Anatomical studies on certain members of Aizoaceae

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ABSTRACT

The present work incorporates the results of anatomical studies on eight members of Aizoaceae. The nodal configurations are: (1) unilacunar one trace-Mollugo cerviana, M. nudicaulis, Gisekia pharnaceoides, Glinus lotoides and Orygia decumbens; (2) unilacunar two trace—Trianthema triquetra; (3) trilacunar three trace-Zaleya govinda and Trianthema portulacastrum. In a reinvestigation of the general vegetative structure, normal secondary growth has been found to occur in Gisekia and Mollugo and anomalous secondary growth in the species of Trianthema, Zaleya, Orygia and Glinus. The abnormal secondary growth met with in roots may be attributed to the perennating habit of these plants. A unique type of secondary xylem arrangement in the form of a spiral occurs in certain roots of Zaleya and Trianthema. An explanation of its origin has been given.

1. INTRODUCTION

The family Aizoaceae is of considerable interest not only for anatomists but also for embryologists, floral morphologists and systematists, etc. The nodal configuration and anomalous secondary growth in angiosperm, have been stressed by many workers in recent years. This has provided the incentive to study the node, leaf structure and anomalous secondary growth in some members of Aizoaceae.

Out of eight species studied here, the material of Gisekia pharnaceoides L., Glinus lotoides L., Mollugo cerviana Ser., Mollugo nudicaulis Lam., Orygia decumbens Forsk., Trianthema portulacastrum L. and Zaleya govinda L., was collected from Pilani while that of Trianthema triquetra Willd. ex Rottl., was collected from Kurukshetra. All material was fixed in F.A.A. and hand or microtome sections were prepared using customary methods of

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dehydration and embedding. Safranin-fast green combination was used for staining.

2. **Observations**

*Gisekia pharnaceoides.*—The plant is a diffusely branched herb with creeping stem and long internodes, bearing two opposite or sub-opposite leaves.

The stem is angular having unicellular hairs on the ridges. Just below the node, the vascular cylinder elongates and opens to give rise one trace on either side (figure 1). Each trace divides into two branches, one entering the petiole and the other going to inflorescence axis (figure 2). If the transverse series is followed further upwards, the vascular cylinder of the axis becomes bilobed and later on gets divided into two (figures 3, 4).

Both stem and root show normal secondary growth. The secondary tissue is abundant in roots, probably being helpful in penetration of the roots to deeper levels. The material of roots collected from sand dunes possess parenchymatous pith which is absent from the material obtained from the stabilized habitats.

*Glinus lotoides.*—Being a plant of low lying area, it has a woody, rarely glabrous, prostrate or creeping, much branched stem having opposite or whorled leaves.

The main axis is reduced, hence, the sections were studied through the hypocotyl upwards. The hypocotyl has a solid core of vascular tissue which becomes siphonostelic later on. It opens up giving simultaneously one trace on either side for each leaf (figure 5). Along with this, the vascular cylinder gets dissected side by side and gives four branch traces (figure 6). Each of the four branch traces gives out the supply for the leaf on its side (figure 7).

In both stem and root secondary growth is anomalous. After the cessation of activity of the normal cambium, successive cambial rings arise in the cortical tissue forming concentric rings of xylem and phloem. Extra eccentric cambial rings arise in those parts of the stem which are adjacent to the ground.

*Mollugo cerviana.*—The stem is reduced and has alternate radical leaves. From the main reduced stem 2 to 15 branches are given off simultaneously. These branches may branch once or twice and each of them has 2 to 6 leaves at each node.
Figures 1-20  
(Explanations of figures in p. 406)
As the main axis is reduced the hypocotyl, which has an unbroken vascular cylinder, opens to give rise to a leaf trace for the first leaf (figure 9). Following the entrance of the first trace into the petiole, successive leaf traces depart from the vascular cylinder (figure 10). A part of the vascular cylinder in the axil of the third leaf supplies the first axillary bud (figure 11). After supplying a number of leaves and a bud, the vascular cylinder becomes three lobed, each one of which later forms the vasculature of a branch (figures 11, 12).

The vascular cylinder of aerial branches which bear a whorl of bracts each subtending an inflorescence, firstly becomes four lobed and secondly each of the four lobes gives out traces (figures 13–15) for the bracts. Each of these lobes represents a branch and terminates in a flower or a group of flowers (figure 16).

The anatomy of the root and stem is simple with normal secondary growth. The cortex is ill-developed and is not assimilatory. The sclerenchymatous layers present below the endodermis sometimes extend downwards, thus giving a false appearance of phloem being included.

*Mollugo nudicaulis.*—The stem is reduced, having 3 to 20 alternate radical leaves and 1 to 12 dichotomously branched cymose inflorescences.
The hypocotyl has a solid vascular cylinder. It opens to give rise to the first leaf trace and then divides into three parts (figure 17). At these division points, it gives traces for the next whorl of three leaves (figure 18). The traces for the next whorl of leaves also arise in the same pattern (figure 19). The tip of the stem usually has four leaves arranged alternately (figure 20).

The stem and root structure is similar to *Mollugo cerviana*. The stem has 3 to 4 layers of assimilatory cortex and the root has pronounced development of cork. Pith and cortical cells have clustered crystals.

*Orygia decumbens.*—It is a plant of rocky areas and has an angular, rigid branched stem with alternate leaves. Internodes are elongated with sheathing leaf bases and cymose inflorescence.

The vascular cylinder is siphonaceous and while proceeding towards a node, it elongates and gives rise to a leaf trace (figure 21). As the leaf trace departs, the vascular tissue becomes lobed and the lobe adjacent to the leaf trace forms the vascular cylinder for the branch (figure 22). At higher levels the branches separate and the vascular cylinder of each branch gives out traces for the successive alternately arranged leaves (figures 23, 24).

The root and stem have anomalous secondary growth. After the cessation of normal cambium activity in roots, the abnormal cambia arise successively just adjacent to the phloem. The abnormally formed cambium is anomalous in its activity also in first giving rise to a few layers of parenchyma on its inner side and then producing secondary xylem and undifferentiated parenchymatous cells. These undifferentiated parenchyma patches later on join with the earlier formed parenchymatous ring and the whole tissue functions as storage tissue. Clusters of crystals are met with in the cells of pith and cortex of the stem.

*Zalena govindia.*—A common weed of stabilized area with a stout, prostrate and diffused stem possessing broadened sheathy nodes with two opposite leaves.

The internode has 12 vascular bundles of which two bundles are large (figure 25). Six leaf traces, three for each leaf, leave the vascular cylinder. As the leaf traces enter the petioles on either side, the two vascular bundles of the stem, facing the leaf, give off traces for the axillary bud. Subsequently, the large bundles of the stem divide and form four vascular bundles (figures 26–28). At higher levels these four vascular bundles of the stem divide once again and thus the axis has twelve vascular bundles.
followed further upwards the axis first becomes bilobed and then two separate axes are formed (figure 29).

The stem and root show anomalous secondary growth. In stem and root a normal cambium functions in the beginning. Later on, segments of cambia cease activity at places and new strips of cambia arise just adjacent to the phloem. These newly formed strips appear to bend on either side to join with the active cambial strips of the normal cambium. In some cases concentric rings of successive cambia develop giving rise to alternate xylem and phloem cylinders. In thirty per cent of the roots examined, the very first ring of cambium is not complete and subsequent cambial rings develop from one of the broken sides of the first formed cambium in the form of a spiral. Thus in roots of *Zaleya govindia* three types of xylem cylinder are met with: (i) incomplete concentric xylem cylinders; (ii) complete concentric xylem cylinders and (iii) spirally arranged xylem cylinders. The epidermis of the stem has unicellular vesicular hairs.

*Trianthema portulacastrum.*—It is a delicate plant with cylindrical, prostrate stem. The main branches arise from the base of the stem with opposite leaves. The anatomy of node and stem is similar to that of *Zaleya govindia*. The root has concentric alternate rings of xylem and phloem.

*Trianthema triquetra.*—It is a common weed and grows luxuriantly on waste land and gardens. The branched stem has long internodes and opposite or sub-opposite leaves. At each node two vegetative branches arise and in between them one or two flowers. The internode has a closed vascular cylinder which opens to give rise to two traces for the first leaf (figure 30). The vascular cylinder after supplying the first leaf becomes bilobed. The smaller lobe adjacent to the leaf gives traces for the two axillary branches (figures 31, 32). After the separation of the second branch, the vascular cylinder becomes three lobed (figure 33). Out of these three lobes, the one adjacent to the second vegetative branch gives traces for the pedicel of the flower. The opposite leaf gets its supply from the cylinder present on the opposite side (figure 33). The vascular lobe adjacent to the opposite leaf supplies an axillary branch (figure 34). The remaining portion of the vascular cylinder, which is in the centre, continues into the main axis (figure 35).

The structure of root and stem is similar to that of *Zaleya govindia*. In both the species of *Trianthema* sphaerocrystals are present in the pith and cortical cells.
3. DISCUSSION

Extensive literature has accumulated on the nodal configuration of different plants of angiosperms. Bailey reported the predominance of unilacunar one trace condition in the Centrospermae. The present study of eight species of Aizoaceae supports the view of Bailey, though three types of nodal configuration have been observed in this family. The unilacunar one trace condition has been observed in Mollugo cerviana, M. nudicaulis, Gisekia pharangeoides, Glinus lotoides and Orygia decumbens. Trianthema triquetra has unilacunar two trace node. A trilacunar three trace node is met with in Zaieya goindia and Trianthema portulacastrum. Trianthema species thus depict two types of nodal configuration—a condition which has also been observed in different species of Rhododentron.

The general anatomy of Aizoaceae, particularly the anomalous secondary growth in stem and root, is interesting. Normal secondary growth occurs in Gisekia and Mollugo while Trianthema, Zaieya, Orygia and Glinus have abnormal secondary growth. Metcalfe and Chalk recognized two types of anomalous secondary growth in the members of Aizoaceae, viz., (1) numerous bundles arranged in distinct concentric rings, and (2) complete alternating rings of xylem and phloem one after another. Both the types have been observed not only in Trianthema and Zaieya but also in Glinus and Orygia. A third type of anomalous secondary growth is seen in certain roots of Zaieya and Trianthema. The very first ring of cambium is not a complete one and subsequent cambial rings develop from one of the broken sides of the cambial ring forming a spiral arrangement of secondary xylem and secondary phloem. Such a situation has been observed in roots of a perennial giant species of Chenopodium growing wild at Kurukshetra. These findings uphold the view that the cambia are bidirectional and that complimentary cambia develop adjacent to secondary phloem in members of Aizoaceae.

The occurrence of anomalous secondary thickening in the roots of Trianthema and Zaieya can be correlated with the perennating habit of these plants as they develop from the root stock every year. The age of a plant can be roughly estimated by counting the number of rings produced in the past. Gisekia and Mollugo, of the subfamily Molluginaceae, exhibit normal secondary growth. However, Glinus and Orygia of the same subfamily possess anomalous secondary growth comparable to that of Trianthema and Zaieya. It would not be out of place to point out that Glinus and Orygia also perennate every year by old root stocks as Trianthema and Zaieya do.
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REFERENCES


EXPLANATIONS OF FIGURES

Figures 1–34. 1–4. Serial transections passing through the node of Gisekia pharnaceoides; 5–8. Same in Glinus lotoides; 9–16. Same through the lower and upper nodes of Mollugo cerviana; 17–34. Same through the nodes of Mullugo nudicaulis, Orygia decumbens, Zaleya govindia and Trianthema triquetra; a—leaf trace of a trilacunar node; b—vasculature of a branch; b1 to b4—vasculature of branches 1 to 4; b.t—branch trace; br—bract; br. t—bract trace; f.a.—floral axis; —leaf; l1 1–5 leaf traces from 1 to 5 leaves; pe—pedicle; ph—phloem; y—xylem; l1 to l6—leaves 1 to 6 in order of development.