Development of Shoot in *Hydrangea macrophylla* I.  
Terminal and Axillary Buds

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The structure of shoots, in particular of winter buds, of *Hydrangea macrophylla* was examined. The non-flower-bearing shoot is usually composed of a lower and an upper part, between which a boundary is discernible by means of a distinctly short internode. This internode is the lowermost of the upper part, and it is usually shorter than the internodes immediately above and below, although the internodes tend to shorten successively from the proximal to the distal part of the shoot. Variations exist in the following characters among the terminal bud, the axillary bud on the lower part of the shoot and the axillary bud on the upper part: (1) length of bud; (2) character of the outermost pair of leaf primordia; (3) degree of development of secondary buds in the winter bud; and (4) the number of leaf primordia. Usually, the terminal bud contains several pairs of foliage leaf primordia with a primordial inflorescence at the terminal of the bud, but the axillary bud contains only the primordia of foliage leaves in addition to a pair of bud scales.

Key words: Axillary bud — *Hydrangea* — Secondary bud — Terminal bud.

There are various characteristic features of timing and morphology in the processes of initiation and development of shoots in woody plants. In many temperate plants, for example, in *Syringa*, *Betula*, and *Euptelea* (Garrison, 1949a, b), three growth seasons are often necessary for the formation of a mature branch. In the first growth season, bud primordia, or secondary buds, are found within a mature terminal or axillary bud. In the second growth season, these bud primordia or secondary buds develop into mature axillary buds, which become further extended as new branches during the third growth season.

In the case of other woody plants, such as *Pinus lambertiana* (Sacher, 1954, 1955) and *Aucuba japonica* (Hara, 1980), fewer than three growth seasons are required for the formation of a mature branch. Secondary buds are formed within a mature bud during the first growth season, and these secondary buds extend to form new branches directly during the next growth season. In *Acer pseudoplatanus*, mature axillary buds are formed within the first growth season, and these buds extend to form new branches during the next growth season (White, 1955). It is a common feature for a large number of temperate plants which have dormant buds, both terminal and axillary, during the winter. In other words, buds contain a few or several bud scales which enclose some leaf primordia, and these primordia develop into foliage leaves during the
next growth season. It has been suggested that such bud scales function as protective organs during a season of dormancy (Kozlowski, 1971).

By contrast with temperate plants, many tropical plants produce syleptic branches as in *Myrsine floridana* and others (Tomlinson, 1978; Wheat, 1980). Such plants have branches which are produced synchronously with the elongation of the main axis during the same growth season, and, commonly, have no bud scales.

However, there is scarcely any significant understanding of various patterns among woody plants, in timing of shoot formation, when we consider the whole process from initiation of an apical meristem to a mature shoot.

This report presents the first of a series of studies on the shoot development of several woody plants. The present study concerns the construction of winter buds of *Hydrangea macrophylla* Seringe, a temperate deciduous shrub with a decussate phyllotaxis. The buds of this plant show some variations in timing of initiation, degree of development and character of the outermost pair of foliar appendages. These variations offer an interesting subject for a study of shoot development in woody plants.

**Materials and Methods**

Several plants of *Hydrangea macrophylla* of about 30 years of age, in the Botanical Gardens, Faculty of Science, the University of Tokyo, were used for the present study. Samples were collected between October 1986 and March 1987. Terminal and axillary buds were taken from shoots which bore no inflorescence. Buds were fixed in FAA and embedded in paraffin. Serial sections were cut at a 10 μm thickness.

Lengths and number of leaf primordia of buds were examined under a binocular dissecting microscope, and lengths of internodes of the shoots were measured *in situ.* For the measurement of bud lengths and counting of the number of leaf primordia, buds were collected from various current-year shoots during December 1986. The data given in Table 1 are the results of observations on 31 shoots, 31 terminal buds, 44 lower axillary buds and 26 upper axillary buds.

For observations under the scanning electron microscope (SEM), several outer pairs of foliar appendages were removed from buds fixed in FAA, and then the sample was subjected to critical point drying. The sample was then placed again under the binocular dissecting microscope, and some more pairs of appendages were removed and the remaining part was coated with Au.

**Results**

*Morphology of shoot*

*Hydrangea macrophylla* has a decussate phyllotaxis. The shoots that have a terminal inflorescence commonly have 6-12 nodes, and those without an inflorescence have 10-20 nodes. The former are here called flower-bearing shoots, and the latter, non-flower-bearing shoots. The non-flower-bearing shoot commonly has a primordial