weed anatomy

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## SECTION I
Cells and Tissues

*No function without structure*

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Introduction

Weeds are plants interfering with the interests of people. They are regarded as problems especially by farmers, by industrial vegetation managers, in ornamental production, in forestry or on sites where vegetation can cause safety risks, for example on railway tracks or along motorways. Some weeds impose a health risk for people by causing allergic reactions, such as Ambrosia artemisiifolia L. Others are toxic to animals, such as Senecio jacobaea L. which kills horses from time to time when eaten. As part of our ability to approach problems systematically, humans try to classify and to prioritise. A famous book cited by weed scientists is The World’s Worst Weeds (Holm et al. 1977). The title categorises weeds as bad. Weeds are, however, parts of ecosystems and are regarded as elements of biodiversity by many scientists today (Radosevich et al. 2007). For these reasons, we will not use value-driven categories in this book. We will also include rare weeds, that is weeds that are endangered and protected in some countries (e.g. according to the UK Biodiversity Action Plan). One might even ask if these plants can be called weeds as they don’t compete with crops and no longer negatively interfere with the interests of people. Proceedings of the Weed Science Society of America (WSSA) formerly classify weeds as either frequent or troublesome. Frequency can be quantified and measured; this is not so easy with troublesome. We will therefore try to concentrate on frequency and use tools described by plant population scientists (e.g. Braun-Blanquet 1964; Dierschke 1994). Anatomy and morphology are signs and the result of adaptation. In consequence, we try to link ecological characteristics with the form of adaptation. Weediness is the ability of unwanted plants to survive in an environment managed by humans. Modern weed control tools have reached a high degree of efficiency. Evolutionary principles, however, allow weeds to escape our efforts to control them. Resistance, physiological and morphological adaptation seem to happen much faster than we had previously realised. Within 6000 years of agriculture, a restricted number of weed species have been selected by humans. The flora has changed to some extent in history due to climate changes and to agricultural practice. A few species, however, have managed to survive over centuries. We will concentrate on these apparently best-adapted weeds and we will highlight their characteristics. The basis of our categories was defined by working groups of the European Weed Research Society.

Any plant can be a weed by definition (i.e. there are no typical structures or features within a plant that make it a weed). There are, however, characteristic features that allow some weed species to survive and proliferate in arable field situations: stolons, rhizomes, bulbs, tubers, buds on roots, seed morphology and reproductive organs. The uptake of herbicides and their distribution within a plant depend on leaf structures.

In Section 9, below, you will find literature on staining techniques and microscopy.

Classical books on plant anatomy start with cells and tissues. They continue with characteristic plant tissues, for example parenchyma, collenchyma, sclerenchyma, epidermis, meristems, phloem, xylem and secretory structures. Organs and plant parts are described thereafter: stem, root, leaves and reproductive organs. We will try to follow this structure with examples from weeds in the first part of this book. For an introduction into cytology and the characteristics of protoplasts, we recommend to read the appropriate chapters in the latest issue of Esau’s Plant Anatomy (Evert 2006). Many textbooks have devoted separate chapters to primary and secondary growth. The most frequent weed species, however, are either annuals, biennials or non-woody perennials. For this reason, we will not refer to noxious trees nor bushes. Only higher plants are considered, that is algae or mosses are excluded. The second part of our book consists of short monographs of weeds with particular reference to anatomy.

We thank all our colleagues who have assisted us with the preparation of this book and have helped us in improving the layout. M. Hess, C. Rosinger, C. Ueno, M. Hills, J. Koehler and L. Lorentz discussed our approach with us regularly. B. Rueffer, M. Linder, P. Remmert and S. Engels assisted us with plant material. S. Teitscheid and Stephanie Giessler produced our illustrative SEM pictures and Philipp Baur contributed by processing SEM picture files. H. Reitzammer checked our manuscript from time to time. Our families encouraged us to go ahead with our book. They tolerated the collection of specimens during private excursions and, from time to time, quite a mess of plant material at home.

We are grateful to our employer, Bayer CropScience, for permission to use screening plant material and to publish SEM pictures produced for various purposes.

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Morphology, Anatomy, Physiology – Explanation of Terms

The term morphology is derived from the Greek words ‘morphe’, meaning form or shape, and ‘logos’, which may be translated here as science. In essence, plant morphology is the science of form, shape, structure and outer appearance of plants. The definition of each of these descriptive terms is, however, not easy. Philosophical discussions about the form of plants concentrate today, more or less, on three different aspects: on the characterisation of organ types, on how plant parts were modified during evolution, what role they play and on the relative importance of these parts when describing the development of a plant (e.g. Classen-Bockhoff 2001). Anatomy is also derived from a Greek word, from anatomos, which means dissected. It deals with the ‘inner’ appearance of plants or plant parts. Anatomy describes tissues and organs as they can be seen when a plant is cut into pieces with a razor blade, a microtome knife or when a plant is analysed by means of electromagnetic waves. Physiology comes from ‘physis’, nature, and explains the function and development of plants or plant parts. You will find all these aspects in our book where appropriate. The major emphasis, however, is placed on the anatomical characteristics of weeds.
Chapter 1

Tissues

No structure without substructure

The reproductive development of higher plants starts with a fertilised egg cell. This cell and its descendants divide and form cell clusters. The growing embryo differentiates into a seedling and characteristic tissues or functional plant parts (Figure 1.1), which later on result in an organism consisting of stem, leaf and root.

Figure 1.1
Germinating seed of *Abutilon theophrasti* Medik.
In between, a number of distinct tissues develop which can be classified according to their appearance and function. The following terms will be used in the next chapters.

- **Epidermis with interfacial cuticle**: the plants’ outer protective layer of cells; it allows the exchange of water, some ions, \( \text{CO}_2 \) and \( \text{O}_2 \) with the environment; many agrochemicals can enter the plant via this layer.
- **Parenchyma**: ground tissue of cells with thin walls; this kind of tissue often fills spaces between other tissues or between organs.
- **Collenchyma and sclerenchyma**: tissues that stabilise the form of stem, leaf and root.
- **Vascular tissues called phloem and xylem**: they transport water and assimilates from one plant part into another.
- **Meristem**: these consist of embryonic cells which divide, form new tissues and are already apparent in seedlings, as shown in Figure 1.2.
- **Secretory tissues**: many plants excrete all kinds of secondary products, for example oils, resins, gums, mucilages and others; these products are stored, transported or excreted by secretory tissues.

Explanations of our figures often describe how tissues were dissected. Figure 1.3 depicts three major ways of generating sections as you may find them in most of our examples.
Figure 1.3
(A) longitudinal, radial; (B) longitudinal, tangential; (C) transverse. Staining and preparation techniques will be described in Section 9 of this book.