CHAPTER 3

MATERIALS AND METHODS
3.1 Materials and Methods

This programme of work was initiated in 2004 and was completed in the year 2011 for the duration of seven years. The study and survey work were done basically for floristic composition of Angiosperms, their phenology, ecology and the species wise information of interpretation as well as to present the forest resources of the district Bankura.

The present study was carried out only on the wild flora of the district Bankura which includes forest areas that are managed by the Department of Forests, wild flora of private lands and other types of unclassified minor wild floristic composition like riverside vegetations, hedges on the embankments of water bodies, etc. and the study is complete devoid of cultivated lands of the inhabitant.

The entire work was completed in five major steps as:

3.2 Collection of specimens and the primary observation in the fields;
3.3 Identification of collected plant specimens;
3.4 Preservation and submission of collections as herbarium specimens;
3.5 Presentation of floristics and phenological study;
3.6 Ecological study;
3.7 Interpretation of data in terms of species wise information; and
3.8 Instruments and Software used.

The literatures were consulted for this district Bankura. The herbarium specimens were also studied from Central National Herbarium (CAL), Botanical Survey of India, P.O. Botanic Garden, Howrah, West Bengal and the herbarium specimens which were preserved in the Department of Botany, Bishnupur Ramananda College, Bishnupur, Bankura, West Bengal.
3.2 Collection of specimens and the primary observation in the fields

It was felt from the very beginning that a vast eco-floristic study of the forests of this district needs identification of plants in the field at first. So, the collection of plant specimens was taken as a priority basis and simultaneously the study of phenology as well as identity of their respective field characters. Collections were covered for most of the areas of the district Bankura for this purpose and was performed nearly 17000 kilometers of motorcycle journey in first 3 years of the study as the area of the district is too large, of about 6,871.24 Sq. km. A total of 531 plant species were collected from the forests under management of the Department of Forests. Moreover when studied the hedge forest then number of species is increased to 602. All those species belong to 403 genera under 98 families as the total collected specimen under study. During this period only observation, collection of plant specimens, taking phenological data like flowering and fruiting time, etc were undertaken. During this collection work the associated plants were also documented. Herbarium sheets were prepared with all the collected specimens and properly kept for study.

3.3 Identification of collected plant specimens

Study for the species specific ecological information, identification of almost all the plant species is required in the field. Thus from the beginning up to 2006 identification of plant species was done with as much accuracy as possible. Herbarium specimens were prepared with information of the collection, habitat, season of flowering; fruiting and morphological features including floral biology and that were used during identification.

Some specimens, in spite of previous efforts, may be escaped being noticed and not collected or identified. Such plant specimens were collected during second phase of field study, more specifically during quadrat study. Photographs and the collection number were written in the quadrat records which were later replaced with the scientific names whenever identified.

For the identification of collected specimens, at first, the specimens and the field records and field notes, etc. were compared with well reviewed works (Hooker, 1872-1897; Bor, 1960; Sanyal, 1994; Sarma, and Sarkar, 2002; Ghosh, 1997, 1998, 2001, 2005; Paria, and Chattopadhyay, 2000, 2005). Those with doubt were
consulted with experts in the Department of Botany, University of Kalyani, Kalyani, Nadia, W.B.

Moreover, the specimens were further matched and verified with the collection of the Central National Herbarium (CAL), Botanical Survey of India. P.O. Botanic Garden, Sibpur, Howrah, West Bengal, and the Collection of Dr. M.N. Sanyal deposited in the Department of Botany, Bishnupur Ramananda College, Bishnupur, Bankura, West Bengal. Many of the books on the flora, relevant journals providing revisions and monographs of families and genera were consulted. Finally the correct nomenclature is provided for each species.

### 3.4 Preservation and submission of collection as herbarium specimens

Two sets of herbarium sheets of the collected plant specimens were prepared with proper label and identification. One set is deposited in the herbarium of Taxonomy and Biosystematics Laboratory of the Department of Botany, University of Kalyani, Kalyani – 741235, Nadia, West Bengal. Another set is kept at the herbarium of the Department of Botany, Bankura Sammilani College, Bankura, West Bengal, India, as local centre of the programme of study and work.

### 3.5 Presentation of floristics and phenological study

Visits to each area of forest in three months interval at least for one annual cycle was carried out to record flowering and fruiting time of the plants. Moreover, the study is confined to general condition of the habitats, habitat wise preferences of the plants, occurrence of exotic plant species and pattern of change in use of forest lands by Department of Forests as well as private lands of considerable coverage.

The observation is presented followed after the classification of Bentham and Hooker (1862-1883) for the arrangement of families and sometimes with the present concept of classification for the segregation of some families (Hutchinson, 1969; Cronquist, 1981; Takhtajan, 1997). Key to the studied genera under family is presented where there are more than one genus. So, also key to the species under each genus is provided where there are more than one species.
The genera under family and the species under genus are presented in alphabetical order.

The correct accepted names of species are provided and with basionym and synonym, etc. when present. Under enumeration short description, occurrence and phenological data are given and in a few cases local names, if available, and some uses or sometimes the present entry is given.

### 3.6 Ecological study

During the survey and the collection of plant specimens and the primary observation for the future work plan was gradually formulated. Various types of quadrat methods like chart quadrat, cover quadrat, list quadrat, list-count quadrat were considered. Among them, cover quadrat and list-count quadrat were tested in the field. However, the list-count quadrat method was found to be the most suitable one and practicable for the type of study as planned and to be undertaken. Species-area-curve method was also followed for the determination of minimum size of the quadrat as here taken and that can cover the maximum number of plant species during list-count quadrat study. Survey during December 2006, April 2007 and August-September 2007, nested quadrates were plotted in interval of 5 meters in 50 separate areas of the forests and 20 hedges which are spread throughout the district to determine minimum size of quadrat. In 19 quadrates of forest and 8 of the hedges, 20 meters by 20 meters quadrat size was minimum to cover maximum number of trees and shrubs. This quadrat size was recorded in highest number of plots as other minimum sizes of quadrates resulted were less than 19 in number for forests and less than 8 in number for hedges. Thus, 20 meters by 20 meters quadrat size was finally taken for further ecological study for both Sal forest and Hedge forest.

During the actual quadrat study, 100 quadrates were plotted in Sal (Shorea robusta) forests of Bankura North Division, 115 quadrates were plotted in Sal (Shorea robusta) forests of Bankura South Division and 86 quadrates were plotted in Sal (Shorea robusta) forests of Panchet Soil Conservation Division to cover almost all important fragments of forests with considerable size and diversity. Whereas in case of Hedges, 35 quadrates were plotted under each forest division.

Though during collections of plant specimens and primary observations a total of 531 plant species were collected from Sal (Shorea robusta) forests under management of the Department of Forests, 451 of them figured in the quadrates...
studied. In case of Hedges, 602 plant species were collected during collections of plant specimens as primary observations but 519 plant species of them were figured in plotted quadrates.

3.7 Interpretation of data in terms of species-wise information

The data collected during the period of study were classified into three categories:
(i) Habitat information;
(ii) Phenological information; and
(iii) Ecological information.

As the study was conducted for each plant species available in the study area, it was possible to record and later analyzed almost every parameter that influences the life of each and every species.

Forest plants were classified according to their different habitats that are present in the varied landscape of the district. The influence of seasonal changes on life of plants of the special habitats was also recorded.

With the help of the recorded data, phenological cycle for each plant as well as collective trend is provided.

The collected ecological information is used in calculation of density, relative density, frequency and abundance of a species. Moreover, Geni-Simpson Index (Jost, 2006) is considered as the parameter of indexing the biodiversity as follows:

Density of the species = \( \frac{\text{Total number of stands of the species in all quadrates}}{\text{Total number of quadrates studied}} \) \hspace{1cm} (1)

Relative density of the species \((P) = \frac{\text{Total number of stands of the species in all quadrates}}{\text{Total number of stands of all species}} \) \hspace{1cm} (2)

Frequency of the species = \( \frac{\text{Total number of quadrats in which the species occurred}}{\text{Total number of quadrats studied}} \) \hspace{1cm} (3)

Abundance of a species = \( \frac{\text{Total number of stands of the species in all quadrates}}{\text{Total number of quadrats in which the species occurred}} \) \hspace{1cm} (4)

(Equation number 5 is mentioned in chapter 4.2.)

Gini-Simpson Biodiversity Index = \( 1 - \sum P_i^2 \) \hspace{1cm} (6)

where, \( P_i \) is Relative density of species i.
3.8 Instruments and Software Used

The instruments used for this study are:
1. GPS receiver Garmin nuvi 1690;
2. Slide calipers;
3. Camera: Nikon Coolpix L1, Nikon D3100;
4. Computer, HP Scanner, HP Printer; and
5. Rotring isograph 0.2 & 0.4

Software used for this study are:
1. Ms Office Word 2003;
2. Ms Office Excel 2003;
3. Adobe Photoshop 7;
4. Origin 6;
5. Primo PDF maker;
6. WinRAR; and
7. Google Earth, Google map, Wikimapia.