Wood anatomical characters of the Egyptian *Tamarix* L. species and its taxonomic significance

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The secondary xylem elem ents show apparent constancy in their characters among the indiginous species of *Tamarix*. These characters were studied to evaluate their taxonomic importance. The characters of vessels (width in cross section and number/mm^2) were found important at the sectional level, while characters of rays and fiber thikness could be important for the distinction of certain species. Wood anatomical characters were found useful for the identification of *Tamarix* species when reliable morphological characters such as flowers and fruits are not available. In this respect, such characters would be useful for the identification of archaeological worked, non-worked wood material and charcoal.

Key words: *Tamarix*, Egypt, wood anatomy, taxonomy.

Introduction

The genus *Tamarix* L. comprises about 90 species mostly in the deserts of temperate and subtropical regions of the Old World. These are halophytic shrubs or small quick-growing trees with scale leaves, minute flowers in dense racemes with nectariferous or non-nectariferous staminal discs (Araffa, 1992).

Willdenow (1816), recognized 16 species of *Tamarix* among which 7 species were described new. Ehrenberg (1827), was the first to apply the characters of staminal disc and insertion of stamens as important diagnostic characters. This concept was adopted by Bunge (1852), who recognized some 200 binomials. However the recent revision of the genus by Baum (1978) comprised only 54 species.

Täckholm (1974) reported 5 species of *Tamarix* in Egypt among which *Tamarix nilotica, T.passerinoides* and *T. tetragyna* were apparently polymorphic. In her recent revision of *Tamarix*, Araffa (1991) recognized 8 species which are grouped according to Baum (1978) under three sections. Section *Tamarix* comprises *Tamarix nilotica* (Ehrenb.) Bunge, *T. mannifera* Bunge, *T. arborea* (Ehrenb.) Bunge *a*nd *T. aphylla* (L.) H. Karst. Section *Oligadenia* comprises *Tamarix tetragyna* Ehrenb. while section *Polyadenia* comprises *Tamarix passerinoides* Del. ex Desv., *T. macrocarpa* (Ehrenb.) Bunge and *T. amplixecaulis* Ehrenb.

In his cheklist to the Flora of Egypt, Boulos (1995:95-96) accepted six of the *Tamarix* species recognized by Araffa *(op.cit*). He regarded both of *Tamarix mannifera* and *T. arborea* as conspecific to *T. nilotica*.

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According to Fahn & Werker (1986:171), the secondary wood of *Tamarix* species growing in Israel and adjacent regions consists of solitary short vessels (up to 120μm) which are storied with parenchyma cells. In vessels, the pits are alternate, rounded slit-like and often with coalescent apertures. The parenchyma are mainly vasicentric and fusiform; rays are wide, up to 1μm or higher.

Zaki *et al.* (1990) carried out a comparative anatomical study of the young stem and leaf among the *Tamarix* species of Egypt recognized by Araffa (*op.cit*). Two anatomical patterns of the young stem (circular and furrowed) were recognized. The anatomical features of these patterns were proved to be significant on the sectional level of Baum's classification (*op.cit*). The characters of the epidermal cells, the cortical zone and vascular cylinder of the young stem provided reliable characters for the distinction of closely allied species of series *Leptostachya* of section *Tamarix* viz. *T.nilotica, T. arborea and T. mannifera.*

The above prelimenary study shows the necessity of investigating other anatomical characters of the Egyptian *Tamarix* species which are among the important lignious species. Wood anatomical characters may prove their value in the taxonomy of investigated species.

Materials and Methods

For each species, woody branches about 1.5 cm in diameter belonging to selected well identified specimens of the *Tamarix* species represented in the flora of Egypt (Araffa, 1992) were the subject of the persent study. Attention was paid for studying specimens which were collected from localities representing the geographical range of each species (Table 1).

Wood branches were soaked over night in boiled water before sectioning with a sledge microtome. Sections for examination with light microscope (T.S & L.S) at 30-50 μ were stored in an aqueous alcohol-glycerin mixture before double staining with saffranin and light green. Stained sections were dehydrated in alcohol-xylol series, cleared in clove oil and mounted in Canada Balsam. For every speciemen; at least five slides were prepared and examined by light microscope. The measurments given in Tables (2 & 3) for the xylem vessels and rays are the means of at least 100 readings using a calibrated occular micrometer.

Results and discussion

Table (2) presents the wood anatomical characters of *Tamarix nilotica, T.aphylla* and *T. tetragyna* which are major constituents of the natural vegetation of the salt marshes (marine and inland), river banks as well as wadi beds of the Eastern and Western Deserts of Egypt.

Table (1) Examined and anatomically investigated specimens of the Egyptian *Tamarix* species, (kept in Cairo University Herbarium).

Species	Specimens
Tamarix nilotica	Ismailia, El Ballah, 16/6/1988, *Sh.Araffa*. West salty areas, Bahariya Oasis,16/10/1966, *Osborn.*. Aswan, E. Nile, 7/12/1964, *L.Boulos*. Kom-Ombo, East salts lands, 19/1/1927, *G.Täckholm.* Bab-El Mahmal, Wadi Feiran, Sinai, 13/5/1956, *V. Täckholm*. Minia, 1/18/1957, *V. Täckholm.* Balouza, North Sinai, 1/5/1976,*V. Täckholm.* Wadi Gerawi, Spring 1953, *N.El Hadidi*.
Tamarix mannifera	Kom Aushim, 21/9/1959, *V. Täckholm*. Kharga Oasis,5/11/1966, *N. El Hadidi*. Wadi Feiran, Sinai, 15/8/1551, *V. Täckholm*.
Tamarix arborea	El Dakhla, Oasis, 15/1/1988, *Sh. Araffa*. Hurghada, Safaga road, 22/1/1990. *K. El Batanuony*. Sinai, Ain Sokhna,1/1/1988, *Sh. Araffa*. South of Giza Pyramids, 1/1/1927, *G. Täckholm*.
Tamarix aphylla	Cairo-Suez Road, near Gebel Ataqa, 25/11/1960, *V.T Täckholm*. Sinai, Yamet, 23/9/1988, *Sh.Araffa*. Bahariya Oasis, 11 km from Bawiti, 8/3/1979, *M. Abdel Ghani*. Bahariya Oasis, Bawiti road, 8/3/1979, *M.Abdal Ghani*. Wadi EL Assiuti, 6/12/1962, *V. Täckholm*. Red Sea, Wadi Araba, 10 km w. of the road, 7/2/1960, *V. Täckholm*.
Tamarix tetragyna	Nile Delta, 10 km south of Baltim, 18/2/1971, *M.Imam*. Salt lands at Gebel Asfar, spring 1958, *V. Täckholm*. Ain-Sokhna 55 km south of Suez, 8/5/1953, *H.A.F.Gohar*. El-Borollos, Sptember 1952, *M.Kassas*. El Heiz, Ain El Ezza, Bahariya, 22/2/1979, *M. Abdel Ghani*.
Tamarix passerinoides	G. Ballah, Ismailia, 30/4/1983, *A.M.Amer*. Malhet El- Hamra, Wadi Natroun, 5/2/1968, *M.Zahran*.
Tamarix macrocarpa	Wadi El Farigh, Wadi Natroun, 19/3/1968, *M.Zahran*. 30 miles South of El Borma, Libyan Desert, 3/4/1965, *Osborn* & *Helmy*. Kharga Oasis, 10/2/1931, *F. W. Oliver*. Wadi El Shooni, 53 km of Mersa Alam, Red Sea, 92/1961, *M. Kassas*.
Tamarix amplexicaulis	Nubia, Nag el-Dakhla, Ballana, 9/1/1964, *L. Boulos*. Near Siwa Town, 26/10/1963, *L.Boulos*. Kom Ombo desert, Mouth of Wadi Kharit, 7/12/1964, *V. Täckholm*.

It will be noticed (Table 2), that these characters are apparently constant under the adverse environmental conditions. The constancy of the wood anatomical characters among these three species would favour the idea of comparing such charactes with those of the other; less common species of limited geographical range.

Table (2). Wood anatomical characters of the three most common *Tamarix* species in Egypt.

Characters	***Tamarix nilotica***	***Tamarix aphylla***	***Tamarix tetragyna***
Number of vessels/mm^2	15-20/mm^2	6-40/mm^2	6-46/mm^2
Vessels diameter	20-160 μm	30-280μm	20-140μm
Ray width	6-10 cells	10-23 cells	6-12 cells
Ray height	1-1.5 mm	1-2 mm	2 mm
Ray frequency	2-4 / mm^2	2-3 / mm^2	4 / mm^2
Wood porosity	Ring porous-semi ring porous	Diffuse porous	Ring porous-semi ring porous
Fiber thickness	Thin-medium ½ - ¼ lumen	Medium ½ lumen	Thick ¾ lumen

In Table (3), the investigated *Tamarix* species are arranged according to the systematic treatment followed by Baum (1978). Three speices viz. *Tamarix nilotica, T. mannifera* and *T. arborea* belong to series *Leptostachya* of section *Tamarix,* while *T. aphylla* belongs to series *Vaginantes* of the same section. The second row comprises *Tamarix tetragyna* of section *Oligadenia,* while the third row comprises the species of section *Polyadenia,* viz. *Tamarix passerinoides* and *T. macrocarpa.* The anatomical characters are arranged horizontally according to their systematic value.

Most significant are the characters of vessel number/mm^2 and vessel diameter in cross section. It will be noticed, that vessel diameter is the largest (20-150μm) among the species of series *Leptostachya* of section *Tamarix.* They are even wider in *Tamarix aphylla* of series *Vaginantes* of the same section. The vessel diameter is apparently narrower among the species of sections *Oligadenia* and *Polyadeni*ia. However, the vessels of *Tamarix tetragyna* (section *Oligadenia*) are wider (20-140 μm) than those of the species of section *Polyadenia (*20-100 μm).

Table (3) also shows that the number of vessels/mm^2 ranges between 10-40 vessels/mm^2 among the species of section *Tamarix.* They are more frequent among the species of sections *Oligadenia* and *Polyadenia.* This can be attributed to the vessel's diameter, since the narrower the vessels, the more frequent in a certain area.

Table (3): Wood anatomical characters of the *Tamarix* species in Egyp

Characters	Sect. *Tamarix*				Sect. **Oligadenia**	Sect. *Polyadenia*		
	Ser . **Leptostachya**			Ser. *Vaginantes*	Ser. *Anisandrae*	Ser. **Pleindrae**		
	9 T. 10 niloti ca	**T. mannifera**	*T. arborea*	*T. aphylla*	*T. tetragyna*	*T. passerinoides*	*T. macrocarpa*	*T. amplixicaulis*
Number of vessels / mm^2	11^{-20-} 26/mm^2	10^{-25-}30 /mm^2	10^{-22-}40 /mm^2	6^{-30-}40 /mm^2	6^{-32-}46 /mm^2	50^{-56-}60 /mm^2	30^{-40-}65 /mm^2	65^{-68-}70 /mm^2
Vessel diameter	20^{-80-} 160/mμ	30^{-71-}120 mμ	30^{-85-}125 mμ	30^{-102-}250 mμ	$20^{-25,100-}$140 mμ	20^{-65-}110 mμ	30^{-68-}100 mμ	30^{-55-}90 mμ
Ray height	1 mm	1.5 mm	1.5-2 mm	1-2 mm	< 2 mm	1.5-2 mm	1-2 mm	< 4 mm
Ray width	6-10 cells	4-8 cells	3-8 cells	5-23 cells	5-12 cells	8-22 cells	1-6 cells	3-14 cells
Ray frequency	2-4/mm^2	2-3/mm^2	2-4/mm^2	2-3/mm^2	< 4/ mm^2	3-4/mm^2	2-4/mm^2	3-4/mm^2
Wood porosity	ring-semi ring porous	diffuse-semi ring porous	semi ring porous	diffuse porous –semi ring porous	ring porous – semi ring porous	ring porous – semi ring porous	semi ring porous	Diffuse porous
Fiber thickens	Medium ½ lumen	Thick ¼ lumen	Medium ½ lumen	Thin ¼ lumen	Medium ½ lumen	Thick ¾ lumen	Medium ½ lumen	Medium ½ lumen
Crystals in ray	Abundant	—	Abundant	Abundant	—	Abundant	—	Abundant

The characters of medullary rays (height, width & frequency) seem to be of moderate systematic value. In section *Tamarix*, the medullary rays are generally 1-2.5 mm high and are 2-4 rays/mm^2. In species of series *Leptostachya,* the rays are 4-10-seriate, they are 5-23-seriate in *Tamarix aphylla* of series *Vaginantes.* In *Tamarix tetragyna* (section *Oligadenia)* the rays are 5-12- seriate, and are 4-22-seriate in species of section *Polyadenia.*

The other characters, viz. the wood porosity, crystals in rays,and the xylem fiber thickness are of less systematic value and can be used for the distinction of certain species. Wood porosity among the investigated percies is in general semiring- ring porous, it is however liable to be diffuse porous in *Tamarix aphylla.* The solitary prismatic ray crystals are not observed in *Tamarix mannifera, T. tetragyna & T. macrocarpa.* These are of abundant occurrence in the rays of the other species. The wood fibers are apparently thick in *Tamarix mannifera* and *T. passerinoides*, thin in *T.aphylla* and *T.tetragyna and* are medium - thick in the other investigated species.

The following key, based on wood anatomical characters shows the effeciency of such characters to distinguish between the investigated species of *Tamarix*.

1.a. Vessels not more than 40/mm^2 ……..……..……. 2
  b. Vessels more than 40/mm^2 ……..……..…5
2.a. Rays broad 10-23 cells wide ……..……..…… *T. aphylla*
  b. Rays narrow up to 10 cells wide ……..……..…… 3
3.a. Crystals absent in rays ……..……..……... *T.mannifera*
  b. Crystals present in rays ……..……..……... 4
4.a. Rays up to 1 mm high ……..……..…… *T. nilotica*
  b. Rays 1.5-2 mm high ……..……..……. *T. arborea*
5.a. Rays 2-4mm high ……..……..…… *T. amplexicaulis*
  b. Rays less than 2 mm high ……..……..…….. 6
6.a. Crystals present in ray ……..……..…… *T. passerinoides*
  b. Crystals absent in ray ……..……..……... 7
7.a. Rays in L.S up to 6 cells wide ……..……. *T. macrocarpa*
  b. Rays in L.S. more than 6 cells wide ……..……..… *T. tetragyna*

The above key shows that species of section *Tamarix* are characterized by wider xylem vessels which are not more than 40/mm. On the other hand, the investigated species of sections *Oligadenia* and *Polyadenia* have however vessels which are more than 40/mm^2. Next in importance, are the characters of rays including its height, width and presence or absence of crystals. The ray height was useful to distinguish between closely allied species viz. *Tamarix nilotica* and *T. arborea*. These are up to 1 mm high in *Tamarix nilotica* and 1.5-2 mm high in *Tamarix arborea*. The rays are narrow (up to 10 cells wide) among the species of series *Leptostachya* of section *Tamarix.* They are wider (10-23 cells wide) in *Tamarix aphylla* of series *Vaginates* of the same section. It is rather possible to distinguish between *T. macrocarpa* of section *Polyadenia* and *Tamarix tetragyna* of section *Olygadenia* which show similarities in their anatomical features. The rays are

narrower (up to 6 cells wide) in *T. macrocarpa* and broader (more than 6 cells wide) in *T. tetragyna*.

The present investigation shows that wood anatomical characters are useful in the identification of *Tamarix* species, when other morphological characters such as flowers and fruits are not available. In this respect, such characters would also be useful for the identification of archaeological worked, non-worked wood material and charcoal (Waly, 1994).

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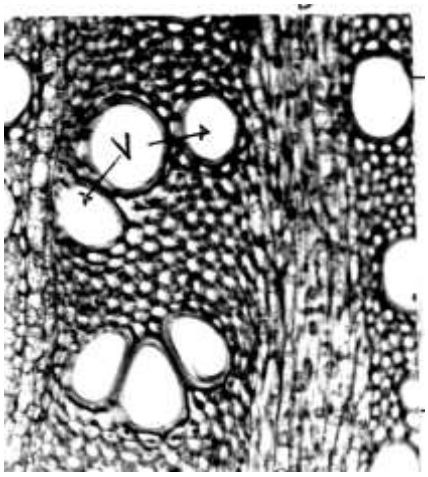
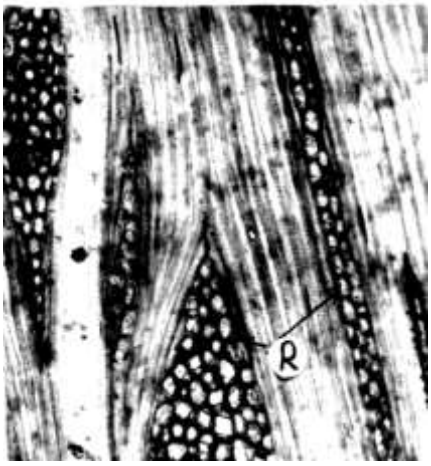
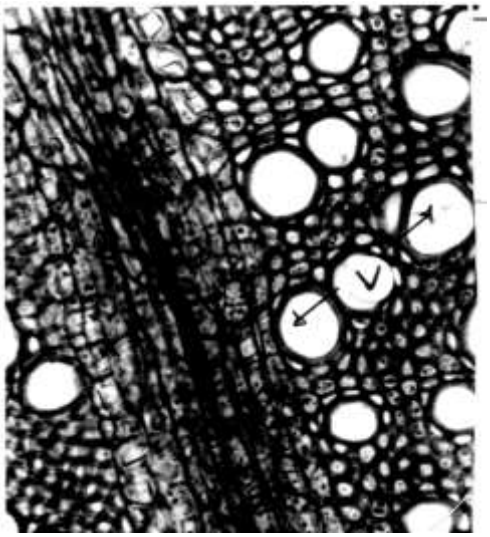


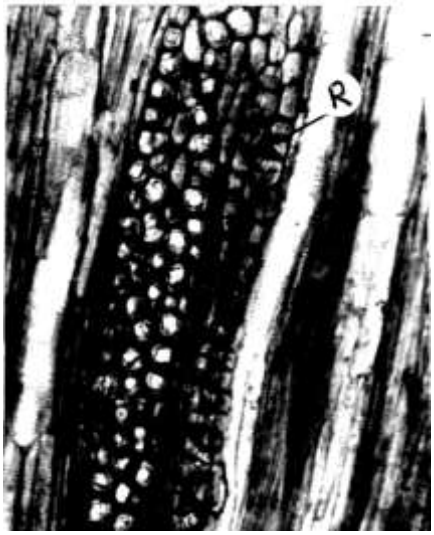
T.S. in *Tamarix nilotica* (x125), showing vessels (V) ring to semi-ring porous, vessels diameter 20-160 mμ ; vessels frequency 11-26/mm^2



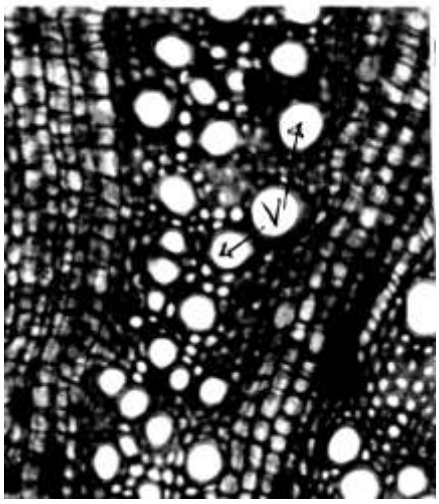
L.S. in *Tamarix nilotica* (x125), showing ray (R) 1-2 mm high, ray width 6-10 cells; ray frequency 2-4/mm^2



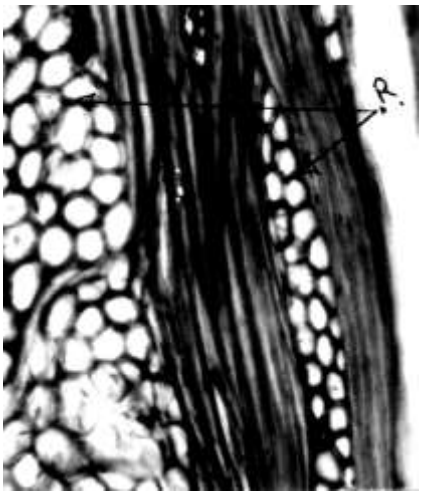
T.S. in *Tamarix aphylla* (x125), showing vessels (V) difuse to semi-ring porous, vessels diameter 30-280 mμ ; vessels frequency 6-40/mm^2



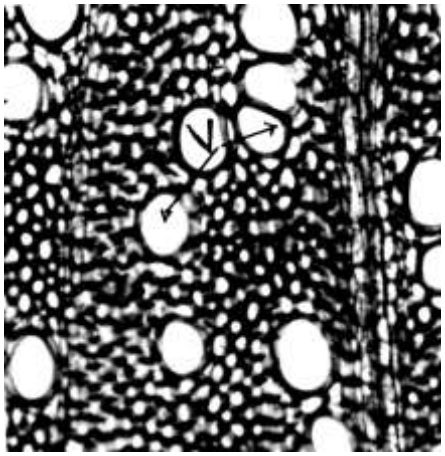
L.S. in *Tamarix aphylla* (x125), showing ray (R) 1-2 mm high, ray width 5-23 cells; ray frequency 2-4/mm^2



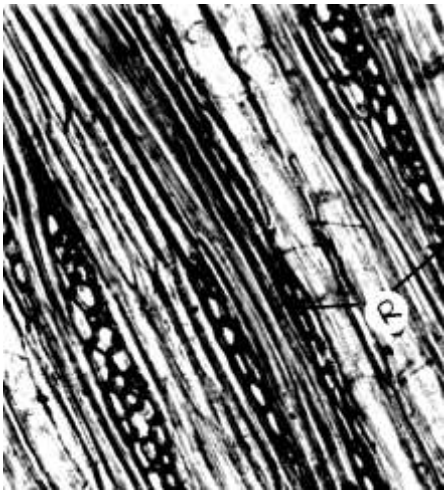
T.S. in *Tamarix passerinoides* (x125), showing vessels (V) ring to semi-ring porous, vessels diameter 20-110 mμ ; vessels frequency 3-4/mm^2.



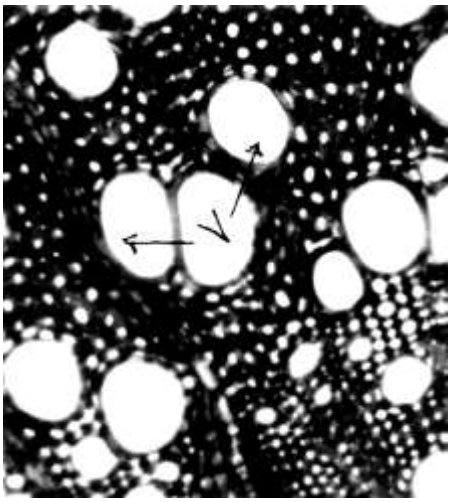
L.S. in *Tamarix passerinoides* (x125), showing ray (R) 1.5-2 mm high, ray width 5-23 cells; ray frequency 50-60/mm^2.



T.S. in *Tamarix macrocarpa* (x125), showing vessels (V) semi-ring porous, vessels diameter 30-100 mμ ; vessels frequency 30-65/mm^2

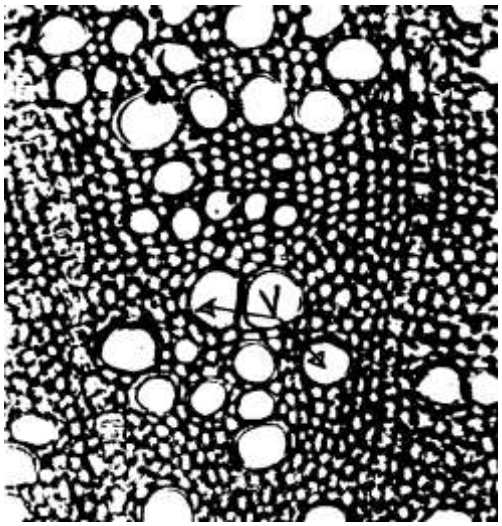


L.S. in *Tamarix macrocarpa* (x125), showing ray (R)1-2 mm high, ray width 1-16 cells; ray frequency 2-4/mm^2



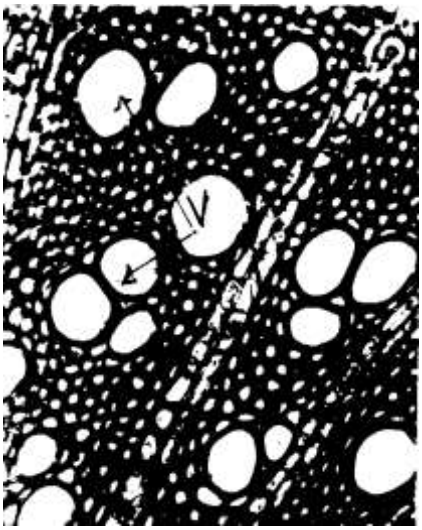
T.S. in *Tamarix tetragyna* (x125), showing vessels (V) ring to semi-ring porous, vessels diameter 20-140 mμ ; vessels frequency 6-46/mm^2

L.S. in *Tamarix tetragyna* (x125), showing ray (R)< 2 mm high, ray width 5-12 cells; ray frequency < 4/mm^2



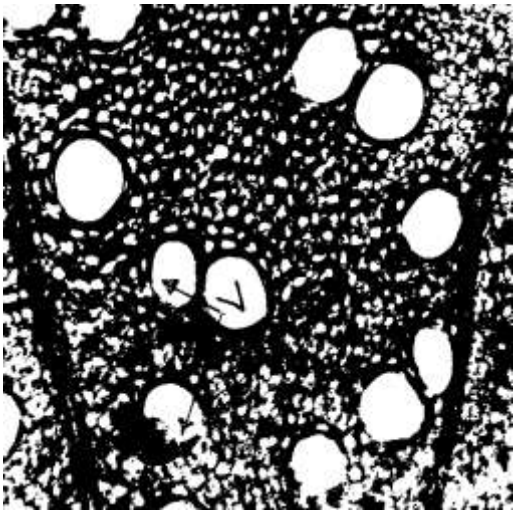
T.S. in *Tamarix amplexicaulis* (x125), showing vessels (V) difuse porous, vessels diameter 30-90 mμ ; vessels frequency 65-70/mm^2

L.S. in *Tamarix amplexicaulis* (x125), showing ray (R) < 4 mm high, ray width 1-14 cells; ray frequency 3-4/mm^2



T.S. in *Tamarix mannifera* (x125), showing vessels (V) difuse to semi-ring porous, vessels diameter 30-120 mμ ; vessels frequency 3-4/mm^2

L.S. in *Tamarix aphylla* (x125), showing abundant solitary crystals (C) in rays.



T.S. in *Tamarix arborea* (x125), showing vessels (V) semi-ring porous, vessels diameter 30-125 mμ ; vessels frequency 10-40/mm^2