MORPHOLOGY AND DISTRIBUTION OF TRICHOMES IN SOME GENERA (MORUS, FICUS, BROUSSONETIA AND MACLURA)OF MORACEAE

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The micromorphology and distribution of trichomes in leaf surfaces of species belonging to *Morus, Ficus, Broussonetia* and *Maclura* which are native or cultivated in Iran were studied. Three types of trichomes including; glandular, nonglandular and cystolith trichomes showed characteristic features in these genera of *Moraceae.* Glandular trichomes are usually with short stalk and spherical or elongated head. The nonglandular trichomes are unicellular but differentiated into 3 types as large, bristle and bracket types. Cystolith trichomes with swollen base and mucronate apex are also present.

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Key words. Micromorphology, Trichomes, Cystolith, *Moraceae.*

بررسی مورفولوژی و پراکنش کرک درسطح برگ جنسهای Broussonetia, Ficus, Morus و Maclura از تیره توت

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تنوع کرکها از نظر شکل ظاهری و پراکنش آنها در سطح برگ گونه های متعلق به جنسهای *Morus* (توت)، *Ficus* (انجیر)، *Maclura* (توت آمریکایی) و *Broussonetia* (توت کاغذی) که بطور طبیعی یا کاشته شده در ایران رویش دارند، بررسی و شرح داده می‌شود. وجود سه نوع کرک شامل: کرکهای غده‌ای، کرکهای غیر غده‌ای به اشکال مختلف و بخصوص کرکهای دارای سیستولیت از صفات مشخص و دارای ارزش تاکسونومیک در گونه‌های مورد مطالعه می‌باشند.

Table1. Species examined in SEM and LM. studies.

Taxa	Origin & Collector
Ficus carica L.	Iran: Fars, Shiraz, Riazi 9253, (TARI); Kohgioluyeh-Boirahmad,c. 10 km from Kakan to Iasuj, Assadi & Abouhamzeh 46361,(TARI). –Turkey; Erzerum, Davis 47654 (K). -West Asia, cultivated, Kew, 433-794628(K).
F. Johannis Boiss.	Iran: Esfahan, Gameshloo, 1900m. Usofi 1861 (TARI); Fars: Kazerun, 850m, Morton 3714 (K), Davis & Bokhari D. 55862 (K); Fars, 33km from Chenar-Shahiian to Shiraz Assadi & Abuhamzeh 46582; Kerman, Sekonj Mt. near to Asgar village, Sonboli, 7801-DA.
Morus alba L.	Iran:.Bandar-I Gaz. Rechinger 5536 (K). -Yazd, 1460m. Bornm. 4510 (TARI), Tehran, Karaj, Mohammadi & Azizian 9604-DA.
M. nigra L.	Iran: Tehran, Darakeh. 1800m, Mohammadi 9720-DA. -England: Richmond, Botanic Gardens, Kew cult. 49201.
Broussonetia papyrifera (L.) Vent	E. Asia: Botanic Gardens Kew cult. 60101.(K)
Maclura pomifera (Raf.) Schneider	Iran: Karaj, Botanic Garden, cultivated, Sonboli 97150DA. -USA. In Botanic Gardens Kew cultivated 66603.

INTRODUCTION

Members of *Moraceae* are mostly confined to tropics and subtropics with a few genera in temperate regions of both hemispheres (Cronquist 1981; Takhtajan1997; Mabberly 1997). *Morus, Broussonetia, Maclura* and *Ficus* of the family are represented in Iran with about 11 species which are either native or cultivated in this area (Browicz 1982, 1986; Javanshir 1995). *Morus alba* L. (White mulberry) is a native of China but widely planted and naturalized in many parts of warm temperate region. *Morus nigra* L. (Black Mulberry) is a native of western Asia but mostly cultivated in Europe and Asia. *Broussonetia papyrifera* (L.) Vent. (Paper Mulberry) which is native in China and Japan but planted and naturalized in Far East and New World. *Maclura pomifera* (Raf.) Schneider (Osage-Orange) is a native in South Central United States and widely spread from cultivation over most part of the world. The genus *Ficus* L. with largest number of species in the family mainly distributed in Indo-Malysian region. *Ficus carica* L. the common cultivated Fig, is a native of Asia Minor and spread widely to the Mediterranean region. *Ficus johannis* Bioss. Is a distinct species occur wild in central and South of Iran, in addition to these two species of *Ficus,* several other species of *Ficus* which are native to Iran were described on micromorphological characters before (Azizian & Sonboli 1999). A total of 6 species represented of 4 genera of *Moraceae* which are growing in cultivation or wild habitat, are studied here.

The aim of this work was to present a more precise characterization and illustration of the leaf surface features in particular to show variation in trichome types with the use of light and scanning electron microscopy.

MATERIAL AND METHODS

The material were obtained from the herbarium of Royal Botanic Gardens Kew (K) and from the herbarium of Research Institute of Forests and Rangelands of Iran (TARI). A total of 14 specimens representative of 6 species of *Morus, Broussonetia, Maclura* and *Ficus* were examined listed in table 1.

For scanning electron microscopy, dry samples of leaf were mounted directly on stubs using double sided adhesive tape and coated with platinum in sputter coater. Micromorphological observation were made in a Cambridge Steroscan 240 SEM.

For light microscope observation, dried materials after boiling were fixed in FAA for 48 hours, then stored in 70% ethanol. Transverse sections of leaves were stained with safranin and alcian blue. A camera lucida was used for drawing.

RESULTS

The following types of trichomes were recognized among the species examined, summarized in table 2.

1. Glandular trichomes, provided with 1-2 celled stalk and spherical or elongated head of 2-4-16 cells. They vary in frequency and distribution on the leaf surfaces.
2. Non-glandular trichomes mainly in three types.

a. large trichomes with prominent base surrounded by epidermal cells, with thick walls, usually with sharp apex.

b. bristle trichomes usually unicellular and slender, terminating gradually into straight or slightly curved apex. They may be short or long, mainly described as long clothing hairs.

c. bracket trichomes, unicellular with thin to more or less thick walls, sometimes very short, hooked or bent at the apex.

3. Cystolith trichomes, with rounded, sometimes swollen base sunken into mesophyll and very shortly mucronate at the apex, usually contains cystolith.

Morus alba L.

The leaf surfaces are generally smooth with scattered trichomes. Three types of trichomes are present in this species. Normally they are not restricted to particular areas. Glandular trichomes with short 1-2 celled stalk and elongated 2-4 celled head are scattered and mainly along the veins abaxically. Bristle trichomes are usually unicellular, short and scattered more on adaxial surface. Cystolith trichomes with swollen bases and sharp tips on both surfaces, (Fig. 1: 1-2; Fig. 3A).

M. nigra L.

The leaf surface is slightly scabrous adaxially, but abaxially is densely pilose, becoming pubescent and slightly somewhat scabrous. Glandular trichomes are more abundant on abaxial surface, with short 1-celled stalk and spherical 2-celled haed. Nonglandular as large trichomes with prominent base and sharp apex which are more frequent these mixed with few bristle trichomes on abaxial surface, and cystolith trichomes with distinct rounded base and mucronate apex are more adaxially. (Fig. 1: 3, 4; Fig. 3: B).

Broussonetia papyrifera (L.) Vent.

The leaf surfaces of this species are scabrous above and grey-tomentose below. Glandular trichomes are very few on both surfaces. Nonglandular types are in varous froms and sizes. Bristle hairs as long clothing trichomes which are characteristic in this species, are usually very long, and tapering to narrow point. Bracket types present, normally simple, short with acute or curved tip, densely covered abaxially. Large trichomes mostly in conical shape only on adaxial surface. Cystolith trichomes are numerous, with large and rounded base, sharp apex, mainly on adaxial surface. (Fig. 1: 5, 6; Fig. 3: C).

Ficus carica L.

Generally the leaf surfaces are smooth and only pubescent. The degree of trichomes density is variable throughout the range. Three types of trichomes present: glandular trichomes of elongated 4-celled head; non-glandular trichomes in various shapes and

Talbe 2. Types of leaf trichomes in *Morus, Broussonetia, Ficus* and *Maclura.*

Taxa	Glandular trichome	Large trichome	Bristle trichome	Bracket trichome	Cystolith trichome
Morus alba	+	-	+	-	+
M. nigra	+	+	+	-	+
Broussonetia papyrifera	+	+	+	-	±
Ficus carica	+	+	+	-	+
F. Johannis	+	+	+	-	+
Maclura pomifera	+	-	+	-	-

sizes as large trichomes with curved end and bristle trichomes in short and long sizes both appear on abaxial surface, large trichomes mainly on adaxial surface; cystolith trichomes with large base sunken in mesophyll and sharp mucronate apex more on abaxial surface than adaxial (Fig. 2: 7, 8; Fig. 3: D).

Ficus johannis Boiss.

Leaf surfaces are scabrous and rough. Glandular trichomes are more abundant on adaxial surface; this type with 1-2 celled slalk, and 4-16 celled heads, usually spherical. Large hairs present with round base and conical thick wall apex on adaxial surface. Bristle trichomes are with large base present on both surfaces but less frequent on adaxial surface, usually long and tapering to narrow apex, variable in size. Cystolith trichomes with mucronate apex, and the base is sunken in spongy mesophyll. (Fig. 2: 9, 10; Fig. 3: E).

Maclura pomifera (Raf.) Schneider

The leaf surfaces are pubescent, slightly rough, but quite uniform in trichomes completment on both surfaces. Glandular trichomes with short 1-celled stalks and 2-4 celled head are few on both surfaces. Bristle trichomes varying in size with stright or slightly curved apex on or along the major veins. Large trichomes absent in this species. Cystoliths trichomes very few present only on abaxial surface sometimes absent (Fig. 2: 11, 12; Fig. 3: F).

DISCUSSION

Of the taxa examined in this study and those of other genera in the family *Moraceae* by Metcalfe and Chalk (1950), Shah and Kachroo (1975), in addition of *Urticaceae* and *Ulmaceae* (Gangadhara & Inamdar 1977) leaf characters such as presece and types of trichomes show characteristic features within the *Moraceae*. There are some differences among species in trichomes complement (Talbe 2).

Glandular trichomes are common in the *Moraceae* as in the genera examined; with short 1-celled slalk and 2-4-16 celled head may be elongated such as *Morus alba* and Ficus *Johannis* or spherical head in the others. Non-glandular trichomes are usually unicellular in various shapes and sizes, mainly four types are recognized:

Large trichomes present in *Morus nigra, Broussonetia papyrifera, Ficus carica,* and *F. Johannis* but absent in *M. alba* and *Maclura pomifera.* Bristle trichomes, exhibit various shapes, with acute to acuminate tips some are bent, vary in their sizes and present in all species examined, but more interesting and distinct types, as clothing trichomes in *B. papyrifera.* Typical bracket trichomes, always short with bent to acute apex present densely in *B. papyrifera* only, but recorded by Metcalfe & Chalk (1950) from other genera of *Moraceae* too. The more characteristic feature of trichomes is cystolith trichomes in

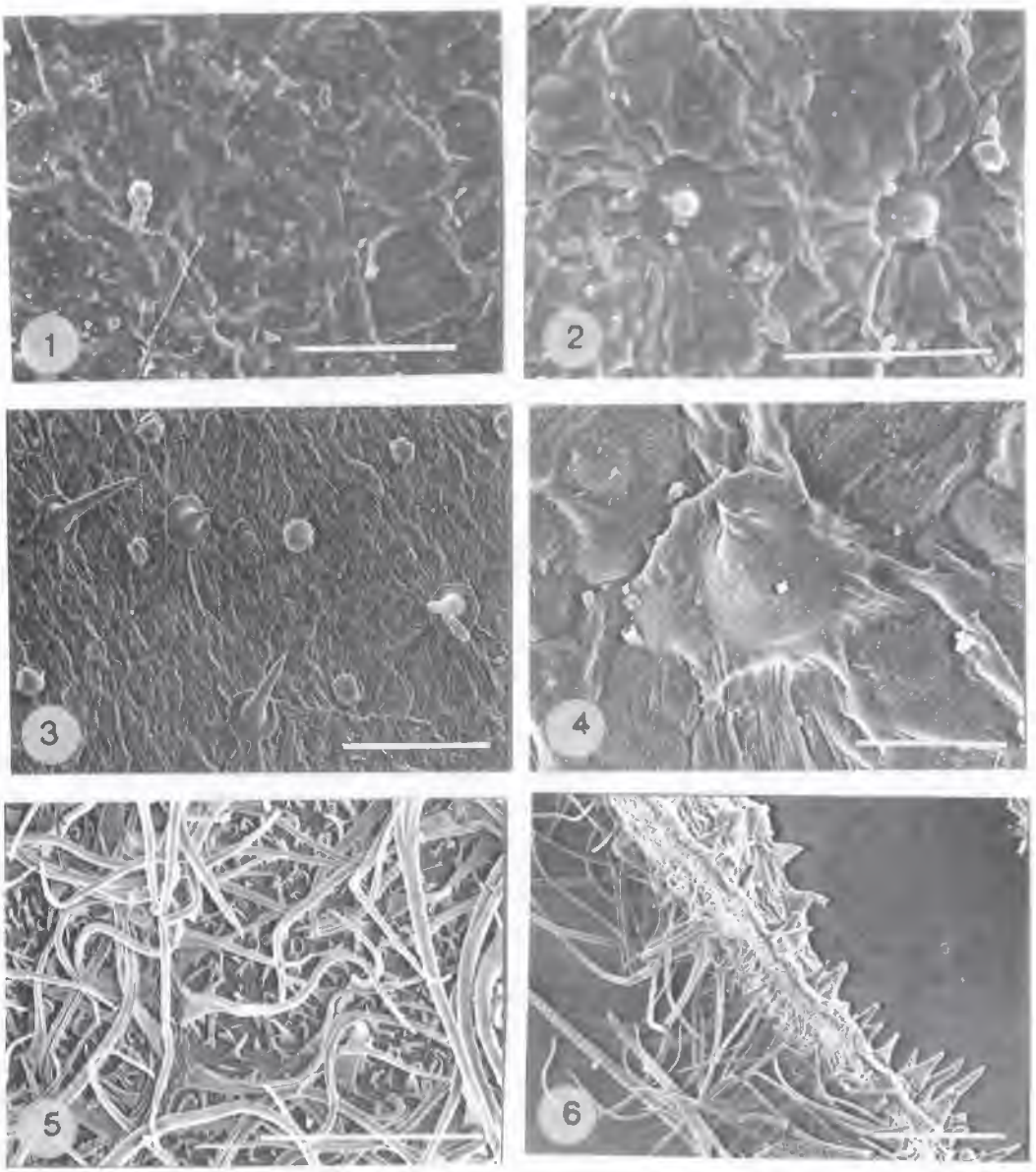

Fig. 1: Type of trichomes, SEM photographs. Scale bar=50 µm except in 2 where scale bar=100 µm. 1,3,5 abaxial surfaces; 2,4,6 adaxial surfaces. 1,2 *Morus alba,* 1. short glandular trichomes ; 2. cystolith trichomes. 3,4 *Morus nigra:* 3. glandular and large trichomes; 4. cystolith trichomes. 5,6 *Broussonetia papyrifera:* 5. brisle long trichomes and short bracket; 6. T.S. cystolith trichomes above and brisle and bracket trichomes below.

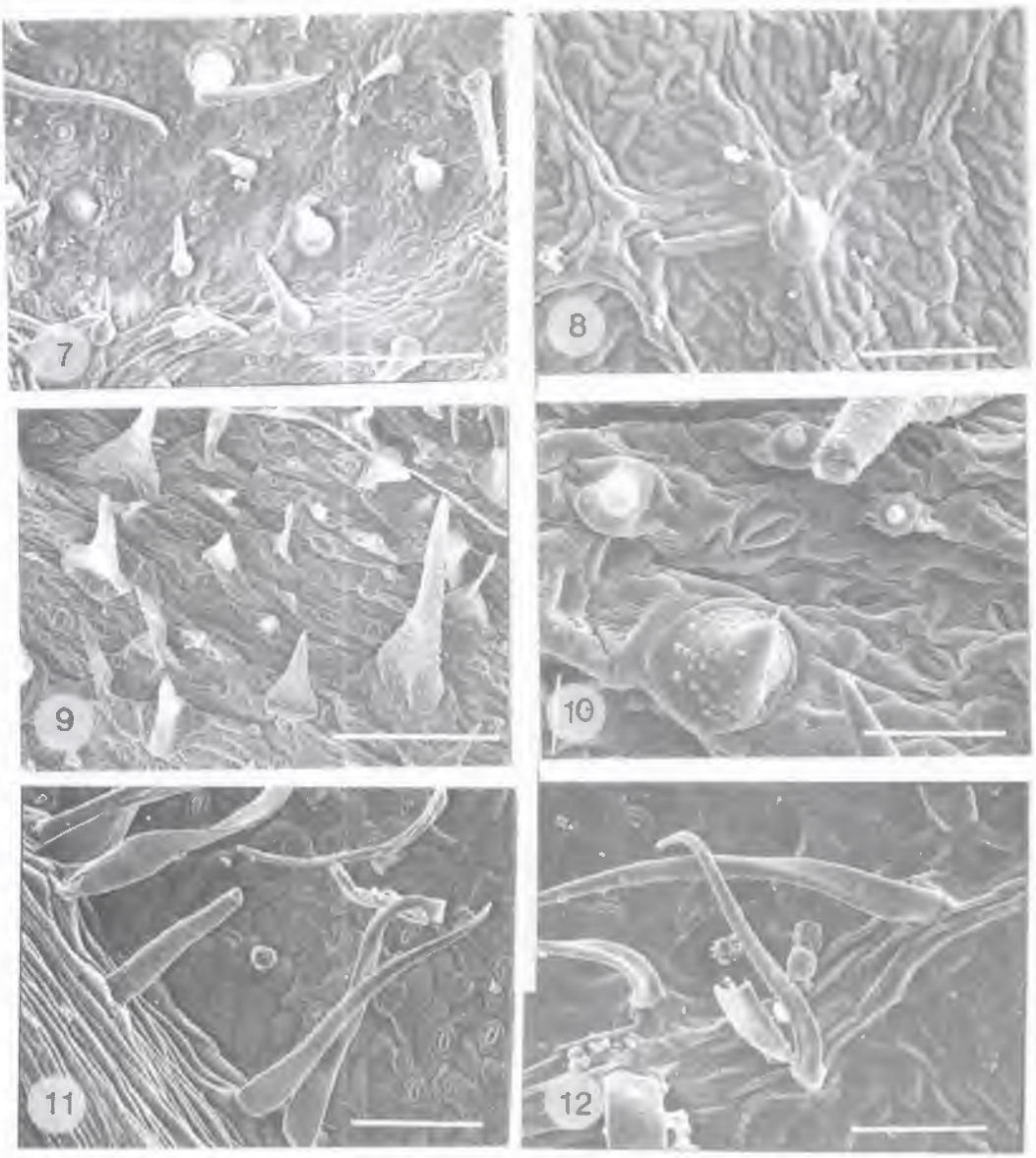

Fig. 2: Type of trichomes SEM photographs, scale bar=100 μm except in 7 and 10 where scale bars=200 μm and 50 μm. 7,9,11 abaxial surfaces; 8, 10, 12 adaxial surfaces. 7,8: *Ficus carica,* 7. large bristle and cystolith trichomes; 8. large trichomes. 9, 10 *Ficus Johannis,* 9. large and bristle trichomes; 10. large and cystolith trichomes. 11, 12: *Maclura pomifera,* 11. long bristle trichomes, 12. glandular and bristle trichomes.

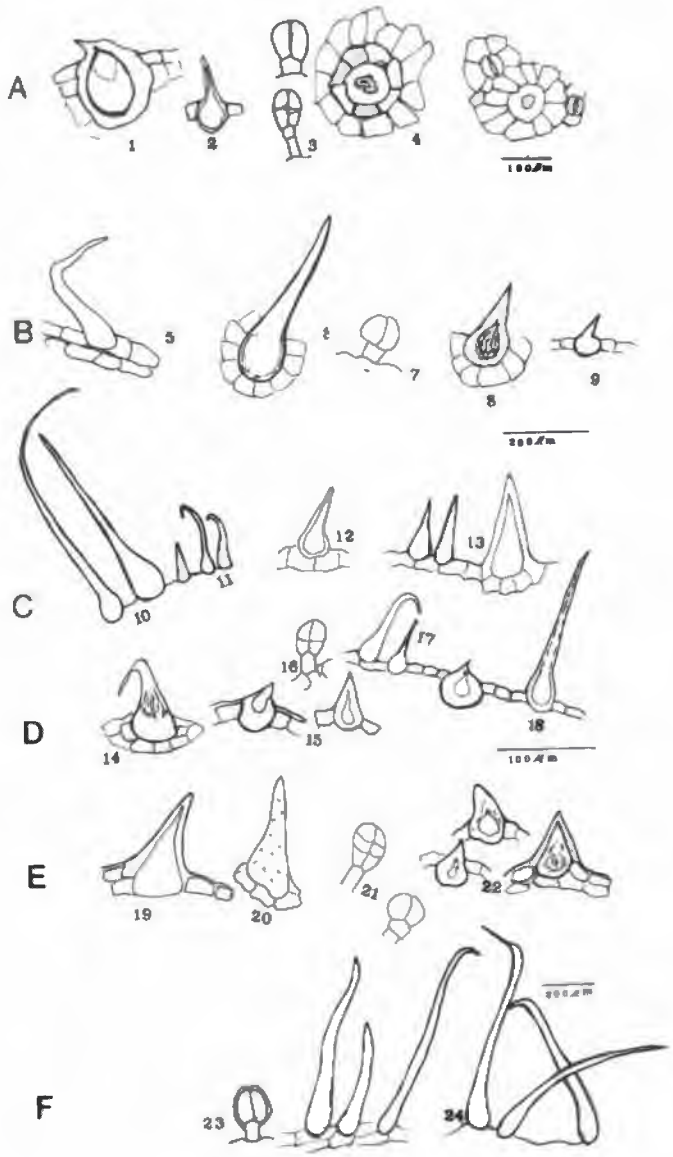

Fig. 3: Type of trichomes. –A. *Morus alba*: 1,2,4 cystolith, 3 glandular trichomes. –B. *Morus nigra:* 5 bristle, 6 large trichomes; 7 glandular trichomes; 8,9 cystolith trichomes. –C. *Broussonetia papyrifera,* 10 bristle, 11 bracket, 12 cystolith, 13 large trichomes. –D. *Ficus carica:* 14 large, 15 cystolith, 16 glandular, 17 bracket, 18 bristle trichomes. –E. *Ficus johannis*: 19 large, 20. bristle, 21 glandular, 22 cystolith trichomes. –F. *Maclura pomifera:* 23 glandular, 24 bristle trichomes.

Moraceae. This type of trichome is remarkable in structure, the base is enlarged or swollen, variable in size and shape from sharp-pointed (*M. nigra, F. Johannis, B. papyrifera*) to rounded, papilla-like apex (*M. alba*) which is very few or lacking in *Maclura pomifera.*

Although in this study the type of trichomes showed characteristic features within four genera, but morphology of trichomes alone is not sufficient evidence for the delimitation of species. As stated by Metcalfe & Chalk (1982), it may be more valuable when combined with other analytical features of leaves, flowers and fruits.

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