which does not take further part in the development of embryo and forms a large vesicular structure (Figs 2–7). The terminal cell cc undergoes transverse division and thus two cells are formed, an upper cc and a lower cd (Fig. 2). The cell cd again undergoes a transverse division and gives rise to ci and m (Fig. 3). The cell cc also divides transversely to form l and l' (Fig. 4). Thus a row of four cells ci, m, l, l' is formed from cd and cc. Of these the three lower cells m, l' and l divide by a vertical division and the upper cell ci shows a transverse wall (Fig. 5). The embryo now shows five tiers of cells. In n, a vertical wall is also laid down (Fig. 6). n' divides by a transverse wall to form O and P (Fig. 6). In this way six tiers of cells are formed. The tier l gives rise to stem tip, l' to cotyledons, m to hypocotyl, n to root cap and O, P to short suspensor.

A globular embryo (Fig. 7) is formed with a short suspensor and vesicle like basal cell as a result of further divisions in l, l', m and n. In the usual way stem tip, cotyledons, etc., get differentiated (Fig. 8). When differentiation is complete there is formation of procambial strands (Fig. 8). Thus the embryo development conforms to "Caryophyllid type" as has been reported for Sagina apetala, Stellaria media and S. aquatică.

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School of Plant Morphology,
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CULMS IN CYPERUS

In an attempt to the anatomy of Cyperaceae, Metcalfe (1971) has stated that culm anatomy of Cyperus esculentus somewhat resembles Cyperus articulatus. Duval-Jouve (1874) examined the culm anatomy of Cyperus aequalis, which he considered identical with C. esculentus. Anderson (1888), Plowman (1905), Buchholz (1921), Greiss (1957), Morita (1963), Shiam (1963), Shah (1967), Mehra and Sharma (1970) and Fisher (1970) have described the stem anatomy of many species of Cyperus, but C. esculentus is least mentioned. D'Almeida and Ramaswamy (1948) studied the anatomy of 10 Indian species of Cyperus, but C. esculentus is not worked out. Thus, the literature shows that the details of the culm anatomy of this species have not received due attention by anatomists.

The inflorescence axis or the culm of C. esculentus is easily distinguished by its considerable length and triangular outline. It is straight and unbranched, and arises singly. The maximum length of the culm recorded in the month of August was 176 cm. Underground part of the culm is delicate and white, while the aerial part assumes a light green colour.

Culm is Y-shaped in a cross-section (Fig. 1). Many continuous air canals, separated by thin, delicate partition walls of parenchymatous cells (Figs 1 and 2), are present all along its length. Partition walls are only one cell thick (Fig. 3). The many vascular bundles lie at intersections of these partition walls. These air canals are divided into a number of small compartments by horizontal partition walls forming diaphragms (Fig. 4). Diaphragms have also been recently reported in the leaves of this species by Shiam and Sharma (1974). These diaphragms are always supported by a cross-bundle which connects the two main bundles, running longitudinally throughout the body of the culm (Figs 4 and 6).

The inner borders of these air canals are lined by parenchymatous cells containing abundant chloroplasts. But in the centre of the compartment, there are many small intercellular spaces, which give the walls, a beaded appearance in transverse section (Fig. 3). Diaphragm cells vary from polygonal to stellate in shape. These are present in groups, and are very long, but narrow, with short arms (Fig. 4). More cytoplasm is present in the diaphragm cells in comparison to that of the other cells (Fig. 5). They also contain some starch grains, and some of the diaphragm cells are completely filled with tannin (Fig. 7). The cross-bundles are made up of xylem and phloem, which are connected with the xylem and phloem of the longitudinal bundles of the culm (Fig. 4). Sometimes, a single longitudinal bundle is seen, connected with the two cross-bundles on either side (Fig. 6).

The longitudinal bundles of the culm are exclusively collateral, and have fiber cells on their outer side. The bundles are arranged in two sets, the outer alternating with the large air canals, and are arranged along the entire length of the arm of culm in two rows, while the inner are irregularly scattered in the culm (Fig. 2).

However, at the three angles of the culm, the margins are extremely pointed (Fig. 2). They are interrupted by two to three vascular bundles in a single row. The xylem and phloem are completely
Figs. 1-9. Figs. 1-2. Serial transverse sections of culm passing from base upwards at different levels. Fig. 3. T.S. of culm showing the stellate cells in the air canal. Fig. 4. T.S. of a portion of culm showing diaphragm, supported by a cross-bundle and obliterating the passage on one side.
Fig. 5. T.S. of a portion of diaphragm showing contents. Fig. 6. T.S. of a portion of culm showing a longitudinal vascular bundle connection on either side by two cross-bundles. Fig. 7. T.S. of a portion of culm showing two tannin-filled cells of diaphragm. Fig. 8. T.S. of one of the three angles of a culm showing a collateral vascular bundle, spongy parenchyma, hypodermal ribs, and a few tannin-filled cells. Fig. 9. T.S. of a vascular bundle.

(AC, air canal; AR, arm of culm; AS, air space; CB, cross-bundle; CH, chloroplasts; DC, diaphragm cells; EP, epidermis; P, parenchyma; PH, phloem; PW, partition wall; SC, stele; cell; SCL, sclerenchyma; SM, stoma; SP, spongy parenchyma; ST, starch grain; T, tannin; VB, vascular bundle; XY, xylem.)

separated in the mature bundles by a plate of sclerotic tissue (Fig. 9). Chlorophyllous parenchyma forms a compact layer underlying the epidermis. The mechanical tissue of the culm is confined to a few, very small, hypodermal ribs, and a few sclerenchymatous strands above the partition walls, separating the air canals and surrounding the vascular bundles. These hypodermal ribs are more prominent in the angles of the culm (Fig. 8), and are composed of small sclerenchymatous cells. All these structures are surrounded by epidermis, which is covered by a thin cuticular layer. The cuticle, though thin, is conspicuous at the extreme edges of the culm (Fig. 8). Over the hypodermal ribs, the epidermal cells are small. Two or three stomata, which are somewhat depressed, open into the air canals.

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O. P. SHARMA.


*Originals not seen.*

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