

## FOLIAR ANATOMY OF THE CARYOPHYLLACEAE FAMILY IN ARASBARAN, NW. IRAN

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Zarrinkamar, F. 2001 12 15: Foliar anatomy of the *Caryophyllaceae* family in Arasbaran, NW. Iran. –*Iran. Journ. Bot.* 9 (1): 93-102. Tehran.

The foliar anatomy of the *Caryophyllaceae* family from Arasbaran Protected Area including the following species were studied under light microscope: *Arenaria dianthoides*, *Arenaria gypsophiloides*, *Arenaria serpyllifolia*, *Cerastium glomeratum*, *Cerastium holosteoides*, *Cerastium szowitsii*, *Dianthus cretaceus*, *Dianthus crinitus*, *Gypsophila elegans*, *Herniaria hirsuta*, *Herniaria incana*, *Minuartia hirsuta*, *Minuartia acuminata*, *Minuartia lineata*, *Minuartia meyeri*, *Minuartia recurva*, *Silene alba*, *Silene ruprechtii*, *Silene spergulifolia* and *Stellaria media*. The different anatomical characters on *Caryophyllaceae* family indicate flexibility of this family in various ecological circumstances.

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*Key words.* Anatomy, *Caryophyllaceae*, Iran.

بررسی آناتومی تیره میخک (*Caryophyllaceae*) در ارسباران، شمال غرب

ایران

فاطمه زرین کمر

ساختمان تشریحی برگ تعدادی از گونه‌های جنس‌های مختلف از خانواده *Caryophyllaceae* از منطقه حفاظت شده ارسباران مطالعه گردید. برگ در این گونه‌ها دارای صفات جالبی می باشد که نشان دهنده انعطاف قابل ملاحظه این خانواده درمقابل شرایط محیطی است.

## INTRODUCTION

Arasbaran lies in the northwest part of Iran on the northern latitude of 39°. 8' and longitude of 47°. 2'.

This mountainous area was designated as a protected area in Eastern Azerbaijan in 1971. It is about 72465 hectares, and encompasses a variety of natural features, such as high mountains, deep valleys, steep slopes, dense forests and vast rangelands which are all of environmental diversity, numerous animals and plant species found in the area demonstrate a variety of biodiversity. The altitude variations are between 450 to 2841 meters. According to the data released by weather bureaus located in Ahar (1350 meter above the sea level). The average temperature in February and August are 1.8° c and 25° respectively.

The annual precipitation is around 450-500 mm. which indicates, the area is categorized a semi- humid zone.

The same bureaus have reported that the temperature decreases 6° c per an increase of 1000 meters in altitude.

In Arasbaran protected area 785 plant species were recognized by Assadi (1987). The richness of flora and fauna in the area and the existence of rare species that some of them are in danger, and lack of basic information, especially of anatomical characters, encourage more research and data collection for further studies.

Research on adaptive characters has been directed mainly towards leaves (Clements, 1929; Eveneri, 1949). Considering the importance of foliar anatomy on ecological developments in environment requires efforts to be concentrated on investigation into maximum number of species, if possible. The following presents the foliar anatomy of majority of the *Caryophyllaceae* family in this area.

## MATERIALS AND METHODS

In order to study histofoliar characters, materials were fixed in FAA and transverse sections of leaf were prepared by hand cutting, sections were cleared with sodium hypochlorite, dehydrated and stained with methyl green and carmino-Vest and mounted in gelatin. In order to study venation and stomata density, the diafanization technique (Stritmatter, 1973) was employed. Observations were carried out with light Microscope.

The list of species under study in this paper is as follows.

*Arenaria dianthoides* J. E. Smith. var. *dianthoides*. -Arasbaran, Abbasabad highland, 2350 m, Hamze'ee & Asri, s. n.

*Arenaria gypsophiloides* L. -Arasbaran, Abbasabad highland, 2426 m, Hamze'ee & Asri, s. n.

*Arenaria serpyllifolia* L. -Arasbaran, Ilankosh, 1975 m, Hamze'ee & Asri, s. n.

*Cerastium glomeratum* Turrit. -Arasbaran, Ilankosh, 2110 m, Hamze'ee & Asri, s. n.

*Cerastium holosteoides* Fries. -Arasbaran, Toopkhaneh highland, 2350 m, Hamze'ee & Asri, s. n.

*Cerastium szowitsii* Boiss. -Arasbaran, Toopkhaneh highland, 2250 m, Hamze'ee & Asri, s. n.

*Dianthus cretaceous* Adams -Arasbaran, Abbasabad highland, 2426 m, Hamze'ee & Asri, s. n.

*Dianthus crinitus* Sm. -Arasbaran, Between Mahmoodabad & Makidi, 2120 m, Hamze'ee & Asri, s. n.

*Gypsophila elegans* M. B. -Arasbaran, Armany Oulan near to Vayghan, 1400 m, Hamze'ee & Asri, s. n.

*Herniaria hirsuta* L. -Arasbaran, Between Tooali & Eskanloo, 380 m, Hamze'ee & Asri, s. n.

*Herniaria incana* Lam. -Arasbaran, Ilankosh, 2080 m, Hamze'ee & Asri, s. n.

*Minuartia acuminata* Turrit. -Arasbaran, Toopkhaneh highland, 2350 m, Hamze'ee & Asri, s. n.

*Minuartia lineata* Bornm. -Arasbaran, Toopkhaneh highland, 2350 m, Hamze'ee & Asri, s. n.

*Minuartia meyeri* (Boiss.) Bornm. -Arasbaran, Between Makidi & Shojaabad, 450 m, Hamze'ee & Asri, s. n.

*Minuartia recurva* (All) Schinz & Thell. -Arasbaran, Toopkhaneh highland, 2250 m, Hamze'ee & Asri, s. n.

*Silene alba* (Miller) Krause. -Arasbaran, Between Abbasabad & Mahmoodabad highland, 2150 m, Hamze'ee & Asri, s. n.

*Silene ruprechtii* Schischk. -Arasbaran, Between Mahmoodabad & Makidi, 2120 m, Hamze'ee & Asri, s. n.

*Silene spergulifolia* (Desf.) M. B. -Arasbaran, Between Mahmoodabad & Makidi, 2120 m, Hamze'ee & Asri, s. n.

*Stellaria media* (L.) Cyr. -Arasbaran, Abbasabad highland, 1795 m, Hamze'ee & Asri, s. n.

Voucher specimens are preserved in Research Institute of Forests and Rangelands and fixed materials are conserved in the laboratory of vegetal anatomy at this institute.

## OBSERVATIONS

### Superficial view

In general epidermis, consisting of cells with sinuous anticlinal walls, smooth cuticle, and deposits of wax in the form of granules. Stomata of *Caryophyllaceae* are generally diacytic type, each stomata is surrounded by two subsidiary cells, the common wall of which is at right-angles to the longitudinal axis of the stomata (Fig. 1 A, D, E, G, H; Fig. 2 A, B), but in certain species (*Arenaria gypsophiloides*, *Cerastium* spp., *Henriaria* spp., *Stellaria media* and *Silene* spp.) stomata is anemocytic (Fig. 1 B, C; Fig. 2 C, D).

### Transversal section

Stomata superficial, present on both surfaces (Fig. 4 G). In *Arenaria* spp. is sunken with higher density (table 1), and in *Cerastium* spp. are raised and showing less density (Fig. 5 C, D, table 1).

Epidermal cells papillose, generally on both surfaces, especially in central vein of certain species of *Dianthus*, *Minuartia* and *Silene* bear trichome, specially at the margins (Fig. 3 D) except in *Gypsophila elegans*, *Minuartia lineata*, *Minuartia meyeri*.

The non-glandular trichome is multicellular, uniseriate, with cutinized walls as are common in *Arenaria* sp., *Dianthus* sp., and *Herniaria* sp. (Fig. 3 B, C, E, F, H). The presence of glandular trichome was noticed in *Cerastium* sp. and *Silene* sp. The long stalk is multicellular and distal cells are oval (fig. 2 F, G; Fig. 3 A, G). In *Arenaria dianthoides*, subepidermal collenchymatous tissue presents at the margins of leaves (Fig. 4 C, H). Mesophyll, is composed mainly of short palisade cells and generally dorsiventral, but sometimes isobilateral or centric. Mesophyll is consisting of 1 or 2 layers of palisade and spongy parenchyma occupying two-thirds of the lamina thickness. Leaves are dorsiventral in *Arenaria serpyllifolia*, *Cerastium* sp., *Henriaria* sp., *Silene alba*, *Silene ruprechtii*, and *stellaria media* (Fig. 5 A, B), but in *Arenaria dianthoides*, *Arenaria gypsophiloides*, *Dianthus* sp., *Gypsophila elegans*, *Minuartia meyeri*, *Minuartia acuminata*, and *Silene spergulifolia* are isobilateral (Fig. 5 E, F). Sometimes lamina is centric in *Minuartia recurva* and *Minuartia lineata*. Mesophyll in medium shows water-storage parenchyma formed by cells with thin walls.

Vascular bundles surrounded by water-storage cells in *Arenaria* sp. and *Dianthus* sp. (Fig. 4 A-D). Vascular Bundles are collateral accompanied by packets of fibers in abaxial and adaxial position specially periphloematic fibers (Fig. 4 E). Fiber In *Stellaria media* is absent in central vein. Vascular bundle in *Arenaria serpyllifolia* is collateral form by little xylem. Numerous solitary and large crystals

Table 1. Data of stomata and trichome in *Caryophyllaceae*

Species	Density of stomata ad(mm <sup>2</sup> )	Density of stomata ax(mm <sup>2</sup> )	Length of stomata ad (μ)	Length of stomata ax (μ)	Type of stomata	Density of trichoma ad(mm <sup>2</sup> )	Density of trichoma ax (mm <sup>2</sup> )	Type of trichoma
<i>Arenaria dianthoides</i>	95.42	122.5	32.175	36.35	diacytic	marginal	Marginal	simple
<i>Arenaria gypsophiloides</i>	95	82.2	32.667	33.733	anemocytic (tetracytic)	glabrous	marginal	simple
<i>Arenaria serpyllifolia</i>	117.44	166.66	27.667	27.611	diacytic	<10%	<10%	simple
<i>Cerastium glomeratum</i>	59.03	82.35	39.133	40	anemocytic	>10%	>10%	glandular
<i>Cerastium holosteoides</i>	68	92	35	36	anemocytic	central vein	>adx	glandular
<i>Cerastium szowitsii</i>	48	130	35	35	anemocytic	dense	dense	simple
<i>Dianthus cretaceus</i>	127	86	32	33	diacytic	<10%	<10%	simple
<i>Dianthus crinitus</i>	81	83	33	35	diacytic	<10%	<10%	simple
<i>Gypsophila elegans</i>	83	96	30	31	diacytic	glabrous	glabr	—
<i>Herniaria hirsuta</i>	168	85	28	31	anemocytic	>10%	>10%	simple
<i>Herniaria incana</i>	146	99	26	26	anemocytic	<10%	<10%	simple
<i>Minuartia acuminata</i>	88	71	34	33	diacytic	central vein	central vein	glandular
<i>Minuartia lineata</i>	143	82	30	30	diacytic	glabrous	glabrous	—
<i>Minuartia meyeri</i>	170	110	25	25	diacytic	glabrous	glabrous	—
<i>Minuartia recurva</i>	170	110	30	30	diacytic	<10%	<10%	glandular
<i>Silene alba</i>	65	106	34	35	anemo>dia	>10%	>10%	simple
<i>Silene ruprechtii</i>	217	166	29	30	dia>aniso	marginal	marginal	simple
<i>Silene spergulifolia</i>	150	104	29	30	diacytic	>10%	>10%	glandular
<i>Stellaria media</i>	15	45	41	41	anemocytic	<10%	<10%	simple

(druses) of calcium oxalate are observed in the mesophyll and vascular bundles, outside the phloem (Fig. 5 G-I) Microtests show the presence of mucilage and tannins at the water storing parenchyma in middle of mesophyll sheaths surrounded the central vein (Fig. 4 F)

## Discussion

The study of the comparative anatomy of *Caryophyllaceae* family revealed interesting anatomical characters. Certain tissues, particularly those of the leaves, become altered structurally in relation to environment.

Observation on *Arenaria*, *Dianthus* and *Herniaria* species indicates that these plants have the following characters:

The epidermal cell walls and the cuticle on the outer surface is thick, deposit of wax in the form of granules, simple trichomes with cutinized walls, a

higher stomatal frequency, collenchyma in margins of the leaves, and more mechanical sclerenchymatous tissue, water storage, tissue developed in the central portion of the palisade parenchyma with deposits of salts in the form of big crystal even as a sheath around the vascular bundle. These characters permits to consider that *Caryophyllaceae* family is resistant to xerophyte condition, meanwhile in *Cerastium* and *Silene* species stomata are raised. Glandular trichomes with distal cells have thin wall, observing of less compact mesophyll (dorsiventral), absence of water-storage parenchyma in medium and rareness of crystals presence. Such characters are totally determining their semi-humid environment that the plants are living in. Semi-humid and mountainous conditions, and existence of different anatomical

characters on *Caryophyllaceae* family indicate flexibility of this family in various ecological circumstances. In ecological point of view, field studies proved that these species have been adapted to microclimate, so this modification create suitable conditions to increase vital activities.

### ACKNOWLEDGMENT

Most of this research has been carried out in collaboration with Kowsari Dehghan, Boostani, *Siavash and Azimi*, laboratory technicians of vegetal anatomy.

Fresh materials collected by Mr. Shirvany, Mr. Hamzeh'ee and Dr. Asri so here by, I would like to express my appreciation to all of them. I specially thank Dr. A. Jalily, director of Forests and Rangelands Research Institute for his valuable help in making such research possible.

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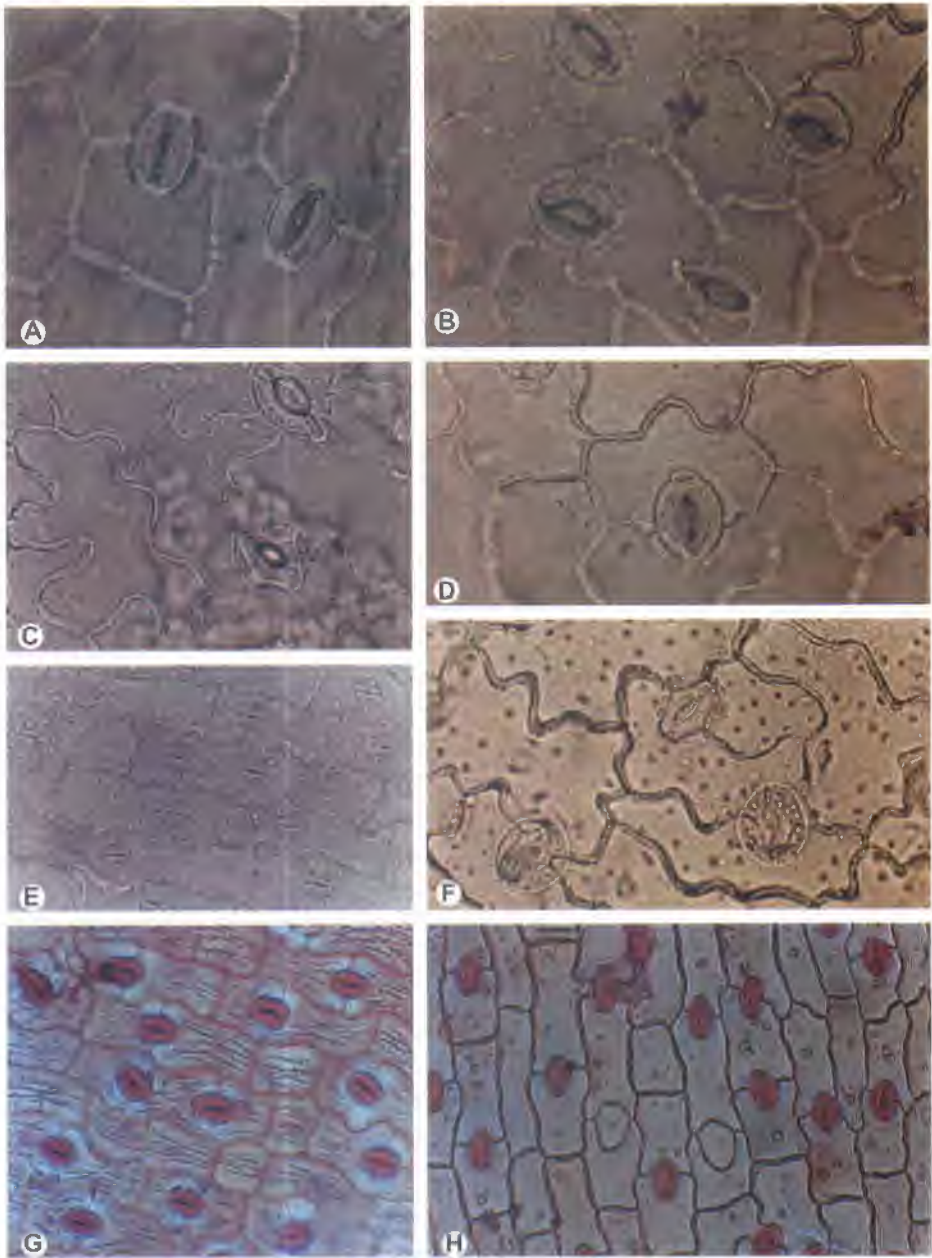


Fig. 1.: A-H, epidermis in superficial view: A, D-F, H, adaxial; B, C, G, abaxial; A, *Dianthus cretaceus*; B, D, *Silene spergulifolia*, C, *Stellaria media*; E, *Minuartia acuminata*; F, *Silene alba*; G, *Minuartia lineata*; H, *Dianthus crenateus*; A-D, F ( $\times 300$ ); E, G, H ( $\times 150$ ).

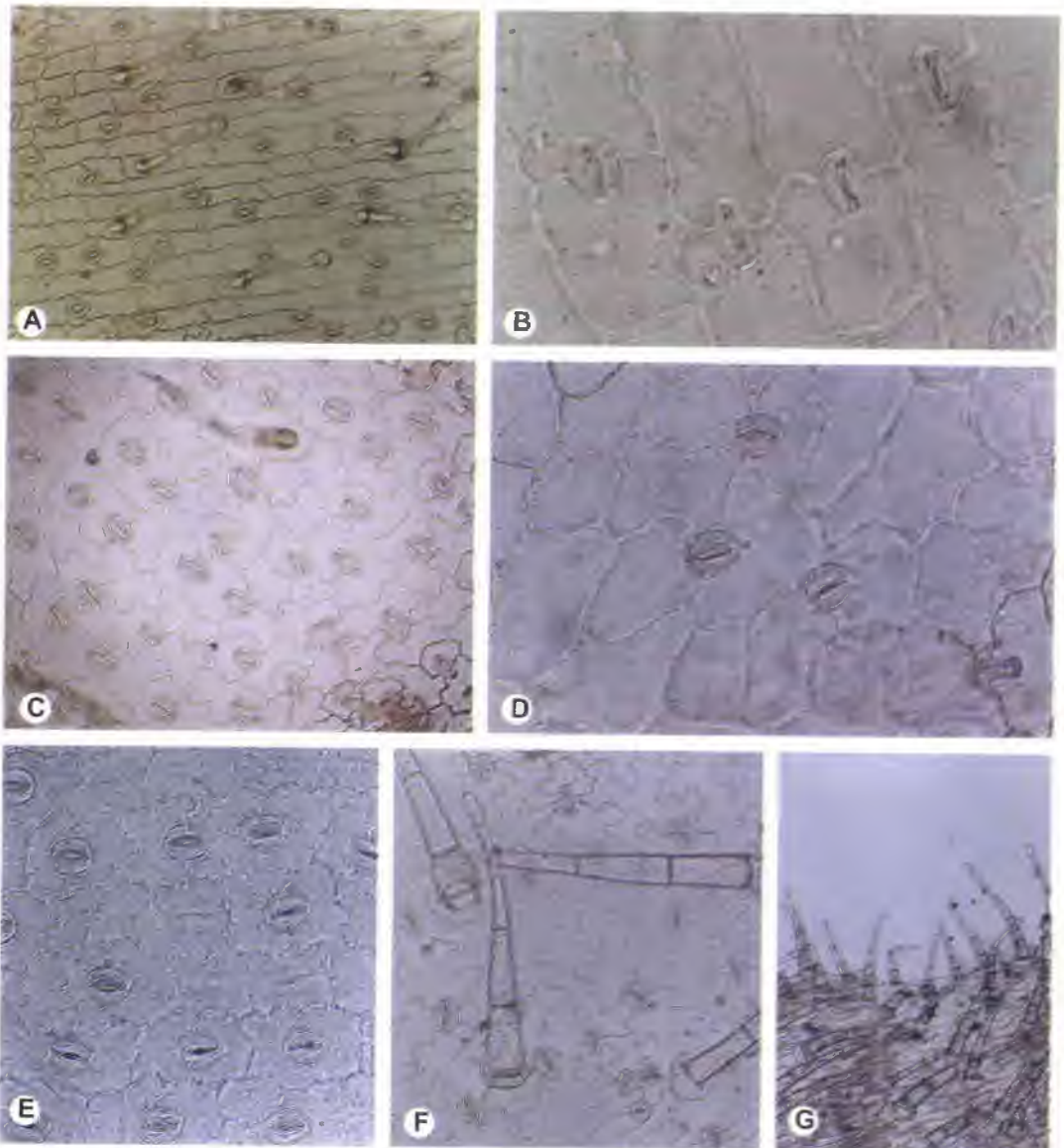


Fig.2.: A-G, epidermis in superficial view: A, G, adaxial; B-F, abaxial; A, B, *Arenaria dianthoides*; C, D, *Silene alba*; E, *Silene ruprechtii*; F, G, *Cerastium glomeratum*; A, D, E, ( $\times 150$ ); B, ( $\times 300$ ); C, F, ( $\times 75$ ); G, ( $\times 30$ ).

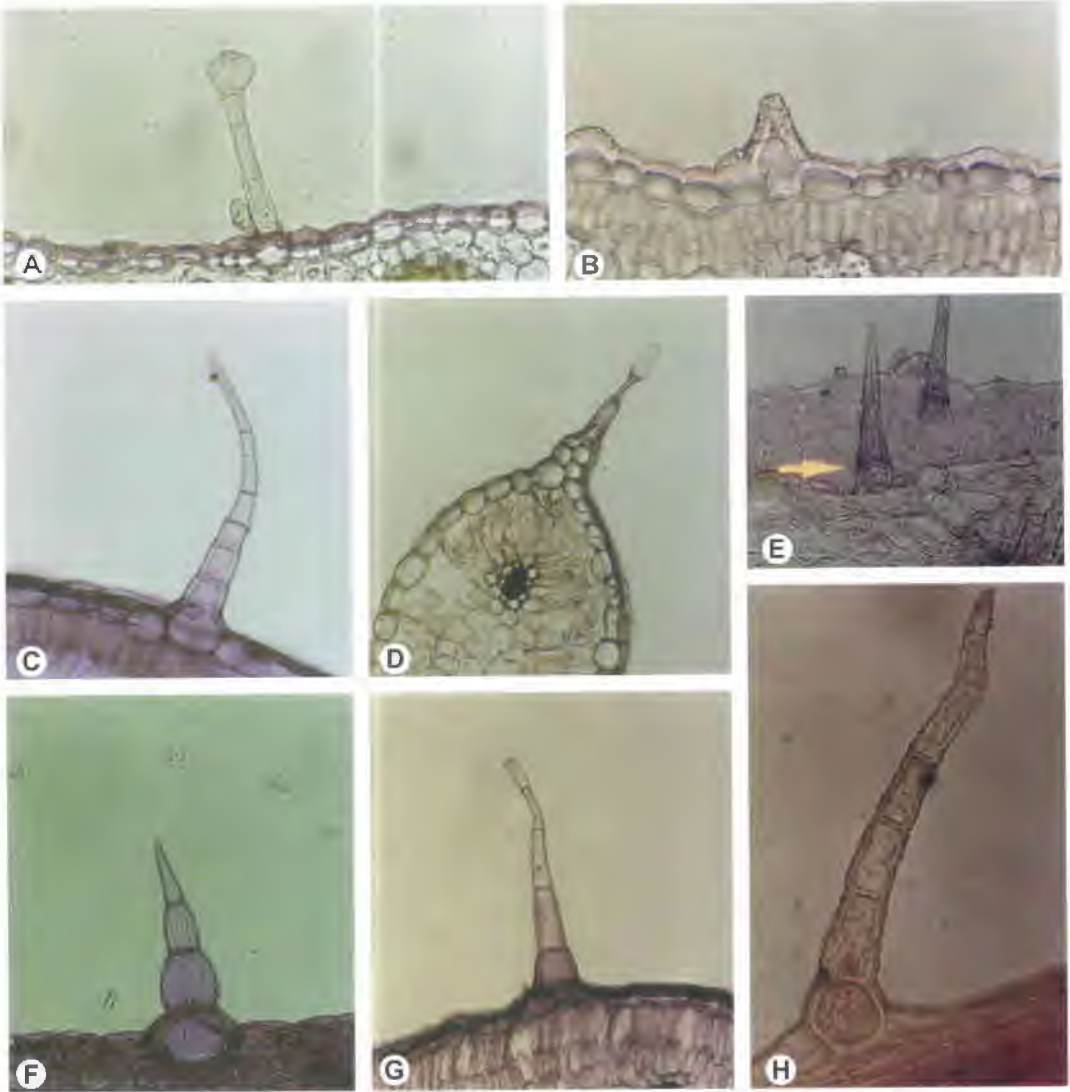


Fig.3.: A-H, trichomes of the *Caryophyllaceae*: A-D, F-H, in TS; E, in superficial view; A, *Minuartia acuminata*; B, E, *Dianthus cretaceus*; C, *Silene alba*; D, *Silene sperguliifolia*; F, *Stellaria media*; G, *Cerastium holosteoides*; H, *Arenaria dianthoides*: A, B, E, H ( $\times 150$ ); C, D, F, G ( $\times 75$ ).



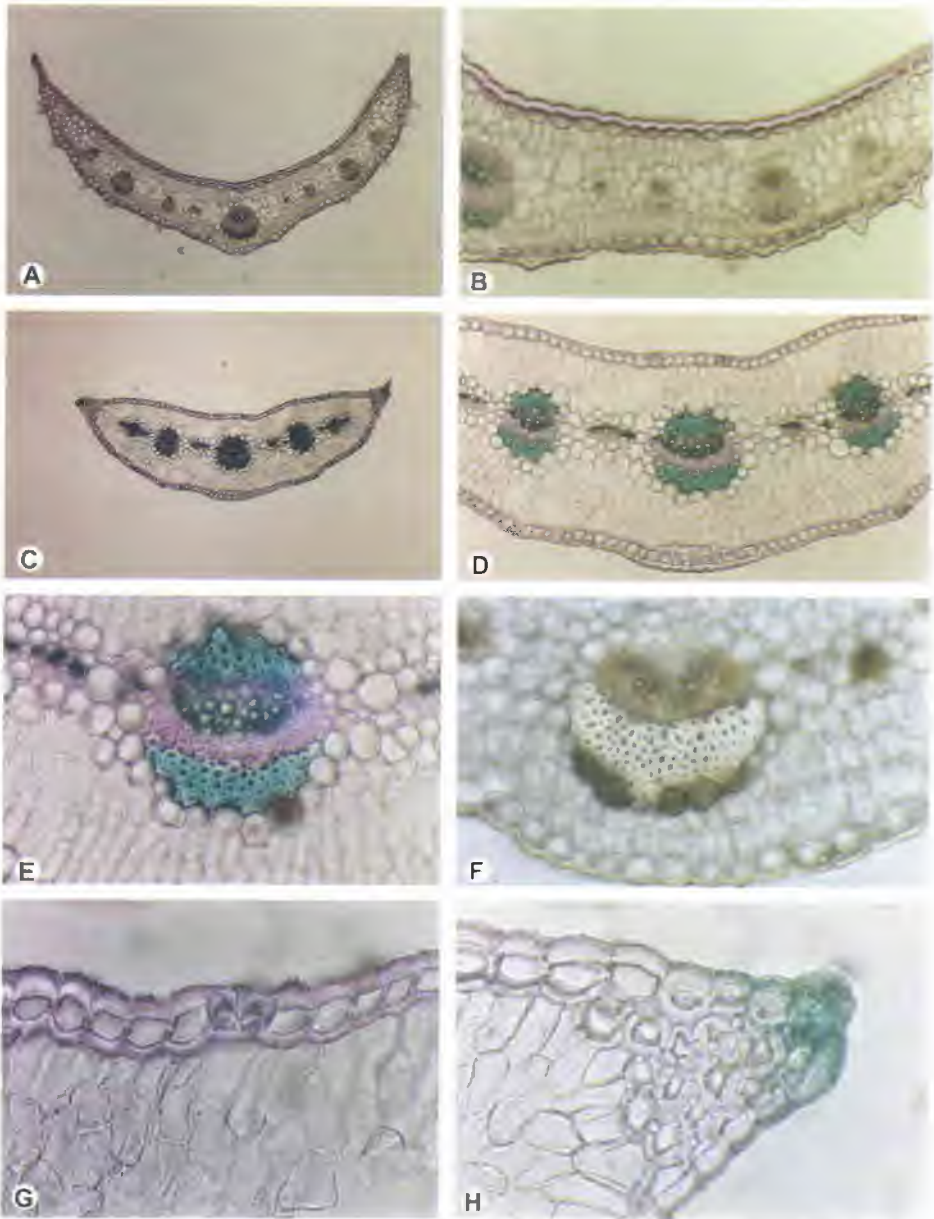


Fig.4.: A-B *Dianthus cretaceus* leaf in transversal section: A, general aspect; B, detail of mesophyll; C-H, *Arenaria dianthoides* leaf in TS: C, general aspect; D, detail of mesophyll; E-F, central vein; E, colored; F, uncolored in natural form; G, stomata; H, margin of the leaf; A, C, ( $\times 30$ ); B, D ( $\times 75$ ); E, F, ( $\times 150$ ); G, H, ( $\times 300$ ).

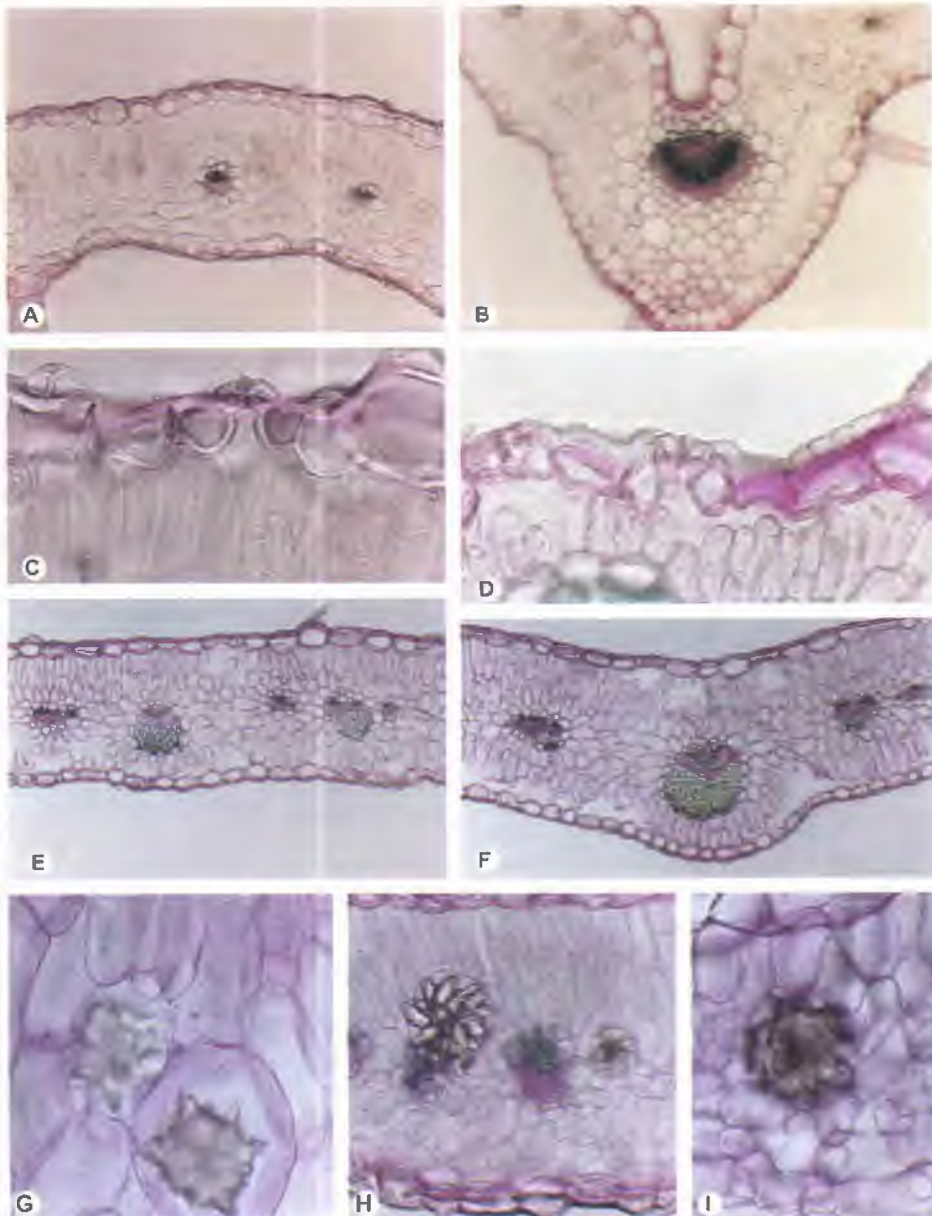


Figure.5: A-C, *Cerastium glomeratum* leaf in TS: A, detail of mesophyll; B, central vein; C, stoma on the upper side; D, G-I, *Silene* sp. in TS; D, stomata in *Silene spergulifolia*; G-I, observation of crystals in mesophyll; E-F, *Minuartia acuminata*; E, general aspect; F central vein; A, B, E, F ( $\times 75$ ); H, I ( $\times 150$ ); C, D, G ( $\times 300$ ).