

- To prepare Comprehensive State of Forest Report (SFR) with generation of Digital Forest Cover maps on 1:250,000 Scale for the entire Country biennially.
- To undertake work in regard to the preparation of Forest Inventory for trees outside the forest areas for the entire country.
- To collect store and retrieve necessary forestry and forestry related data needed for National and State level planning and to create National Basic Forestry Inventory system (NBFIS).
- To design methodologies related to Forest surveys and subsequent processing and updating.
- To impart training in modern Survey techniques to forestry personnel working at various levels in State/UTs with the aid of modern infrastructure of digital Image processing using GIS S/W like ERDAS Imagine and Geo media professional like PC-ARC INFO and PC-ARC VIEW and other GPS and DGPS for ground locations.
- To under take special studies and consultancies

## **Organisation**

The FSI is headed by a Director. The headquarter of the organization is at Dehradun. FSI has four zones each headed by a Regional Director, located at Shimla (North Zone), Kolkata (East Zone), Nagpur (Central Zone) and Bangalore (Souther Zone). The total sanctioned strength of the organization is 436. Zonal officers largely carry out inventory of forest resources inside and outside forest areas. During the year, infrastructure of these offices was strengthened for carrying out digital image processing activities.

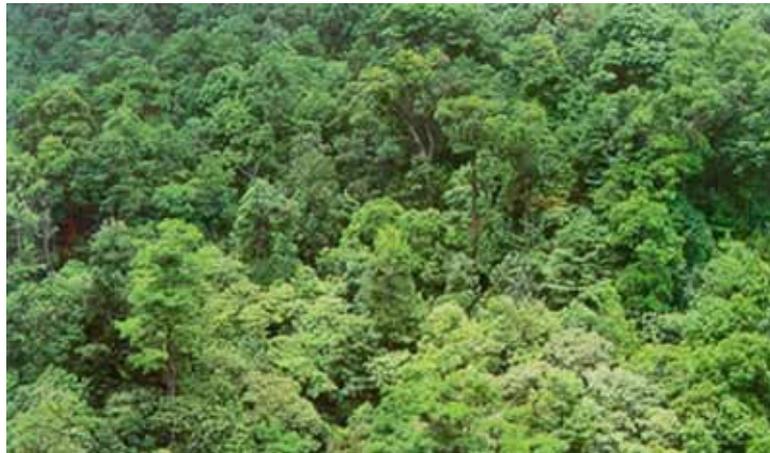
## **Activities undertaken by the Forest Survey of India during the year :**

### **Forest Cover Mapping**

FSI has been assessing the forest cover of the country using satellite imagery on two years cycle. First assessment was made in 1987 by visual interpretation of Landsat MSS satellite data on 1:1 million scale having 80 meters resolution. The seventh assessment was made in 1999 using IRS-1B, 1C and 1D data on 1:250,000 scale. The resolution of IRS-1B (LISS II) sensor is 36.25 m whereas IRS 1C and 1D (LISS III) is 23.5 m. In the seventh assessment digital method of interpretation was used for fourteen states which included Andhra Pradesh, Chhattisgarh, Madhya Pradesh, Maharashtra, Himachal Pradesh, Delhi, Sikkim and the North-eastern states. The eighth assessment has also been completed and for the first time digital interpretation of the satellite data has been carried out for all the States/UTs of the country. Forest cover mapping of the entire country has been done using digital interpretation of satellite data.

The country is covered by 363 Survey of India (SOI) toposheets on 1:250,000 scale. Target of the work of interpretation for one year is about half of the country. During 2000-2001, interpretation of 182 sheets pertaining to Andhra Pradesh, Madhya Pradesh, Maharashtra, Delhi, Rajasthan, Himachal Pradesh, Sikkim, A&N Islands and

North Eastern States was completed. The interpretation of the rest of the country has been done during 2001-2002. Interpretation is followed by extensive ground verification and corrections are incorporated.



**Fig 20.** A view of forests of Silent Valley

Apart from regular activities that are currently going on, special studies for assessment of change in the forest cover of seven Biosphere Reserves, thirteen Tiger Reserves, twelve National Parks and fourteen Wildlife Sanctuaries have also been done. Besides, FSI has undertaken one project of Mizoram Forest Department for providing assistance in preparation of Working Plan with the Application of Remote Sensing and GIS techniques. A methodology is being standardized for assessing growing stock by stratifying forest area into homogenous strata. Application of Remote Sensing and GIS has been made in creating different layers of information like forest cover, administrative boundaries, roads, forest boundaries, compartments etc.

### **Forest Inventory**

FSI has been conducting field inventory on non-forest areas till 2001-02. However, under Xth Five Year Plan during 2002-2007 FSI is carrying out inventory of forest resources inside and outside forest.

A methodology has been developed for a comprehensive assessment of forest resources inside and outside forest areas at national level by stratifying the country into physiographic zones and to take a sample of 10 percent districts for detailed inventory during a cycle of two years. This information, thus generated, will form a part of the biennial State of Forest Report. These estimates will be further improved in the subsequent reports as another set of 10 percent districts are sampled and surveyed, and so on. Together with forest inventory, assessment of Non Wood Forest Produce (NWFP) would be made. In addition, efforts are being made to assess regeneration status, biodiversity indices and soil carbon in forest areas. During assessment of trees outside forests in rural and urban areas, estimation of wood consumption in selected villages and urban centers are being carried out.

### **Methodology for Forest Inventory**

The country is stratified into 14 physiographic zones according to tree species composition and other physiographic and ecological parameters. In strata, districts are

being considered as first sampling units (fsus) and grids of size 1 ¼' x 1 ¼' as secondary sampling units. Ten percent of districts have been inventoried in every cycle of two years.

## **Methodology for Tree Outside Forest (TOF) Inventory**

Separate methodologies have been developed for assessment of TOF for these two strata, which are discussed below.

### **Assessment of Trees Outside Forest (Rural)**

Trees outside the forest have a relatively low density that makes assessment by conventional methods costly and time-consuming. Large area information is needed which can be provided by remote sensing data. Remote sensing data is used to stratify the area on the basis of geometrical formation of tree resources. Satellite images from the two sensors, IRS PAN and IRS LISS III having spatial resolution of 5.8m and 23.5m respectively are used. Due to Pan's high spectral resolution, small group of trees and partly single trees are recognizable. The high spectral resolution of LISS is used to discriminate between various earth features.

After classification of the imageries two types of patches of TOF, viz. Linear and Block are clearly discernible in the TOF area. The linear patches of tree are then recorded into a different stratum of linear tree formations. Similarly, block patches of trees are recorded into a separate stratum of block tree formations. The remaining TOF area is taken as the third stratum comprising of scattered trees. Optimum number of random points for the three strata is fed into the computer, for randomly marking of all sample points pertaining to the three strata on the maps.

The generated maps are taken to the field for carrying out field survey. Plots are laid out in the field for all strata. The plot sizes are different in different strata. Data are collected on the designed formats on various parameters, like dbh, crown diameter, species name and category of plantation, etc.

### **Assessment of Trees Outside Forest (Urban)**

The sampling technique, which is followed, is stratified random sampling. The district is divided into five categories of town as strata based on population size. Urban Frame Survey Blocks (UFS Blocks) are the sampling units. Frame of such blocks for each district are obtained from the National Sample Survey Organisation. The number of sample blocks to be surveyed in the district is decided based on pilot study. The sample blocks in each class of town are selected by using random number table. A town class wise sample list of randomly selected blocks in each district are formed and provided to concerned field parties for carrying out complete enumeration of all the trees of 10 cm and above dbh in the prescribed formats having similar parameters as for rural inventory.

## **Targets and Achievements**

### **Forest Inventory and TOF area**

A target of 1,10,000 sq.km. of area for tree resources for forest inventory and non forest inventory was fixed for the year 2002-2003 which would be achieved by March 2003.

During the year till December, 2002 wood consumption study was carried out in 39 districts of Maharashtra, Madhya Pradesh, Uttar Pradesh, Rajasthan and Bihar.

### **Electronic Data Processing**

The data collected by different zones during the inventory is processed at the head quarter's of FSI. After processing, the data is sent to the respective zones for writing of inventory reports. During the year 2002-2003 a target of data processing for 3,50,000 sq.km. of forest and non forest areas was fixed against which the achievement till December 2002 is 2,89,065 sq.km. The target would be achieved by March 2003.

### **Digital Image Processing (DIP)**

FSI has, 13 state of art workstations to support Digital Image Processing (DIP) and GIS analysis. Regional offices of FSI have also been equipped with such workstations. For DIP ERDAS Imagine software is being used. Four workstations with ERDAS imagine Software (one for each zonal offices with Arcview software and plotters) have already been procured. Training on these work stations has been imparted to the staff of the zonal offices. Central Zone, Nagpur has already completed digital interpretation of four sheets. Other zonal offices are likely to be engaged in the interpretation work related to forest cover mapping.

In addition to the above workstations, one sun spark workstation procured under Technical Cooperation Programme (TCP) of FAO in 1995 is now being used for GIS activities using ARC/INFO softwares. This system is also being used for imparting training on GIS work to Forest Officers of different states.

During 2001-2002, 2 sets of LEICA GS5 GPS system have been purchased. Besides these 20 sets of GRAMIN Etrex handheld system GPS were also procured alongwith 2 sets of Trimble Geo enflour 3 C DGPS.

During 2002-2003, 27 more GPS alongwith one DGPS is proposed to be procured. GIS software would be procured based on felt needs of different regional centres.

### **Projects/Special Studies undertaken during 2002-2003**

- Assessment of growing stock, biomass and carbon in India's forests under NATCOM (India's Initial National Communication) to UNFCCC (United Nation Frameworks Convention on Climate Change).
- Commencement of Technical Collaboration Project with European Commissions.
- Application of Remote Sensing and GIS in preparation of Working Plan — Assistance to Mizoram Forest Department.
- Forest Fire detection and monitoring using NOAA — AVHRR system and development of a Forest Fire Ranger Rating System.

### **Other Activities taken during the year**

## Assessment of National Forest Cover Area

For the assessment of national forest cover area, 125 districts of TOF rural area from 22 states covering all 14 physiographic zones were surveyed and data was analyzed.

Similarly for assessment of national forest area of TOF urban 15 districts of TOF urban from 13 states spread over 14 physiographic zones were surveyed and data was analyzed.



**Fig 21.** Pelican flower (*Aristolochia*) - rare climber on forest trees with attractive flowers

## Preparation of Manuals for Forest and TOF Inventory Areas

Field manuals for forest inventory and TOF (urban) have been finalized for data collection. The manual of instructions is primarily meant for the guidance of personnel concerned with field inventory like JTA, STA's, Draftman, Supervising staff and Data processing officers at HQ's. The manual takes into account almost all aspects involved in the inventory right from the start of survey to the stage of final dispatch of data on the Zonal Head Quarters for entry.

## Determination of Sample Plot size for TOF (Rural) Inventory in Non-hilly Area

FSI has already modified the methodology for inventory in TOF (rural) using remote sensing data. To ascertain the sample plot size and shape for carrying out inventory in Block, Linear and Scattered stratum, FSI has conducted a pilot study in Kapurthala District of Punjab State. Since characteristics of block stratum are similar to forest area, so its plot size can be taken as 0.1 ha., which has already been ascertained for forest inventory. For linear and scattered strata, 20 plots in each strata were randomly selected on map prepared for the purpose. Accordingly, lists along with information on latitude and longitude for each plot were prepared to conduct the survey in those plots only. For ascertaining the plot sizes for linear and scattered strata six plot of varying sizes were tried in both the cases. The data collected was analyzed.

## **Development of relation between crown width and DBH**

During the year up to December 2002 the inventory data consisting of tree species and dbh collected from 51 districts, rural and urban areas of all 14 physiographic zones were used to estimate average number of trees per hectare in that zone. In order to convert number of trees into tree cover, relationship has to be developed between dia and crown area of the species in each zone. Regression models between dbh (independent variable) and crown area (dependent variable) were developed and analyzed to calculate the number of trees of a particular dbh if a particular species are required to form one ha. of tree cover.

## **Assessment of TOF Punjab Project**

A project on assessment of TOF of Punjab has been approved by the Punjab Forest Department. In this project, growing stock, number of trees, species and diameter class wise trees outside forest are to be estimated. Remote sensing techniques are being used to stratify the study area into three geometrical formations i.e. Linear, Scattered and Block Plantations. The project work has been initiated and field data is being collected.

## **International Training Workshop**

Forest Survey of India (FSI), Dehradun organized an International Training Workshop on “Assessment of Trees Outside Forests (TOF)” from 22<sup>nd</sup> to 26<sup>th</sup> April, 2002. The Workshop was attended by 22 participants from 11 countries from South and South East Asia. Food and Agriculture Organisation (FAO) of the United Nations sponsored the Workshop. The training workshop dealt with all aspects of TOF assessment, viz. theoretical background of statistics and sampling, survey methods for rural and urban TOF, collection of data in different formats, processing and analysis of data.

## **Training Manual of Assessment of Trees Outside Forests (TOF) – Consultancy from FAO**

Expertise of FSI has been recognized by FAO in the field of assessment of trees outside forests. In this connection, a consultancy has been awarded by FAO to FSI to prepare a “training manual” which will be used for a “training workshop” to be conducted for participant from South Asian countries by FSI.

## **Expert Consultation on NWFP and Biodiversity**

FSI is carrying out comprehensive assessment of forest and tree resources inside and outside forest areas at national level from 2002-2003. In addition, during field inventory, relevant data is also collected to assess NWFP, floral biodiversity and soil carbon in the forest areas. This information, thus generated, will form part of the biennial State of Forest Report. In this connection, a workshop on “Quantitative Assessment of NWFP and biodiversity” was held on August 26<sup>th</sup>-27<sup>th</sup>, 2002 at Van Vigyan Bhawan, New Delhi to discuss inventory methods proposed by FSI for assessing NWFP and floral biodiversity at the national level and the formats in which the quantitative data should be presented. The important recommendations that are the outcome of this workshop focuses on inclusion of important NWFP species in a district by laying out extra plots in consultation with the local officials, assessment of vegetation to be carried out in a manner to ensure that seasonal variability is captured,

selection of a few districts which are to be assessed every 5<sup>th</sup> year by FSI in collaboration with other Forest Departments and the data generated by FSI to be shared with interested agencies.

### **Involvement with NSDI and launching of Website**

FSI is part of national initiative on creation of National Spatial Data Infrastructure (NSDI). NSDI aims to promote and establish an infrastructure for organized spatial and non-spatial data and multilevel information networking to fulfill local, national and global needs for data. FSI will function as focal organization in NSDI framework for compilation, storage and dissemination of forest maps and forestry data.

### **The Andaman and Nicobar Islands Forests and Plantation Development Corporation Ltd., Port Blair**

The Andaman & Nicobar Islands Forest and Plantation Development Corporation Ltd., a Government of India undertaking has an authorized capital of Rs. 600 lakhs. The paid up share capital is Rs. 359.18 lakhs, all the share capital being held by the Central Government. The Company started functioning in 1977 and is a category 'C' Central Public Sector Undertaking. The Corporation has also financed its capital from the resources generated internally.

The main activities of the Corporation are timber logging and regeneration, oil palm cultivation and processing and commercial management of rubber plantation. The Corporation is also in the process of diversify its activities wherever possible within the ambit of its objectives.

On 10th October, 2001, Hon'ble Supreme Court has issued an order in Civil Writ No. 202/1995 putting complete ban on felling of all naturally grown trees except plantation in Andaman and Nicobar Islands, which has resulted in complete standstill of activities in the Corporation.

Subsequently, after the receipt of Shekhar Singh Report, the Apex Court vide its order dated 7th May, 2002, imposed ban on the felling of trees, eviction of encroachment from forest lands, ban on removal of saw mill licenses and other wood based industries etc. These two orders halted the functioning of the Corporation. The Corporation is now under severe financial constraints, as the other two activities namely, rubber and red palm oil extraction, are loss making.