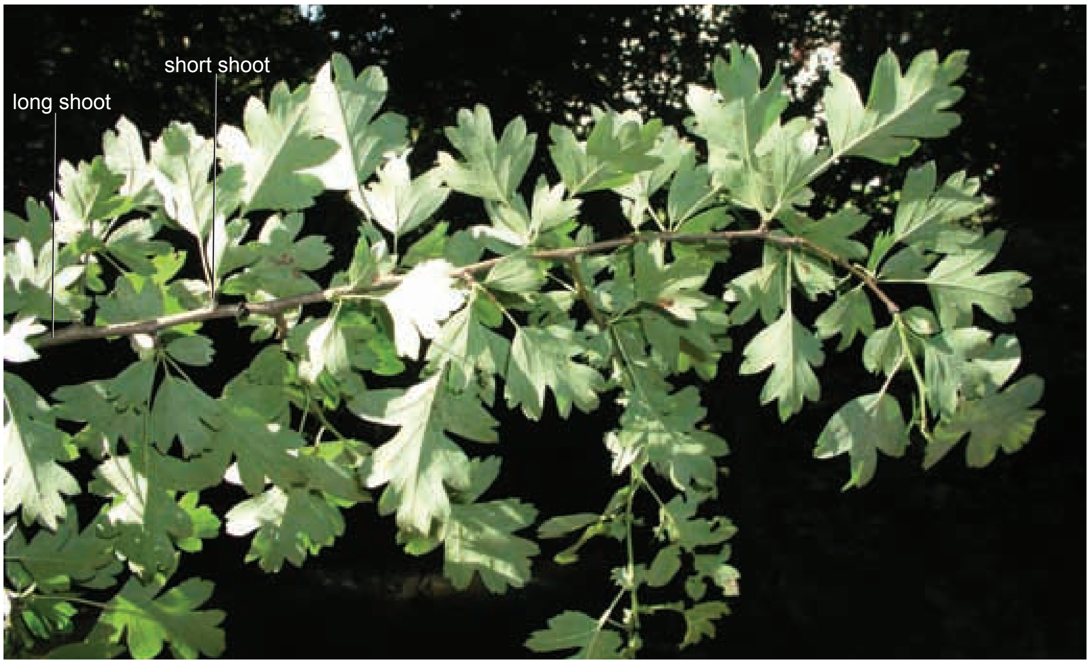
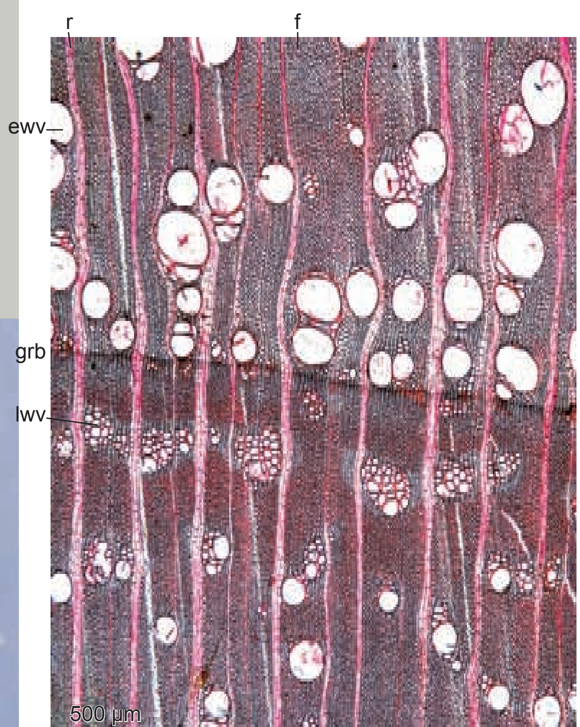
Modification of Shoots: Long and Short Shoots

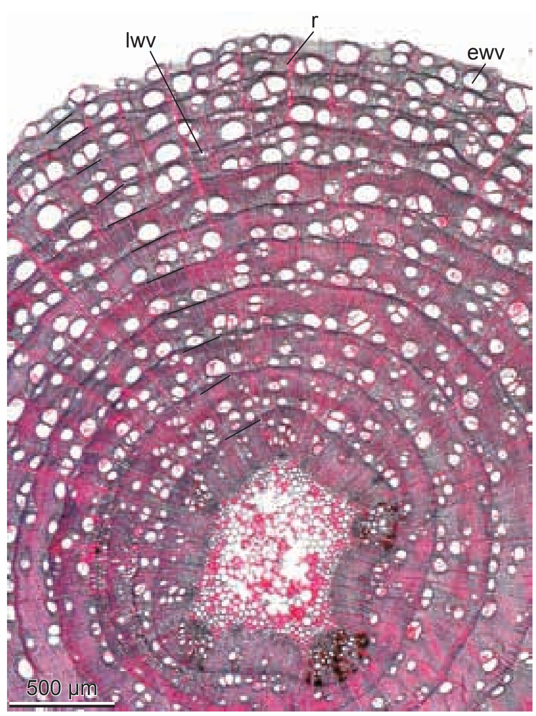
The formation of plant crowns depends on the initiation of buds and the variable growth of twigs (Roloff 2001). Some twigs grow fast and turn into long shoots; others grow slowly and become short shoots (7.1-7.5). Genetic and ecological factors determine the growth of twigs. The genetic influence is very obvious in some conifers, such as larch (7.7-7.10). Annual longitudinal growth may be determined by bud-scale scars. Annual radial xylem growth is indicated by the ring width (7.6). □



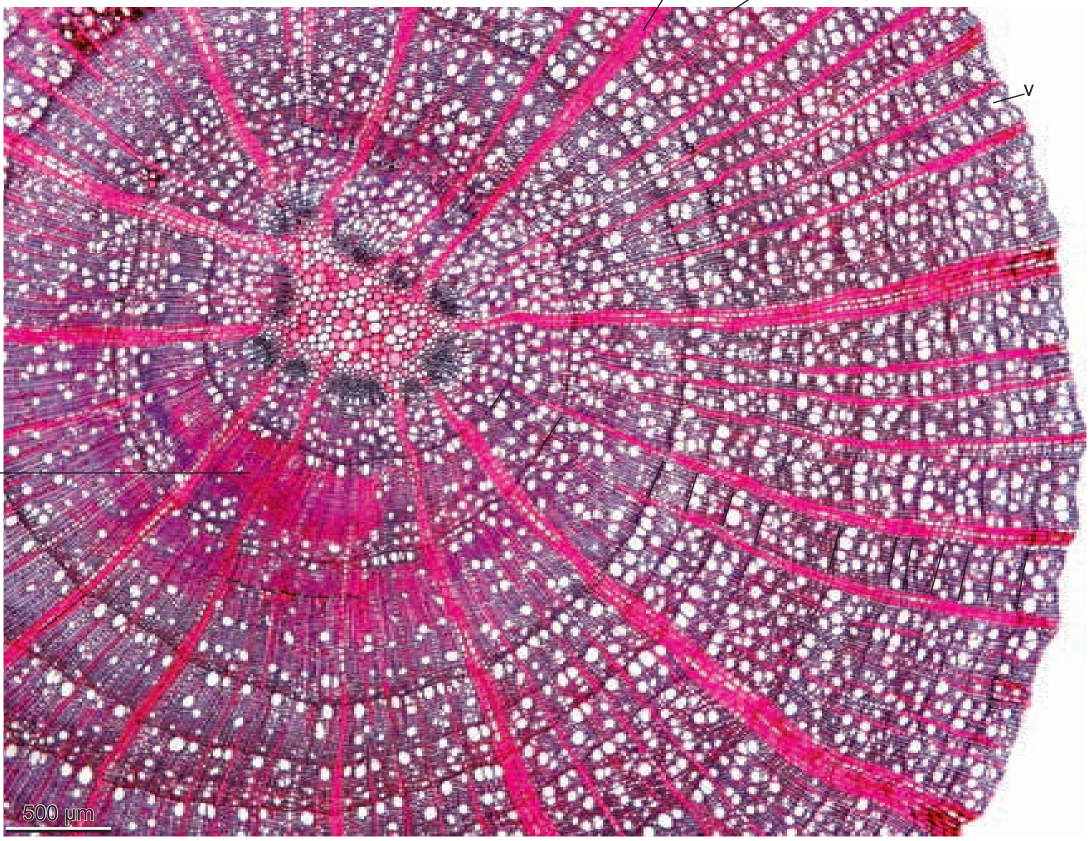
7.1 *Short shoots on a long One-seed Hawthorn shoot (Crataegus monogyna).*



7.2 *Cross-section of a long Black Locust tree shoot (Robinia pseudoacacia). In the large rings, the latewood is wide and dense.*

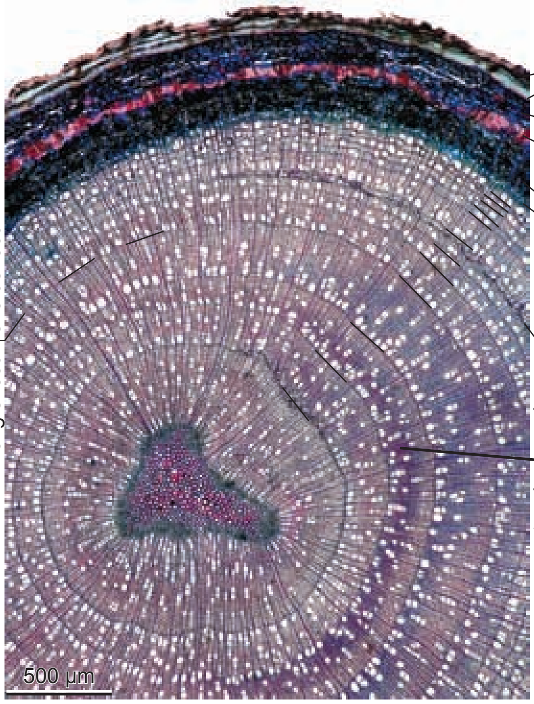


7.3 *Cross-section of a short Black Locust tree shoot (Robinia pseudoacacia). In the very small rings, the latewood is almost absent.*



7.4 Cross-section of a short shoot of Beech (Fagus sylvatica). The narrow rings are typical of this short shoot. The first wide rings indicate that the twig started as a long shoot.

7.5 Cross-section of a long shoot of Silver Birch (Betula pendula) with large rings.

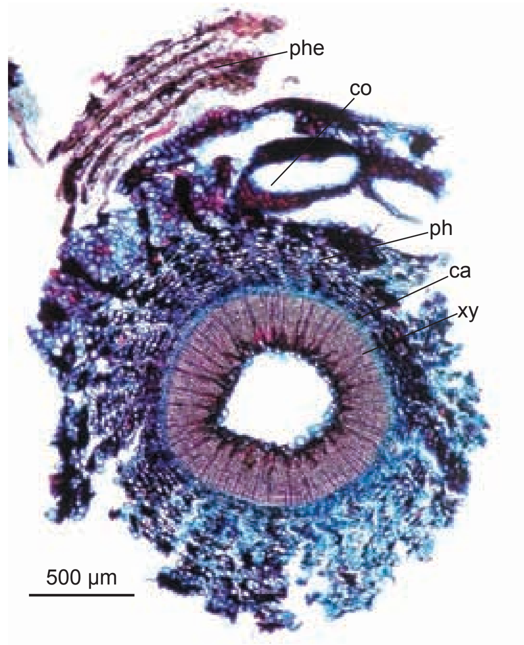


7.6 The transition from a long-shoot-phase to a short-shoot-phase in Silver Birch (Betula pendula) is reflected in a sudden radial growth change.

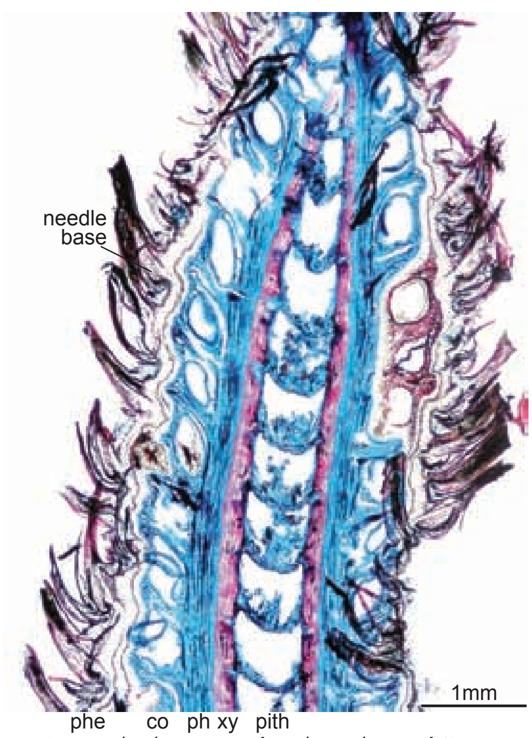
continued next page

Modification of Shoots: Long and Short Shoots

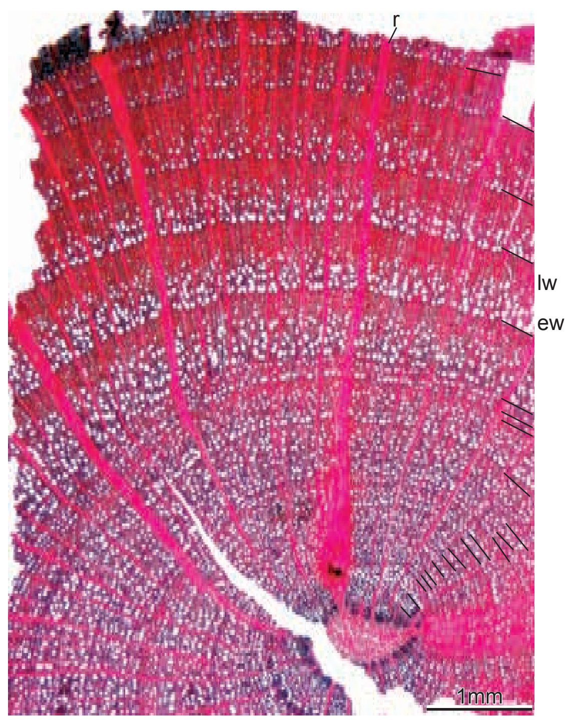
7.7 Short shoots and male flowers on a horizontal, long shoot of European Larch (Larix decidua).



7.8 Cross-section of a short shoot of a European Larch tree (Larix decidua). The bark is extremely thick in relation to the xylem. The 18-year-old short shoot does not contain any rings in the xylem.



7.9 Longitudinal section of a short shoot of European Larch (Larix decidua). The chambers in the pith represent annual shoots.



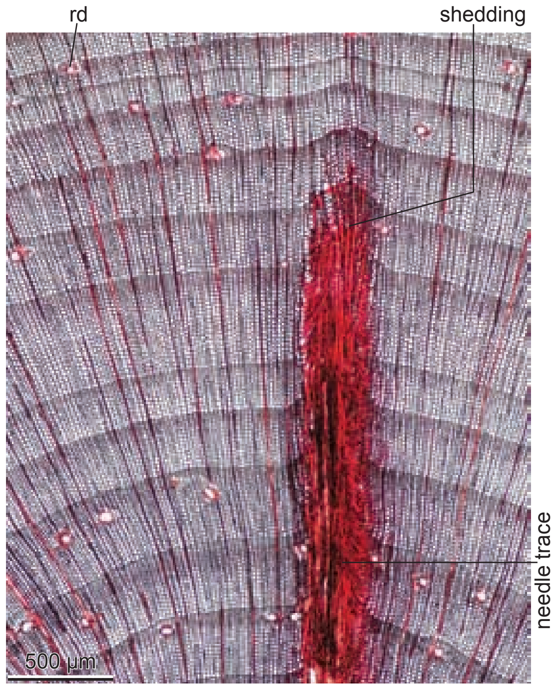
7.10 Microscopic section of a twig of Common Beech (Fagus sylvatica). The very small rings in the center indicate that the twig remained in the short-shoot-phase for many years. Due to suddenly improved light conditions, after a neighbouring tree had been felled, the twig went into a long-shoot-phase. This is shown by the large rings towards the periphery.

MODIFICATION OF SHOOTS: SHEDDING NEEDLES, MALE AND FEMALE FLOWERS

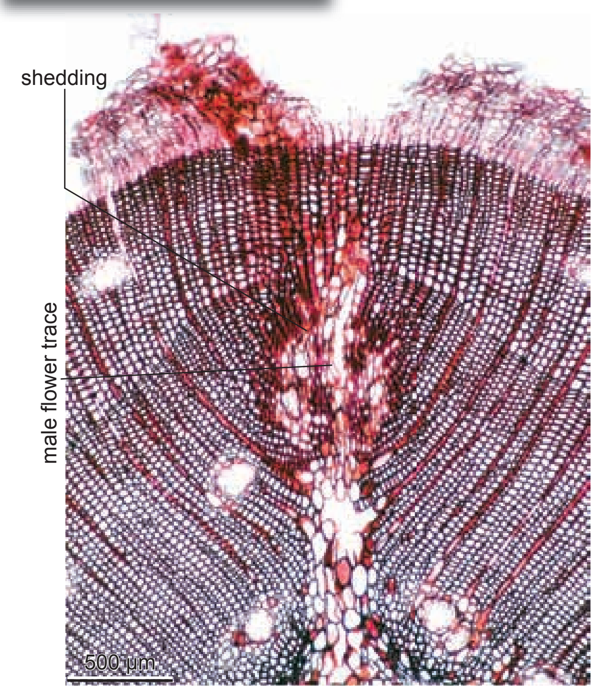
After a certain number of years, evergreen conifers shed their needles, male flowers (7.11) and cones. At first, these parts are isolated from the twig, then dropped and, finally, the wound becomes overgrown. The exact position of this wound is datable dendrochronologically. On the basis of that observation, Jalkanen *et al.* (1995) were able to date the life expectancy of needles over a time-period of more than 100 years.

Programmed cell death determines when the needles are shed. They break off at an anatomically fixed position (the needle base), after this tissue has dried. The life expectancy of pine needles varies from 3 to 15 years (7.12). Male flowers are shed after a few weeks (7.13), whereas the cones remain on the twig for many years (7.14). □

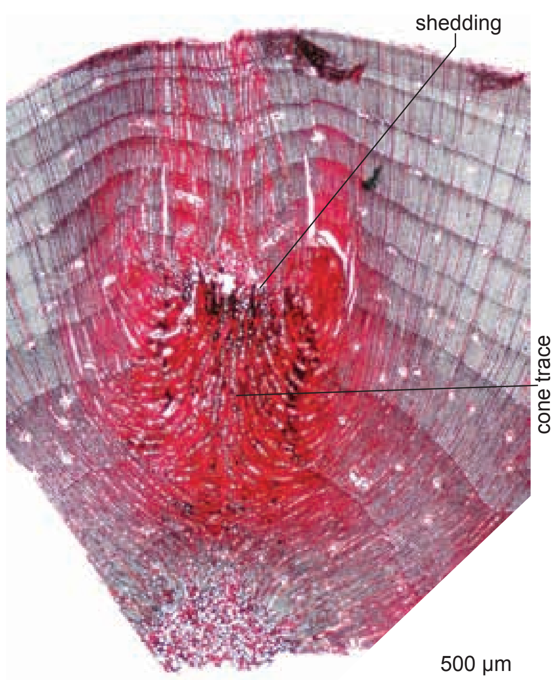
7.11 Spirally arranged traces of male flowers on a long shoot of Mountain Pine (Pinus mugo). ←



7.12 Needle trace on a twig of Mountain Pine (Pinus mugo). The needle was alive for over eight years. After shedding of the needle, callus formed for two years. For a few years, the overgrown needle trace may still be identified as a bent latewood zone.



7.13 Overgrown trace of a male flower of Mountain Pine (Pinus mugo). This flower had originated in the pith; it was a latent shoot. The twig shed the flower during the first year's latewood formation. Callus was formed until the following year. The open space in the periderm indicates where the flower was shed.



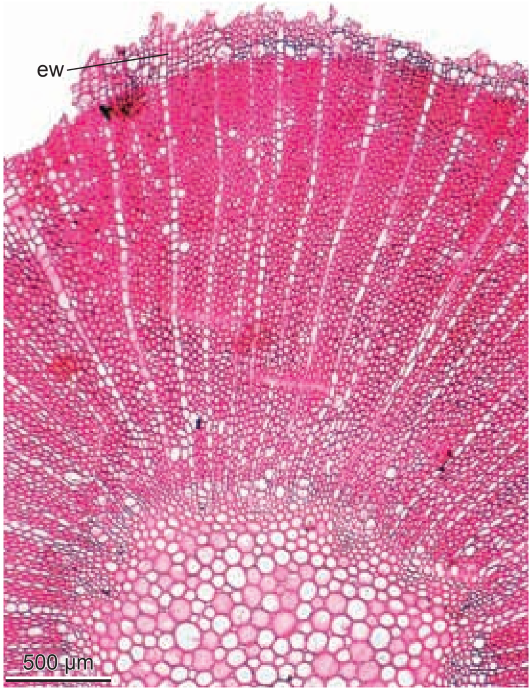
7.14 Overgrown trace of a female cone of Mountain Pine (Pinus mugo). It remained on the twig for four years and was shed during earlywood formation. The two following years are characterized by callus formation. It took several years until the differentiation process normalized again.

Shedding of twigs see Abscission pp. 64.

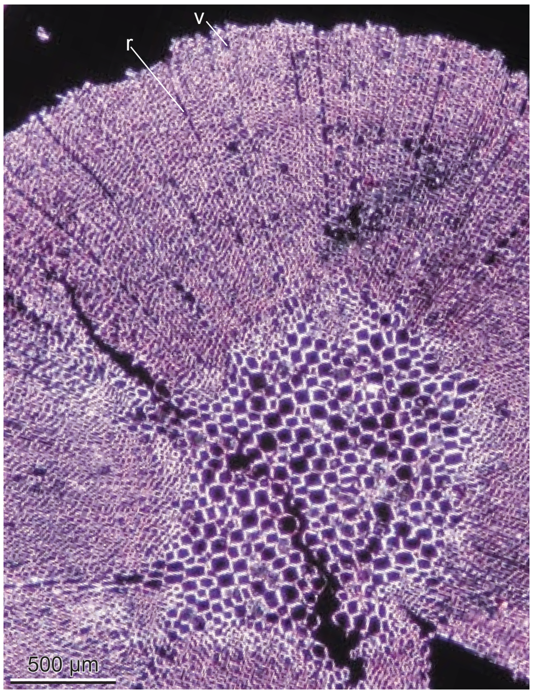
A very effective method for a plant to resist grazing is the formation of spins and thorn. The evolutionary pressure of herbivores was so strong that stems, branches, twigs and leaves developed thorns (7.15-7.20), and the bark developed spines (7.21, 7.22). All defence mechanisms are based on extreme cell wall growth, the lignification of fibers and parenchyma cells (7.17), and the formation of a sharply pointed tip. Thorns are metamorphosed short shoots or leaf veins (7.19, 7.20), for example in *Berberis*. Spines form from cortex cells, for example in rose twigs (7.21, 7.22). □

7.15 Transformation from a short shoot (flowering part) to a thorn (tip). Blackthorn (Prunus spinosa).

7.16 Honey Locust (Gleditsia triacanthos). A shoot transformed into a thorn.



7.17 Cross section of a thorn of Blackthorn (Prunus spinosa) with two leaves. Characteristic is the pith and the absence of vessels. The fibers are very thick-walled.



7.18 Cross section of a thorn on a one year-old long shoot of an Apple Tree (Malus sylvestris). Characteristic is the pith and the presence of very small vessels (polarized light).

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