CYCAS BEDDOMEI DYER[1]

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Introduction

Cycas beddomei is confined to two regions in India and is less known of all the members of Cycadaceae. Except mention of this species in taxonomic works nothing is known about its general habit, anatomy, and reproductive parts. It is with this idea of providing a general knowledge of the plants an attempt is made to work out and describe the different parts in detail.

Cycas beddomei Dyer plants are endemic to the hills of Chittoor and Cuddapah District, in Andhra Pradesh (1,5). They grow wild in well-drained slopes of the hills preferring open sunny spots in the forests.

Their general habit is palm-like. The plant grows in clumps after the death of the main axis and consequent growth of its buds (Figs. 1-3). The main stem, if spared from annual fire, which consume all the dried up matter in the area, may grow to a height of 180-190 cm with a crown of 20-30 leaves. The stem is covered over by leaf-bases exhibiting zonation as in the case of Cycas circinalis (6). Leaves are from 100-120 cm long with a petiole of 10-20 cm. The upper half of this petiole contains a few minute spines, leaflets 9-12 cm long and 0.5 to 0.75 cm broad. Spine is acuminate and margin straightly recurved. The leaf-bases are packed with rementa which can be seen on removing the recurrent leaf-bases. This type of packing is more conspicuous in C. beddomei than in other species. Such a packing with insulated material like rementa gives the leaf-bases and the stem protection from mechanical injury. A longitudinal section of the leaf-base taken from the lower parts of an old stem will show 3 to 4 layers of cork and phellogen which help waring out of the leaf-base. The phellogen is more vigorous and successive layers are sealed off until the leaf-bases becomes indistinguishable. Cases of C. circinalis stem with a smooth surface have been recorded (Fig. 19), but I have not come across a smooth stem of C. beddomei. Long stem does not possess a uniform girth throughout but shows certain lengths of greater diameter. A plant of 190 cm high must have taken at least 60 years or more to attain that height, the greatest circumference being 42 cm and the smallest 32 cm. In another case 50 cm and 40 cm respectively were recorded.

A stem of Cycas beddomei with a diameter of 15 cm had periderm and leaf-base occupying 2 cm, cortex 2 cm, xylem and phloem of 3 rings 1.5 cm and pith 4.5 cm of the diameter. Compared to this I found that a male branching stem of C. circinalis had the circumference of 124 cm at its base and 138 cm below the branching. Thus C. beddomei produces stem

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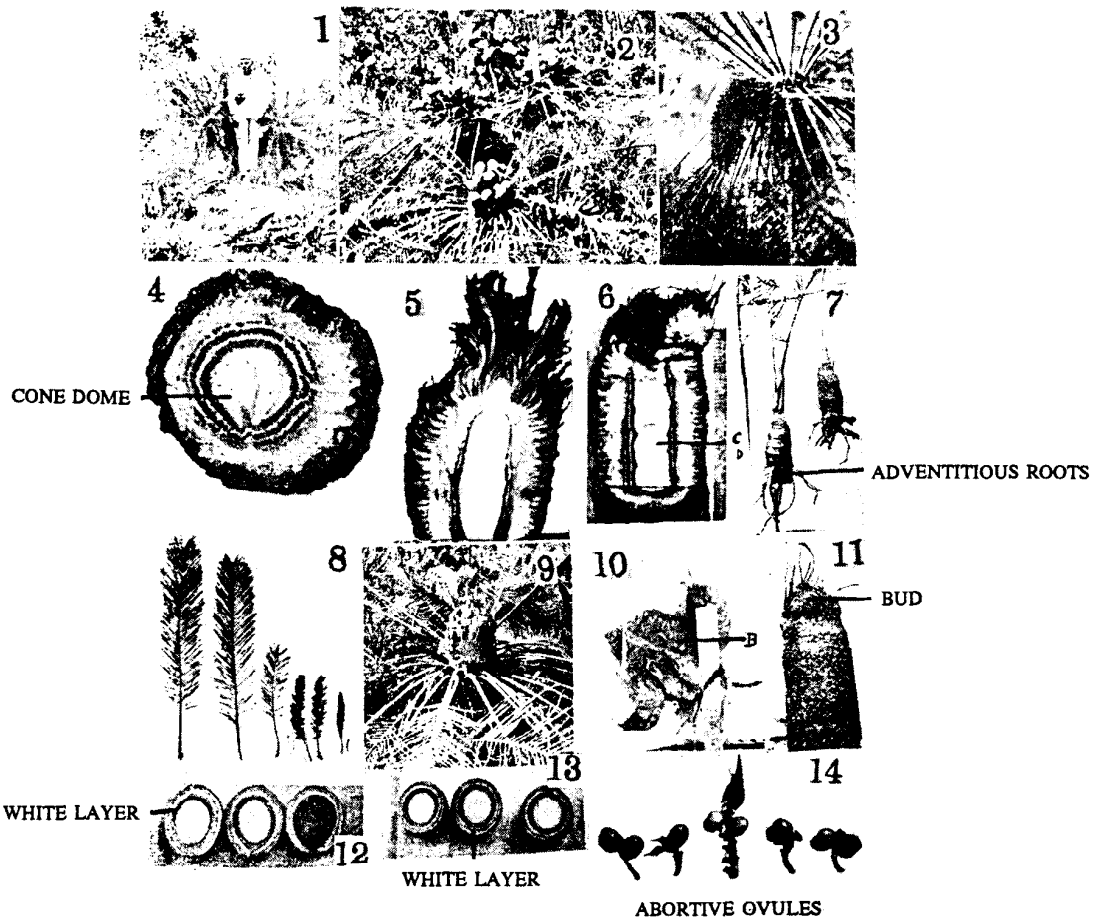


Figures 1-14:

1. A clump of Cycas beddomei in its natural surroundings of male plants.
2. 3 clumps of female plants with ovules almost ripe and ready for dispersal.
3. A male plant with its male cone almost dry, all microspores being dispersed.
4. Cut end of a stem to show 3 concentric rings of vascular cylinder and a cone dome at the place of it joining the cone (Treated with phloroglucinol and hydrocloric acid).
5. Female plant cut length-wise. Note the leaf-bases closely packed with the rementa and megasporophyll at the top. There are no cone domes. (Treated with phloroglucinol and hydrocloric acid).
6. Male plant cut lengh-wise and treated with phloroglucinol and hydrocloric acid. Note the number of cone domes, seven in all. Three concentric cylinders of xylem can be seen. The decapitated male plant has produced number of buds of which one has been cut length-wise. CD = Cone dome.
7. Two young plants with their adventitious roots.
8. Leaf variations - note the arrangement of the leaflets.
9. A plant with developing female cone.
10. Decapitated male plant producing several buds. B = Bud.
11. A male plant with the buds intact.
12. Ovules cut length-wise to show the different regions. Note the white line which has been magnified in Fig. 17. This is the layer of hairs produced on the stony wall.
13. Ovules cut across to show the white layer.
14. Megasporophylls with ovules, ranging from one to 8 per sporophyll.

of very much smaller diameter than that of C. circinalis, C. pectinata or C. revoluta.

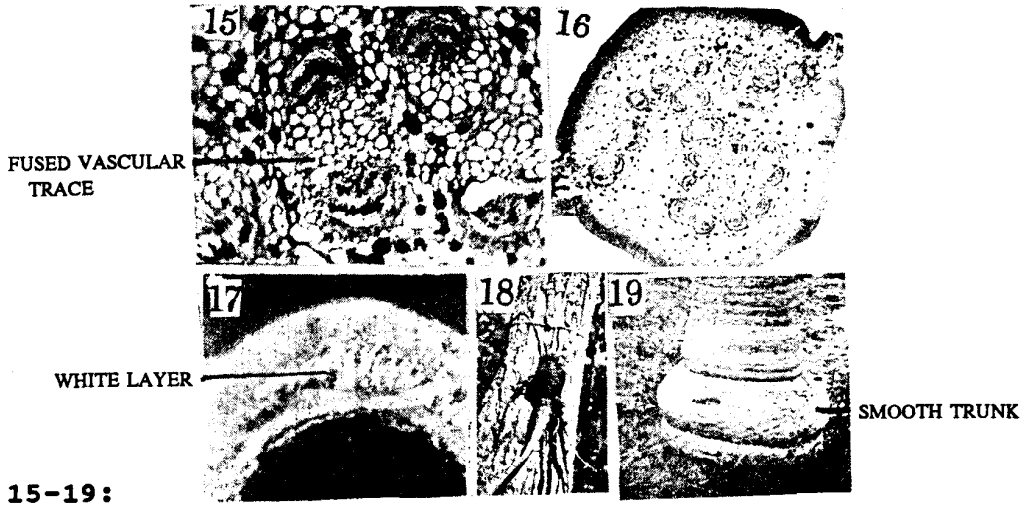
Several vascular bundles are separated by large medullary rays (Fig. 23) and these vascular bundles are arranged along the circumference midway between the center and the periphery (Figs. 20, 21). The cambium may remain functional for a long time and contribute to the formation of a thick mass of xylem and phloem. Generally, the first formed cambium is short-lived and the xylem formed by it is also of small thickness. By passing out of the medullary rays from the pith to the cortex the xylem cylinder becomes perforated. The first formed xylem and phloem are derived from the apical meristem while the subsequent cylinders are formed by the cortical cambiums. So we may call them as adventitious. In some cases there may be 1-17 cylinders formed at different times, one outside the other. The last cylinder formed may not be a continuous circle and it is of short thickness (Figs. 4,5). Medullary rays travel through all the rings of xylem, making them look perforated. Each medullary ray has a vascular trace in the center and a mucilage canal below it. The vascular trace or leaf trace leaves the outer xylem cylinder going up at an angle of 30 degrees and does not divide into two to form the girdle in the cortex but goes direct to enter an arc of vascular traces situated near the periderm and is called "circumferential plexus". From this ring of circumferential vascular plexus, traces go to the individual leaves, dividing several times during its passage in the petiole. Thus in Cycas circinalis and C. beddomei the leaf traces go direct to the leaves in the young stage and the same appears to be the case in the older stages also. During the course of investigation nowhere the leaf-girdle has been seen.

The male plants are generally taller than the female plants (Figs. 3,11). Apart from the zonation on the surface of the stem, a longitudinal section of a male plant stem exhibits a number of "cone domes". Figure 6 shows seven such "domes" of diaphragms. Figure 4 shows a cone dome in a transverse section taken at the level of its entry into the peduncle. It looks like an eccentric circle of vascular bundles. Chamberlain (2) states, "as soon as the cone begins to develop, a new meristem appears very close to the peduncle and this new meristem may form successive crowns of leaves but sooner or later it becomes transformed into "domes" which is really only a highly modified crown of leaves terminating the growth of its axis. This process is repeated". The scar left by the cutting off of the cone and the new apex of the stem covered over by the scaly leaves can be observed clearly. Figure 5 shows the longitudinal section of the stem of a female plant treated with phloroglucinol and hydrochloric acid and this shows no cone domes. Thus the female plant grows monopodially, while the trunk of the male plant is really sympodial. "The trunk of the columnar forms is easily cut with an axe but it is almost impossible to saw off a large plant. It is like sawing a mass of tough cloth" (3). The stem of C. circinalis about 45 cm diameter and C. beddomei 30 cm diameter can easily be sawn and there was no difficulty. The reason for this lies in the few fibers (Fig. 21) present in the cylinder as well as the cortex and pith. Chamberlain (4) says while phloem has not been studied critically in enough forms to warrant a generalization, it may

be that such a comparative study of Cycadofilicales, Bennettitales and Cycadales could be worthwhile.

Petiole is roughly circular as seen in transverse section. It is traversed by 10-12 vascular strands arranged in an omega-shaped arc (Fig. 16). Some of the strands fuse to form a single strand (Fig. 15). There is a ring of sclerenchyma tissue forming a thick outer protective layer enclosing the parenchymatous pith in the center in which are embedded the vascular strands, mucilage ducts and tannin ducts or cells. Each vascular strand will show the proto- and meta-xylems and phloem. The xylem is not massive. The strands at the ends of the omega arc will send out to leaflets the traces of vascular tissue both xylem and phloem. Traces of centrifugal xylem can be found even in the strands and leaflets. There are 1 to 3 mucilage ducts, one below and the other two on either side of the vascular bundle (Fig. 25).

The lower epidermis of the leaflet is single layered, thickly cuticularised (Figs. 23,24). Number of stomata found are situated beneath the level of the epidermis in a pit. There are few hairs in an old leaflet but young ones contain many one-celled or two-celled coiled hairs. Just above the lower epidermis is the spongy parenchyma with large air spaces, which open into the stomata. Barring the midrib, the two wings of the leaflet are of uniform thickness. The upper epidermis has a thick layer of cutin which shows continuous lamellation. Epidermal cells are small with thick wall which are lignified. Below the epidermis is a hypodermis - a continuous layer of round cells which are slightly elongated. The upper layer of palisade cells are partly lignified specially the outer tangential and radial walls (Fig. 24). The leaves are light green or pale green in color while those of Cycas circinalis is of deep green in color. By this means we can distinguish



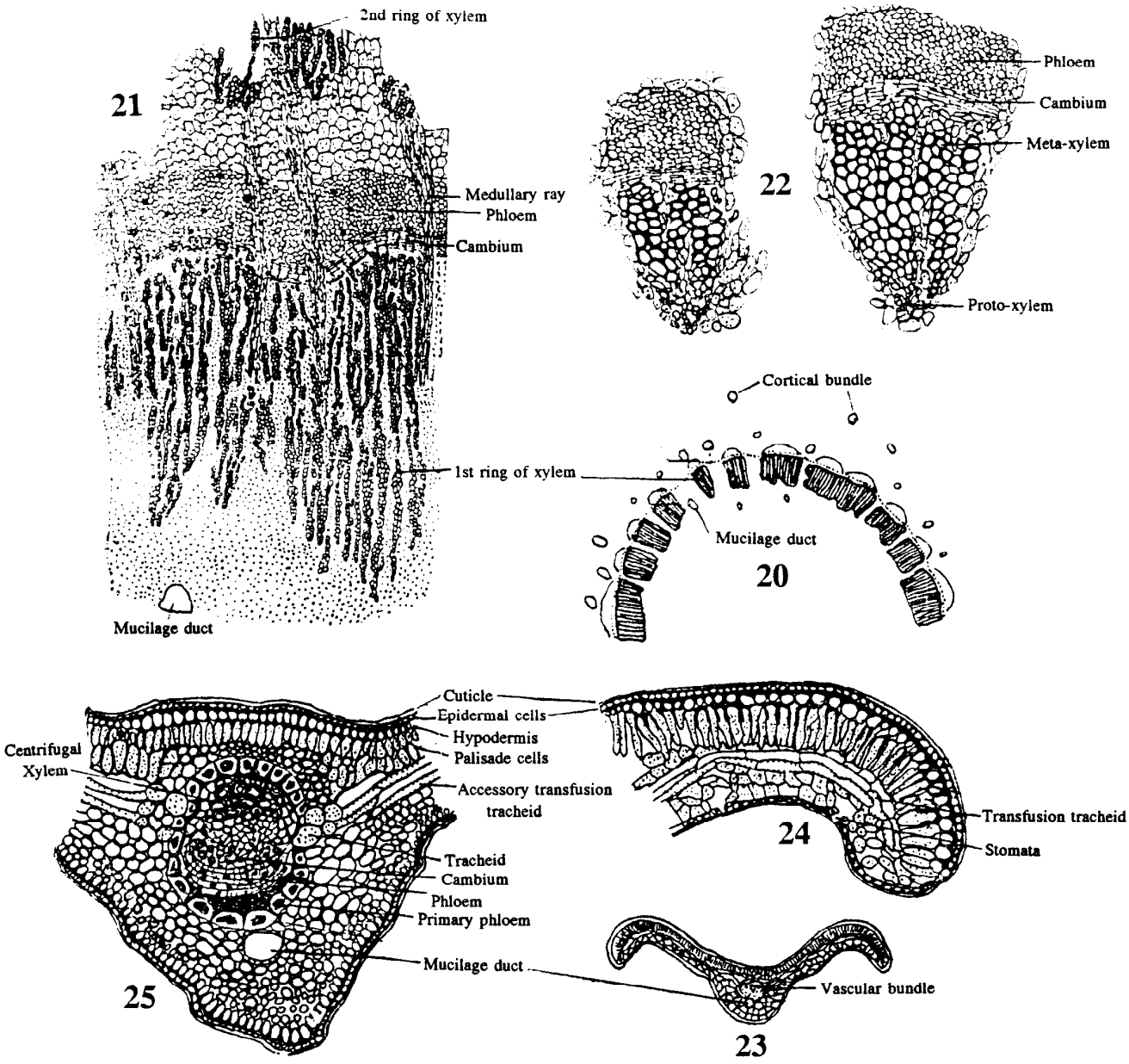
Figures 15-19:

15. Transverse section of the petiole with the vascular bundles - the one in the center shows two vascular strands have united while the one on the right that they are free.
16. Section of the petiole to show omega-like arrangement of the vascular strands.
17. Growth of hair-like structure grown from the stony layer magnified.
18. The swollen root of a seedling of Cycas beddomei.
19. Cycas circinalis stem whose cortical portion has bulged out with constrictions. The surface of this trunk is smooth, all traces of leaf-base having worn out.

the plants even from a distance. Below the palisade tissue runs the transfusion tissue, consisting of tracheids and very few parenchyma. This tissue starts from the vascular trace of the leaflet and spreads towards the margin of it (Fig. 24,25). There are transfusion tissue and accessory transfusion tissue. Accessory transfusion tissue is made up of colorless, broad tracheids which run end to end and form a network in the wings. They are elongated with modified cell walls and run parallel to the vascular bundle.

Root - The root system of Cycas beddomei appears to be of the fibrous type. The main root or the tap-root stops its growth early giving rise to and promoting the growth of the adventitious roots (Fig. 7). It is the adventitious roots that are prominent and take a vital role in the adult plants. As in the case of C. circinalis (8), there are four types of roots, tap-root, lateral roots (which are adventitious), coralloid roots and swollen roots. Tap-root is the continuation of the stem axis downwards and stops its growth early. To begin with, it is as thick as the stem from which it continues downwards but becomes small or slender further down in the soil. The adventitious roots grow extensively branching and rebranching and take vital part in the intake and transport of water. Just below the first pair of leaves, the taproot gives rise to a pair of lateral roots which are apo-geotropic. Very early they become infected with an alga and repeatedly branch. They are called coralloid roots. In addition to the above roots, some seedlings show the swollen roots whose function seems to be the absorption and storage of water for the dry season. Cycas beddomei is a xerophyte and suffers arid conditions for some months of the year (Fig. 18).

The male cone is short-stalked, compact, solitary and is normally terminal. It is 30 cm long and 20 cm in diameter. The cone is oval in shape with the sporophylls attached to the central axis perpendicularly in a close spiral. It is very compact to begin with and when the pollen grains are ready for shedding, the cone-axis suddenly elongates and sporophylls are separated from each other. Further drying of the cones results in the sporophylls becoming hard due to loss of turgidity. Thus the cone bends to a side (Fig. 3) and the spores are dispersed. The sporophylls at the base and the tip of the cone are generally shorter than the ones near the middle of the cone. Each sporophyll has two parts - basal part which lodges a number of sporangia over abaxial surface and the terminal portion which bends upwards towards the apex of the cone. Since the sporophylls are compactly packed, their tip portions overlap and this gives a very good protection to the young ones. On the adaxial side of the sporophylls there are a number of hairs - rementa - pink in color, characteristic of the species. Sporangia are in groups of 3, 4, 5, usually in 3. Thus they form a sorus. The dehiscence of the sporangia is by a slit. Even in the season, going to the field to collect the male cones at various stages, one gets disappointed for not getting one cone either. This is because the young cones are sought after by ayurvedic physicians and their agents. They collect them as well as purchase them. Hence the male cones are not readily available in the field. The male cones are known as "perita" and are supposed to have cooling effect when prepared in dried and sugared form. While taking the male cone some people decapitate the plant and thus a number of buds arise from the wounded



Figures 20-25:

20. Transverse section of the young stem of C. beddomei showing general contour of the central cylinder, cortical bundles in the cortex and mucilage ducts in the center, x 2.
21. A portion of the above magnified to show the vascular plates bound by medullary rays. First ring and portion of the second ring are also seen, x 17.
22. Two of the cortical bundles or leaf-trace bundles with proto-metaxylems, phloem and cambium, x 65.
23. Leaf section to show the general layout and the margin recurved, x 17.
24. Portion of the above magnified to show the details. Note the palisade chlorenchyma partly lignified, x 65.
25. Transverse section of the midrib of a leaflet - note the single mucilage duct below the vascular bundle and transfusion tissue, x 65.

stem (Figs. 10,11) and they grow into branches giving the clumpy appearance.

Female cones - They are produced in the terminal point of the plant (Figs 2,9) and the apex continues to grow after seeds are formed and shed. The female cone is very compact to begin with and as the ovules develop and central axis elongates the cone becomes less and less compact and finally it becomes loose so that the sporophylls with the attached seeds droop down (Fig. 5) The cone is a small one when compared with that of C. circinalis. The seeds are generally two and sometimes four are found per sporophyll (Fig. 14). Some do not develop and undergo abortion. One can find 6-8 such abortive ovules in some sporophylls.

Each megasporophyll has 2 parts, the stalk which is about 15 to 20 cm long and squarish in a sectional view and is covered all over with rementa, the broad portion bearing ovules at the margins. This broad portion has got a number of elongated frill-like projections above the ovules and covered over by rementa. The rementa are characteristic of this species being brick red to pinkish in color. There are very few sporophylls with ovules fully developed and the total for a cone may not reach even 50. After seed setting and seed dispersal, the sporophylls droop down, thus making way for the next year's leaves to emerge from the apex. The ovules are larger in size than those of C. circinalis, green when young and yellow to brown when old. They are bilaterally symmetrical and somewhat flat in the plane of the sporophyll. When the ovules are cut along the median plane, they exhibit the seedcoats the usual 3 layers - outer fleshy inner thin and papery, and the middle stony layers. There appears to be an additional layer of white fleshy substance. This layer is formed by the thick growth of branching hair-like growth from the outermost cells of the stony layer (Fig. 17). The layer remains permanent on the ovules even after the outer fleshy layer is removed, specially by birds and bears (Figs. 12,13). It is interesting to study the development of the stony layer and the formation of the branched hairs, whose function is not clear. The seed devoid of the outer fleshy coat becomes slimy on wetting with water and this retains water for germination. The other parts of the ovule are found such as micropyle pollen chamber, archegonial chamber, female gametophyte, etc. In those ovules which are fertilized, the embryo with a long tortuous suspensor develops. Germination appears to be rapid and the seeds do not have a resting period at all.

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