Laboratory 4 - Shoot Lateral Symmetry

I. Lateral Symmetry of Shoots

A. Radially symmetrical shoots

Obtain shoots of a living plant with spiral phyllotaxis as an example of shoots with a radial symmetry. (There should be a few to select from. Note that leaves can be found in equidistant positions around the circumference of the shoot axis. With a selected plant, make a x-section of the terminal bud which illustrates the radial symmetry of leaf initiation in this shoot. On one demonstration plant, someone should peel off all the leaves until the initiation of the youngest leaves at the shoot apex are exposed. Determine the phyllotactic formula by counting the leaves upward around the stem to the next superimposed leaf in the sequence. Phyllotaxis = # of concentric spirals needed to repeat the pattern of leaf initiation divided by number of leaves in the complete cycle.

B. Bilaterally symmetrical (plagiotropic) shoots

1. Platyclades

Platyclades are flattened shoots that are segmented into definite nodes and internodes. Study the displayed platyclades from the greenhouse. What is the symmetry of these shoots and their orientation with respect to the main axis of the plant? Do all shoots of these plants show a similar organization and symmetry, or are there only certain branches on the plant that assume the platyclade configuration? If present, what is their morphology? How is the vascular system organized? How similar is it to a typical stem?

2. Phylloclades

Phylloclades are flattened branches that are not differentiated into marked nodes and internodes and hence resemble leaves to a remarkable degree. *Ruscus aculeatus* (Liliaceae) is an excellent example of phylloclades. Study the displayed illustrations of aerial shoots and the nature of the phylloclades which are the ultimate lateral branches in this shoot system. Again, how would you determine that these are branches and not just leaves? How would these look in cross section—particularly with respect to the organization of the vascular bundles? In what respects do phylloclades differ from platyclades? Draw the structure of this organ.

C. Dorsiventral shoots

Observe the gross habit of the dorsiventral rhizome of *Iris, Acorus* or whatever other examples are available, and examine the morphology of their subterranean shoot system. What is the direction of growth of this shoot during the vegetative period of development? Is there any change in the direction of growth with the onset of flowering? What types of symmetry are related to the respective growth habits of the plant during vegetative versus reproductive shoot development? Observe a prepared slide of a transection of the rhizome of *Acorus* and make an outline drawing of this shoot. Can you identify the dorsal and ventral sides? Can you see any leaf or root traces? What features of the form of the rhizome are responsible for its dorsiventral organization? Is the vascular system arranged in the same bilateral arrangement as the rhizome body?
D. Anisophyly as an expression of lateral symmetry in shoot systems

Anisophyly refers to unequal development of leaves around the circumference of the stem. Two types of anisophyly can be recognized in seed plants and are illustrated here by coniferous shoots.

1. Lateral anisophyly

In lateral anisophyly the shoot actually has a radial symmetry but the plagiotropic orientation of the shoot induces a dorsiventrally and, correspondingly, an unequal development of leaves on the dorsal versus the ventral sides of the shoot. If the particular shoot in question could be induced to grow orthotropically, that is at right angles to a substrate, it would be radially symmetrical and isophyllous. Observe the ultimate shoots of the specimens of *Taxus* available in the laboratory. Notice that all the leaves lie in essentially one plane. Make a transverse section with a razor blade through the terminal bud, place the sections on a slide and observe them on the microscope. What is the lateral symmetry of the shoot tip? What is the actual phyllotaxis? Note that the apparent distachous, two-ranked appearance of the leaves is due to the fact that the leaves on the underside of the shoot are differentially developed; those on the ventral side are longer and have become twisted so that they lie in about the same plane as those of the upper and lateral surfaces. Verify this feature by removing several of the leaves and keeping track of their relative positions.

2. Habitual anisophyly

In habitual anisophyly the shoots display unequal leaf development despite the position of the shoot; it is what has been called an autonomous anisophyly. Determine the actual differences in leaf structure in relation to position for shoots of *Thuja orientale* available in the laboratory. Make transverse sections as well as observing the differences in leaf morphology with the dissecting microscope. With what particular type of shoot symmetry is anisophyly associated?

II. Heterophylly During Transition to Flowering

Heterophylly is the phenomenon in which leaves on various portions of the shoot system display markedly different shapes. Anisophyly is a lateral form of heterophylly seen in shoot systems. Longitudinal expressions of heterophylly, however, are much more common. The most marked expression of heterophylly is displayed as the shoot undergoes a transition to flowering. Obtain shoots of *Coleus* and examine carefully the nature of leaves on the vegetative and reproductive portions of the shoot. Is the transition gradual or abrupt? Diagram vegetative and floral leaves. Is there a noticeable difference in lateral symmetry between these two forms?