I. INTRODUCTION

The genus *Musa* which produces the fruits commonly known as banana is a very ancient one. Centuries of cultivation have obscured the past history of this important crop. However, there are ample references to cultivated banana as "Kadali and Mocā" in the great epics of India - Mahābhārata and Rāmāyana and in the Pali Buddhist literature of the 5 and 6th century B.C. Reynolds (1951) quotes numerous literary and archaeological evidences from India, to show that the banana was a cultivated plant in tropical India for well over two thousand years. He shows that the generic name *Musa* itself is derived from the Sanskrit word Mocā - which means banana. Further he is of the opinion that from its original home in India and South Asia, it has migrated to the far off Pacific islands, eastern coast of Africa and the New world.

The members of this genus have a wide geographical and ecological distribution. A survey of their distribution has been made recently by Chakravorti (1951). The accompanying map gives the distribution of the members of the three sub-genera of *Musa*. In the light of known
distribution Assam, Burma, Siam and Indo-china appears to be the centre of origin of the cultivated bananas.

The essential characters of all commercial or edible bananas, are the presence of a well developed pulp and absence of seeds. These characters are mainly a result of the parthenocarpic development of the fruit and almost complete female sterility. Due to this, vegetative propagation becomes inevitable for growing bananas as a crop. A large number of edible varieties of banana are triploids. Therefore four factors, vegetative propagation, parthenocarpy, sterility and polyploidy (especially triploidy), characterise the edible bananas. The complex action of the above four factors, together with the very heterozygous condition of the cultivated bananas, brought about by the accumulation of structural and other chromosomal changes and perpetuated in nature by the long vegetative propagation of the species and varieties has made the production of new varieties of bananas a comparatively very difficult task.

Plant breeders and geneticists today fully appreciate the great possibilities of wide crossing in crop breeding. The transference of desirable characters from
wild relatives to cultivated crop plants, through suitable hybridisation has been effected in a number of crop plants and this line offers a good scope in the case of banana also. It is therefore worth while investigating the possibility of utilizing wild related species for breeding superior forms of banana. The initial step in this direction is the collection and study of all the available wild relatives from the taxonomical, genetical and cytological stand points and their evaluation as an initial material for breeding.

Cytogenetical studies of plants and animals have proved of immense value both to breeders and to taxonomists. It is now possible (1) to determine their chromosomal constitution and (2) to assess their proper taxonomic position on the basis of their cytological behaviour. For example, the existence of Drosophila simulans from D. melanogaster was detected by breeding experiments in 1919 and those of D. Miranda from D. pseudo-obscure by chromosomes studies (Dobzhansky, 1935). It is doubtful if they would ever have been recognized by the study of their morphology alone.
Cytogenetical studies have led to the recognition of the large role polyploidy has played in the evolution of plants. Muntzing (1936) estimated that more than half of the angiosperms were polyploids. Studies of cultivated plant species and species hybrids have led to the understanding of the methods of speciation and in some cases of the nature of the relationship between cultivated plants and their wild relatives. Thus the origin of many cultivated plants can be traced to hybridisation in nature and in some cases to doubling of the chromosomes of the sterile F1 hybrids, e.g., *Brassica juncea* (Ramanujam and Srinivasachar, 1943) *Nicotiana tabacum* (Greenleaf, 1941) and *Saccharum barberi* (Parthasarthy, 1946). Similarly the garden strawberry, has now been proved to have resulted by hybridisation between two octoploid species *Fragaria virginiana* and *F. chiloensis* (Crane, quoted by Huxley 1940). The European plums arose through hybridisation between two Asiatic species, *Prunus divaricata* (2n = 16) and *P. spinosa* (2n = 32) in the region of North Caucasus (Rybin, 1936) followed by chromosome doubling in the hybrid.

The importance of cytology in unravelling taxonomic inter-relationships can scarcely be exaggerated. A comprehensive review on the subject "Cytology in its
relation to Taxonomy" has been written by Edgar Anderson (1937). Cytology has often been found to offer effective aid in clearing up doubts regarding taxonomic positions of several species. Thus *Erioxylum aridum* and *Thurberia thespesioides* were shown to belong to the same genus, viz., their specific names being *Gossypium aridum* and *G. thurberi* respectively (Harland 1949). Harland (1949) thinks "that while without the aid of cytology and genetics the taxonomists could make logical classifications of real validity, the final polish in many cases would perhaps have to be given by cytological and genetical data". The details of cell structure and such karyological features as the number, size and shape of the chromosomes, might be considered to have the same taxonomic value as other morphological characters.

Information about chromosome numbers has in many cases been of direct use in the delimitation of species or genera. "Chromosome studies unrelated to the evidence of experimental breeding have another bearing on systematics namely in the elucidation of relationships between species and larger groups that will not cross" (Darlington, 1940). Thus, in the genera *Crepis* (Babcock and Cameron, 1934) and *Primula* (Smith, 1933)
almost all the species could be recognized by their
chromosome numbers and their interrelationships and the
lines of evolutionary descent could be inferred from
karyological data.

Apart from chromosome numbers, the importance of
detailed karyological studies for unravelling the
phylogenetic relationship between groups of plants has
often been stressed by workers like Delaunay (1926);
Darlington (1930); Babcock, Stebbins and Jenkins (1937);
Longley (1941) and Bhaduri (1944).

Further, the primary pairing behaviour of chromo-
somes and the mode of secondary pairing between
bivalents has often been found to furnish valuable
clues to relationships between plants and to the
evolutionary sequence in groups of species (Lawrence,
1931; Nandi, 1936; Catcheside, 1937; Gates, 1939 and
Srinath 1940).

The early taxonomists (Baker, 1893; Schumann, 1900
and Winkler, 1930) divided the genus *Musa*, into three
sub-genera. The three distinct sub-genera recognized
by Baker (1893), with which later workers more or less
agree, have different chromosome numbers viz., \( n = 9 \)
in *Physocaulis* and \( n = 11 \) in *Rhodochlamys* and \( n = 11 \)
Further investigations have shown that the delimitations of the above three sub-genera on the basis of morphological characters alone does not correspond with their recognition according to their chromosome numbers. Cheesman (1947 b) points out that the sub-genus Rhodochlamys (Baker, 1893; Schumann, 1900; White, 1928; and Winkler, 1930) includes species with $2n = 22$ as well as $2n = 20$ chromosomes. He therefore separates species with $2n = 20$, from those with $2n = 22$ which alone form his Rhodochlamys. The 20 - chromosome species are further divided into Australimusa and Callimusa according to their seed characters. The creation of the genus Ensete by Cheesman (1947) is not considered to be justified by Chakravorti (1951). He prefers to retain Physocaulis as a section of Musa. Opinion is thus divided even to-day regarding the exact systematic position of the species of the genus Musa.

Further it must be mentioned that adequate attention has not been given by previous workers on banana to karyological investigations such as morphology of the somatic chromosomes, the secondary pairing of chromosomes during meiosis and the behaviour of the nucleolus. Chakravorti (1945) attempted
such a study of the karyotypes of chromosomes in some banana varieties collected mainly from Bengal and Assam. The main conclusion drawn by him from this study was that the species of Eumusa (2n = 22) evolved from those of Physocaulis (2n = 18), by the increase in their chromosome number by chromosome fragmentation.

The present thesis includes the results obtained from a detailed karyological study of the somatic chromosomes of a number of wild and edible species and varieties of banana collected from the Western Ghats in Bombay and Mysore as also from some localities in Assam (pp.36-50) and indicate their taxonomic value. Meiosis in P.M.C. has also been studied in the above material which includes fertile and sterile diploid species, and triploid varieties (pp.51-80). Observations on secondary association of chromosomes at meiosis, which would be of additional use in drawing conclusions regarding the basic chromosome number in the genus, have also been presented (pp.54.). Also presented is the study of the nucleoli and nucleolar organisers undertaken with a view to determining evolutionary trends in the genus in respect of these characters (pp.49.).