

developed in the axil of the cotyledon, and that this bud develops into a small tuber (B in Fig. 7). So far as concerns the structure of the cotyledon, its apex and short sheath, this type of seedling is common to many, *Liliaceæ*, *Amaryllideæ*, *Palmeæ*, *Dioscoreaceæ*, *Irideæ*, etc.

A fourth type is characteristic of *Commelinaceæ*, and it differs from the former by the prolongation of the free part of the cotyledon, which here represents a long, filiform organ between the apex and the sheath; moreover, the primary root is surrounded by a sheath, the so-called coleorhiza, which it has to penetrate.

These four types thus illustrate the most frequent structure of seedlings of *Monocotyledones* excl., *Cyperaceæ* and *Gramineæ*, and the principal distinction consists in the position of the cotyledon, being epigeic or hypogeic; moreover, in the varied development of the cotyledonary sheath. In regard to the hypocotyl we have seen this to be well differentiated in *Smilax*, while it is either obsolete or undeveloped in the others. The primary root may persist for a longer or shorter period, but the most important character derived from this organ is the presence of a coleorhiza as observed in *Commelina*.

A feature common to these types is, however, that the root is the first organ to appear when the seed germinates; then follows the cotyledonary sheath, and finally the first leaf of the plumule. In this respect the *Cyperaceæ* make a notable exception from all the other *Monocotyledones* with perfect embryos. We might examine *Cyperus vegetus*, Willd., as an example of this type of germination, illustrated on Plate IV, Figs 8 and 11.

When the seed germinates (Fig. 9) the plumule surrounded by the coleoptile is the first to appear, pushing out through the opened base of the achene, and carrying with it the small root, merely visible as a minute wart. If we remove the cotyledon from the seed (Fig. 10), we notice the very simple structure of the embryo: the large clavate cotyledon, the sheath of which (coleoptile) covers the plumule completely, and finally the small root with a wreath of hairs. All these organs are, also, readily to be observed in the still younger embryo (Fig. 8) just before germination. The further development of these organs may be observed in Fig. 11, where the root has commenced to grow out, and where the coleoptile has attained its final shape: as a tubular leaf with a small, blade-like apex; no such advanced development of the coleoptile was observed in the other types described above. In the *Cyperaceæ* the coleoptile thus develops into a long sheath raised high above the plumule, and it turns its back toward the absorbing portion of the cotyledon. Sometimes, as for instance in *Fuirena squarrosa*, Michx., a long stem-like organ develops between the coleoptile and the enclosed portion of the cotyledon,