

# Studies on nectary structure of some members of family Cucurbitaceae

Kadu Sandhya R.

Bhartiya Mahavidyalaya, Amaravti, 444603.

## Abstract:

Reproduction is the most vital event in the life cycle of angiospermic plants. To accomplish this, the process of pollination is carried by different methods. The biotic agents involved in the process of pollination are rewarded in many ways. One of which is nectar produced in nectary. Nectaries are specialized tissues that secrete a sugary fluid involved in interactions with animals. The two types of nectaries are present namely, extrafloral and floral. The present work deals with the detailed structure of nectaries studied in four different plants of family Cucurbitaceae. The studies revealed that the extrafloral nectaries are found on leaf lamina and stipules while the floral nectaries on the flower. The anatomical structure stated the differences in male and female flower nectaries. The male flower consists of epidermis and 8-10 layers of secretory parenchyma while the female flower tissue revealed more up-to 10-12 layers of secretory parenchyma and outer non-secretory 10-14 layered parenchymatous zone.

**Keywords:** Cucurbitaceae, extrafloral nectary, floral nectary, anatomy, pollination, pollinator.

## Introduction:

Angiosperms are conspicuous by virtue of their beautiful and attractive reproductive structure called 'Flower'. The process of reproduction is vital in the life cycle of angiosperms. To achieve successful reproduction there should be effective pollination. The pollination process is carried by different agencies i.e. biotic and abiotic. From biotic agents' insect pollination (entomophily) is very crucial. To accomplish insect pollination there are many rewards to attract the insects in the plant. Nectar is the most important reward for the visiting pollinator. The nectar is present in a specially developed structure called nectary.

The two types of nectaries, floral and extrafloral, were recognized by Bonnier (1879). They may be considerably differing in anatomical structure, source of nectar components, and mode of presentation (Davis *et al.*, 1988 and Pacini *et al.*, 2003). The functions of both the nectaries are the same. The floral nectaries however, are better known than extrafloral nectaries. Floral nectaries are also important sources of food for honeybees and are involved in reproduction of many economical significant plant in the production of many fruit and seed crops. Extrafloral nectaries, which occur mainly in tropical and subtropical plants, are noteworthy from an ecological point of view, but have limited economic applications, at least at present.

Extrafloral and floral nectaries may be found in the same plant species with their secretion being collected by different kinds of animals. The structure, composition and ecology of extrafloral and floral nectaries in the same species have been compared in various papers, e.g. *Croton sarcopetalus*, Euphorbiaceae (Freitas *et al.*, 2001), *Tabebuia serapatifolia*, Bignoniaceae (Thomas and Dave, 1992) and *Turnera ulmifolia*, Passifloraceae (Elias *et al.*, 1975). The floral nectaries function as reward for animals for transporting pollen and for the extrafloral nectaries reward animals defending plant from herbivores. The position of floral nectaries in different parts of flower are ovary, stamen, calyx, corolla and receptacle while extrafloral nectaries are very common in leaves, petiole, blade, stipule (Koptur, 1992).

Nectary structure may vary with nectary position in the flower. Independently from the anatomical organization, the extent of nectary parenchyma determines the quantity of nectar produced and hence the type of pollinator. The anatomical diversity of nectaries may be matched by a similar diversity in the mechanisms of nectar secretion and presentation.

In the present work four different plants from family Cucurbitaceae namely *Diplocyclos palmatus* L., *Coccinia grandis* (L.) Voigt, *Cucurbita maxima* Duch. and *Luffa cylindrica* (L.) Roem. revealed both floral and extrafloral nectaries. The flowers are unisexual. The extrafloral nectaries are laminar and also stipular. In case of male flowers inner side of thalamus is secretory. Nectariferous zone distinct by virtue of its yellow color.

Nectary of male flower structurally consists of epidermis and 8-10 layers of secretory parenchyma. Nectar oozes out through the stomata in epidermis. Female flowers with yellow epigynous bowl shaped nectary. Anatomically it consists of two distinct zones. Inner zone of 10-12 layers of secretory parenchyma and outer non-secretory 10-14 layered parenchymatous zone.

## Review of Literature:

The history of pollination ecology goes back to 1793 when Christian Conrad Sprengel published his book "The secret of Nature in the Form and Fertilization of Flowers Discovered". Charles Darwin influenced pollination ecology more deeply than anybody else during the nineteenth century.

The term nectarium (nectary) was introduced by Linnaeus (1735). Though it was known since a long time that nectaries occur both on reproductive and non-reproductive structures, it was Linnaeus who first clearly described nectaries for 24 genera of angiosperms. He extended the concept of nectary from reproductive organs to vegetative ones.

The history regarding about nectaries and nectar shows that it is was a long time before the role of nectar in insect pollination was recognized earlier it was assumed that nectaries originated as excretory organs to rid the flower superfluous liquid (Lorch, 1978). The most ancient extant plant with nectaries is the bracken fern *Pteridium aquilinum*, which showed the extrafloral nectaries on its fronds (Hedges and Lawton, 1985). In gymnosperms, secretions resembling nectar occur in Gnetales and are involved in pollination (Bino *et al.*, 1984; Wetsching and Depisch, 1999). Nectaries are far in angiosperms, dating back to the late Cretaceous.

Most angiosperms are pollinated by insects, which are rewarded with nectar during visits to flowers with floral nectaries, whereas extrafloral nectaries reward a more limited set of animals, mainly ants, that keep herbivores away. There are different types of nectary, situated anywhere in the flower and in widely different parts, with different origins and types of organization. The structural diversity of nectaries in angiosperm families was described by Vogel (1997, 1998).

Floral nectaries are comparatively simple structures of different origins that are involved in the pollination process. They can occur in virtually all parts of the flower and produce a variety of sugary exudates. The shape, structure, and position of these nectaries has been used for taxonomic and phylogenetic considerations (Bonnier, 1879; Brown, 1938, 1961, and Norris, 1941).

In recent years, electron microscopy has helped in studying the structure of nectaries. Outermost layer of nectary may be specialized or unspecialized, but it is through this layer only that the secretion oozes out. The exuding epidermal cells may be simple cubical or columnar palisade like or may be having trichomes that are excretory. When exuding cells are covered with cuticle, the cuticle shows alternate thick and thin areas through which nectar exudes out as in *Lonicera japonica* (Fahn and Rachmilevitz, 1970).

Fahn (1952 and 1974) has described stomata on the nectary surface of *Colchicum ritchii*. He has also noted occurrence of modified stomata on the nectaries of *Citrus*, *Bupleurium* and *Trapeolum*. In these nectaries intercellular spaces are generally well developed in the subepidermal nectariferous tissue.

Bignoniaceae has remained a favoured family for nectary and nectar studies. Both floral and extrafloral nectaries have been studied by number of authors like, Rao (1926), Dop (1927), Inamdar (1969), Elias and Gelband (1975 and 1976). Subramanian and Inamdar (1986) studied structure, development and biology of nectaries in *Kigelia pinnata*. Sometimes it is the trichomes on epidermis of nectaries that are secretory. These trichomes may be unicellular or multicellular with distinct secretory heads as in *Vicia faba* and *Abutilon* (Schnepf, 1969), or the hairs may be simple without glandular head as in *Tropaeolum majus* (Rachmilevitz and Fahn, 1975)

## Materials and Methods:

The four plants were selected for study from family Cucurbitaceae. The species selected are readily available local plants either from wild or cultivated ornamentals. Identification were done with the help of standard floras. The morphological and anatomical structure were studied.

Location and morphology of nectary was studied from fresh plant material. Sketches were made to show the exact positions on various organs and to illustrate the shape of nectaries. For anatomical studies, mostly hand sections of the fresh material were taken. Camera lucida sketches were done mostly from temporary mountings only.

## Observations:

The following observation were made during the investigations:

Nectaries consists of three components

- a) An epidermis, with or without stomata and trichomes, where nectar is released to the exterior.
- b) Specialized parenchyma that produces or stores nectar solutes.
- c) The vascular bundle that conveys water and nutrients to the parenchyma.

1. *Diplocyclos palmatus* L.

The plant flowers throughout the year but profuse flowering during November-February. Both foliar and floral nectaries present. Foliar nectaries are small and remain scattered on lamina abaxially, more so in the lower part lamina. Nectaries saucer shaped, in transverse section each nectary is lined by a distinct limiting layer forming a sort of rim. Tissue within the rim secretory, cells thin walled with small intercellular spaces. No vascular supply is observed going to the nectary. Nectary thus is apovascular. Nectar secretion is scanty (Fig. No. 7 and 8).

2. *Coccinea grandis* (L.) Voigt.

Flowering throughout the year, but profuse flowering during July- October. Both extrafloral and floral nectaries studied. Stipular nectaries are present at the tips of stipules. They are small, annular structures. Foliar nectaries present on abaxial surface of lamina. They are many per leaf. Nectaries are more frequent in the lower half of the lamina. Distribution of laminar nectaries though unequal, their position is somewhat specific. Nectaries are found along the main veins. They are annular with broad rim. Sepaline nectaries unspecialized. Outer tips of sepals are secretory in nature (Fig. No. 1, 2, 3, 4 and 5).

3. *Cucurbita maxima* Duch.

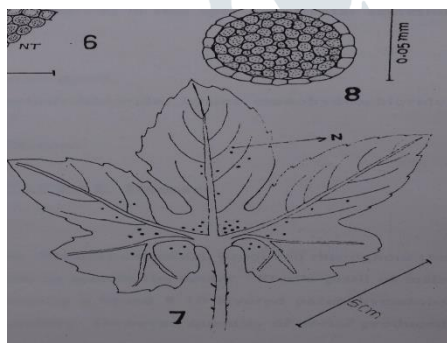
The flowering period of this plant is throughout the year, but maximum during September-November. Both extrafloral and floral nectaries observed. Foliar nectaries are present on the abaxial surface of lamina as shortly stalked glands with narrow button like head. Head secretory. They are located on veins. Nectar secretion scanty (Fig. No. 7 and 8).

4. *Luffa cylindrica* (L.) Roem.

The flowering is throughout the year. Both extrafloral and floral nectaries observed. Extrafloral nectaries are present on stipules and leaf. Stipular nectaries present on outer surface of stipules. They were annular with non-secretory rim and central nectariferous cells. In V.S. tissue of the nectary is separated from rest of the stipular tissue by a layer of hyaline cells. Nectary consists of single layered epidermis and 10-12 layers of thin walled, polygonal, compactly placed parenchyma.

Foliar nectaries are scattered on under surface of lamina. They are saucer shaped and smaller than stipular nectaries. Anatomically similar to the stipular nectaries, with more prominent foot layer consisting of 1-2 layers of columnar hyaline cells. Vascular strand present in subsecretory tissue.

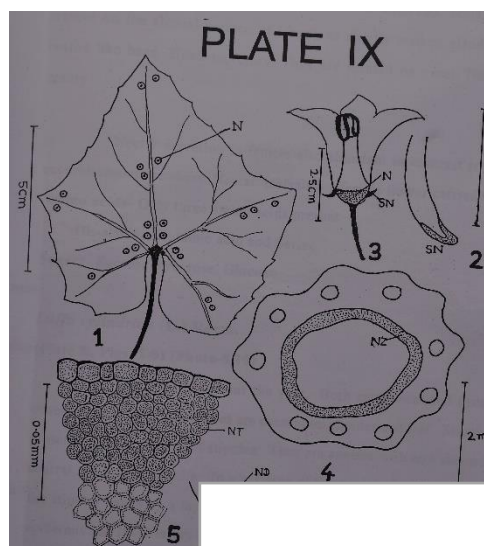
Sepaline nectaries are similar to the extrafloral nectaries but are slightly elevated from the sepal surface.



*Diplocyclos palmatus* L.

**Fig. No. 7:** Leaf showing small nectaries scattered over abaxial surface of lamina.

**Fig. No. 8:** Single nectary magnified in surface view.



***Coccinea grandis* (L.) Voigt.**

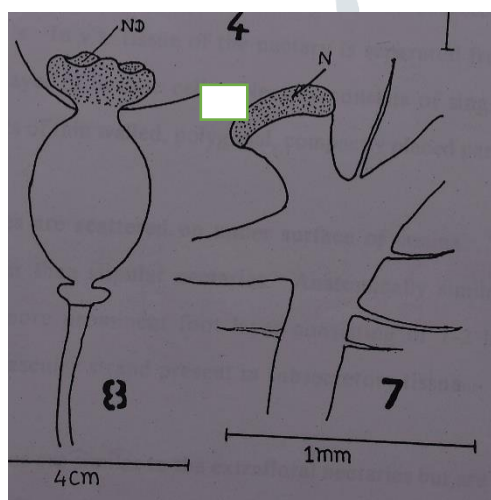
**Fig. No. 1:** Nectaries present on abaxial surface of leaf.

**Fig. No. 2:** Single sepal, showing nectariferous tip.

**Fig. No. 3:** L. S. male flower, showing inner nectariferous surface of thalamus

**Fig. No. 4:** T. S. thalamus, showing inner nectariferous zone.

**Fig. No. 5:** Part of T. S. thalamus, showing nectariferous zone (nector magnified)



***Cucurbita maxima* Duch.**

**Fig. No. 7:** Laminar nectary on under surface of leaf along the vein.

**Fig. No. 8:** Basal part of female flower, showing epigynous nectariferous disc.

**Fig. No. 1:** Single stipule, showing abaxial nectaries

**Fig. No. 2:** Abaxial surface of leaf, showing laminar nectaries

**Fig. No. 3:** Laminar nectary in V. S.

**Fig. No. 4:** Part of secretory tissue laminar nectary magnified

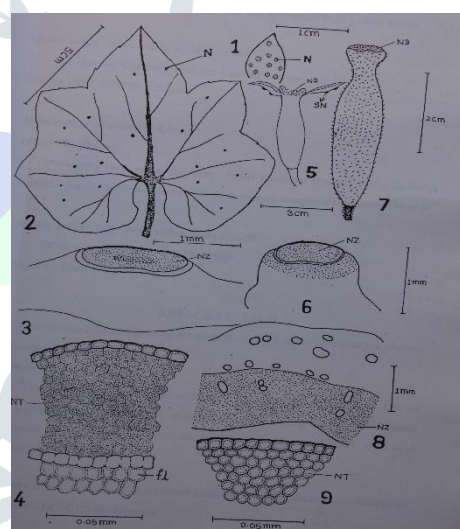
**Fig. No. 5:** Part of flower, showing sepaline nectaries and epigynous nectary disc

**Fig. No. 6:** Sepaline nectary in V. S.

**Fig. No. 7:** Ovary showing nectary disc in surface view

**Fig. No. 8:** T. S. nectary disc

**Fig. No. 9:** Part of nectariferous zone of disc magnified



***Luffa cylindrica* (L.) Roem.**

## Results and Discussion:

Most of the literature regarding pollination biology deals with the structure of nectary and flower visitors. The present work deals with extent and form of nectariferous tissue. Gross observations regarding vascular supply to the nectary have also been made. In some cases flower visitors were noted.

Extra floral nectaries were confined to dicotyledonous families. The Cucurbitaceae family has shown laminar nectaries. Secretory tissue of Malvaceae, though simple, trichomic simple, trichomic type, is well organized into a deeply embedded nectary in case of *Hibiscus cannabinus*. However, surface nectaries are most common in Malvales (Rao and Ramayya, 1998) or they may be in the form of shallow depression as in case of *Gossypium*. They were referred to as hair nectaries by Wilkinson (1979).

Raciborsky as back as (1900) noted colonization of nectaries by sooty moulds in Malvaceae. Nectaries of *Passiflora caerulea*, *Stigmaphyllon periplochifolia* and *Impatiens balsamina* should be considered advanced as they receive the vascular supply (Frey-Wyssling, 1955). Nectaries of first two are comparatively less advanced as their secretory tissue consist of large palisade like cells, while the later is more advanced as its secretory cells are all small, parenchymatous (Zimmermann, 1932).

Laminar nectaries of Cucurbitaceae and *Campsis* represent an evolved feature. The absence of vasculature here is attributed to their small size (Elias and Gelband, 1976). Reduction in size of the nectary is compensated by their abundance. *Cucurbita maxima* presents a bit less advanced condition. Within the family *Momordica charantia* and within the order Malvales, Bombacaceae, Tiliaceae and Sterculiaceae by virtue of absence of foliar nectaries should be considered less advanced or primitive (Shanmukha Rao and Ramayya, 1998). Regarding the vascular supply of nectaries, Carlquist (1969) is of the opinion that vasculature in a structure is directly proportional to its size.

The observations on the position of extrafloral nectaries in *Luffa cylindrica* (L.) were found to be similar to the findings of Agarwal and Rastogi (2010).

Present findings confirm both the views that laminar nectaries act as sap-valves and as ant guards (D. Clair-Maczulajtys and Bory, 1998). Extra floral nectaries eliminate excess sugars and play an important role in regulation of photosynthesis.

According to Brown (1938) the position of nectaries in Malvales is probably connected with lack of gamopetalous flowers in the order. When sepals are free, nectary is present mostly between the and stamens or at petal base as in *Grewia*. Though trichomic nectaries are recorded by earlier authors especially for Malvales; other taxa were also found to possess trichomic nectaries during present investigations.

The result of the studies shown that in angiosperms, the diversity of nectaries may be related to several causes involving three basic aspects of nectary biology: nectar presentation, nectary structure and nectary fate. Wherever both foliar and floral nectaries are present, foliar ones are usually structurally more complex or specialized than floral ones.

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