1. Introduction
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Nectaries are tissues or organs secreting a fluid containing mostly sugars. Nectaries are broadly classified into: (i) extrafloral, and (ii) floral on the basis of their function (see: Elias and Gelband, 1976: Fahn, 1979 a). Though these terms were earlier proposed by Caspary (1848), it was Delpino (1873) who derived function as a parameter for the classification of nectaries using 'nuptial' for floral and 'extranuptial' for extrafloral nectaries. Nectaries have long been the subject par excellence for persons interested in correlating structure and function.

The past few decades therefore have witnessed a lot of descriptive work being carried out with light microscope on various nectar secreting tissues. Attempts are also being made recently to investigate the diversity
in the structure and mode of secretion of various nectaries using transmission and scanning electron microscopes, enzyme localization techniques and autoradiography (Durkee, 1983).

The history of nectaries is well trodden ground and dates back to mid-fifteenth century according to Behrens (1879). However, Guettard (1745-1756) was the first person known to study the anatomy of nectaries. Mirbel (1809) studied the anatomy of nectaries in *Cobaea scandens* of Polemoniaceae. Caspary (1848) carried out the first comprehensive study on the anatomy of nectaries followed by Brongniart (1854 a,b) and Parlatore (1854). The two pre-eminent workers of the same period are Behrens (1879) and Bonnier (1878). Their monographs provided useful descriptive information which are still frequently cited.

Since nectaries eliminate sugars at high concentrations, they prove to be an excellent choice of tissue for ultrastructural studies. Schnepf and his co-workers (1964 a,b, 1969, 1974, 1980) and Fahn and co-workers (1970, 1972, 1975, 1979) made significant contributions to the knowledge on the ultrastructure of nectaries. Wergin et al. (1975), Tacina (1972), and Heinrich (1975 a,b) also studied the ultrastructure of floral and extrafloral nectaries of various plant species. Recently, Inamdar et al. (1985) and Mohan and Inamdar (1986) studied the development, ultrastructure and secretion of extrafloral nectaries of Holarrhena antidysenterica and Plumeria rubra respectively.

The chemical composition of nectar is another area of extensive research. Buxbaum (1927) and Bentler (1930) are two of the earliest workers to study the composition of nectar. They observed that sugars are present in more quantities than any other compound. Later investigations by Dold (1947), Fahn (1949), Wykes (1952 a,b) and Zimmermann (1953) confirmed the dominance of sugars over other constituents such as amino acids, proteins and lipids. Percival (1961) made a significant contribution towards understanding the composition of nectar in a number of angiosperms. She classified each nectar according to its dominant sugar. Baker and Baker (loc. cit) from the University of California, U.S.A. did
pioneering work on the amino acids of nectar and their significance in terms of evolution and nutritive value of insect visitors (See: Baker and Baker, 1957, 1973a,b, 1976a,b, 1977, 1982a,b,c, Baker et al., 1978 and Koptur et al., 1982). Other relevant works include those of Van Handel et al. (1972), Gottsberger et al. (1984) and Bahadur et al. (1986).

As a result of the contributions and influences of the aforenoted workers an enormous efflorescence of literature on the morphology, anatomy, cytology, physiology and biology of nectaries have resulted. In recent years three lengthy summaries on nectaries appeared. A very obscure Russian book by Kuliev (1959) on the morphology and evolution of nectaries of angiosperms, another little known Russian work by Kartashova (1965) strictly on dicotyledons (see Schmic, 1975) and a large monograph by Daumann (1970) on just the septal nectaries of monocotyledons. In addition Fahn (1979a,b) and Vassilyev (1969) have dealt at length with secretory tissues especially the structure of various extrafloral and floral nectaries.

It is evident from the foregoing account that extensive and intensive work has been carried out on nectaries by a number of workers. However, these studies deal with individual aspects rather than interrelated aspects. The study of the various interrelated aspects
of nectary systems therefore, still presents a sizeable field of research. The present investigation was motivated due to a number of factors. Nectaries are present in a large number of species belonging to about 58 angiosperm families (Metcalfe and Chalk, 1979). The development structure, secretion and biology of nectaries in a number of plant species listed by Metcalfe and Chalk (1979) are yet to be investigated.

Moreover, the function of the nectaries especially the extrafloral ones is a subject of debate till today. Various theories have been proposed on the functions of extrafloral nectaries:

i) Control of phloem function by elimination of extra sugars through metabolism (Grant et al., 1980).

ii) Elimination of excretory products of metabolism (Frey-Wyssling, 1955; Vogel, 1974).

iii) Attracting pollinators and plant protectors by offering secretory products as rewards (Bentley, 1976; 1977a, b; Koptur, 1979; Keeler and Kaul, 1984).

Evidence and support for the last theory is rapidly mounting. Experimental studies on the functional
significance of various nectaries have been mostly
carried out on temperate plant species (See Schmid,
1988). However, in India, a country with a rich and varied
tropical flora the study of nectaries and their biology
has surprisingly escaped the attention of the scientists.

Hence, it was thought worthwhile to carry out an investi-
gation on the development, structure, secretion as well
as biology of cyathial nectaries in the genus Euphorbia
of the family Euphorbiaceae. The family Euphorbiaceae
was chosen since it is endowed with different types
of extrafloral as well as floral nectaries. The genus
Euphorbia is one of the largest in the angiosperms with
over 1500 plant species (Willis, 1973).

Metcalfe and Chalk (1950) reported the presence
of three extrafloral nectary types viz.: i) Patelliform,
ii) glandular leaf margin, and iii) morulose in the family
Euphorbiaceae. Radtke (1926), Feldhofen (1933) and Agthe
(1951) studied the anatomy and development of nectaries
in the Euphorbiaceae. Aufrecht (1891) described the
development of extrafloral nectaries in Ricinus communis.
Genc and Rauh (1984) summarised the light microscope
investigations carried out by various workers on the
structure and development of Euphorbiacean nectaries
and presented a comprehensive idea regarding the struct-
ural diversity among various nectary systems. Recently,
Nichol and Hall (1983) studied the characteristics of nectar secretion by the extrafloral nectaries of *Ricinus communis*.

The morphology, development and functions of the cyathial nectaries are variously interpreted. Fahn (1974) considered them as extrafloral while Keeler (1979) reported them as floral nectaries. Bentley (1977 a,b) supported Schnepf (1974) and opined that the positional extrafloral nectaries in *Poinsettia* function as floral nectaries (see: Delpino, 1886-1889; Zimmerman, 1932). Dressler (1957) reported on the morphology of the cyathial inflorescence and considered the zygomorphic cyatham as an adaptation for hummingbird pollination. Croizat (1962) opposed Dressler's (1957) views and proposed that the appendages of cyathia are morphologically indefinable. However, Cronquist (1968) and Stebbins (1950) considered the cyathia as an adaptation for insect pollination. The nature of the cyathial inflorescence and the role of cyathial nectaries are therefore yet to be resolved. Recently, Jose and Iramdar (1988, 1989) and Arumugasamy and Inamdar (1988) reported on the structure, development and biology of cyathial nectaries in *Macaranga peltata*, *Croton bonplandianus* and *Euphorbia thymifolia* respectively.
The present study embodies both light and electron microscopic studies on the development, structure, secretion and functions of cyathial nectaries in selected plant species of the genus *Euphorbia*. In addition to being an academic exercise, it is sincerely hoped that a broad spectrum study of the cyathial nectaries will provide baseline data on the secretory mechanism and pollination dynamics of cyathial inflorescences. A number of Euphorbiaceaeous plants are economically important and a better understanding of their pollination biology is essential for better crop management and better yields.

The thesis encompasses in itself the following aspects:

1. Ontogeny of cyathial nectaries.


5. Preliminary chemical analysis of nectar.