*CYTO-MORPHOLOGICAL STUDIES IN
ASTERACANTHA LONGIFOLIA NEES.
(HYGROPHILA SPINOSA. T. AND.)

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I. Introduction

The name of this family, Acanthaceae to which Asteracantha longifolia Nees. belongs, comes from the typical genus, Acanthus. Acanthus is a Greek term (Acanthos) meaning a spine (Bailey, 1933). Since several species of this genus Acanthus (Acanthus ilicifolius) and other genera (Barleria, Asteracantha) under this natural order possessed spines or thorns, the family came to be called Acanthaceae or more popularly Acanthus family. The members of this family confined mostly to the tropical and sub-tropical regions of the world, present certain very interesting morphological and ecological characters. Cytologically, they seem to be no less important. However, work both cyto-
logical and morphological in this family of diverse habit has been but

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scanty. While other families like Scrophulariaceae, Gesneriaceae, Pedaliaceae, Labiatae, Verbenaceae belonging to the Tubiflora (Rendle, 1938), or the Bi-carpellatae (Benthm and Hooker, 1682–83), have been sufficiently dealt with, literature on Acanthaceae is very small. Schnarf (1931) speaks of a number of authors (Hartmann, Gigante) who have given a short account of the development of the mega and the microspores and the nature of the endosperm. Schürhoff (1926) has similarly given a brief catalogue of the various kinds of haustoria in a few members that were noted by different authors, during embryogeny. Karsten (1891) studied the embryo-sac of the genus Acanthus, but was uncertain about some details. Maheshwari (1937) has recommended reinvestigation of this. Only meagre information is available about the following genera:—Acanthus (Gigante, 1929); Strobilanthes, Ruelia, Eranthemum, Barleria, Acanthus, Crossandra, Aphelandra, Cryptophragmium, Schaueria, Belloporone (Hartmann, 1923); Acanthus spinosus (Hofmeister, 1858–59); Thunbergia (Juel, 1915; Strasburgher, 1882); Acanthus (Tieghem, 1908) and Eranthemum (Vesque, 1878).

Karyological studies in this family have been very few. The meiotic chromosomes of the members of this family were not known until Gigante counted them in Acanthus mollis in 1929 though even that count was quite uncertain.

Thus it would appear that though some members of this family have been the objects of investigation in the past at the hands of various authors, Asteracantha longifolia Nees., a tropical plant of the Indian soil which is supposed to be a sudorific and a somewhat bitter tonic, though very troublesome because of the sharp thorns, is interesting in more ways than one. In the present paper, the development of the embryo-sac and pollen, growth of the embryo and endosperm, and some details relating to the anatomy of the stem, root and leaf, have been described. Besides, the morphology of the conspicuous thorns and the floral tip has also been studied. The meiotic and the somatic chromosome numbers have been determined for the first time.

II. Material and Methods

Asteracantha plants were available in plenty in the neighbourhood of pools, ponds, streams and ditches of Annamalainagar. Especially during the rainy season when they are most exuberant, it was easy to get good root-tips from the swampy marshes by gentle pulling. Root-tips were fixed at about 10 A.M., when the formative cells were in a state of active division, in chrom-acetic formalin of Karpechenko and Langlet (Manton, 1932) without prefixation in carnoy. Anthers of the desired stages of development were
first determined by the acetocarmine smear method and then fixed in chrom-acetic formalin. For ovaries and ovules of different stages of development, either formalin-acetic-alcohol or hot corrosive sublimate was used. In order to study the organogeny of the flower, floral tips were fixed in corrosive sublimate, which gave good results. Mature seeds were first soaked in glacial acetic acid for a few days before fixation in order to soften the tissue and facilitate sectioning. Materials were dehydrated in alcohol, cleared in chloroform and imbedded in paraffin. Sections were cut at thicknesses varying from 5-20 microns. For sections of anthers and root-tips both Heidenhain's iron-alum haematoxylin and Newton's iodine-gentian violet were used as the stains, while for the preparations of ovaries, ovules, seeds and floral tips, haematoxylin was exclusively employed.

**III. Description of the Plant**

This is a stout, erect herb 2–5 ft. in height growing abundantly in marshy places on the brinks of streams, pools and ditches. They are profusely common particularly near paddy fields. Branching is sparse and the plant body is covered by numerous hispid hairs. Outwardly spreading stiff woody thorns, six in number at each node, form the most conspicuous part of the plant. The nodes are swollen like those of its congeners in the family and the stem is somewhat pink in colour.

Leaves, opposite and decussate, linear-lanceolate, subsessile with acuminate tip and hairy.

The axillary buds in the axils of the two opposite leaves become more often transformed into thorns than develop into branches. Each of these two thorns bears at its base one on either side, two more leaves shorter than the first two. So, for the two thorns there are four smaller leaves and these four again bear in their axils more thorns. At the base of each one of these four thorns two more leaves arise and the buds in the axils of the latter develop into flowers. Thus there are actually three whorls of leaves arising one above the other as do the floral leaves in a flower, the lowermost whorl consisting of the two big opposite leaves. This seems to confirm the view already expressed by Raghavan and Venkatasubban (1941) supporting the classical concept relating to the morphology of the flower. From the axil of each of these two big leaves on the main stem, therefore, there appear three thorns, six leaves, and four flowers. Since the uppermost or the innermost whorl of small leaves bears immediately in their axils flower buds, these leaves can be regarded as the bracts. All these parts are sessile and are crowded at the base and form a cluster.
The blue-purple sessile flower has a pair of membraneous linear bracteoles. Each of these bracteoles sometimes bears in its axil another flower bud and this has its own bracteoles and so on. Calyx, deeply 4-partite; corolla of five petals, bilabiate; upper lip of two petals, the lower of three, with two crested folds on the palate. Stamens, 4, didynamous, anthers two-celled, the lobes standing parallel and at the same level. Ovary, bicarpellary, syncarpous with axile placentation; it is surrounded at the base by a prominent fleshy annular nectariferous disc; ovules in the young stages are arranged obliquely in the carpels with their chalazal ends pointing upwards. Style filiform. Stigma is bilobed in very early stages, later becoming simple by the suppression of one of the lobes. Fruit is a linear oblong loculicidal capsule covered by white hairs, with hook-like funicular projections, the jaculators, (Figs. 47, 48, 49 and 50) which help in their dispersal.

IV. Anatomy of the Stem, Root, Leaf and Thorn

The stem shows a herbaceous type of vascular system (in which the vascular tissue is in the form of discrete bundles, big and small, arranged in a square or rectangle) undergoing secondary thickening. The pith and cortex are composed of very loosely arranged parenchymatous cells with large intercellular spaces. Solereder (1908) refers to this as the lacunar cortex. Conspicuous collenchyma forms a broad hypodermal zone. Calcium oxalate crystals, in the form of very long isolated needles, are distributed throughout the stem. Besides, cystoliths though more common in leaves, are also found in the stem. The epidermal hispid hairs are multi-cellular and their cytoplasm is almost closely packed with calcium oxalate needles which are comparatively much smaller than those of the stem. The pink colour of the stem is due to anthocyanin pigment in some of the epidermal cells.

The cortex is filled with large air-chambers separated by narrow bridges of cells that connect the hypodermis and the cells that border upon the endodermis. There is no well-defined epidermis, but like the monocot root, possesses an exodermis with a thick outer wall scarcely distinguishable from the inner cortical cells. The endodermis is seen clearly with the conspicuous Casparian bands. It is interesting to note in this connection that the plant is capable of vegetative propagation especially during favourable conditions, because of adventitious roots springing from some nodes above the soil. These roots form stilts just as in Pennisetum or Andropogon. While that part of the adventitious root below the soil shows the normal root structure the part above the soil shows anatomical features that are intermediate between stem and root. It has a fairly large pith, but it has also very large air-chambers. In its habit, Asteracantha is partly aquatic and so it has got a well-developed aerating system.
The leaves of some members of the family have been described as centric and some as bifacial (Solereder, 1908). The leaf of *Asteracantha* is not bifacial, but centric, *i.e.*, having palisade tissues towards both upper and the lower surfaces. There is no hypodermis and the stomata which appear in a surface view to be capped by a subsidiary cell, were found to occur on both sides. Cystoliths abound in the epidermal cells as elongated club-shaped bodies blunt at both ends. Solereder speaks of the attempt of a certain author named Hobein who has classified Acanthaceae into various tribes according to the shape, size and position of the cystoliths. Hobein places *Asteracantha* in the tribe, Ruelliæ, which is characterised by cystoliths of varying shapes. The chromosome number of the plant also seems to support this.

The morphology of the thorn has not yet been investigated critically. Three important factors go to support their axillary origin. The most familiar fact is that they arise in the axils of the leaves. Secondly their internal structure especially in the younger stages of development, is an exact prototype of that of the stem or branch, though the thorn becomes soon hardened into a stiff structure by every thick-walled sclerenchyma. This almost fills the inner part, especially the vascular region even to the exclusion of the vessels (Fig. 52). Thirdly these thorns themselves in luxurious plants were seen to bear on them nodes and internodes, small caducous leaves and tiny axillary branches which also sooner or later become transformed into stiff branch thorns.

**V. Organogeny of the Flower**

The primordium of the flower first makes its appearance as a knob-like protuberance in the axil of a leaf (Fig. 12). The order of development of the floral whorls was found to be calyx, androecium, corolla and gynoecium. Schertz (1919) noticed the same order of formation of the floral whorls in *Scrophularia marylandica*. Similarly Srinivasan (1940) has observed the same in *Angelonia grandiflora*. Both these plants belong to Scrophulariaceae, a family closely allied to Acanthaceae in the Tubiflores. The primordia of the sepals arise as lateral lobes from the apical dome (Fig. 12 se). These enlarge and are soon accompanied by the appearance of the primordia of the stamens and not by those of the petals. The appearance of these is much like that of the sepals. By this time the sepals have very much elongated because of their rapid growth and are many times longer than the stamens (Fig. 13). By now the primordia of the petals have already become initiated at a slightly lower level than the stamens. They soon overtake the stamens in their growth (Figs. 13 and 14). Lastly the two carpels arise from the dome-shaped apex. Careful observation shows that these two carpels are not
VI. Development of the Microspore

All the four anthers in the flower are fertile. The pollen-mother cells are comparatively larger while the chromosomes are small. At the time when the anther appears four-lobed in the cross-section, the primary archesporium
of the microsporangium just makes its appearance as three or four cells in a hypodermal fashion (Fig. 16). So the archesporium is not very extensive. These archesporial cells of the anther can easily be recognised amidst other cells of the anther by their larger size, bigger nuclei and denser cytoplasm. The lobes of the anthers become more and more conspicuous after the initiation of the archesporium. The archesporial cells divide periclinaly giving rise to a layer of primary wall cells or parietal cells on the outside and a layer of primary sporogenous cells on the inside. The primary wall cells repeatedly divide periclinaly forming three layers of wall cells of which the innermost functions as the tapetum (Fig. 17). The layer of wall cells immediately outside the tapetum get tangentially elongated.

The tapetal cells enlarge and in the beginning, each has a single conspicuous nucleus and deeply staining cytoplasm. This nucleus undergoes mitotic division just when the prophase of the pollen-mother cell nuclei is well under way (Fig. 18). Bi-nucleate tapetal cells were commonly seen while a solitary case of a tri-nucleate tapetal cell was also met with (Fig. 20). Some authors have mentioned amitosis or fragmentation in regard to the division of the tapetal cell nucleus. Suguira (1936) has spoken of the likelihood of such a division, while O'Neil (1920) found that the nuclei in the tapetal cells of Datura stramonium divide by amitosis. But Bonnet (1912) and later Cooper (1933) have found in several cases in the Angiosperms that the tapetal nuclei divide by mitosis. The latter has grouped 43 species of Angiosperms in a critical study into three classes according to the behaviour of the tapetal nucleus: (1) in which the tapetal cell throughout remains in a uni-nucleate condition without division; (2) in which the nucleus divides once and remains bi-nucleate; and (3) in which multi-nucleate tapetal cells are present. Large vacuoles form a conspicuous feature of the tapetal (Figs. 20–22) cells though Joshi (1936) has reported the complete absence of the vacuoles in the tapetum of Stellaria media. The tapetum in the latter stages of development of the pollen mother cells disorganises and disintegrates. The pollen mother cells enlarge and remain closely packed in the early stages. But at about the stage of diakinesis they begin to round off.

Diakinesis.—In this stage sixteen pairs of homologous chromosomes are distributed in the periphery of the mother cell in a very condensed form. The nucleolus itself appears to be placed in a slightly peripheral position. The bivalents are approximately placed in an equidistant manner. This equidistant disposition of the bivalents according to Lawrence is due to a repulsion phase which commences at early diakinesis and continues till mid-diakinesis and this suggests that the inter-bivalent repulsion is almost equal.
Then the pairs of chromosomes become very much contracted so that their bivalent nature can hardly be recognised. What appeared to be ring-bivalents were noted in this plant (Fig. 23). But it is not quite certain.

**Metaphase.**—The contracted bi-valents sixteen in number then arrange themselves in the equatorial plane (Fig. 24). Secondary association seems to be prevalent in this plant, but sufficient number of metaphase plates were not available to illustrate the different kinds of secondary association. Catcheside (1937) found that the bi-valents in secondary association in the first metaphase are those that have occupied adjacent positions in the diakinesis. In the
metaphase that I obtained, the number of secondary associations is eight. Out of the sixteen bi-valents three are free while remaining thirteen have entered into association. There are three secondarily associated groups of three bi-valents each and two such groups of two bi-valents each. In the present case secondary association was seen to persist even in the second metaphase (Fig. 28). Catcheside, however, reports that in Brassica secondary association disappears during anaphase I. The haploid number was confirmed by somatic count (Fig. 25).

Then, after the segregation of the chromosomes for which Kuwada (1929) assumes that polar attraction is responsible, they reach the poles and reorganise themselves into inter-kinesis nuclei. The nucleolus appears and the chromosomes are uniformly placed, connected by strands (Fig. 30). This uniform spacing of chromosomes at inter-kinesis was first recorded by Gates (1909) in Oenothera and again by Raghavan (1938) in Gynandropsis. Cross-wall seemed to be formed by cell plate. But it was hazily seen. The result is the formation of a dyad. The two daughter nuclei then divide simultaneously (Figs. 26 and 27). Fig. 29 shows two groups of sixteen chromosomes each in second metaphase polar view. Secondary association is to be seen up to this phase (Fig. 28).

In the second metaphase the spindles of the two groups of sixteen univalents may be placed in the same plane (Fig. 27) both showing side view or the polar view (Fig. 29). Or they may be placed in two planes which are perpendicular to each other (Fig. 26). Now, when the tetrads are developed, their relative dispositions depend upon the spindle positions in the II metaphase. The two spindles showing the side view (Fig. 27) develop into a tetrad of four microspores or pollen grains which are all to be seen in one focus (isobilateral) (Fig. 32), while the spindles placed at right angles to each other in the same plane develop into a tetrad wherein three spores are seen in one focus and one in another. In other words, this is the tetrahedral arrangement of spores (Fig. 31). In the other polar view of the former case two spores only are to be seen in one focus, the other two in another (Fig. 33). Thus three types as it were of tetrads were noted (Figs. 31, 32 and 33). The mature pollen grain at the time of shedding is distinctly bi-nucleate (Fig. 34). Fig. 34 shows the lens-shaped generative nucleus. The diploid number of chromosomes was found to be 32 in the somatic cells of the root-tip (Fig. 25).

The pollen grains of the Acanthaceae in general present wide variations in the sculpturing of their walls. Wodehouse (1935) deals with this in an elaborate manner, but no mention of Acanthaceae pollen grains has been made. All these sculpturings are beautiful and in Asteracantha, particularly
they appear as thickening bands radiating from a central circular position on
the wall (Fig. 35). So varied and at the same time so definite are these
sculpturings on the pollen grains in the various plants of the Acanthaceae,
that Rendle speaks of a classification of this family into tribes according to the
types of pollen grains.

VII. Megasporogenesis

The ovary is bi-carpellary typical of the bi-carpellate, of Bentham and
Hooker. About four ovules arise as tiny protuberances in each carpel and are
obliquely arranged with reference to the axile placenta. The archesporium
of the megaspore arises as a hypodermal cell which is much bigger than
the surrounding cells. Its cytoplasm is dense and nucleus large and promi-
nent (Fig. 3). The archesporium is initiated earlier than the formation of the
integument (Fig. 3). Such an early differentiation of the primary arches-
porium has been reported by Joshi and Rao (1934) in *Digera*, Langdon (1934)
in *Carya* and *Juglans*, Woodroff (1928) in *Hicoria pecan* and Srivastava (1939)
in *Orobanche aegyptiaca*. By this time the anthers show meiotic phases in the
pollen mother cells. The flower of *Asteracantha* is therefore protandrous.
This appears to be the rule not only in a majority of families, but also in
almost all the members of the Acanthaceae.

The archesporial cell enlarges and functions as the megaspore-mother
cell (Fig. 4). The single integument characteristic of the Gamopetalae
develops enormously and the bulk of the ovule is more or less made up of the
integument. The megaspore-mother cell is enveloped by a single layer of
narrow cells which stain lightly compared to the other cells of the ovule.
There is no other parietal tissue, the hypodermal cell directly developing into
a megaspore-mother cell without cutting off any primary wall cell. This
enveloping layer is regarded as the nucellus which, when the embryo-sac has
been formed, disappears by disorganization. Such an early disorganization
of the nucellus during the developmental stages of the embryo-sac appears
to be a characteristic feature, of Acanthaceae, Scrophulariaceae (Srinivasan,
1940) and other closely related families. Balicka-Ivanowska (1899) calls this
‘nucelle’ and has reported its prevalence in *Pedicularis palustris* (Scrophu-
lariaeae), *Klugia notoniana* (Gesneriaceae), *Campanula rotundula* (Campanula-
caeae), etc., Bhaduri (1935) has a similar report about a number of sola-
neeuous plants. In Lobeliaceae too, the same was noted by Kausik (1938)
in *Lobelia nicotianafolia*, and by Srivastava (1939) in *Orobancheae*. Schertz
(1919) is of the opinion that the nucellus in the micropylar region is
destroyed by the elongation of the embryo-sac while towards the chalazal
part it persists till its disorganization during endosperm development. In
*Asteracantha*, however, it becomes destroyed even earlier.
No tapetum was observed in this. Mitchell (1915) reports its absence in *Striga lutea*; Srinivasan (1940) in *Angelonia grandiflora*.

The megaspore-mother cell by a heterotypic division gives rise to a dyad (Fig. 5). The dyad by homotypic division forms a linear tetrad of megaspores, the cell nearest to the chalazal end developing into the embryo-sac (Fig. 6). This enlarges and vacuoles appear while the nucleus remains about the centre of the cell. This is the uni-nucleate embryo-sac (Fig. 7). This nucleus divides and forms a bi-nucleate embryo-sac with a vacuole in the middle and the nuclei at the ends (Fig. 8). This in its turn develops into a four-nucleate embryo-sac by further division (Fig. 9). The increase in the size of the embryo-sac almost comes to a standstill at this stage so that when subsequently the eight-nucleate embryo-sac (Fig. 10) is formed, there is not much difference between the former and the latter in size. Two nuclei, one from each end of the embryo-sac, migrate towards the centre and fuse so that at this stage the embryo-sac consists of only seven nuclei (Fig. 11). The meeting place of the polar nuclei is reported to be various by Schmid (1906) especially with reference to *Pedicularis palustris*. The embryo-sac is of the normal type (Maheswari, 1937). The mature eight-nucleate embryo-sac consists of two synergids, an egg cell, two polar nuclei and three antipodals. The egg-apparatus is prominent while the antipodals are not so. The embryo-sac appears to be curved owing to the crooked and faster growth of that integumental half farther away from the funicle.

Even slightly earlier than fertilisation the antipodals degenerate and are therefore of an ephemeral character. The synergids whose chief function is supposed to help in the fertilisation process having done its work disintegrate.

**VIII. Embryo and Endosperm**

The first division of the fertilised egg is transverse (Figs. 36 and 37). Further transverse divisions of the two cells thus formed produce a four-celled linear pro-embryo (Figs. 38 and 39). To facilitate description these four cells of the pro-embryo will be designated as A, B, C and D (Fig. 39). This stage of the embryo is an important one, as each one of them gives rise to a definite region in the mature embryo. A longitudinal wall laid down in the cell D produces a quadrant (Fig. 40). A transverse wall across the quadrant forms the octant (Fig. 41). The cells C1 and C2 (Fig. 41) are formed by the transverse division of the cell C. The cell C2 is the hypophysis (Fig. 41). The suspensor is composed of three cells A, B and C1. The embryo at the octant stage is six cells long. Fig. 42 represents a later stage in the development of the embryo. The primary meristems, dermatogen, periblem and plerome
have been differentiated. The hypophysis cell $C_2$ has undergone a transverse division to form two cells, $C_2^1$ and $C_2^2$ (Fig. 42). The upper of the two cells, $(C_2^1)$ becomes continuous with the dermatogen while the lower $C_2^2$ forms part of the periblum (Fig. 42). In the mature seed the suspensor is about seven to eight cells long. This is due to the repeated division of the original three suspensor cells A, B and C. In one of the embryos two of the suspensor cells have put forth laterally haustorial protuberances

![Diagram of seed development](image)

**Figs. 43–52**

*Fig. 43.* Shows the bi-nucleate micropylar endosperm haustorium, the embryo and the cellular endosperm. $\times$ 150. *Fig. 44.* Suspensor haustorium. $\times$ 700. *Fig. 45.* Mature seed in longitudinal section. $\times$ 75. *Fig. 46.* A hair of the seed coat. $\times$ 75. *Figs. 47–50.* Various stages in the development of the jaculator. *Fig. 48* shows the periclinal division of the hypodermal cells in the primordium of the jaculator. $\times$ 75. *Fig. 51.* Ovule showing micropylar haustorium, embryo and cellular endosperm and also the jaculator. $\times$ 75. *Fig. 52.* T. S. of thorn. *Ep.,* Epidermis; *Col.,* Collenchyma; *Chl.,* Chlorenchyma; *Phl.,* Phloem; *Xyl.,* Xylem. Note the scanty development of the vessels.

Though the haustorium observed was distinct, for want of sufficient data regarding this, nothing definite can be said about its origin, occurrence and function. Various kinds of haustoria, chalazal endosperm haustorium, micropylar endosperm haustorium and suspensor haustorium

(Fig. 44).
Cyto-Morphological Studies in Asteracantha longifolia Nees.

have been recorded in the different genera of Acanthaceae. Suspensor haustoria have been recorded in Ruellia rosea and Eranthemum albo-maculatum (Schürhoff, 1926). Lloyd (1902) in Callipeltis cucullaria (Rubiaceae) has recorded such a suspensor haustorium (Schnarf, 1931). The mature seed consists of a more or less oblong embryo with rather long equal cotyledons. The cotyledonary part of the embryo is much longer than the hypocotyledonary region including the radicle. In the ripe seed the two plerome strands of the cotyledons meet those of the radicle at the hypocotyledonary region (Fig. 45). The plumule which is enclosed between the two cotyledons appears as a small papillate protuberance. The seed is non-endospermous. The cotyledons are replete with reserve food chiefly in the form of oil and starch. Fig. 45 shows not a fully mature seed so that a narrow portion of the endosperm is still to be seen. The testa is composed of two or three layers of cells. From this arise numerous very long multicellular hairs (Fig. 46), attenuating at their free ends developing when wet abundant mucilage which helps the seeds to stick to the soil during germination.

The dissemination of seeds is facilitated by hook-like structures called jaculators or retinacula. The first indication of the origin of the retinaculum is a knob-like protuberance from the funicle of the ovule and it grows with the ovule. Fig. 48 shows one of the hypodermal cells in division in the knob-like region. Some of the stages in the development of the jaculator are shown in Figs. 48 to 50. Fig. 51 shows a fully developed jaculator.

Endosperm.—The endosperm is cellular in development. Such a cellular endosperm seems to be a common feature in Sympetale. Cellular endosperm has been recorded previously by various authors. Hartmann (1923) has recorded the presence of cellular endosperm in Acanthus longifolius, while Gigante (1929) in A. mollis found the nuclear development of the endosperm. An endosperm haustorium was observed in the micropylar region of the ovule. The endosperm haustorium is a narrow irregularly curved tube-like structure. It is bi-nucleate (Fig. 43). It arises as a protuberance from a micropylar endosperm cell (Fig. 51) and grows towards the micropylar end of the ovule eating its way through the micropylar region. Such a micropylar endosperm haustorium has been found to be present in Cryptophragmium ceylanicum and Acanthus spinosus (Schürhoff, 1926). Chalazal endosperm haustoria have also been observed in Acanthus longifolius; Crossandra undulafolia and Barleria strigosa (Schürhoff, 1926). The haustorium has a nutritive rôle namely supply of nutrition to the developing embryo, as has been determined in various other closely allied families, like Scrophulariaceae, Gesneriaceae, Lentibulariaceae, Labiatae, Verbenaceae and many others besides.
IX. Discussion

The prevalence of haustoria in one form or other is a common feature in the several genera of the Acanthaceae. Different types of endosperm haustoria, chalazal and micropylar, and suspensor haustorium have been reported to occur. In some genera one type of haustorium may be present while in others more than one may occur. In the present case two types, the micropylar endosperm haustorium and the suspensor haustorium, were noted.

Hobein (Solereder, 1908) has classified Acanthaceae into different tribes on the basis of the presence or absence, shape and position of the cystoliths. In this classification, he has in the main followed Benthem and Hooker with a few modifications here and there suggested by Radlkofer (1883). He has placed Asteracantha in the tribe Ruelliæ, which he says is characterised by cystoliths of varying shapes. The haploid chromosome numbers of some members of the family have been determined by Sugiura (Tischler, 1935–37; 1938). Between the classification of Hobein according to cystolith characters and the meiotic chromosome numbers, there seems to exist some correlation. The haploid chromosome number of Asteracantha has been found to be sixteen, which number is also found in Ruellia tuberosa. Eighteen also appears to be the chromosome number of some other Ruellia species. Since 18 and 16 are the haploid numbers of the members of the tribe Ruelliæ, the inclusion of Asteracantha in that tribe by Hobein on the basis of cystolith character seems to be justified from a cyto-taxanomical point of view. The chromosome numbers known in this family are too few to warrant a generalisation in regard to classification.

X. Summary

The haploid and diploid chromosome numbers of Asteracantha longifolia Nees., are 16 and 32 respectively.

The floral parts develop in the order calyx, andræcium, corolla, and gynæcium. The anatomy of the stem, root and leaf and the morphology of the thorns have been described.

The development of the micro- and megaspores is traced. In the embryo development suspensor haustorium and micropylar endosperm haustorium have been observed. The endosperm is cellular and the micropylar haustorium is bi-nucleate.

The morphology of the jaculator is described.

In regard to the position of the genus in the family correlation between Hobein’s classification on the basis of cystolith features and the chromosome numbers is suggested.
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