FRUIT STRUCTURE OF SOME SPECIES OF VERONICA (SCROPHULARIACEAE: TRIBE VERONICEAE) FROM IRAN

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The structure of the fruit of 10 taxa belonging to the genus *Veronica* L. from Iran is studied morphologically and anatomically. An exact description of fruit characteristics is presented for each taxon. A natural grouping of these taxa on the basis of fruit seems to be possible. Corresponding to fruit structure a key to examined taxa is provided.

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Key words. Veronica, fruit,morpholgy, anatomy, Iran.

ساختار میوه چند گونه ورونیکا (خانواده Scrophulariaceae، تبار Veroniceae) از ایران

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ساختار میوه ۱۰ تاکسون از جنس ورونیکا از نظر ریخت‌شناسی و تشریحی مورد مطالعه قرار گرفت. شرح کامل مشخصات میوه هر تاکسون ارائه می‌شود. گروه‌بندی طبیعی از این تاکسون‌ها براساس ساختار میوه امکان‌پذیر است. کلید شناسایی با استفاده از ویژگیهای میوه برای تاکسون‌های مورد بررسی ارائه می‌گردد.

INTRODUCTION

Veronica is widely distributed throughout the world. This genus comprises annual and perennial herbs with a wide variety of ecological niches, including humid soils, cultivated farms and rocky slopes. The genus *Veronica* was included in the *Veroniceae* Rchb. by Bentham (1846). This taxon was then transferred into the *Digitaleae* by Bentham (1876) and Wettstein (1891). Pennell (1921) reestablished the *Veroniceae* as a separated tribe from *Digitaleae*. The only sharply definable character helping to distinguish the *Digitaleae* from the *Veroniceae* is the septicidal dehiscence in the former contrasting the loculicidal or both loculicidal and septicidal dehiscence in *Veroniceae* (Hong, 1984).

Veronica is composed of 60 species in Iran which have been classified in 5 sections. Recently, *V. davisii* was recorded for the North-West Iran (Saeidi & al., in press). In group Agrestis, *V. francispetae* and *V. siaretensis* are endemic to the Elburz range which is the main centre of diversity and variability (Fischer 1987). *V. ceratocarpa* is native to subhumid deciduous forests of the Caucasus and of the Elburz mountains located at North Iran (Fischer 1987). *V. filiformis* has its origin in Pontic-Caucasian-Aremanian mountain, but today it has been naturalized in many parts of Europe and North America (Norbert & Sukopp 1993).

Veronica sect. *Pocilla* and *Veronica* sect. *Veronicastrum* differ in the raceme and the manner of capsule dehiscence. Among several combinations to the study of *Veronica*, the taxonomic and cytotaxonomic investigations of Pennell (1921), Li (1952) and Fischer (1981), the palynological studies of Hong (1984) are some of the important ones. Besides them there are several reports on the fruit structure in different species of *Veronica* (Walters & Webb 1972; Juan & al. 1977), which show the taxonomic importance of fruit characters.

Although some morphological features of the fruits were used in the diagnostic keys presented in regional Floras, more detailed data are usually not included. The aim of the present study is to illustrate fruit features in the identification of the species considered and to relate such characters to the systematic of the group.

MATERIAL AND METHODS

Plant material used for this study are deposited in the Centeral Herbarium of the University of Tehran (TUH). A list of voucher specimens is given in Table 1. For anatomy of fruit, mature capsules were placed for 2 days in a mixture of distilled water, 96% ethnol and glycerol in equal proportions.

Capsules were sectioned with hand, then the sections were cleared with sodium hypochlorite diluted, acetic acid and stained in methylen blue and kongo red solutions.

Epidermal preparations were obtained by maceration using Jeffery solution (equal parts of 10% chromic acid and 10% nitric acid). Letiz light microscopy were used for observing and photography. For scanning electron microscopy, capsules were mounted on stubs and coated with sputtered gold. Morphological observations were made in a " Philips LX-30 Autoscan SEM".

RESULTS

In ten taxa examined, the capsules are arranged solitary or in racemes. The capsules are formed of two subequal locules separated by a longitudinal septum. They are bilaterally symmetric and have a persistent style variable in length (Fig. 1). The studied species possess glandular and eglandular hairs on capsule surface or glabrous.

In all cases the pericarp is differentiated into three layers; epicarp, mesocarp and endocarp. The epicarp is composed of a single cell layer surrounded by thin walls. The

Table 1: List of *Veronica* herbarium specimens used in this study.

Taxon	Locality
V. serpyllifolia L.	Mazendran: Kiasar, forests Do-Dangeh, 1350 m, 9 June 1999, Saeidi & Gholipor 24196 -Mazendran: Pole-sefid, forests -Above Sang-Deh, 1700-2200 m, 30 May 1998, Saeidi 22049. -Guilan: 3km fron Fuman to Rasht, 70 m, 10 May 1990, Ghahreman & Mozaffarian 9633
V. davisii Fischer	Prov.W. Azarbaijan: Uromieh, Ziveh, Dizaj Kesian village,Boze-Sina mt., 2000-2400 m, 2 Julay 1999, Saeidi & Asaadi 24195
V. gentianoides Vahl	Guilan; Siahkal, Espili, 1000-1200 m, 20 May 1998, Saeidi 22062. - Azarbaijan: Kaleibar to Ghaleh-Babak, 2000 m, 17 May 1993, Saeidi 17192. - Ardebil;Asalem to Khalkhal, near Khalkhal, 1500-1700 m, 22 June 1998, Saeidi 24200
V. francispetae Fischer.	Guilan: near Langeroud, Talesh-Mahleh, 20 m, 27 April 1999, Saeidi 24205
V. siaretensis Lehmann	Gorgan: Golestan forest, Gol-Loveh, 550 m, 4 April 1998, Saeidi 24206
V. capillipes Neveski	Esfahan: Inter Ardakan and Murchekhort, near Lat, 1500, 27 May 1998, Saeidi 24201. -Khorassan: Shirvan, Milanlou, 1700-1800 m, 12 May 1998, Saeidi 24202. –Khorassan: SE Sabzevar, Hares-Abad, 940 m, 25 April 1997, Aliabadi 24212.
V. campylopoda Boiss.	Chahar-mahale Bakhatiari: Sabz kuh, Chahrtagh, 2300-2370 m, 16 May 1998, Saeidi 24208. -Markazi: from Saveh toward Nobaran 1300-1400 m, 12 May 1998, Saeidi 24211. -Lorestan; 58 km on road from Aligoodarz to Shoul-Abad, 1900 m, 20 June 1998, Saeidi 24207. -Tehran: 56 km from Karaj to Chalus, 1860 m, 30 April 1998, Saeidi 22057
V. biloba Schreb	Tehran: 10 km Kandavan from Karaj, 2500-2700 m, 20 June 1998, Saeidi 24199. -Tehran; Chalus road, Kushak, 1800-2100 m, 27 May 1998, Saeidi 24214
V. filiformis J. E. Smith	Ardebil: Razi, Alikaran, 1400 m, 29 June 2000, Saeidi 24220
V. ceratocarpa C. A. Mey.	Mazendaran: Sari, Kiasar, forests of Do-Dangeh, 2000-2100 m, 9 June 1999, Saeidi 24020. -Mazanderan: Klardasht, 1300-1400 m, 27 April 1998, Saeidi 24021

mesocarp is composed of a variable number of cell-layers from one to six. The cells of mesocarp are in different shapes. The endocarp is generally formed of one to three cell-layers surrounded by lignified walls.

The results of the study are summarized as follows:

Veronica davisii

Surface of capsule with convex polygonal cells, glabrous or glabrescent. Cuticle smooth; stomata not seen (Fig. 2A). Pericarp 62-27 µm thick. Epicarp formed by irregular cells. Mesocarp shows 1-2 rectangular cellular layers. Endocarp 13- 17 µm thick and of one cell-layer with lignified walls (Fig. 3A).

Veronica gentianoides

The capsule surface with an indistinct reticulate pattern. The epidermal cells are irregular in shape with indistinct borders because of the thick, striate cuticle. The periclinal walls are depressed and sinous, they are of two kinds: prominent and ridged-pitted. Indumentum pubescent, consisting of warty glandular hairs. Hairs 100-193 µm long, stalk with 3-4 cells and an obovate unicellular head (Fig. 2B). Pericarp 103-121 µm thick. Epicarp

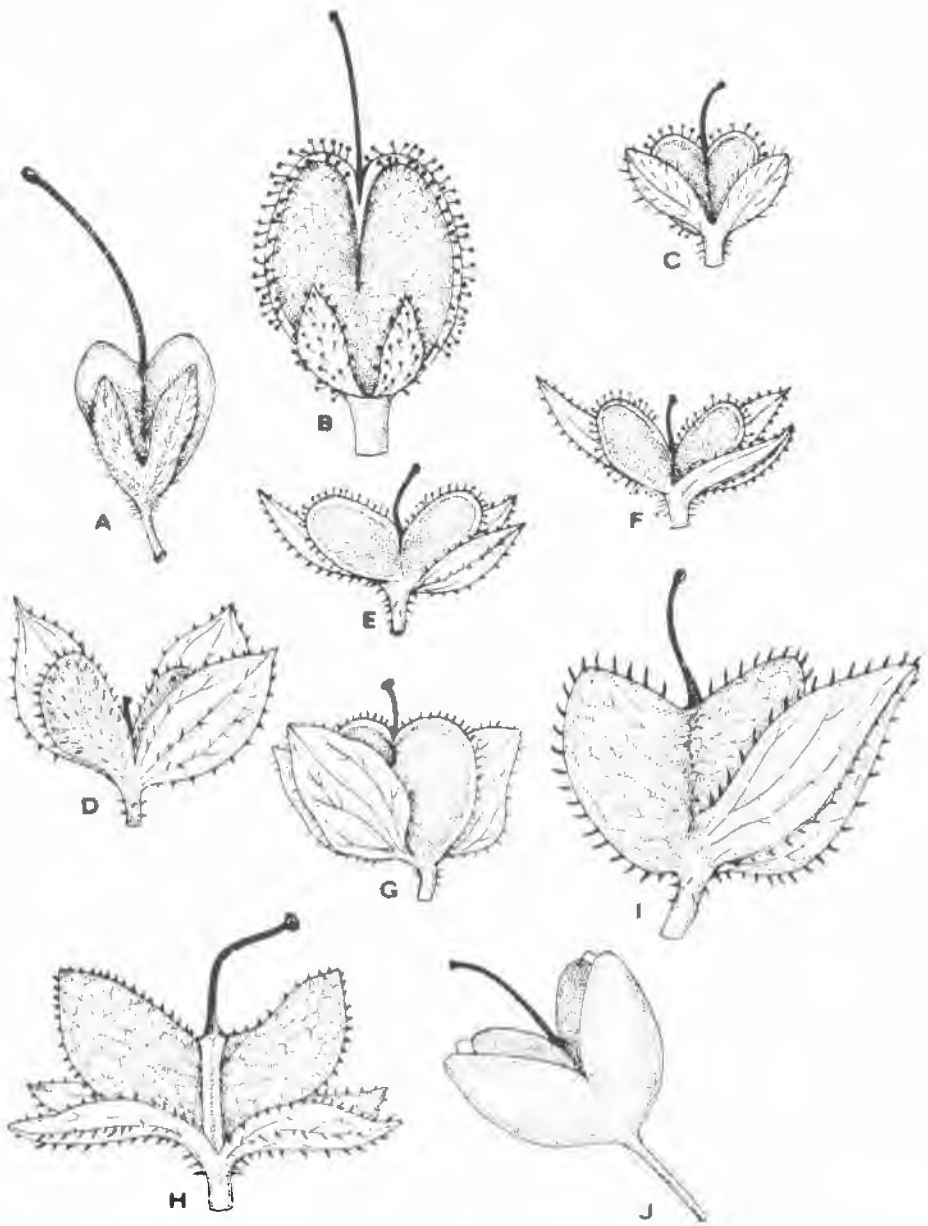

Fig. 1. Drawings of *Veronica* capsules. A, *V. davisii;* B, *V. gentianoides*; C, *V. serpyllifolia*; D, *V. biloba*; E, *V. capillipes*; F, *V. campylopoda;* G, *V. siaretensis*; H, *V. ceratocarpa*; I, *V. francispetae*; J, *V. filiformis* (× 2.5).

formed by isodiametric cells. Mesocarp shows 2-3 layers of regular cells. Endocarp 20-45 μm thick and of two cell-layers with lignified walls (Fig. 3B).

Veronica serpyllifolia

Surface of capsule with convex cell with sinous margins, glabrous or glabrescent (Fig. 2C), glndular hairs located at marign and on keel (Fig. 1). Cuticle striate with stomata. The periclinal and anticlinal walls are depressed and straight, respectively. Pericarp 97-107 μm thick. Epicarp formed by isodiametric cells. Mesocarp shows 2-3 layers of more or less rounded cells. Endocarp 23-30 μm thick and composed of one layer of irregular cells with lignified walls (Fig. 3C).

Veronica biloba

Surface of capsule with convex polygonal cells. Cuticle striate-granulate. Indumentum pubescent, consisting of warty glandular hairs (Fig. 2D). Hairs (110-170 μm long). Stalk with 2-3 cells and an obovoid unicellular head. Preicarp 45-62 μm thick. Epicarp of isodiametric cells. Mesocarp shows 2-3 layers of rounded cells. Endocarp 7-14 μm thick and composed of one layer of square cells with lignified walls (Fig. 3D).

Veronica capillipes

Surface of capsule is corrugate and consist of convex, oblong or polygonal cells. Cuticle rugulate-granulate (Fig. 2E) with stomata. Indumentum villous, uniformly distributed with glandular and/or eglandular hairs. Glandular hairs 233-310 μm long; stalk with 3-4 cells and an obovoid unicellular head. Pericarp 27-48 μm thick. Epicarp formed by tangentially elongate cells. Mesocarp shows one layer of more or less rounded cells with sinous walls. Endocarp 7-19 μm thick and composed of one cell layer of irregular cells with lignified walls (Fig.3 E).

Veronica campylopoda

Surface of capsule and cuticle is similar to *V. capillipes* but differs from it that the glandular hairs (178-225 μm long) (Fig. 2F). Besides, the structure of its fruit is similar to *V. capillipes.*

Veronica siaretensis

Surface of capsule with convex polygonal cells. Cuticle slightly striate. Indumentum pubescent, regularly arranged with warty glandular and eglandular hairs (Fig. 2H). Glandular hairs 192-214 μm long; stalk with 3-4 cells and a subcircular unicellular head. Pericarp 83-96 μm thick. Epicarp formed by rounded cells. Mesocarp 0f 2-3 layers of rounded cells. Endocarp 14-30 μm thick and composed of one layer of irregular cells with lignified walls (Fig. 3F).

Veronica ceratocarpa

Surface of capsule with oblong or polygonal cells, glabrescent (Fig. 2G), with reticlate-granulate cuticle. Anticlinal walls are more prominent. Pericarp 137-172 μm thick. Epicarp formed by rectangular cells. Mesocarp shows 4-6 rounded cellular layers. Endocarp 44-62 μm thick and composed of three cell-layers with lignified walls (Fig. 4G).

Veronica francispetae

The capsule surface is reticulate, glabrescent (Fig. 2I), eglandular hairs located at marign and on keel (Fig. 1); cuticle smooth. The epidermal cells of the pericarp appear polygonal. The periclinal walls are flat, depressed or convex, furrowed or striate-furrowed. Pericarp 69-93 μm thick. Epicarp formed by quadrangular cells. Mesocarp of 3-4 layers of rounded cells. Endocarp 24-31 μm

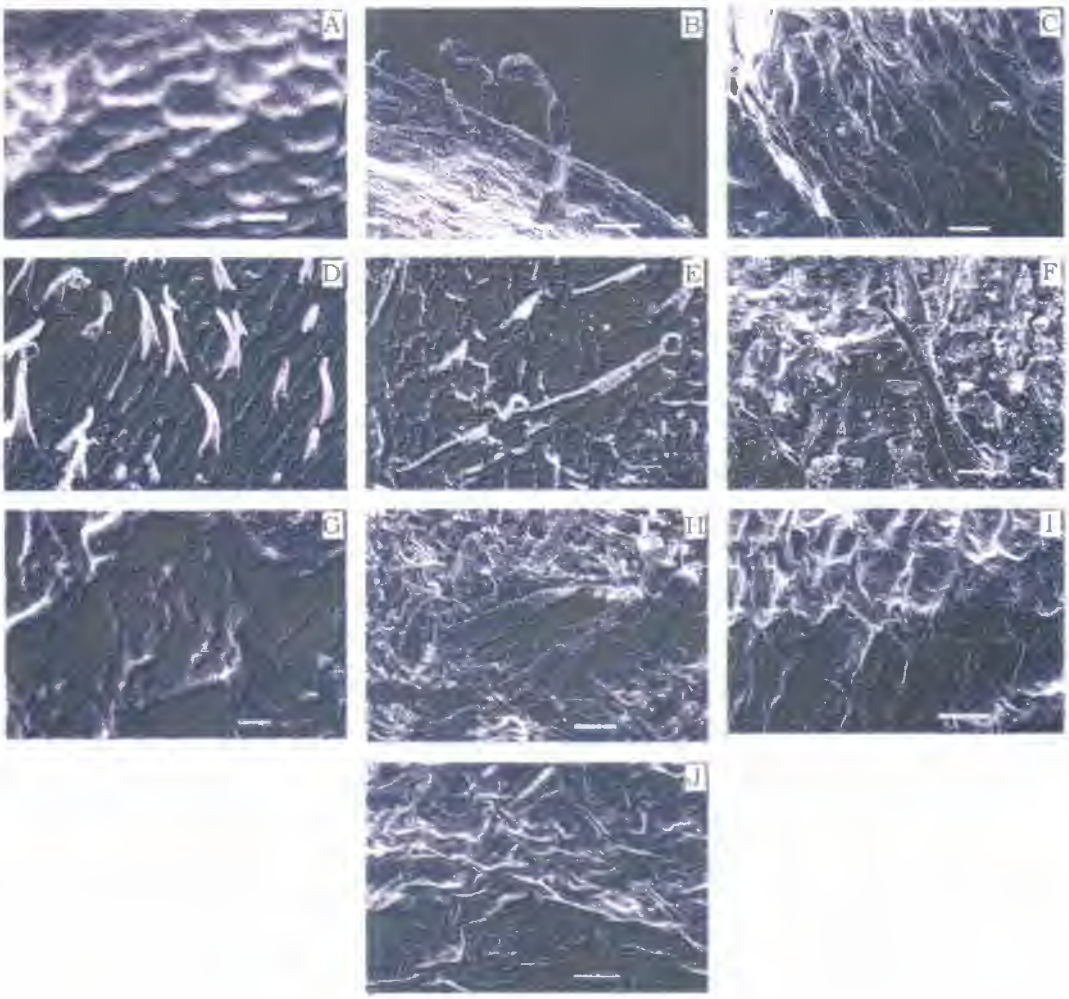

Fig. 2. Scanning electron micrographs of *Veronica* capsules. A, *V. davisii*; B, *V. gentianoides*; C, *V. serpyllifolia*; D, *V. biloba*; E, *V. capillipes*; F, *V. campylopoda*; G, *V. siaretensis*; H, *V. ceratocarpa*; I, *V. francispetae*; J, *V. filiformis*.- In Figs. A, B, C, H, I, G, scale bar = 50 μm; in fig. F, scale bar =10 μm; in fig. j, scale bar =20 μm; in figs. D & E., scale bar=200 μm.

thick and composed of one layer of square cells with lignified walls (Fig. 4H).

Veronica filiformis

The capsule surface is ribbed. Indumentum pubescent, located at apex. The anticlinal walls are prominent. Cuticle rugulate (Fig. 2J). Pericarp 100-124 µm thick. Epicarp formed by quadrangular cells. Mesocarp of 3-5 layers of rounded cells. Endocarp 24-45 µm thick and one cell-layer with lignified walls (Fig. 4I).

Key to the species based on fruit features

1- Surface of capsule glabrous or glabrescent 2
- Surface of capsule with more or less dense indumentum 5
2- Cuticle smooth *V. davisii*
- Cuticle not smooth 3
3- Pericarp>110 µm thick *V. ceratocarpa*
- Pericarp<110 µm thick 4
4- Epicarp with isodiametric cells, pericarp≥ 97 µm thick *V. serpyllifolia*
-Epicarp with quadrangular cells, pericarp<97 µm thick *V. francispetae*
5- Pericarp>100 µm thick *V. gentianoides*
- Pericarp<100 µm thick 6
6- Mesocarp with one cell layer 7
- Mesocarp with 2-3 cell layers. 8
7- Glandular hairs>233 µm long *V. capillipes*
- Glandular hairs<233 µm long *V. campylopoda*
8- Epicarp with isodiametric cells, stalk of glandular hairs, with an obovid head *V. biloba*
Epicarp with rounded cells, stalk of glandular hairs with a subcircular head *V. siaretensis*

DISCUSSION

The results of light and scanning electron microscopy of the fruits has revealed some useful characters for identification of the treated taxa and can be applied for other species of *Veronica*.

The utility and importance of fruit characters in determination of other genera of *Scrophulariaceae* such as *Verbascum* (Juan & al. 1997) and *Linaria* (Juan & al. 1999) were reported recently. It was shown that some important characters such as cuticle or presence/absence of glandular hairs, the thickness of pericarp or endocarp are useful for determination at the specific level. Furthermore, endocarp in most of the examined species is formed of 1-6 cell layers. The cells of endocarp are different in shapes. The cuticle is also variable within the genus (smooth, granulate, striate and rugulate-granulate). The exceptions are *V. campylopoda* and *V. capillipes* which fruit structures are very similar. Although glandular hairs in *V. capillipes* are larger than *V. campylopoda*.

Both types of capsule, i.e. glabrous (*V. davisii* and *V. serpyllifolia*) and covered by glandular hairs (*V. gentianoides*) can be observed in sect. *Veronicastrum*. The capsule in three of the six species of the group Agrestis of *Veronica* sect. Pocilla are glabrous (*V. frncispetae*, *V. ceratocarpa* and *V..filiformis*), while the other three are hairy (*V. siaretensis, V. polita* and *V. persica*).

The pericarp and endocarp thickness are 62-27 µm and 13-17 µm in *V. davisii*, 97-107 µm and 23-30 µm in *V. serpyllifolia*, respectively.

The pericarp and endocarp thickness of *V. ceratocarpa* is much more than *V. filiformis* and *V. francispetae* and its cuticle surface is granulate. On the other hand, the cuticle of *V. filiformis* and *V. francispetae* are rugulate and smooth respectively. Meanwhile fruit of *V. siaretensis* has short and soft hairs which are glandular or eglandular. *V. biloba* is closely related to *V. campylopoda* and *V. capillipes*

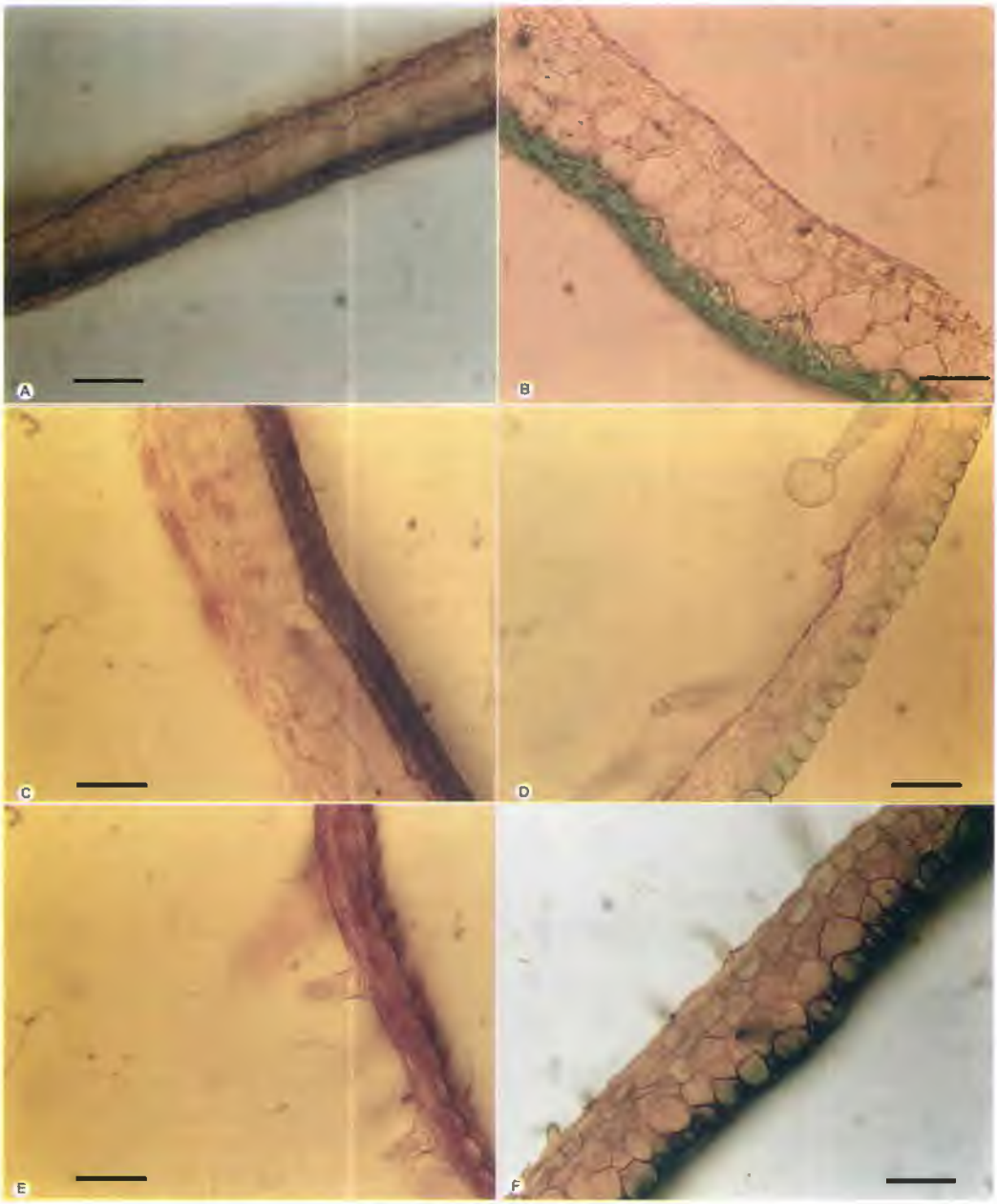

Fig. 3. Light micrographs of *Veronica* pericarps in cross section. A, *V. davisii*; B, *V. gentianoides*; C, *V. serpyllifolia*; D; *V. biloba*; E, *V. capillipes*; F, *V. siaretensis* (in figs. A, C, D, E, F, scale bars= 40 μm; in fig. B, scale bar= 25 μm).

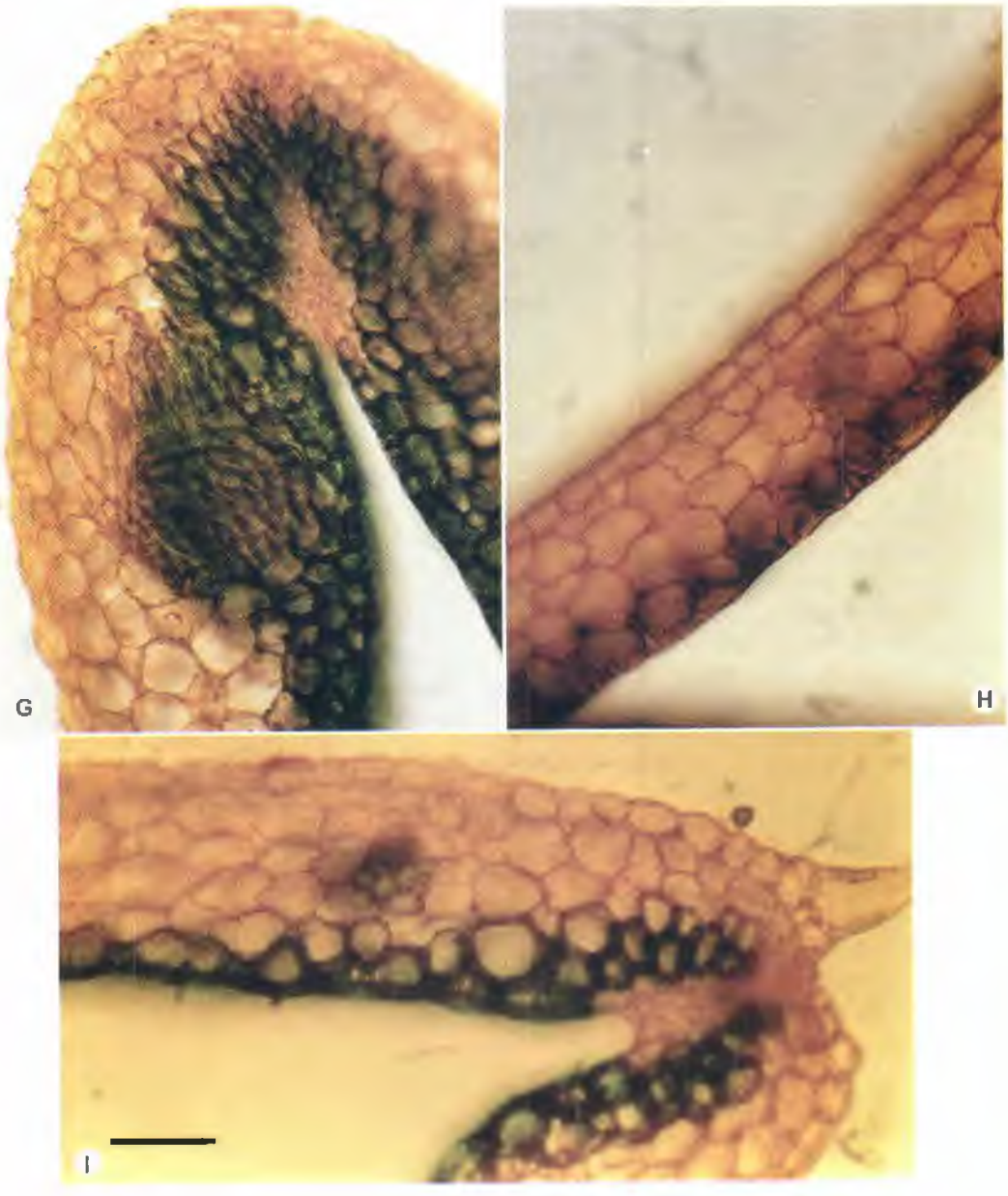

Fig. 4. Light micrographs of *Veronica* pericarps in cross section. G, *V. ceratocarpa*; H, *V. francispetae*; I, *V. filiformis* (scale bars= 40 µm).

and constitutes together with them the group Biloba (Saeidi 2001). It differs from these species by the seed-coat anatomy, the length of the capsule hairs, pericarp thickness and number of the cell layers making mesocarp.

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REFERENCES

Bentham, G. 1846: Scrophulariaceae. In de Candolle, A. P., (ed.) Prodromus Systematis Naturalis Regni Vegetabilis, 10: 186-586. -Parisii.

- 1876: Scrophulariceae. In Bentham, G. & Hooker, J. D., (eds). Genera Plantarum 2: 913- 980. -Londini.

Fischer, M. A. 1981: *Veronica*. In Rechinger K. H. (ed.): Flora Iranica 147: 25-165.- Akad. Druck. -u. Verlagsansalt, Graz.

- 1987: On the origin of Veronica persica (Scrophulariaceae). A contribution to the history of a neophytic weed. -Plant Systematic and Evolution 155: 105-132.

Hong, D. 1984: Taxonomy and evolution of the Veronica (Scrophulariaceae) with special reference to palynology. -Opera Botanica 75: 5-60.

Juan, R., Fernandez, I. & Pastor, J. 1997: Morphological and anatomical studies on fruits of Veronica from South-West Spain. - Bot. J. Lin. Soc. 123: 157-171.

- 1997: Systematic consideration of microcharacters of fruits and seeds in the genus Verbascum (Scrophulariceae). - Annals of Botany 80: 591-598.

- 1999: Morphological and anatomical studies of Linaria species from South-West Spain: Fruits. -Annals of Botany 84: 21-31.

Li, H. L. 1952: The genus Veronica (Scrophulariaceae) in China. Proceeding of the Academy Natural Science of Philadelphia 104: 197-218.

Norbert, M. & Sukopp, H. 1993: Synathropic distribution and association to the slender speedwell V. filiformis Smith. -Tuexenia 13: 399-413.

Pennell, F. W. 1921: Veronica in North and South America. -Rhodera 23: 1-22.

Saeidi, SH., Ghahreman, A. & Assadi, M. 2001: Notes on the genus Veronica (Scrophulariacae) in Iran; seed characters and a new record. -Pak. J. Bot. (in press).

Saeidi, SH. 2001: A numerical analysis of two natural groups of Veronica (Scrophulariceae) from Iran. Proceedings of the 10th Iranian Biological Congress. Shiraz University. 3-5 September.

Walters, D. H. & Webb, D. A. 1972: Veronica. In: Tutin T. G. & al., eds. Flora Europaeae 3: 242-251.- Cambridge University Press.

Wettstein, R. 1891. Scrophulariacea. In Engler, A. & Prantl, K., (eds) Die natulichen pfanzenfamilien, IV. 3b: 39-107.