

Aizoaceae

Number of species, worldwide and in Europe

The Aizoaceae family includes 127 genera with 2500 species. Most of the species grow in the tropics of the southern hemisphere. In Europe, there are 7 genera with 10 species. Only 2 species of the genus *Mesembryanthemum* are endemic. All other taxa are naturalized in Europe and the Canary Islands.

Analyzed material

The xylem and phloem of 5 Aizoaceae species are analyzed here.

Life forms analyzed:		Studies from other authors:
Semi-woody chamaephytes	2	18 genera
Hemicryptophytes and geophytes	1	
Therophytes	2	
Plants analyzed from different vegetation zones:		Studies from other authors:
Mediterranean		18 genera
Arid	3	
Subtropical	2	

All species analyzed grow near the seashore in the Mediterranean and in subtropical climates.

Analyzed species:

- Aizoon canariense* L.
- Aptenia cordifolia* (L. fil.) N.E. Br.
- Carpobrotus acinaciformis* (L.) L.
- Mesembryanthemum crystallinum* L.
- Mesembryanthemum nodiflorum* L.



Mesembryanthemum crystallinum



Carpobrotus edulis



Aptenia cordifolia

Characteristics of the xylem

Annual rings are absent. Characteristic is the presence of successive cambia. The more-or-less circular arranged xylem/phloem zones are separated by parenchymatic zones (conjunctive tissue) (Figs. 1-4). Perforations are simple and inter-vessel pits are small and round (Fig. 5). Fibres are thin- to thick-walled. The

axial parenchyma is absent or paratracheal (Fig. 4). Rays can be fairly large with often irregularly formed cells, 1-3-seriate or absent (Figs. 2, 4 and 6). Ray cell walls are mostly thin and unlignified (Fig. 1). Short raphides (20 µm) are bundled in a few idioblasts in the inter-vascular bundle zone (Fig. 3). Crystals are absent in *Aizoon canariensis*.

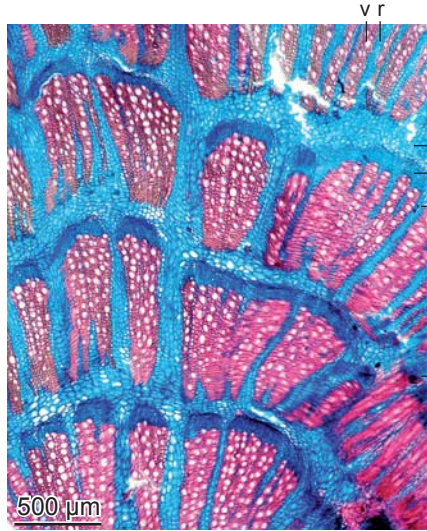


Fig. 1. Stem with successive cambia. Irregular bands of xylem, phloem and adjacent parenchymatic cells, connected with large rays. Root collar of a 15 cm-high plant with succulent leaves, ruderal site, thermophile zone, subtropical climate, Gran Canaria, Canary Islands. *Aizoon canariense*, transverse section.

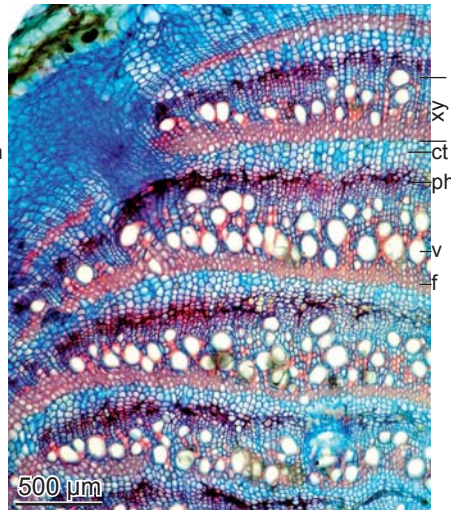


Fig. 2. Stem with successive cambia. Tangential bands of xylem, phloem and adjacent parenchymatic conjunctive tissue. Rays are absent. Root collar of a long hanging plant with succulent leaves, thermophile zone, subtropical climate, Gomera, Canary Islands. *Aptenia cordifolia*, transverse section.

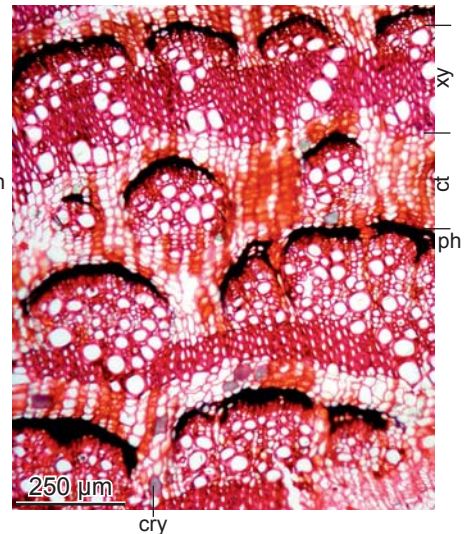


Fig. 3. Stem with successive cambia. Irregular bands of xylem, phloem and parenchyma bands. Grey filled cells represent idioblasts with bundles of raphides. Stem of a several-meter-long chamaephyte with succulent leaves, garden on the coast, Mediterranean zone, Algarve, Portugal. *Carpobrotus acinaciformis*, transverse section.

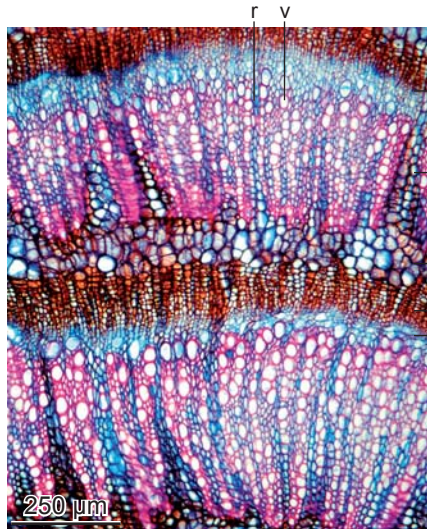


Fig. 4. Stem with successive cambia. Tangential bands of xylem and phloem, in formation process in mid February. Phloem with small, radially oriented cells, adjacent parenchyma with large cells. Rays mostly unlignified, 1-3-seriate. Root collar of succulent, 10 cm-high plant, ruderal site, thermophile zone, subtropical climate, Tenerife, Canary Islands. *Mesembryanthemum crystallinum*, transverse section.

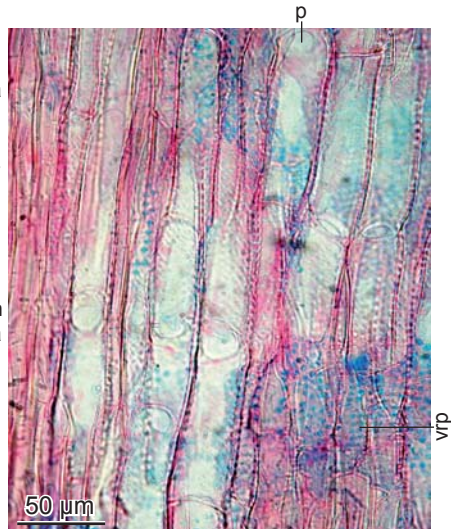


Fig. 5. Vessels with simple perforations and small round inter-vessel pits. Root collar of a 15 cm-high annual plant with succulent leaves, ruderal site, thermophile zone, subtropical climate, Gran Canaria, Canary Islands. *Aizoon canariense*, radial section.

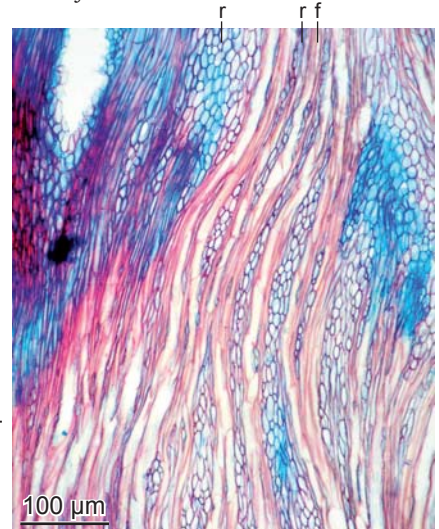


Fig. 6. Rays 3 to 6-seriate. Cell size and form is variable. Root collar of a 15 cm-high annual plant with succulent leaves, ruderal site, thermophile zone, subtropical climate, Gran Canaria, Canary Islands. *Aizoon canariense*, tangential section.

Characteristics of the phloem

Outside the peripheral circle of vascular bundles is a parenchymatic zone, which is delimited by the lateral meristem and the phellem (Fig. 7-9). Many idioblasts with raphides are in both *Mesembryanthemum* species (Fig. 9).

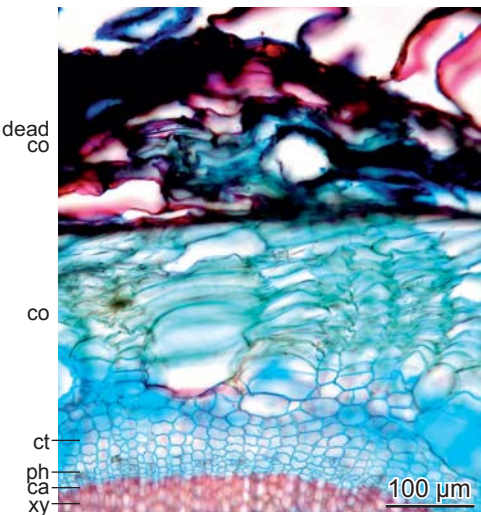


Fig. 7. Bark with a small phloem with small cells, large parenchyma cells and very thin-walled phellem cells (black and red). Root collar of a long hanging chamaephyte with succulent leaves, wall, thermophile zone, subtropical climate, Gomera, Canary Islands. *Aptenia cordifolia*, transverse section.

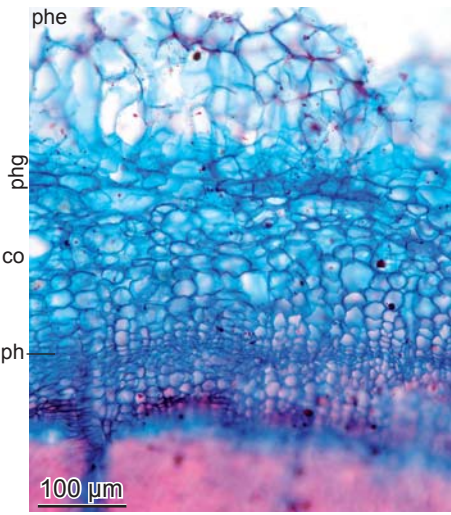


Fig. 8. Bark with a small phloem with small cells, a primary bark with large parenchyma cells and an irregular, very thin-walled phellem. A lateral meristem consisting of a band of small cells is outside of the phloem. Root collar of a succulent 10 cm-high plant, ruderal site, thermophile zone, subtropical climate, Gomera, Canary Islands. *Mesembryanthemum nodiflorum*, transverse section.

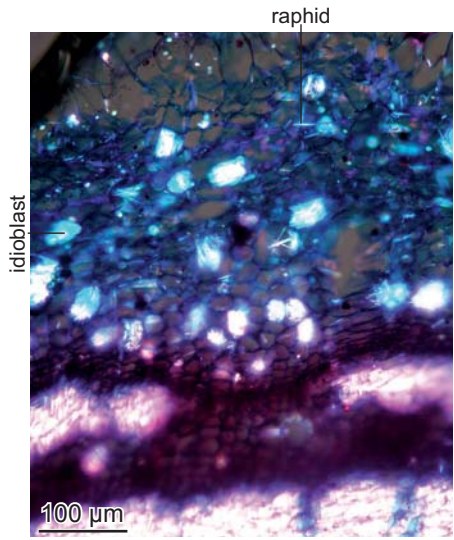


Fig. 9. Bundles of raphides in idioblasts in the parenchyma zone of the primary bark. Root collar of a succulent 10 cm-high plant, ruderal site, thermophile zone, subtropical climate, Gomera, Canary Islands. *Mesembryanthemum nodiflorum*, transverse section, polarized light.

Characteristic features of taxa

The presence or absence of ray-like radial strips of thin-walled parenchyma, the size and distribution of earlywood vessels, as well as the presence of raphides can differentiate species. There is not enough material to present a definite classification neither in relation to species nor to growth forms.

Ecological trends and relations to life forms

Since all species analyzed grow in dry regions an ecological grouping could not be recognized.

Discussion in relation to previous studies

CARLQUIST 2007 analyzed much material and studied in detail the ontogeny of successive cambia of 11 perennial species of 11 genera representing a wide range of growth forms. The present study does not include the whole range of anatomical structures. Not represented are species with vascular strands (*Stayleria neilii*) or species with scalariform inter-vessel pits.

Present features in relation to the number of analyzed species		
IAWA code		frequency
	Total number of analyzed species	5
2	growth rings indistinct or absent	5
5	diffuse-porous	5
10	vessels in radial multiples of 4 or more common	3
40.2	earlywood vessels: tangential diameter 20-50 μm	5
50.2	200-1000 vessels per mm ² in earlywood	5
58	dark-stained substances in vessels and/or fibers present (gum, tannins)	1
61	fiber pits small and simple to minutely bordered (<3 μm = libriform fibers)	5
70	fibers thin- to thick-walled	5
75	parenchyma absent or unrecognizable	3
79	parenchyma paratracheal	2
96	rays exclusively uniseriate	1
97	ray width predominantly 1-3 cells	2
98	rays commonly 4-10-seriate	4
105	ray: cells upright or square	2
117	rayless	2
133	successive cambia, Caryophyllacea type	5
133.2	successive cambia, concentric continuous	5
134.1	conjunctive tissue thin-walled	5
149	raphids present	2
R1	groups of sieve tubes present	1
R10	phloem not well structured	5
R11	with raphides	2
P1	with medullary phloem or vascular bundles	1

Amaranthaceae

Number of species, worldwide and in Europe

The Amaranthaceae family, including Chenopodiaceae, has 170 genera with 2400 species. Cosmopolitan and especially characteristic of disturbed, arid or saline habitats.

In Europe there are 38 genera with 106 species. The majority are represented by the genera *Salsola* (25 species), *Chenopodium* (23 species), *Atriplex* (19 species), and *Amaranthus* (12 species).

Analyzed material

The xylem and phloem of 15 genera with 62 species are analyzed here.

Life forms analyzed:		Studies from other authors:	
Nanophanerophytes 0.5-4 m	15	30	species
Woody chamaephytes	11		
Semi-woody chamaephytes	3	16	genera
Liana	3	1	species
Hemicryptophytes and geophytes	3		
Therophytes	27	1	species

Plants analyzed from different vegetation zones:		Studies from other authors:	
Alpine and subalpine	1		
Hill and mountain	12		
Mediterranean	12	2	species
Arid	22	23	
Subtropical	10	2	species
Tropical		2	species



Haloxylon ammodendron (photo: W. Schulze)

Analyzed species:

- Achyranthes aspera* L.
- Achyranthes sicula* (L.) All.
- Aerva javanica* Juss. ex Schult.
- Aerva persica* Merr.
- Agathophora alopecuroides* (Del.) Fenzl.
- Amaranthus blitum* L.
- Amaranthus cruentus* L.
- Amaranthus deflexus* L.
- Amaranthus hybridus* L.
- Amaranthus lividus* L.
- Amaranthus retroflexus* L.
- Amaranthus standleyanus* Covas
- Amaranthus viridis* L.
- Anabasis brevifolia* C.A. Mey
- Arthrocnemum fruticosum* (L.) Moq.
- Arthrocnemum glaucum* (Del.) Ung.
- Arthrocnemum macrostachya* Moris et Delponte
- Arthrocnemum perenne* (Mill) Moss.
- Atriplex canescens* (Pursh) Nutt.
- Atriplex dimorphostegia* Kareilin & Kiriloff
- Atriplex glauca* Maire
- Atriplex halimus* L.
- Atriplex patula* L.
- Atriplex portulacoides* L.
- Atriplex prostrata* DC
- Atriplex sagittata* Bork.
- Atriplex semibaccata* R.Br.
- Bosea cypria* Boiss.ex Hook
- Bosea yervamora* L.
- Cheneloides tomentosa* Botsch
- Chenopodium album* L.
- Chenopodium bonus-henricus* L.
- Chenopodium frutescens* C.A. Mey
- Chenopodium glaucum* L.
- Chenopodium hybridum* L.
- Chenopodium murale* L.
- Chenopodium polyspermum* L.
- Chenopodium strictum* Roth
- Chenopodium urbicum* L.
- Cornulaca monacantha* Del.
- Einadia nutans* Scott
- Haloxylon articulatum* (Moq.) Bunge
- Haplopeplis perfoliata* (Forsk.) Bg. ex Schweinf.
- Kochia prostrata* DC
- Krascheninnikovia ceratoides* (L.) Gueldenst.
- Krascheninnikovia lanata* (Pursh) A. Meeuse & Smit
- Mairena pyramidata* (Benth.) Paul G. Wilson
- Noea mucronata* Ascherson et Schweinf.
- Patellifolia patellaris* Scott et al.
- Patellifolia procumbens* F. L. et W.
- Polycneum arvense* L.
- Salsola foetida* Del.
- Salsola genistoides* Juss. ex Poir.
- Salsola kali* L.
- Salsola oppositifolia* Desf.
- Salsola vermiculata* L.
- Salsola verticillata* Schousboe
- Suaeda fruticosa* Forsk.
- Suaeda pruinosa* Lange
- Suaeda vera* L.F. Gmelin
- Suaeda vermiculata* Forsk.
- Traganum moquinii* Webb



Amaranthus caudatus (photo: Zinnert)



Amaranthus lividus



Salsola kali



Chenopodium bonus-henricus

Atlas of Stem Anatomy in Herbs, Shrubs and Trees

Volume 1

Schweingruber, F.H.; Börner, A.; Schulze, E.-D.

2011, VIII, 495 p., Hardcover

ISBN: 978-3-642-11637-7