

A CONTRIBUTION TO THE PALYNOLOGICAL SURVEY OF THE GENUS *CONVOLVULUS* FROM SOUTH WEST ASIA AND ARABIAN PENINSULA

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Abstract

Pollen morphology of 22 species of the genus *Convolvulus* L. from S. W. Asia and Arabian peninsula was carried out. Pollen grains are mostly trizonocolpate, occasionally tetra or hexazonocolpate, prolate-spheroidal to oblate spheroidal rarely prolate; tectum reticulate or punctate-scabrate. On the basis of tectal surface, 4 groups viz. 1) Coarsely reticulate-scabrate 2) Medium reticulate/punctate-scabrate, 3) Finely reticulate/punctate-scabrate 4) Sparsely punctate-scabrate have been recognized. Taxonomic implications of the infragenic classification are also discussed.

Introduction

The genus *Convolvulus* L., of the family Convolvulaceae is the largest genus with c. 250 species, is rare in the tropics but widely distributed in temperate and sub-tropical areas (Wills, 1973; Mabberley, 1987). The pollen morphology of some species of Convolvulaceae was first carried out by Hallier (1893) who recognized *Psiloconiea* and *Echinoconiea* as two main groups. Gamble (1933) divided the family into two groups based on spinulose or non-spinulose pollen grains, with further division on the basis of apertural types. Erdtman (1953) distinguished the pollen of Convolvulaceae into two distinct types, viz. *Ipomoea* (*Echinoconiea*) and *Convolvulus* (*Psiloconiea*) type. O'Donnell (1959) followed the same basis for separating the genera of *Convolvulaceae* as proposed by Hallier (1893). Lewis & Oliver (1965) described the pollen grains of *Convolvulus* as prolate to more frequently subspheroidal. Sengupta (1972) in his comprehensive palynological survey of *Convolvulus* separated the family into 4 main groups and placed the genus *Convolvulus* in tricolpate pollen group. No comprehensive survey of pollen morphology for the genus *Convolvulus* from S. West Asia and Arabian peninsula is available. The present studies provide a detailed information of the pollen morphology of 22 species of the genus *Convolvulus* distributed in South West Asia, comprising of Pakistan, Afghanistan, Iran and the Arabian Peninsula, including Saudi Arabia, Oman, Bahrain, Yemen and Kuwait (Fig. 1).

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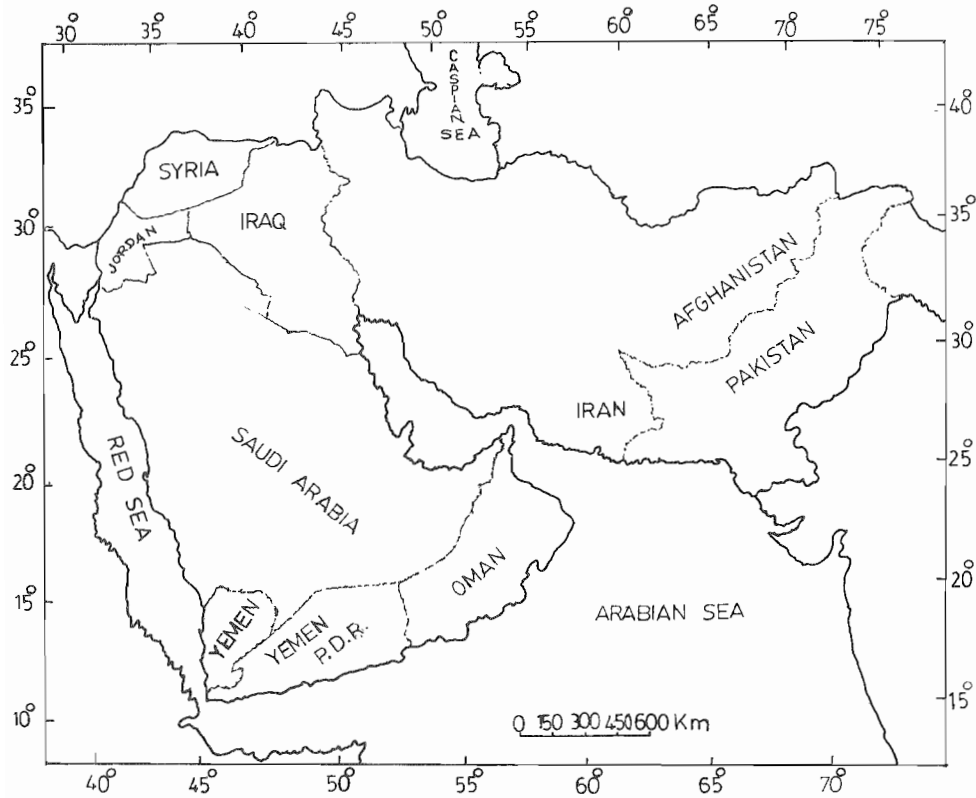


Fig. 1. Study area of south west Asia and Arabian Peninsula.

Materials and Methods

Pollen samples were collected from herbarium specimens present in the herbaria of Royal Botanic Gardens, Edinburgh (E), Plant Science laboratories of the University of Reading (RNG), Karachi University Herbarium, Pakistan (KUH) and Regional Agricultural and Water Research Center, Saudi Arabia (RAWRC). A list of specimens investigated is given in Appendix 1. Pollen grain samples for light microscopy (LM), and scanning electron microscopy (SEM), were processed by the standard acetolysis method of Erdtman (1952, 1960) with slight modification, where 1% Teepol was used as a wetting agent and a few drops of lactic acid were added after 2-3 minutes to prevent further expansion of the grains. The pollen grains were mounted in glycerine jelly, stained in safranin and sealed with paraffin wax. For light microscopy (LM), the pollen slides were examined using Nikon-Type-102, under (E40, 0.65) and oil immersion (E'10, 1.25) using 10x eye piece. Photographs were taken with Carl Zeiss Photo microscope. The measurements are based on 20 readings from each slide. The polar axis (P), equatorial diameter (E) and length of colpi (C) were measured and P/E ratio calculated (Table 1).

Table 1. Summary of pollen grains measurement, and exine patterns of investigated taxa of the genus *Convolvulus*.

Species	Polar length (P) μm	Equatorial diameter (E) μm	Mean P/E X100	Colpus length (C) μm	Shape of the grains	Tectum of the grains
<i>C. acanthocladius</i>	61.03(56.72)39.49	59.23(48.10)43.08	85	57.44(48.77)43.08	Sb-Oblate	Fr/Pt-Sc
<i>C. aitichisonii</i>	68.21(68.81)50.26	66.4(55.86)50.26	109	64.62(49.06)39.49	Prolate-Sp	Fr/Pt-Sc
<i>C. arvensis</i>	65.45(58.28)49.40	64.22(55.01)37.05	180	49.93(42.26)34.58	Prolate	Cr-Sc
<i>C. austro-egypticus</i>	61.75(54.71)49.40	59.28(53.96)44.40	101	44.46(38.03)34.58	Prolate-Sp	Cr-Sc
<i>C. buschiricus</i>	51.83(69.52)43.22	51.86(46.93)40.76	106	37.05(35.93)32.11	Prolate-Sp	Cr-Sc
<i>C. cephalopodus</i>	66.69(59.07)51.87	56.81(49.31)41.99	119	54.34(45.07)39.52	Sb-Prolate	Fr/Pt-Sc
<i>C. deserti</i>	66.96(60.06)49.46	54.24(50.24)39.52	125	54.34(44.05)35.58	Sub-Prolate	Mr/Pt-Sc
<i>C. fainensis</i>	54.93(51.52)46.93	51.87(45.63)41.99	113	49.99(37.55)32.11	Prolate-Sp	Cr-Sc
<i>C. fruticosus</i>	68.21(47.73)50.26	64.62(46.89)43.08	98	61.03(49.01)43.08	Oblate-Sp	Fr/Pt-Sc
<i>C. glomeratus</i>	59.29(52.15)46.40	59.28(41.86)35.58	126	44.46(38.28)32.11	Sb-Prolate	Fr/Pt-Sc
<i>C. hystrix</i>	61.75(53.90)46.93	56.81(52.75)41.99	102	44.46(35.75)29.64	Prolate-Sp	Cr-Sc
<i>C. leiocalycinus</i>	64.62(57.73)52.05	61.03(54.44)50.26	106	50.46(43.08)35.90	Prolate-Sp	Fr/Pt-Sc
<i>C. leptocladius</i>	48.46(40.68)39.49	50.26(48.26)44.87	84	39.49(32.08)28.72	Sb-Oblate	Fr/Pt-Sc
<i>C. lineatus</i>	55.64(50.26)43.08	55.45(45.49)35.90	100.3	39.49(35.9) 25.13	Prolate-Sp	Fr/Pt-Sc
<i>C. oxyphyllus</i>	54.34(50.17)44.46	39.52(38.28)32.11	131	46.93(38.08)34.58	Sb-Prolate	Fr/Pt-Sc
<i>C. pilosellaefolius</i>	51.86(49.39)45.74	56.80(50.93)41.99	97	39.52(36.24)32.11	Oblate-Sp	Fr/Pt-Sc
<i>C. prostratus</i>	66.69(60.06)49.40	54.25(50.24)39.52	119	51.87(45.22)37.05	Sb-Prolate	Fr/Pt-Sc
<i>C. pseudocantabrica</i>	50.26(46.48)43.08	50.26(45.95)43.08	84	39.49(32.21)28.72	Oblate-Sp	Fr/Pt-Sc
<i>C. rhyniospermus</i>	55.64(52.41)46.67	53.85(50.83)46.67	103	43.08(40.92)39.49	Prolate-Sp	Sparsely/Pt-Sc
<i>C. sindicus</i>	52.05(41.56)43.08	48.46(47.26)46.67	101	39.49(37.09)32.33	Prolate-Sp	Fr/Pt-Sc
<i>C. spinosus</i>	53.85(50.37)46.67	57.44(48.22)43.08	104	44.87(39.95)32.31	Prolate-Sp	Mr/Pt-Sc
<i>C. virgatus</i>	64.61(51.01)61.87	61.75(51.31)41.99	118	54.34(45.93)37.05	Sb-Prolate	Sparsely/Pt-Sc

Abbreviation: Cr = Coarsely reticulate, Mr = Medium reticulate, Fr = Finely reticulate, Pt = Punctate, Sc = Scabrate, Sb = Sub, Sp = Spheroidal.

For SEM, acetolysed pollen grains were dehydrated in acetone series and mounted on a metallic stub in few drops of acetone. The specimens were coated with gold in a vacuum chamber, coating were restricted to 150 Å and SEM examination carried out by (JSM-T200) Joel Microscope.

Photomicrographs of fractured pollen grains were also taken with SEM for 3-dimensional view of the internal structure (Cerceau-larrival & Roland-Heydacker, 1972). Unlike ultra-sonic method of previous workers, in the present study, the pollen grains were grounded in a test tube and transferred to metal stub for examination.

The terminology followed here is based on Erdtman (1952, 1969, 1970); Faegri & Iversen (1950, 1964); Erdtman *et al.*, (1961) and Walker & Doyle (1975).

Results

The genus *Convolvulus* is stenopalynous taxon. The pollen grains are radially symmetrical, isopolar, medium in size.

Polar axis (P) 39-(61) - 68 µm, equatorial diameter (E) 32-(65) - 66 µm. P/E ratio x100 (84-180), trilobed fossaperturate in equatorial outline. The shape of the grains range from prolate-spheroidal to oblate-spheroidal often sub-prolate to prolate, trizonocolpate, occasionally tetra-hexazonocolpate, ectoaperture long with tapering or acute ends, colpal membrane granulated. Exine thick, sexine thicker than nexine, baculated, distinctly stratified in LM (Fig 2). The ectexine is generally three layered with a clearly differentiated foot layer, the middle columellar layer or interstitium (Walker & Walker, 1981), columellae sometimes dichotomously or trichotomously branched, densely spaced (Fig 5). Tectum reticulate/punctate - scabrate.

Discussion

Convolvulaceae is a eurypalynous family in which the pollen morphology has been quite useful in resolving several taxonomical problems, particularly at subfamily and generic level. Spinulose and non spinulose type of grains are present in the family (Hallier, 1893; Lewis & Oliver, 1965). The number, position and shape of apertures are also quite variable in Convolvulaceae. Sengupta (1972) reported tricolpate, penta, hexacolpate, dodecacolpate and pentaporate types of grains in the family. However, the pollen of the genus *Convolvulus* seem to be fairly uniform and the species do not depict much variations. In the genus *Convolvulus* Sengupta (1972) recognized 2 different pollen types on the basis of exine pattern. *C. arvensis* and *C. clavertii* with distinctly punctate exine were placed in one group while the remaining species with finely punctate exine were placed in the second group. Cronk & Clarke (1981) although did not observe any significant variation among *Convolvulus* species, but they separated *C. lineatus* from other species due to the presence of

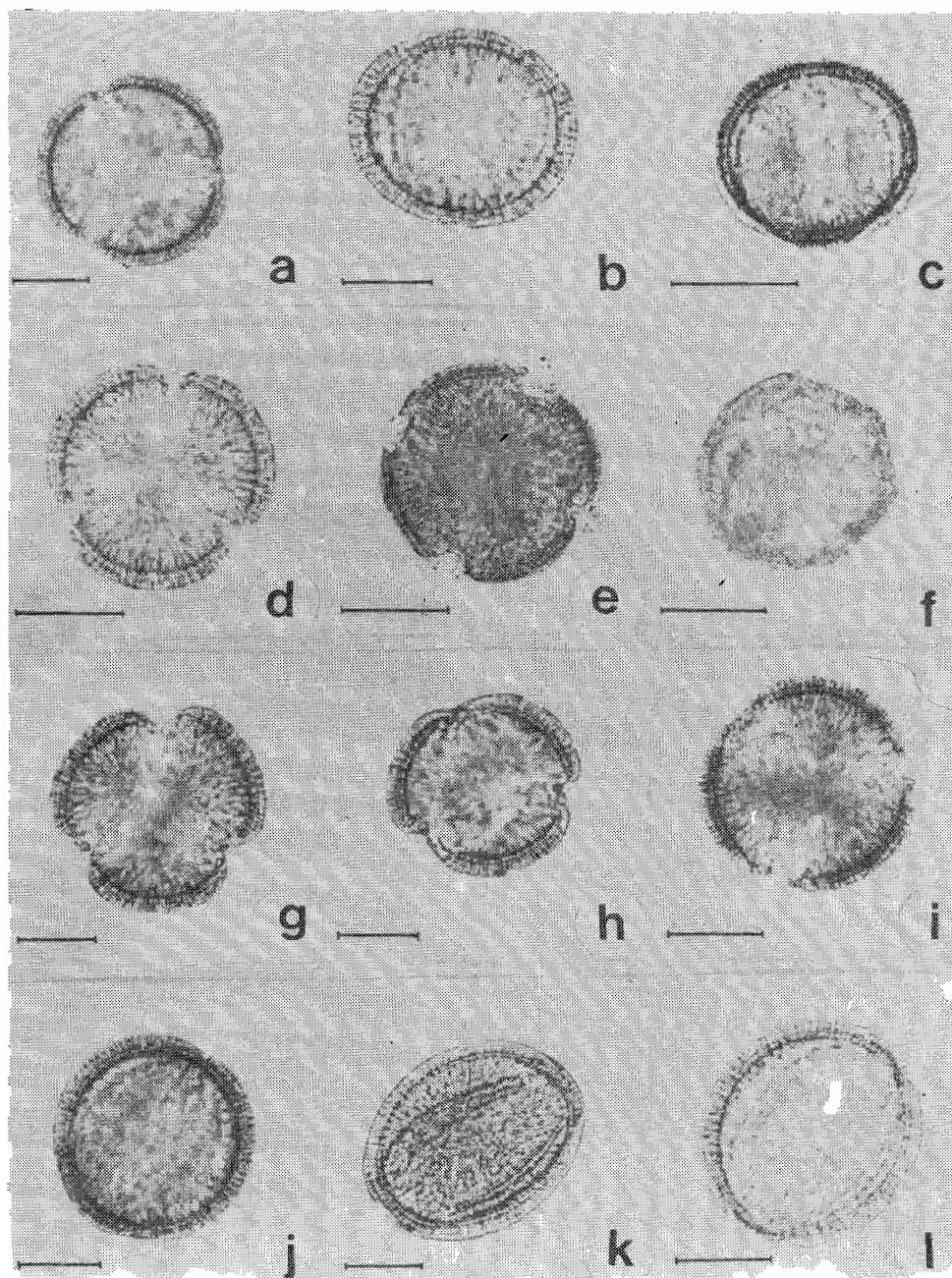


Fig. 2. Light micrographs (LM) of the grains, *Convolvulus pilosellaefolius* a, Polar view. *C. hystrix* b, equatorial view. *C. cephalopodus* : c, equatorial view. *C. austro-aegypticus* : d, polar view. *C. glomeratus* e, f polar view tetra-hexacolpate grains. *C. prostratus* : g, polar view. *C. fatmensis* : h, polar view. *C. bushiricus* i, polar view. *C. arvensis* : j, equatorial view. *C. oxyphyllus* : k, equatorial view. *C. deserti* : l, equatorial view. Scale bar = 20µm.

Account of pollen-types

I: Coarsely reticulate - type (Fig. 3 , a, b, c, d).

Pollen tricolpate, medium, prolate-spheroidal to prolate (P/E : 101-181) , trilobed fossaperturate, ectoaperture long, with tapering ends. Tectum very coarsely reticulate to coarsely .

Species included : -

<i>C. arvensis</i>	<i>C. austro-aegypticus</i>
<i>C. fatmensis</i>	<i>C. hystrix</i>
<i>C. buschiricus</i>	

II: Medium reticulate - type (Fig. 3 , e, f,).

Pollen tricolpate, medium, subprolate to prolate - spheroidal (P/E: 104 - 125), trilobed fossaperturate, ectoaperture long, with tapering ends. Tectum medium reticulate/punctate - scabrate.

Species Included : -

<i>C. spinosus</i>	<i>C. deserti</i>
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III: Finely reticulate-type (Fig. 4, a, b, c, d,).

Polen tri-tetra colpate rarely hexa colpate, subprolate to prolate-spheroidal or sub-oblate to oblate-spheroidal (P/E : 84-131) trilobed fossaperturate, ectoaperture long tapering ends. Tectum finely reticulate/Punctate - scabrate.

Species included :-

<i>C. acanthocladus</i>	<i>C. aitchisonii</i>
<i>C. fruticosus</i>	<i>C. cephalopodus</i>
<i>C. glomeratus</i>	<i>C. leptocladus</i>
<i>C. lineatus</i>	<i>C. leiocalycinus</i>
<i>C. oxyphyllus</i>	<i>C. prostratus</i>
<i>C. pilosellaefolius</i>	<i>C. pseudocantabrica</i>
<i>C. indicus</i>	

IV: Sparsely punctate-type (Fig. 4, e, f).

Pollen grain tricolpate, sub-prolate to prolate spheroidal (P/E : 103-118) trilobed. fossaperturate, ectoaperture long with tapering ends. Tectum scabrate-sparsely punctate.

Species included:-

<i>C. rhyniospermus</i>	<i>C. virgatus</i>
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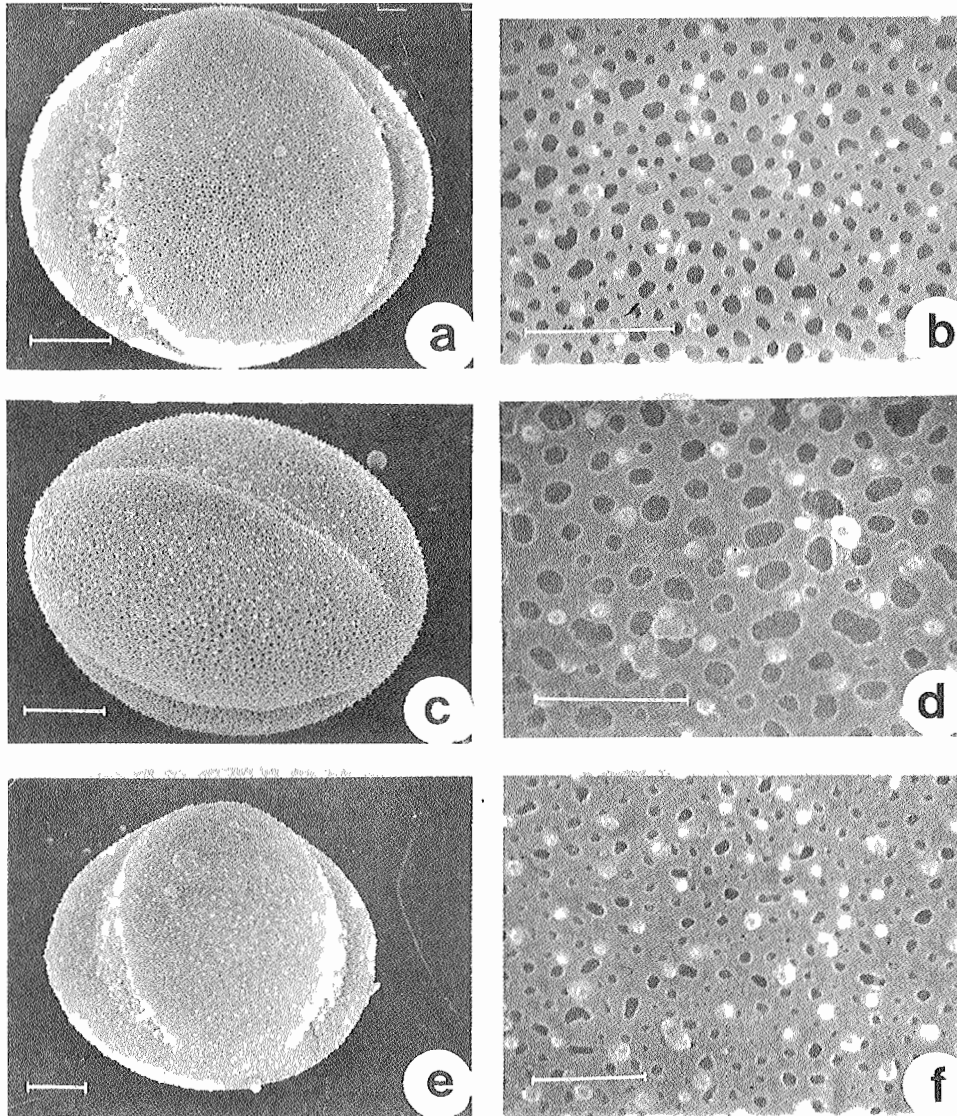


Fig. 3. Scanning micrographs (S.E.M) of the pollen grains *Convolvulus arvensis* : a, equatorial view ; b, exine pattern. *C. hystrix* : c, equatorial view ; d, exine pattern. *C. deserti* ; e, equatorial view ; f, exine pattern. Scale bar (a,c,e)=3 μ m ; (b,d,f)=10 μ m.

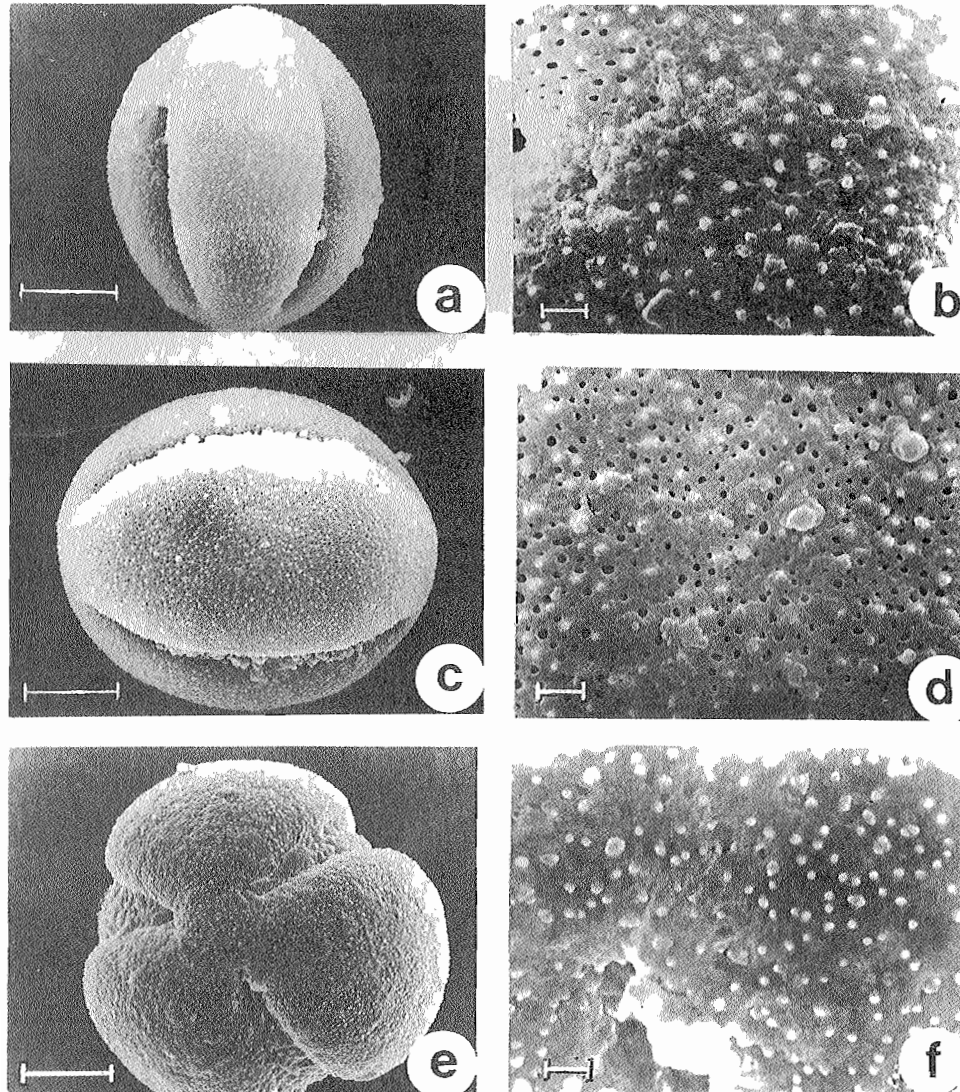


Fig. 4. Scanning micrographs of pollen grains. *Convolvulus leptocladus* a, equatorial view ; b, exine pattern. *C. pseudocantabrica*: c, equatorial view ; d, exine pattern. *C. rhyniospermus* e, polar view ; f, exine pattern. Scale bar (a,c,e)=10μm;(b,d,f)=1μm.

irregularly shaped luminae formed by the fusion of tectal punctae. The present studies showed that all the 22 *Convolvulus* species have trizonocolpate grains. However, in addition to trizonocolpate grains *C. glomeratus* showed 4-zonocolpate and *C. fatmensis* 6-zonocolpate grains, but their occurrence were infrequent. Cronk & Clarke (1981) also reported 6-zonocolpate grains in *C. lineatus* from north European species, while remaining species had normal trizonocolpate grains.

In the present survey, the following 4 different pollen types are recognized on the basis of exine pattern-luminae/punctae; which can be further subdivided on the basis of the shape of the grains.

Type I – Coarsely reticulate type: The tectum is clearly reticulate in which luminae are more or less irregular in shape, c. 4 μm in diameter e.g., *C. arvensis*, *C. austro-aegypticus*, *C. buschiricus*, *C. fatmensis* and *C. hystrix* are included in type I. However, *C. hystrix* can easily be delimited from the rest of the species by having a very coarsely reticulate tectum, where the luminae are more regular in shape. On the basis of the grains shape type I may be subdivided into 2 subtypes A and B. Subtype A is characterized by the prolate grains which includes a single species viz., *C. arvensis*, while the subtype B is characterized by prolate-spheroidal grains which includes the remaining 4 species.

Type II – Medium reticulate type: The tectum is medium reticulate/punctate-scabrate, luminae are more or less circular in shape, 0.5-2 μm in diameter. Only *C. deserti* and *C. spinosus* are included in this type.

Type III – Finely reticulate/punctate-scabrate type: This is characterized by finely reticulate/punctate-scabrate tectum with circular luminae/punctae, which are 0.1-0.5 μm in diameter. This type is the largest among all the four types comprising of 13 species. The type III also shows considerable variation in the grains shape. Four subtypes A-D can be recognized on the basis of the shape of the grains. *Subtype A* includes *C. aitchisonii*, *C. leiocalycinus*, *C. lineatus* and *C. indicus* which are characterized by prolate-spheroidal grains, while in subtype B subprolate grains are found viz., *C. cephalopodus*, *C. glomeratus*, *C. oxyphyllus* and in *C. prostratus*, *Subtype C* includes *C. pilosellaefolius*, *C. fruticosus* and *C. pseudocantabrica* which have oblate-spheroidal grains. *Subtype D* comprises of two species viz., *C. acanthocladus* and *C. leptocladus* characterized by suboblate grains.

Type IV – Sparsely punctate-scabrate type: This type is readily recognized from the other types by its densely scabrate-sparsely punctate tectum *C. rhyniospermus* and *C. virgatus* can easily be separated on the basis of the shape of the grains. In *C. virgatus*, subprolate and in *C. rhyniospermus* prolate spheroidal grains are found.

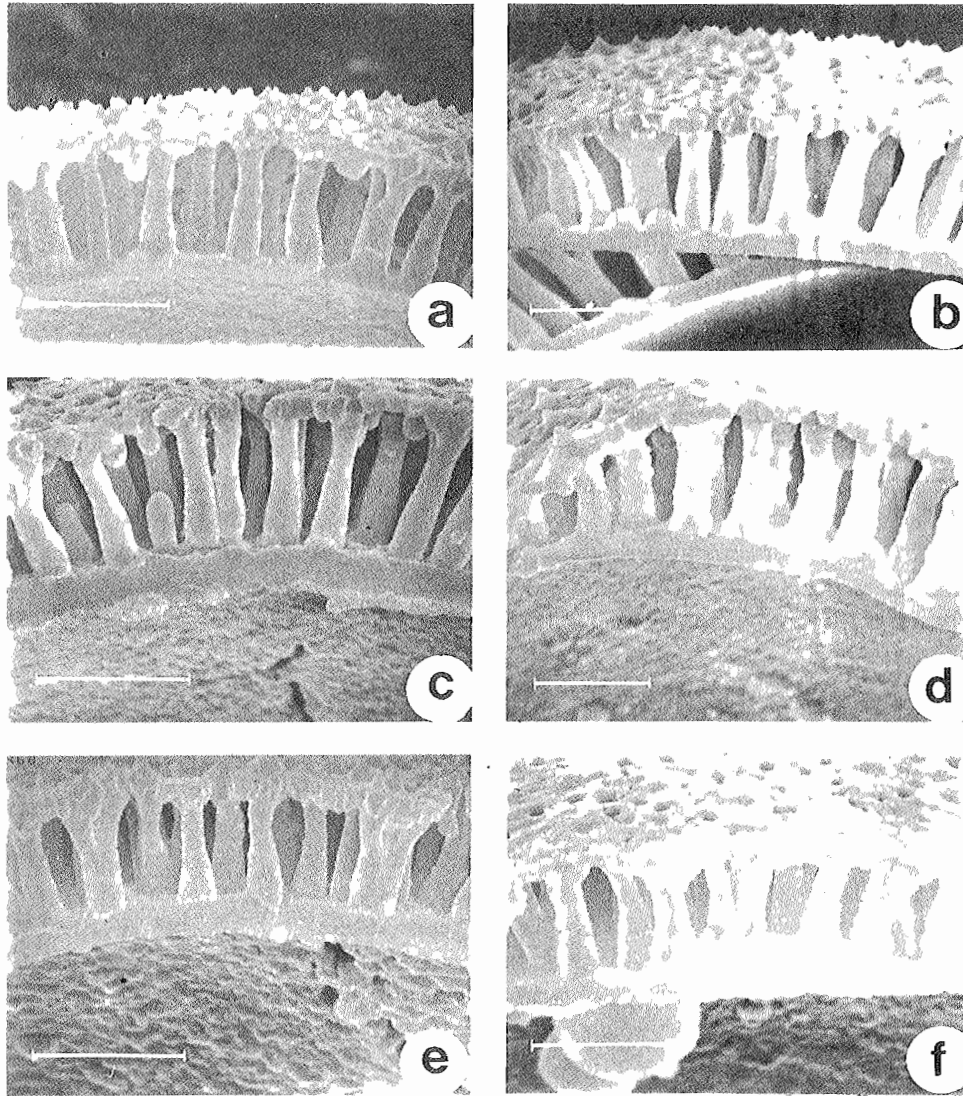


Fig. 5. Scanning micrographs of fractured pollen. *Convolvulus glomeratus* a, *C. deserti* b, *C. buschirius* c, *C. austro-aegypticus* d, *C. fatmensis* e, *C. arvensis* f. Scale bar=3 μ m.

Taxonomic implications: Boissier (1879) divided the genus *Convolvulus* L., into two groups viz., Perennes (perennial) and Annus (annual). The perennial group was further divided into 8 Series viz., Acanthocladi, Spinescentes, Compacti, Innermes, Pannosi, Diffusi Volubilis and Scandentes, on the basis of the presence or absence of spines, habit and branching patterns, under the annual group two series viz., Siculi and Undulati have been recognized, on the basis of the pubescence of capsule. Six series of perennial group were included whereas in the present investigation 2 series Compacti and Volubilis could not be investigated due to non availability of material. However 4 types, recognized on the basis of the tectum do not correspond with the different series of the genus *Convolvulus*. In all the groups, taxa of different series are present, eg., finely reticulate punctate type included the taxa of series Acanthocladi and Diffusi. On the other hand some of the taxa of the series Acanthocladi are found in medium reticulate type. Similarly *C virgatus* and *C rhyniospermus* have similar type of tectum but are included in different series. It is therefore apparent that infera generic classification proposed by the previous workers seems to be arbitrary as it is not supported by the pollen morphology. A proper infera generic classification is therefore necessary.

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Appendix 1. List of specimens of the genus *Convolvulus* examined.

Species	Collection	Location
<i>C. acanthocladus</i>	Leonard 5877 (KUH)	Iran, Jauz Muraian
<i>C. aitchisonii</i>	Afandi 977 (KUH)	Pakistan, Parachinar
<i>C. arvensis</i>	Chaudhary 6704 (RAWRC)	Saudi Arabia, Itadda
	Dean E.51 (E)	Saudi Arabia, Al Hassa
	Nasher H 49 (E)	Saudi Arabia, Asir
	Ritchie 14 (E)	Bahrain
	Anjum perveen 132 (KUH)	Pakistan, Karachi
<i>C. austro-aegypticus</i>	Chaudhary 6696 (RAWRC)	Saudi Arabia, Riyadh
	Chaudhary 6696 (RAWRC)	Saudi Arabia, Riyadh
	Chaudhary 3803 (RAWRC)	Saudi Arabia, Wadi Nisa
	Alawy 26 (RAWRC)	Saudi Arabia, Qassene
<i>C. buschiricus</i>	Collenette 2497 (E)	Saudi Arabia, Buraydah
	Alawy 43 (RNG)	Saudi Arabia, Buraydah
	Chaudhary 7560 (RAWRC)	Saudi Arabia, A-Kharj
	Chaudhary 7819 (RAWRC)	Saudi Arabia, Buraydah
<i>C. cephalopodus</i>	Qasir et ol 995 (KUH)	Pakistan, Karachi
	Maconochie 3322 (E)	Oman, Seeb Airport
	Challagher 6692/1	Oman, Qurm natur
	Collenette 2661 (E)	Saudi Arabia, Abha
<i>C. deserti</i>	Schimper 783 (E)	Saudi Arabia, Jeddah
	Alawy 28 (RNG)	Saudi Arabia, Qasseene
<i>C. fatmensis</i>	Chaudhary 6710 (RAWRC)	Saudi Arabia, Al-Kavj
	Al-Hassan 11 (RAWRC)	Saudi Arabia, N. of DS
<i>C. fruticosus</i>	Ghafoor & R. Yusuf 103 (KUH)	Pakistan, Sibi
<i>C. glomeratus</i>	Anjum Perveen 42 (KUH)	Pakistan, Karachi
	Anjum Perveen 272 (KUH)	Pakistan, Karachi
	Chaudhary 3977 (RAWRC)	Saudi Arabia, Wadi Nisah
	Dawood E-797	Saudi Arabia, Bana
	Alawy 81-82 (RNG)	Saudi Arabia, Riyadh
	Miller 2270a (E)	Oman, Dhofar
<i>C. hystrix</i>	Chaudhary 6713 (RAWRC)	Saudi Arabia, Jeddah
	Gallagher 6768/6 (E)	Oman, Wadi Itaytam
	Kurschner 6476 (E)	Saudi Arabia, Mekkah
<i>C. leiocalycinus</i>	Sarwar Alam S.n. (KUH)	Pakistan, Ziarat
<i>C. leptocladus</i>	Leonard 5921 (KUH)	Iran, Bandar Abbas & Sirjan
<i>C. lineatus</i>	Hedge & Wendelobe 3233 (KUH)	Afghanistan, Kabul
<i>C. oxphyllus</i>	Chaudhary 3464 (RAWRC)	Saudi Arabia, Itail
	Chaudhary E.801 (RAWRC)	Saudi Arabia, Buradah
	Alawy 7 (RNG)	Saudi Arabia, Riyadh
	Alawy 38 (RNG)	Saudi Arabia, Alafraj
	Chaudhary E. 298 (RAWRC)	Saudi Arabia, Zihirah
<i>C. pilosellaefolius</i>	Hedge & Wendelob 3847 (KUH)	Afghanistan, Balkh
<i>C. prostratus</i>	Anjum Perveen 70 (KUH)	Pakistan, Karachi
	Anjum Perveen 106 (KUH)	Pakistan, Karachi
	Abrar S.n. (KUH)	Pakistan, Karachi
<i>C. pseudocantabrica</i>	Ghafoor & Qaiser 269 (KUH)	Pakistan, Makran
<i>C. rhygiospermus</i>	Anjum Perveen (KUH)	Pakistan, Karachi.
	S.M.H. Jafri S.n. (KUH)	Pakistan, Karachi
<i>C. indicus</i>	S.M.H. Jafri S.n. (KUH)	Pakistan, Jamshoro
<i>C. spinosus</i>	Qaiser & Ghafoor 33 (KUH)	Pakistan, Awaran
<i>C. virgatus</i>	Leonard 5876 (KUH)	Iran, Jauz Murain