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Anatomical Studies in Relation to Taxonomy of Persian *Linum* Species

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Abstract: The present survey was performed on twelve Persian *Linum* species with the aim to illustrate species inter-relationships and to evaluate the taxonomic treatments proposed for the genus *Linum* in Iran. It includes comparative anatomy of the species based on leaves and stems transverse sections. The results are highly in agreement with the previous morphologic based taxonomic treatments of the genus and anatomical traits used are efficient for application at generic and sub-generic levels of the genus *Linum* in Iran.

Key words: *Linum*, anatomy, taxonomy, Iran

Introduction

The genus *Linum* L. belongs to the family Linaceae S. F. Gray with about 230 species that are distributed throughout temperate regions of the world (Heywood, 1993). Rechinger (1974) has reported sixteen species from Iran Plateau in Flora Iranica and has divided the genus into five sections. However, Sharifnia and Assadi (2001) in the course of study of the genus *Linum* in Iran have reduced the number of species for flora of Iran and have relatively removed *L. tenuifolium* from section *Linum* and placed it in section *Linastrum* (Planch) H. Walker in Engler and Prantl. (Sharifnia and Assadi, 2001). Moreover, Sharifnia (2002) has conducted phenetic studies based on morphological characters of different Persian species in order to confirm the previous studies. Several researchers have studied Persian *Linum* species taxonomically, but they have been restricted to considering morphological traits (Parsa, 1951; Rechinger, 1974; Mobayen, 1995).

Anatomical studies have great implications for clarification of taxonomic relationships in higher ranks of classification. However, in some plant families, several anatomical traits are of great value for application at generic and sub-generic levels (Jones and Luchsinger, 1987).

Esau (1977) and Fahn (1989) have performed previous anatomical studies of the genus *Linum* with the emphasis on characteristics

of bast fibers.

In this paper, we have conducted anatomical studies to indicate species inter-relationships, evaluate the previous taxonomic treatments of the genus *Linum* in Iran and to provide evidence for efficiency of application of these data at generic and sub-generic level of the genus.

Materials and Methods

We initiated the anatomical studies in the Laboratory Center of Tehran Science and Research Branch, Islamic Azad University with dried herbarium material which were previously collected from different regions of Iran during the summer of 1999 (Table 1) and revived them by boiling in water followed by cooling and fixation in F.A.A. {HCOOH: CH₃COOH: C₂H₅OH (10:5:85 v/v)} as described by Azizian (1996).

All the chemicals were purchased from Merck, Germany.

For the hand sections, we chose the same site, which were taken from stems (beneath the terminal inflorescence) and leaves lamina in the species studied.

The methylene blue-carmin procedure was followed for staining as described by Albouyeh *et al.* (2002) and were studied the specimens with a light microscope, which was equipped with a camera Zeiss light microscope, model: standard 25 was used.

Table 1: list of *Linum* species used in anatomical studies, including their localities and accession numbers

Section	Species*	Locality
<i>Linastrum</i>	<i>L. strictum</i> L.	Bushehr: Road of Taheri to Asaloyeh, Om Maassoumi and Abuhameh 51990
	<i>L. tenuifolium</i> L.**	Azərbayjan: Arasbaran, Shabkhaneh, Asri and Hamzee
	<i>L. corymbolusum</i> Reichenb.	Khorasan: between maraveh tappeh and Bojnoord, 830 m Hever 3948
<i>Syllinum</i>	<i>L. album</i> Ky. ex Boiss.	Tehran: NE. Tehran, Lashgarak, 1960 m, Sharifnia 80081.
	<i>L. mucronatum</i> Bertol.	Kermanshah: Kuh-e Sefid, Protected region, 1500 m, Fatahi and Hamzee 768
	<i>L. nodiflorum</i> L.	Kermanshah: Javanrood, 15 km W. Javanrood, 1150 m, Nemati and Roshanzadeh 3908
<i>Linum</i>	<i>L. nervosum</i> Waldst. and Kit	Mazandaran: Siah Bisheh, 2300 m Sharifnia 80079
	<i>L. austriacum</i> L.	Kermanshah: Hovaro mountain 1850-1900 m, Mirabdali and Heydari 2993
	<i>L. peyonii</i> Post	Kermanshah: Gahvareh, 1600 m Nemati and Mirabdali 3551
	<i>L. usitatissimum</i> L.	Khuzestan: Shushter, 250 m, Sharifnia 80083.
<i>Cathartolinum</i>	<i>L. catharticum</i> L.	Tehran: NE. Tehran, Fasham, 2000 m, Sharifnia 80080
<i>Dasylinum</i>	<i>L. densiflorum</i> P.H. Davis	Azərbayjan: Maku, Tikmeh, 2650 m, 67947

* Voucher specimens are deposited in central herbarium of Iran (TARI)

** Placed as such in table 1 for the sake of simplicity in comparative study with *L. strictum* and *L. corymbolusum*

Results and Discussion

Our results of comparative leaf anatomy among members of section *Linastrum* suggest that they share the same characteristics including leaves with one vein, which has prominence in both leaf surfaces. The same is also true for *L. tenuifolium* and is another indicative for placement of *L. tenuifolium* in section *Linastrum* in Iran as suggested by Sharifnia (2002), (Fig. 1, A, B, C).

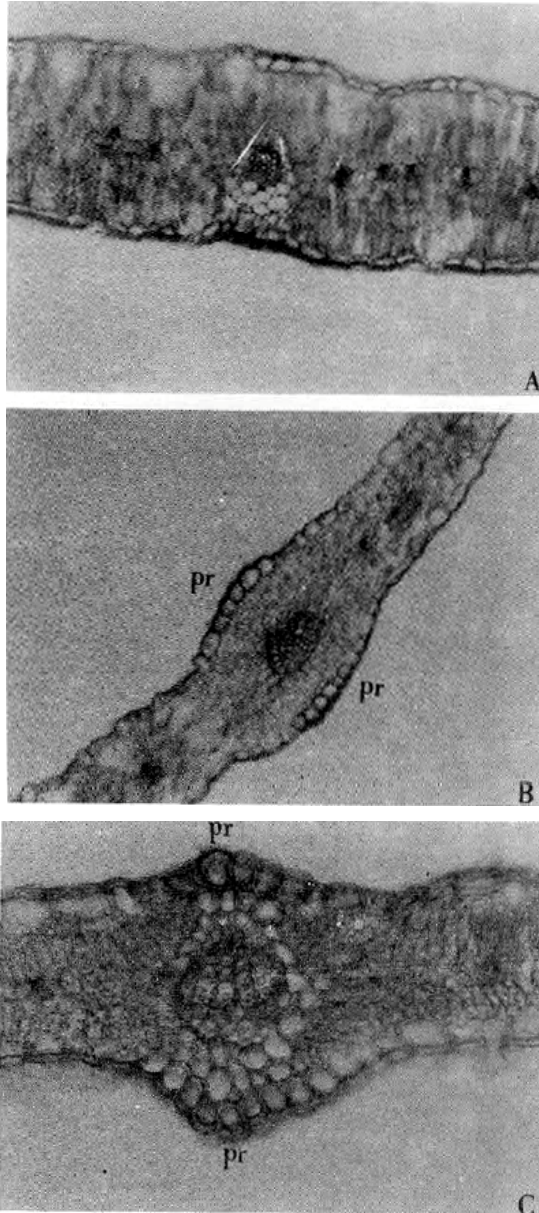


Fig. 1: Leaf transverse section of *L. strictum* X40 (A) and *L. tenuifolium* X40 (B) and *L. corymbulosum* X80 © pr= prominence

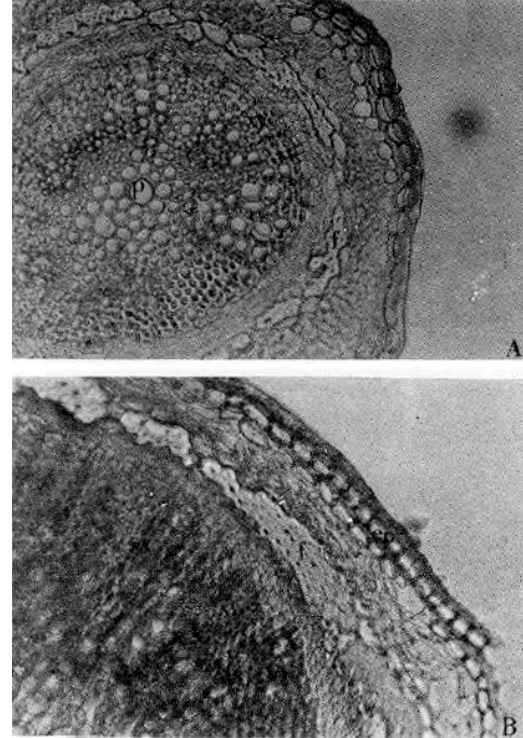


Fig. 2: Stem transverse section of *L. corymbulosum* X 80 (A) and *L. tenuifolium* X 80 (B). ep= epidermis, c= cortex, xy= xylem, f= fibers, p= pith

However, stem comparative anatomy in section *linastrum* reveals some differences in thickness and density of different tissues among species studied (Fig. 2, A, B).

Members studied from section *Syllinum* Griseb. have similar leaf anatomy with having one veined, one sided prominent leaves, except for *L. album* in which the prominence is less evident (Fig. 3, A, B). However, multi-circular appearance of stems in transverse sections is a common feature among species studied from section *Syllinum* and cannot be seen in other *Linum* species studied and therefore supports their membership together under a separate section (Fig. 4, A, B, C).

Anatomically, we refer to section *Linum* as a heterogeneous group. Variation in leaf anatomy is noticeable from leaves without prominence in *L. peyronii* (Fig. 5, A), leaves prominent in both sides (e.g. *L. usitatissimum*), (Fig. 5, B) to three veined leaves in *L. nervosum*. (Fig. 5, C). Stem transverse sections also represent variation from circular form (in *L. nervosum*), (Fig. 6, A) to waved form (*L. peyronii*), (Fig. 6, B). Stem epidermal cells can be seen in one layer (*L. usitatissimum*) (Fig. 7, A) and two layers (*L. austriacum*), (Fig. 7, B).

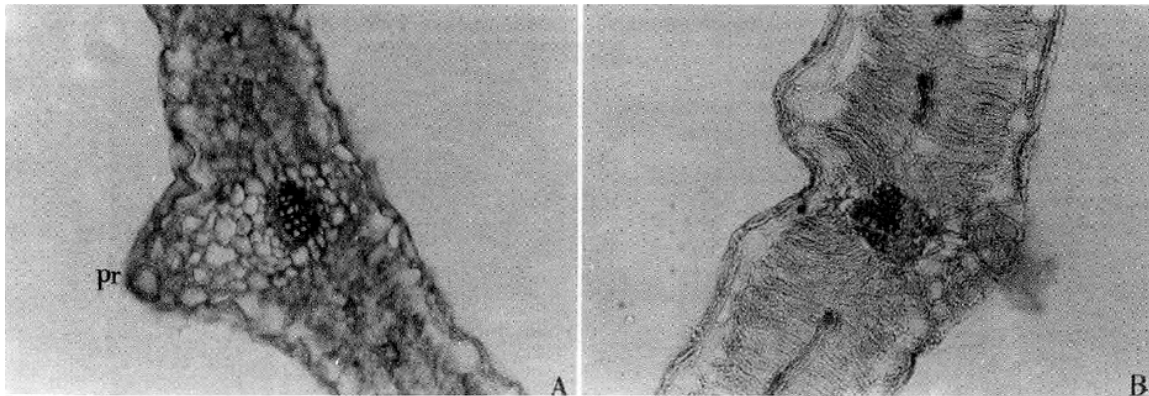


Fig. 3: Leaf transverse section of *L. nodiflorum* X 80 (A) and *L. album* X 80 (B) pr= prominence

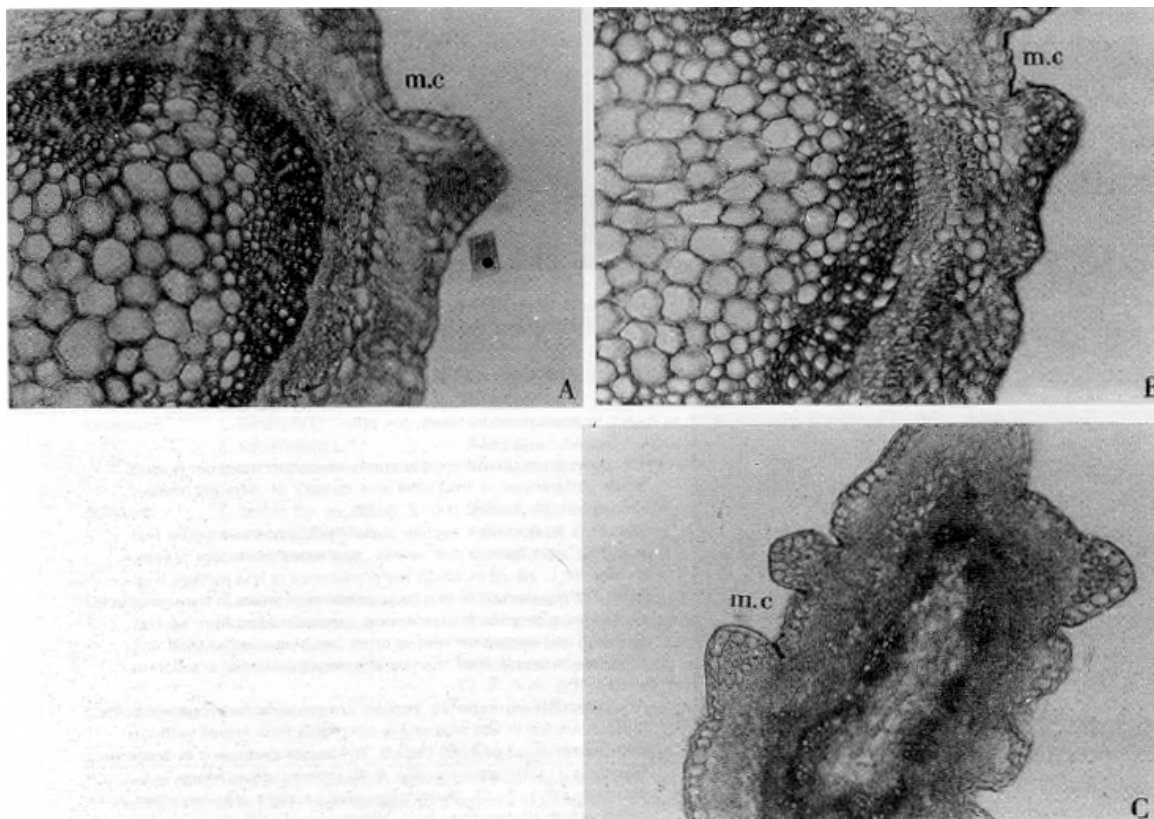


Fig. 4: Stem transverse section of *L. album* X80 (A), *L. nodiflorum* X80 (B) and *L. mucronatum* X 40 m.c= multi-circular

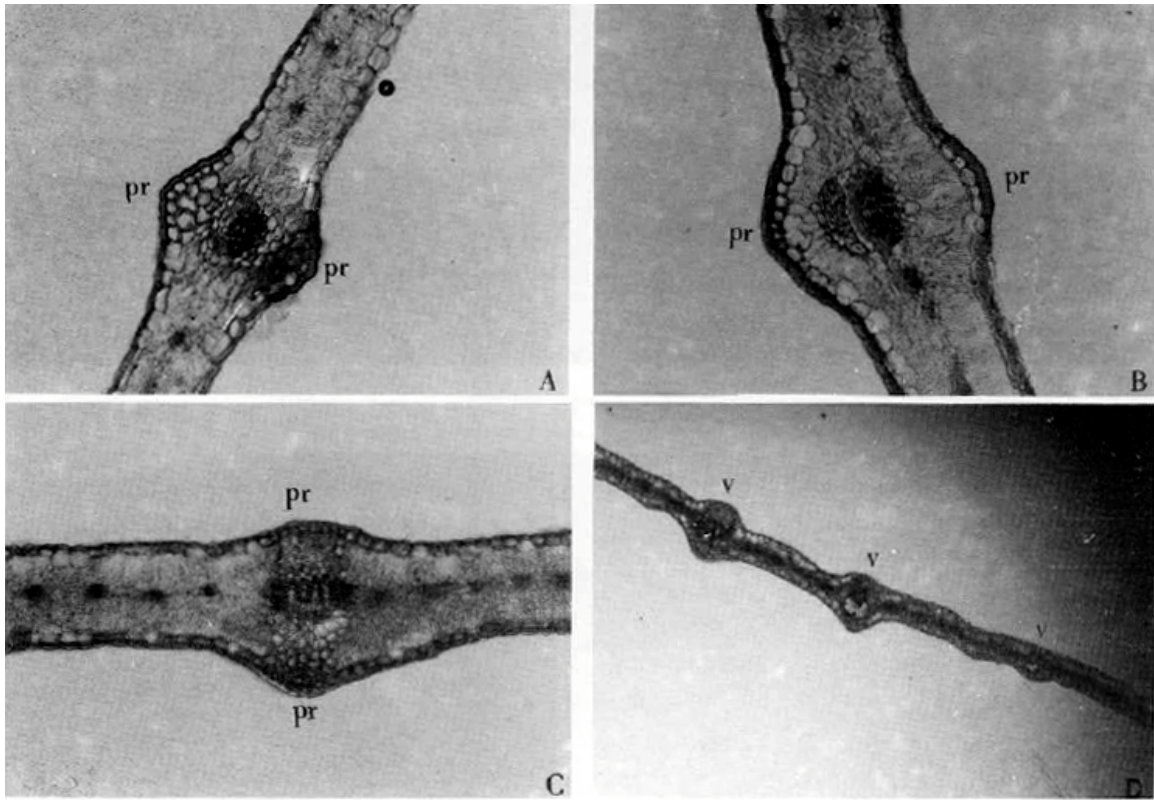


Fig. 5: Leaf transverse sections of *L. peyronii* X 80 (A), *L. usitatissimum* X 40 (B), *L. nervosum* X 40 © and *L. nervosum* X 16 (D), pr= prominence, v= vein

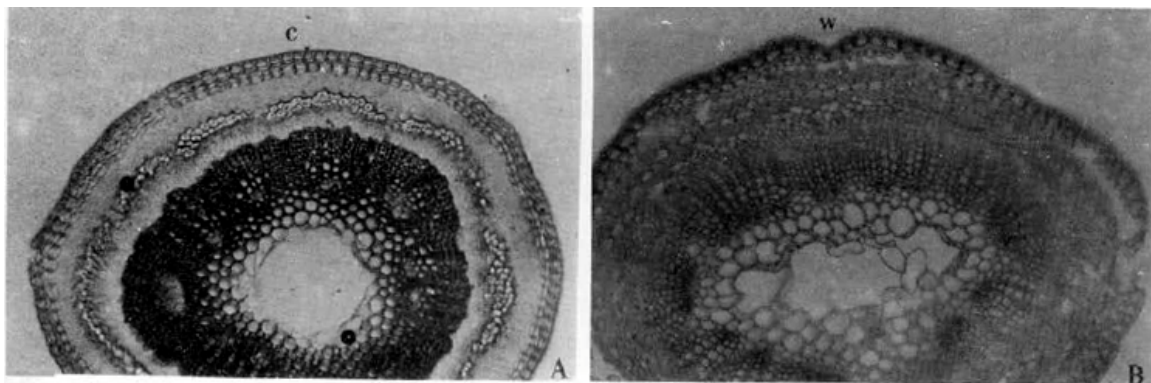


Fig. 6: Stem transverse sections of *L. nervosum* X 40 (A) and *L. peyronii* X 40 (B), c= circular, w= wavy

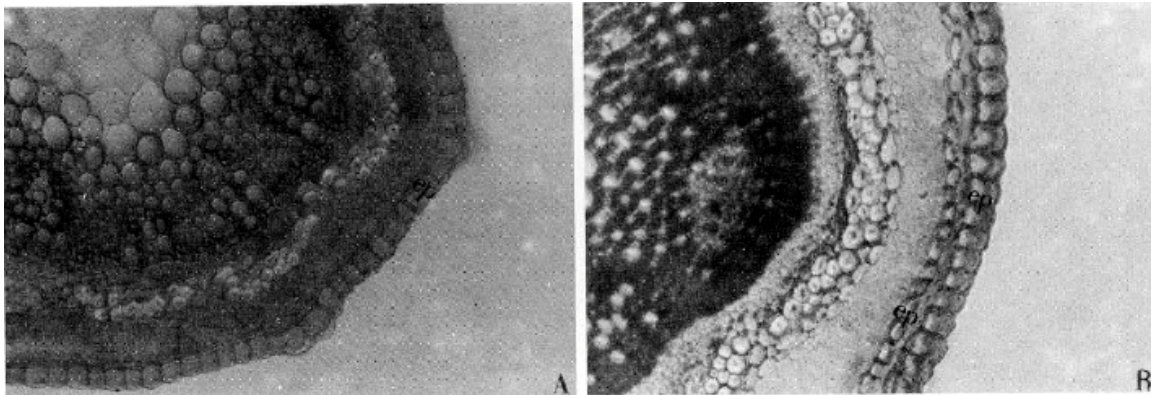


Fig. 7: Stem transverse sections of *L. usitatissimum* X 80 (A) and *L. austriacum* X 80 (B), ep= epidermis

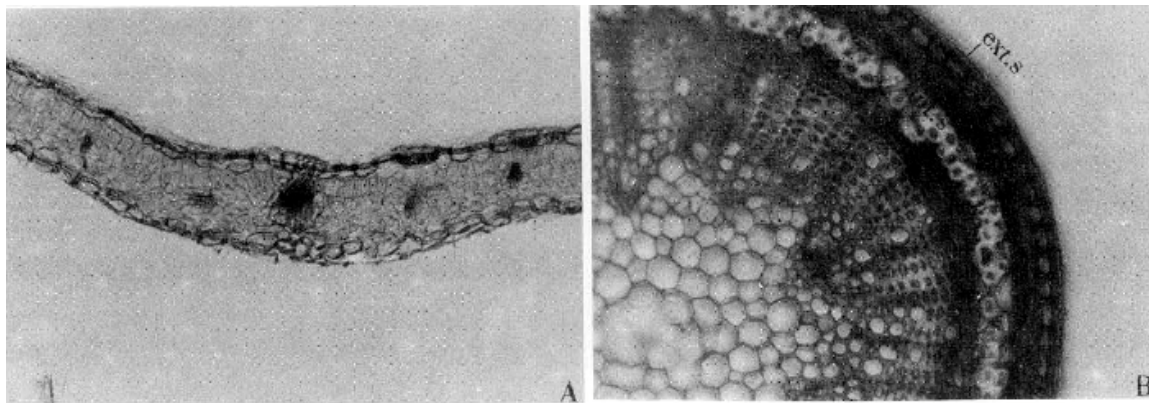


Fig. 8: Leaf transverse section of *L. catharticum* X 40 (A) and stem transverse section of *L. catharticum* X 80 (B), ep= epidermis, ext. s = external surface, int. s= internal surface, F= fibers

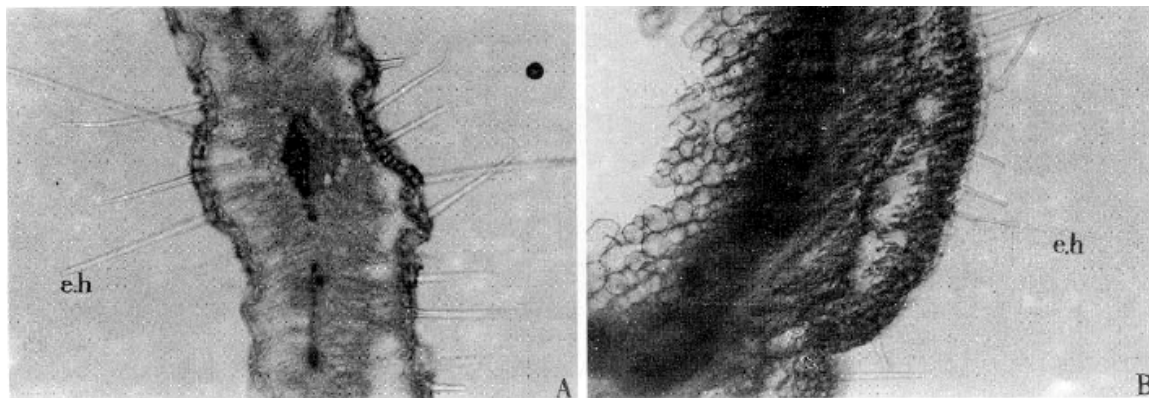


Fig. 9: Leaf transverse section of *L. densiflorum* X 80 (A) and stem transverse section of *L. densiflorum* X 80 (B) e.h= epidermal hairs

Section *Cathrolinum* (Reichenb.) Planch. is monotypic with single taxonomically isolated species *L. catharticum* in which leaves are one veined without any prominence. The distinguishing features in stem anatomy are epidermal cells with thickened walls in both external and internal surfaces and connected phloem fibers (in contrast to more or less scattered fibers in other *Linum* species studied), (Fig. 8, A, B).

Section *Dasylinum* Planch. is again monotypic with the single taxonomically isolated species *L. densiflorum*. Covering of stem and leaves from long epidermal hairs, a feature not found in other *Linum* species studied, is anatomically fair enough evidence for isolation of *L. densiflorum* (Fig. 9, A, B).

In conclusion, our results highly support the previous taxonomical treatments of the genus *Linum* in Iran and show the selectivity of anatomical traits for application at the sub-generic level of the genus *Linum* in Iran and therefore represent the efficiency of anatomical studies for investigation into the taxonomy of Persian *Linum* species.

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