INTRODUCTION

The bamboos belonging to family Poaceae are associated since ages with human civilisation, having been constructively exploited for fishing, paper making, handicraft, medicine, vegetables and also as decorative and protective hedges. The faster growth, easy and cheap availability has made it an important natural raw material for different uses, such as manufacture of insulation board, veneer mat board. The rising demand for paper manufacture has made the bamboos as one of the most important raw material.

There are about 30 genera and 550 species of Bamboos. Asia and South America account for 320 and 179 respectively. About 136 species occur in India, 39 in Burma, 29 in Malaysia, 9 in Japan, 30 in Philippines, 8 in New Guinea and a few in South America and Australia. The more important genera of bamboo are Arundinaria, Bambusa, Cephalostachyum, Dendrocalamus, Melocanna and Ochlandra. Most of them are indigenous to India, Burma, China and Malaysia and a few to South America.

In India bamboo forms a rich belt of variety and density in Assam, West Bengal, Arunachal Pradesh, Manipur, Tripura, Madhya Pradesh, Maharashtra, Kerala and Andaman. Though there are over 100 species naturally occurring in India Bambusa arundinacea, b. tulda, B. polymorpha, Dendrocalamus strictus, Melocanna baccifera, ochlandra travancorica are more important from the point of view of availability.

Considering its wide aspect of utilisation, it is justified to claim that without bamboos it is difficult to imagine life in rural India. It is generally questioned whether all kinds of bamboos can be put to any of the specific use or a particular bamboos species is required for a particular use. Though it may appear an exaggeration but the fact is that bamboos are specific as far as their properties and uses are concerned as evidenced by the following examples. Bambusa ventricosa because of pitcher shaped internodes and B. vulgaris because of yellow and green strips on its culm are preferred for ornamental purpose. A very
good example from the field or pulp and paper technology is Ochlandra travancoric a well known bamboo species, used in paper making in South India. Due to non-availability of Ochlandra travancoric which is commercially utilized for paper making in South India Punalur paper mills experimented on other two species of Ochlandra growing in that region. One of them O. scriptoria (O. rheedii) was found to be as good as O. travancoric. O. scriptoria is now considered to be a new species named as O. obtacteata by Forest Botanist which was not reported earlier and also considered better than O. travancoric by Paper Technologist. Another good example cited is Cephalostachyum peracile. This species grows in quantity in association with D. strictus in Balaghat Forest of Madhya Pradesh and by ignorance was used as D. strictus for paper manufacture. In other countries too, specific bamboo species are preferred for paper making like Phyllostachys pubescence and P. bambusoides in China and Japan. In Bangladesh Melocanna baccifera is a preferred species for paper making. For cane manufacture no other species can surpass Arundinaria amabilis popularly known as Tonkin cane. It is an endemic species growing naturally in a small area of South-East China and entire production is shiped abroad. Hence the emphasis is given on the specific nature of bamboos and need for their correct identification.

There is hardly any other group of flowering plants so difficult to identify and classify as are the Bamboos (Grosser and Liese 1973). It is because of the fact that most of the bamboo species flower only at irregular intervals and die soon after the flowering; there are a few species which are sterile through out their life as B. vulgaris (McClure 1966). A few species flower annually or keep on flowering continuously as Arundinaria wightiana, Bambusa lineata, Ochlandra rheedeii, O. striata, Schizostachyum brachycadum, S. gracile and S. grandi (Gamble 1896, Holttum 1946, Raizada and Chattarji 1956). It is well known that a population of a given bamboo species belonging to the same provinance would flower simultaneously irrespective of their planting location. A few recorded examples are cited below, Seeds of Thyrsostachys oliveti that flowered in Burma in 1891, were planted at Calcutta and Dehra Dun, 1500 km apart, the clumps flowered synchronously in 1940 at both the places. The period between two gregarious flowering of a species seems to be constant and cyclic which is evident from the published records of flowering cycle of some of the bamboo species found either wild or cultivated in India as detailed below:
Bamboo species

1. Bambusa atra
2. Ochlandra scriptoria (O. theedii)
3. B. arundinacea
4. B. Copelandii
5. B. polymorpha
6. B. tuldia
7. Chimonobambusa falcata
8. C. jaunsaransis
9. Dendrocalamus hamiltonii
10. D. strictus
11. Melocanna baccifera
12. Ochlandra travancorica
13. Oxytenanthera abyssinica
14. Phyllostachys bambusoides
15. Thysostachys olivieri
16. B. vulgaris

Flowering-Cycle

Annual
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30-45 years
48 years
35-60 years
30-60 years
28-30 years
45-55 years
30-40 years
20-60 years
30-45 years
7 years
30 years
60 years
48-50 years

Moreover the flowers of many tropical bamboo species undergo changes during their development so that their morphological characteristics vary according to the time of observations (Grosser and Liese 1973). Hence many species might have been described under the different names or members of the same species might have been placed in the different genera (McClure 1957a).

This has resulted in a rather confused account reflecting in the classification of bamboos. McClure (1975b) in his first revision on 88 genera concluded that there are really 63 genera, rest of them were described twice.

As the flowering of bamboos is uncertain and irregular, vegetative structures were considered of next prime importance for bamboo identification. Several studies have been made on this aspect worth mentioning are of Holttum’s (1958) Taxonomic account of bamboos of Malayan peninsula with a key based on vegetative characters. Chatterji and Raizada (1963) with special attention on culm sheath gave an account of 22 Indian bamboos. This key has not been considered satisfactory, as no distinction was made between ligule and auricles (Holttum 1972).
Moreover the key is restricted in its application because of considerable variations within the same species and genera (Pattanath and Ramesh Rao, 1969). The culm sheaths vary in their shape, size and texture in the immature culm hence the culm sheaths of mature culm only can be used, thereby restricting the use of culm sheath. External morphology of the young culm shoots has also been considered useful for bamboo identification (Bahadur 1979; Varma and Bahadur 1980). This method is quite promising in species identification, but its application is possible only during the rainy season.

It is further stressed that vegetative structure like culm sheaths, leafy twigs, young culm shoots and other vegetative structure alone can not substitute the flowering herbarium specimens, though they are quite useful in identification of bamboos (Holtum 1972).

Hence McClure suggested that complete description of vegetative structure of sterile bamboos may first be made and the description of the reproductive structure may be added after observing the flowering. These suggestions become all the more important as culm sheath disappear in the older culm and at the time of flowering new culms are not produced, because of that both culm-sheaths and flowers of the same plants are rarely present together in herbaria (Grosser and Liese 1973).

Besides the description of vegetative structure, anatomical studies of culm also have been done, but it is rather limited, though investigations are going on since Schwendener (1874) published his first paper on this aspect, followed by Strasberger (1891) Haberlandt (1924) Takenouchi (1931 a, b); Ota and Sugi (1933). Descriptions of some comparative studies are also made by Velas Quez and Santosh 1931b, Sampudi 1959, Metcalfe 1960, Li and Chin 1960, Li, Chin and Yao 1962, Chiang 1968, 1969, Lin 1968, Pattanath and Ramesh Rao 1969, Grosser 1971, Grosser and Liese 1971, Grosser and Zamuco 1971, Grosser and Liese 1973. These studies have proved beyond doubt that for classification of species and genera in to the natural systematic group besides morphology of the reproductive structure, anatomical characters can also be used. Hence Grosser and Liese suggested that "more emphasis should be placed on anatomical structure, because of significant anatomical differences exist between species of
a genera in to natural systematic units and for the further development of a modern bamboo classification. For a system of identification of bamboos to be more independent of any one morphological state (e.g. sterile, flowering, cut, converted) - it is suggested that the following approach should be adopted.

(a) Consideration of the morphology of reproductive structures - according to Holtum's classification.

(b) Consideration of the morphology of all important vegetative organs - according to the results of Holtum 1958, and Chattarji and Raizada (1963), and a proposal of McClure 1957a; 1966

(c) Consideration of anatomical characters of the culm according to the vascular bundle type described by Grosser and Liese 1971 and the results of study of the epidermal structure by Ghosh and Negi (1960) and Pattanath and Ramesh Rao 1969."

The earlier studies of Ghosh and Negi, Pattanath and Ramesh Rao have revealed that the bamboos can be identified on the basis of epidermal features. These studies are based on the structure of epidermal peels of culm as observed under the light microscope; but to get the peels a drastic acid reaction is necessary; which many times macerates the material. The extent of damage done to tissue is not known and more over their studies are restricted to a few better known species and genera. Considering these facts a systematic studies on the epidermis of culm and leaves of the available, properly identified genera and their species planted in the arboretum of F.R.J. Dehradun and collected from Meghalaya, Assam, and Arunachal Pradesh forests have been carried out and discussed in this work. SEM studies neither require any acid treatment nor the epidermal peels, since the culm or leaf portion as such is observed, a natural, culm or leaf epidermal features are recorded in a wider area.

The taxonomic value of epidermal features of grass leaves in identifying and classifying members of the family is well established (Prat 1932, 1936, Tateoka et al. 1959; Metcalf, 1960; Jacques-Felix 1962); which has been studied traditionally with light microscope. Palmer (1976) has shown the suitability of SEM for studying the cuticle and applied this technique to study the fresh as
well as fossilised grass cuticular fragments. The studies of Palmer and Tucker on SEM survey of epidermis of East African grasses 1981-I, 1983-II is the most complete description of epidermal features of grasses, besides Metcalf 1960. Their system of classification and terminology of epidermal features have been used throughout this study with minor modifications as the need arisen.