

## SEED MORPHOLOGICAL STUDIES OF SOME COMMON PLANTS OF KARACHI

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### Abstract

Seed morphology of 78 species, belonging to 62 genera, distributed in 28 families have been studied. These investigations involve the study of shape, colour, surface and position of hilum and lens, size, weight and number of seeds/fruit. Seed surface have been studied by scanning electron microscopy.

### Introduction

Seed is commonly defined as fertilized ovule (Duke, 1969). The classical idea of the seed as an integumented megasporangium is the source of modern theories that seeds are evolved with special multiplicative layers (Corner, 1976). Seed morphology plays an important role in the systematics and is helpful in the delimitation of many taxa (Duke, 1969; Corner, 1976). The importance of seed morphology in plant systematics is readily apparent in Gray's manual where the second major division is termed as spermatophyta (Fernald 1950). Recently the technique of scanning electron microscopy has been widely used for the study of seed surface (Gutterman, 1973a, 1973b; Skvortsov & Rusanovitch, 1974; Seavey *et al.*, 1977; Hynes, 1979; Wickens & Bywater, 1979; Carolin, 1980; Lye, 1981, 1983; Jones & Safa, 1982; Chuang & Heckard, 1983; Gunn, 1984; Wagner & Goldblatt, 1984; Mathews & Levins, 1985; Rabelev, 1985; Panigrahi, 1986; Khushk & Vaughan, 1986; Bacon *et. al.*, 1986; Terrell *et al.*, 1986).

In Pakistan little work has been done on the seed morphology. Nasir (1985, 1986) employed the data of seed morphology in the taxonomy of the genus *Androsace* L. and *Primula* L. species from Pakistan. Qaiser (1987) studied the seed morphology of family Tamaricaceae from Pakistan and used the data in the taxonomy of this intricate family. The object of the present study is to delimit the different taxa on the basis of their seed morphology.

### Material and Methods

Seeds of 78 taxa growing wild in and around Karachi were collected. Only fully matured and healthy seeds were considered and for each observation 20-25 readings were taken. Following parameters were studied: 1. seed shape, 2. seed colour, 3. shape and position of hilum, 4. shape, position and colour of lens (in case of Leguminous seeds), 5.

seed weight, 6. number of seeds per fruit, 7. size of seeds, 8. hilum length/diameter, 9. seed surface. For detailed observation of seed surface, scanning electron microscopy was employed. For this purpose seeds were mounted on the metallic stub with the help of double adhesive tape. Each stub was subjected for six minutes in a sputtering unit for gold coating. The seeds were studied by scanning electron microscope (Jeol JSM – T200) in SEM laboratory of the Biological Research Centre, University of Karachi.

## Results and Discussion

Results are presented in Table 1. Angiospermic seeds vary in structure, but are fairly constant in the narrow taxonomic groups, therefore frequently used in the evaluation of various taxonomic studies (McClure, 1957). Stace (1980) distinguished four European subspecies of *Montia fontana* (Portulacaceae) on the basis of the seed morphology. In the present investigation various seed morphological characters viz., seed colour, shape, surface, size, weight, shape, position and colour of lens and hilum have been used in the identification of the various taxa.

Duke (1969) pointed out that brown seed colour was most frequent and occurred in almost half of the angiospermic families. In the present investigation brown colour had also been found quite common (46.2%) followed by black (26%), yellow (7.7%), grey (5.2%), white (5.2%), green (2.5%) and maroon (1.3%). As evident from Table 1 monochromic condition was most abundant while bichromic was rare (only 7.7%). Bichromic seeds were present only in Aizoaceae, Boraginaceae, Salvadoraceae and Papilionaceae. At family level several seed colour types were present but at generic and specific level, this character seemed to be fairly constant. Consequently, colour appeared to be good diagnostic character to delimit various members of a family. In Papilionaceae and Boraginaceae both monochromic and bichromic seeds were observed. In the genus *Rhynchosia* (3 species) and *Alhagi maurorum* seeds were bichromic in all other studied genera monochromic seeds were present. Gillet *et al.*, (1971) demonstrated that the seeds of *Rhynchosia pulverulenta* were red-brown, mottled black; but our observations did not accord his findings i.e., the seeds were yellow, besets with light green patches. *Polygonum barbatum* seemed to be unique in producing dimorphic seeds. Both types i.e. trigonous and biconvex seeds were produced by the same plant. Harper *et al.*, (1971) have already observed seed dimorphism in the species *Atriplex* and *Polygonum*. In *Launaea nudicaulis* also dimorphic cypselas were observed within the same capitulum i.e., disc floret cypselas were ribbed, whitish brown, while ray floret cypselas were black and not distinctly ribbed.

Taxa of some families were provided with arils viz., *Atriplex stocksii*, *Cadaba fruticosa*, *Glinus lotoides*, *Momordica balsamina* and *Rhynchosia capitata*. Corner (1954) suggested that the truly arillate seed was a primitive character in angiosperms, but on the other hand arils and sarcotestae were generally regarded as adaptations for seed dispersal

Table 1. Some morphological characters of seed and fruits of the studied taxa.

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit		Seed/Cypselae Description
					Min.	Ave.	
1. <i>Peristrophe bicalyculata</i> (Retz.) Nees Voucher: Karachi University Campus, 23.10.86, Razia Ahmed 53.	2 ± 0.02	2 ± 0.02	0.28 ± 0.004	0.008	2	5	Seeds orbicular, compressed, black tuberculate, tubercles wide spread with hexagonal areoles forming net like structure in between tubercles; hilum marginal, oblong in out line and provided with dense white tissue.
2. <i>Ruellia tuberosa</i> L. Voucher: Karachi University Campus, 23.10.86, Razia Ahmed 55.	2.6 ± 0.04	2.1 ± 0.04	0.48 ± 0.00	0.0016	16	28	Seeds sub-orbicular, compressed, densely hairy, hairs unicellular, brown, persistent; hilum marginal, linear-oblong in our line (Fig. 1a-b).
3. <i>Limeum indicum</i> Stocks ex T. And. Voucher: Thatta, 24.1.87, Razia Ahmed 83.	0.98 ± 0.03	1.61 ± 0.05	0.06 ± 0.01	0.0007	2	2	Seeds sub-reniform, plano-convex, dull blackish-brown and besets with distinct light brownish spots; at young stage 2 seeds are attached with each other; dorsal surface with distinct rim like structure and rounded tissues; hilum basal, circular in out line (Fig. 1c).
4. <i>Amaranthus graecizans</i> L. Voucher: Sajawal, 18.4.87. Razia Ahmed 106.	0.96	0.96	0.04	0.0004	1	1	Seeds circular-orbicular, biconvex, shining black; surface areolate but psilate in the centre, areola ± polygonal in shape; hilum marginal situated in groove, ± circular in out line (Fig. 1d-e).
5. <i>Calotropis procera</i> (Willd.) R. Br. Voucher: Karachi University Campus, 20.11.86, Razia Ahmed 23	6.5* ± 0.2	4.5* ± 0.1	—	0.003*	227	350	Seeds broadly ovate, flattened with a narrow papery margin, brown, comose at the apex (coma deciduous) otherwise sparsely hairy, shortly tuberculate; hilum not prominent.

(Table 1 Contd.)

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit			Seed/Cypselas Description
					Min.	Max.	Ave.	
6. <i>Heliotropium europaeum</i> L. Voucher: Botany Department, 1.7.87, Razia Ahmed 124	1.6 ± 0.04	1.02 ± 0.04	0.21 ± 0.00	0.001	4	4	4	Seeds obovate-reniform, dull black; dorsal surface besets with setae, setae not tuberculate, tubercles within the setae, setae narrowly ovate, acute at apex, on ventral surface no distinct pattern visible; aveolae lateral, oblong with white tissue. (Fig. 1f-g).
7. <i>H. ophioglossum</i> Stocks Voucher: Karachi University Campus, 23.10.96 Razia Ahmed 54	1.4 ± 0.02	1 ± 0.00	0.2 ± 0.00	0.0007	4	4	4	Seeds oblong, dull black; dorsal surface tuberculate; tubercles with rounded heads, on ventral surface no distinct pattern visible ± psilate; aveolae basal, oblong in out line. (Fig. 1h-i)
8. <i>H. ramosissimum</i> Sieber, Voucher: Karachi University Campus, 1.7.87, Razia Ahmed 123	1.9 ± 0.09	1.04 ± 0.09	0.32 ± 0.04	0.001	4	4	4	Seeds obovate, dull black; dorsal surface besets with setae, setae slightly curved to ± hooked at the apex, flattened in the centre, tapering at both ends, sparsely tuberculate; on ventral surface no distinct pattern visible; aveolae lateral, oblong in out line (Fig. 1l-m).
9. <i>H. strigosum</i> Willd. Voucher Karachi University Campus 1.1.87, Razia Ahmed 76.	1.3	1	0.23	0.0006	4	4	4	Seeds reniform, dull grey; dorsal surface besets with long setae like structure, setae linear – narrowly ovate, obtuse, minutely tuberculate; but tubercles dense in between the setae, aveolae lateral, linear – delioid, with white tissue (Fig. 1j-k).

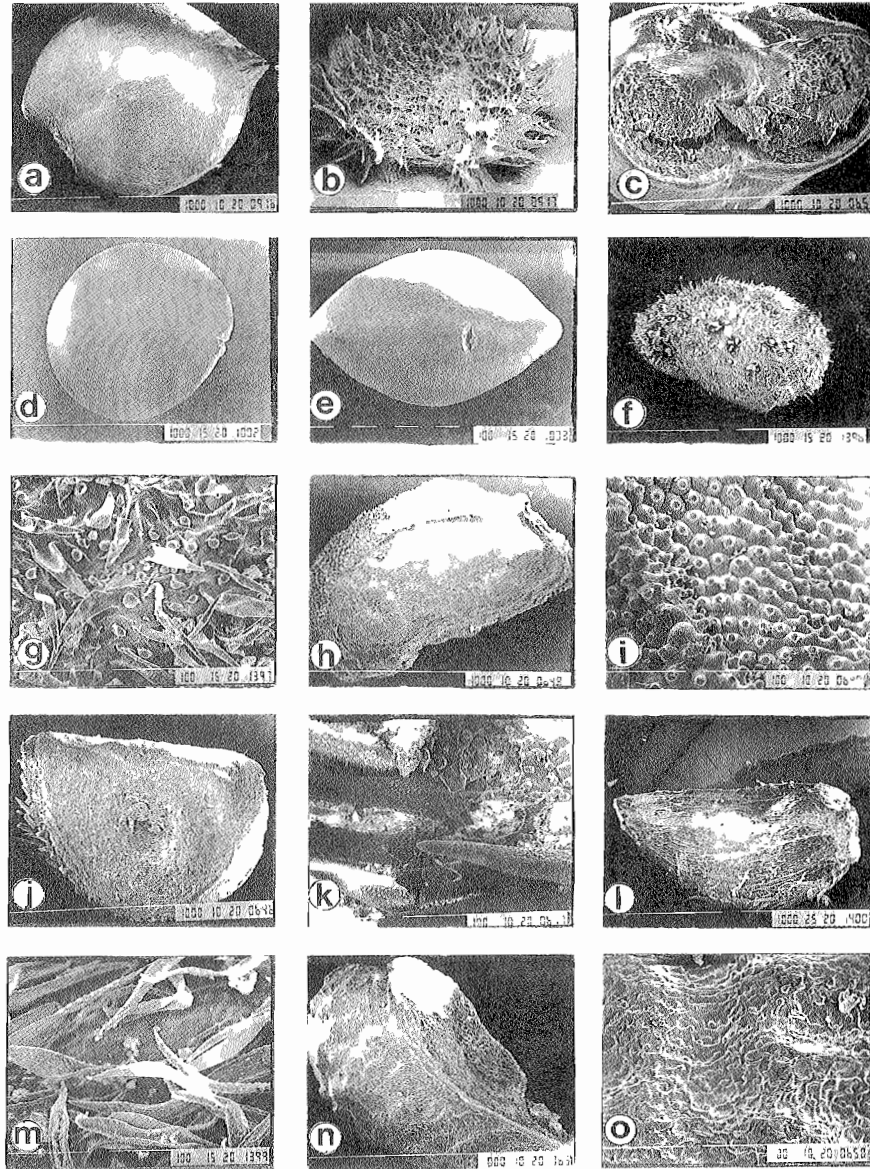


Fig. 1. Scanning micrographs: *Ruellia tuberosa*: a, entire seed; b, seed hairs (moist with water); *Lineum indicum*: c, ventral surface; *Amaranthus graecizans*: d, entire seed, e, entire seed showing shape and position of hilum; *Heliotropium europaeum*: f, entire seed/nutlet; g, surface pattern of nutlet; *H. ophioglossum*: h, entire seed/nutlet; i, surface pattern; *H. strigosum*: j, entire seed/nutlet; k, surface pattern; *H. ramosissimum*: l, entire seed/nutlet; m, surface pattern; *H. subulatum*: n, entire seed/nutlet; o, surface pattern (Figs. a-d, f, h, j, l, n, white bar= 1000  $\mu$ m; Fig. e, g, i, k, m, o, white bar = 100  $\mu$ m).

(Table 1 Contd.)

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit		Seed/Cypselae Description	
					Min.	Ave.		
10. <i>H. subulatum</i> (Hochst.) Vaitke. Voucher: Karachi University Campus, 19.11.86, Razia Ahmed 21	1.4 ± 0.94	1 ± 0.00	.2	0.0006	4	4	4	Seeds obovate, brown; ventral surface with distinct rim; surface striated ± wavy, intermingled with small rounded projections (tubercle?); aveolae sub basal, oblong deltoid in out line with white tissue (Fig. 1n-o).
11. <i>Trichodesma amplexicaule</i> Roth, Voucher: Karachi University Campus 6.10.86, Razia Ahmed 68.	3.9	2.5	—	0.0114	4	4	4	Seeds obovate, plano-convex, greyish-white besets with distinct grey spots; dorsal surface with rounded warts, ventral surface with broad irregular ridges but without warts; hilum or aveolate not prominent (cocci attached to the ovary wall with their whole length).
12. <i>Caesalpinia bunduc</i> (L.) Roxb., Voucher: Darsino Chino, 24.1.87 Razia Ahmed 88.	20.1	19.5	0.9	1.95	2	2	2	Seeds spherical, carunculate, dull green, psilate; hilum basal, circular in out line; lens circular, dull yellow, not confluent with the hilum.
13. <i>Cassia senna</i> L., Voucher: Thatta, 24.1.87, Razia Ahmed 89.	6 ± 0.12	3.5 ± 0.4	0.4 ± 0.00	0.023	3	7	5.45	Seeds wedge shaped, ± compressed, yellow; irregularly and distinctly striated; hilum lateral, ovate in out line and surrounded by some whitish tissue; lens inconspicuous.
14. <i>Cadaba fruticosa</i> (L.) Druce, Voucher: Karachi University, 6.10.86, Razia Ahmed 6.	1.99 ± 0.04	2.11 ± 0.06	0.12 ± 0.002	0.0024	6	18	10.62	Seeds reniform, black, arilate, aril orange-red; surface striated while the central part of the seed is ± psilate and without any distinct striation; hilum marginal, circular in out line.

(Table 1 Contd.)

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit			Seed/Cypselia Description
					Min.	Max.	Ave.	
15. <i>Spergularia diandra</i> (Guss.) Heldr. & Sart. Voucher: Sajawal, 18.4.87 Razia Ahmed 103.	0.6 ± 0.008	0.4 ± 0.004	0.03 ± 0.001	0.000018	±90	±208	±125.8	Seeds broadly obovate, brown; tuberculate, tubercles club shaped with distinct warts on and in between the tubercles; hilum sub-basal, linear-spindle shaped (Fig. 2a-b).
16. <i>Atriplex stockii</i> (Wt.) Boiss., Voucher: Karachi University, 19.11.86, Razia Ahmed 17.	2.15 ± 0.04	2.07 ± 0.04	0.08 ± 0.004	0.0019	1	1	1	Seeds orbicular, compressed, plano-convex, arilate, aril membranous; seeds of 2 different colour either dull black or some what brown; surface with somewhat transversely elevated ridges; hilum marginal ± circular in out line.
17. <i>Haloxylon recurvum</i> Bunge ex Boiss., Voucher: Thatta, 24.1.87. Rais Ahmed 91.	1.71 ± 0.05	1.71 ± 0.05	0.12 ± 0.00	0.0024	1	1	1	Seeds ± orbicular, scurfy whitish-brown; with persistent style, central part concave with distinct margin; surface without distinct pattern, hilum marginal, circular in out line.
18. <i>Salsola baryosma</i> (R.&S.) Dandy, Voucher: Karachi University Campus, 6.10.86, Razia Ahmed 117.	0.87 ± 0.080	0.86 ± 0.08	0.09 ± 0.004	0.0002	1	1	1	Seeds orbicular, whitish brown, central part ± convex; without distinct surface pattern, however, near the hilum small island like structures can be seen which are formed by small longitudinal and transverse ridges; hilum marginal, circular in out line (Fig. 2c).
19. <i>Suaeda fruticosa</i> (L.) Forssk., Voucher: Capemonze, 21.10.87, Razia Ahmed 69.	0.9 ± 0.007	1.3 ± 0.02	0.13 ± 0.002	0.0004	1	1	1	Seeds sub-reniform, convex, shining black; irregularly areolate, areola somewhat elevated and rectangular, central part ± psilate, hilum lateral, circular in out line with white tissue (Fig. 2-d).

(Table 1 Contd.)

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit		Seed/Cypsela Description
					Min.	Ave.	
20. <i>S. nudiflora</i> (Wild.) Moq. Voucher: Capemonteze, 21.10.86, <i>Razia Ahmed</i> 31.	0.67 ± 0.008	1 ± 0.03	0.08 ± 0.00	0.0002	1	1	Seeds sub-reniform, convex, shining black; irregularly areolate, areola somewhat elevated, central part ± psilate, hilum lateral to marginal, ± circular with white tissue.
21. <i>Cichorium intybus</i> L., Voucher: Sajawal, 18.4.87. <i>Razia Ahmed</i> 105.	2.3 ± 0.11	1.2 ± 0.44	—	0.008	—	—	Cypsela oblong-linear, slightly curved, abruptly truncate at the apex, dull black; surface ribbed with wavy transverse striations traversed by small longitudinal striations; carpodium absent; pappus uniseriate, scaly (Fig. 3d-e).
22. <i>Dicoma tomentosa</i> Cass., Voucher: Karachi University Campus, 19.11.86 <i>Razia Ahmed</i> 14.	3.2 ± 0.9	2.5 ± 0.08	—	0.003	—	—	Cypsela oblong to broadly obovate, densely tomentose, surface strongly ribbed (by removing hairs), distinctly areolate in between the ribs; carpodium absent; pappus heteromorphic with 5-7 distinct broad and many thin densely scabrate setae (Fig. 2d-f).
23. <i>Echinops echinatus</i> DC. Voucher: Karachi University Campus, 6.10.86, <i>Razia Ahmed</i> 67.	14.5	5.05	—	0.0112	—	—	Cypsela obconic, densely villous; Carpodium ± circular; epappose.
24. <i>Gnaphalium americanum</i> Voucher: Botany Department, Karachi University Campus, Pappus 5.3.87, <i>Surayya Khatoon</i> 324.	0.46 ± 0.007	0.23 ± 0.04	—	0.000015	—	—	Cypsela oblong-elliptic, green; sparsely hairy, hairs very short, obtuse, surface ± psilate, carpodium from distinct ring; pappus barbelate from base to apex, frequently deciduous. (Fig. 2g-h).



(Table I Contd.)

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit		Setd/Cypsela Description
					Min.	Max. Ave.	
25. <i>Lactuca remotiflora</i> DC. Voucher: near Physics Department Karachi University Campus, 5.3.87, Surayya Khatoon s.n.	4.2 ± 0.06 6.3 ± 0.08	0.69 ± 0.03 4.1 ± 0.03	— —	0.0004	—	—	Cypsela spindle-narrowly ovate, apically beaked, black; longitudinally 4-5 ribbed which are running from base to apex; surface longitudinally striated traversed by transversely closed striations; carpodium not distinct however, 4-5 lobed structure is formed; pappus composed of several setae, sparsely scabrate (Fig. 2i-j).
26. <i>Launaea nudicaulis</i> (L.) Hook. f., Voucher: Capemonze, 21.10.86 Razia Ahmed 39.	2.5 ± 0.06 5.5 ± 0.12	0.61 ± 0.01 2.89 ± 0.05	—	0.0004	—	—	Cypsela linear, heteromorphic i.e. disc floret cypsela are whitish brown with 4 longitudinal ribs running from base to apex (Fig. 2k-l). Ray florets cypsela compressed, black, not longitudinally ribbed. Surface areolate, polygons are much longer than breadth; tuberculate, tubercles irregular in shape ± rounded-subtriangular carpodium absent; pappus sparsely barbelate-scabrous
27. <i>Launaea resedifolia</i> (L.) O. Kuntze, Voucher: Capemonze, 21.10.86 Razia Ahmed 43.	4.63 ± 0.13 8.5	0.51 ± 0.06 2.63	—	0.0006	—	—	Cypsela linear-cylindrical, dull grey, densely hairy, papillose, papillae ± club shaped; carpodium absent; pappus smooth, central setae made up of closely compact elongated cells while side setae are ± unicellular.

(Table 1 Contd.)

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit			Seed/Cypsela Description
					Min.	Max.	Ave.	
28. <i>Oligochaeta ramosa</i> (Roxb.) Wagenitz Voucher: Capmonze, Pappus 21.10.86, Razia Ahmed 29.	4.83 ± 0.09 12.5 ± 0.098	1.7 ± 0.06 6.9 ± 0.83	—	0.005	—	—	—	Cypsela broadly linear, acutely angled, golden brown; longitudinally ribbed; carpodium absent; pappus brown, heteromorphic, composed of 2-5 inner longer (12-15mm), broader (0.5-1mm), compressed, densely barbelate setae and outer several cylindrical, moderately barbelate setae (Fig. 2n).
29. <i>Pluchea arguta</i> Boiss. Voucher: Capmonze, 21.10.86 Razia Ahmed 32	1.21 ± 0.02 4.45 ± 0.04	0.54 ± 0.008 1.82 ± 0.82	—	0.00029	—	—	—	Cypsela broadly spindle shaped, brown, sparsely hairy; cypsela hairs tricellular including one basal cell and two elongated cells of which one is slightly longer than other giving an appearance of a bifurcated hair; surface areolate, areola longer than breadth; carpodium, basal, broad-circular in outline; pappus composed of several setae, setae densely barbelate. (Fig. 20, 3a).
30. <i>Pulicaria angustifolia</i> DC., Voucher: Capmonze, 21.10.86, Razia Ahmed 28	1.5 + 0.00 3.5** ± 0.0	0.5 + 0.00 3.5** ± 0.00	—	0.000133	—	—	—	Cypsela broadly linear, quadrangular, brown with few scattered cypsela hairs, nature of the hairs ± similar to <i>Pluchea arguta</i> ; surface areolate, rectangles almost equal in size and giving an appearance of closely fitted; Carpodium sub-basal, forming a distinct rim like structure; pappus biseriolate, inner pappus short, composed of ± scales like structure, outer setae long, densely barbelate. (Fig. 3b-c).

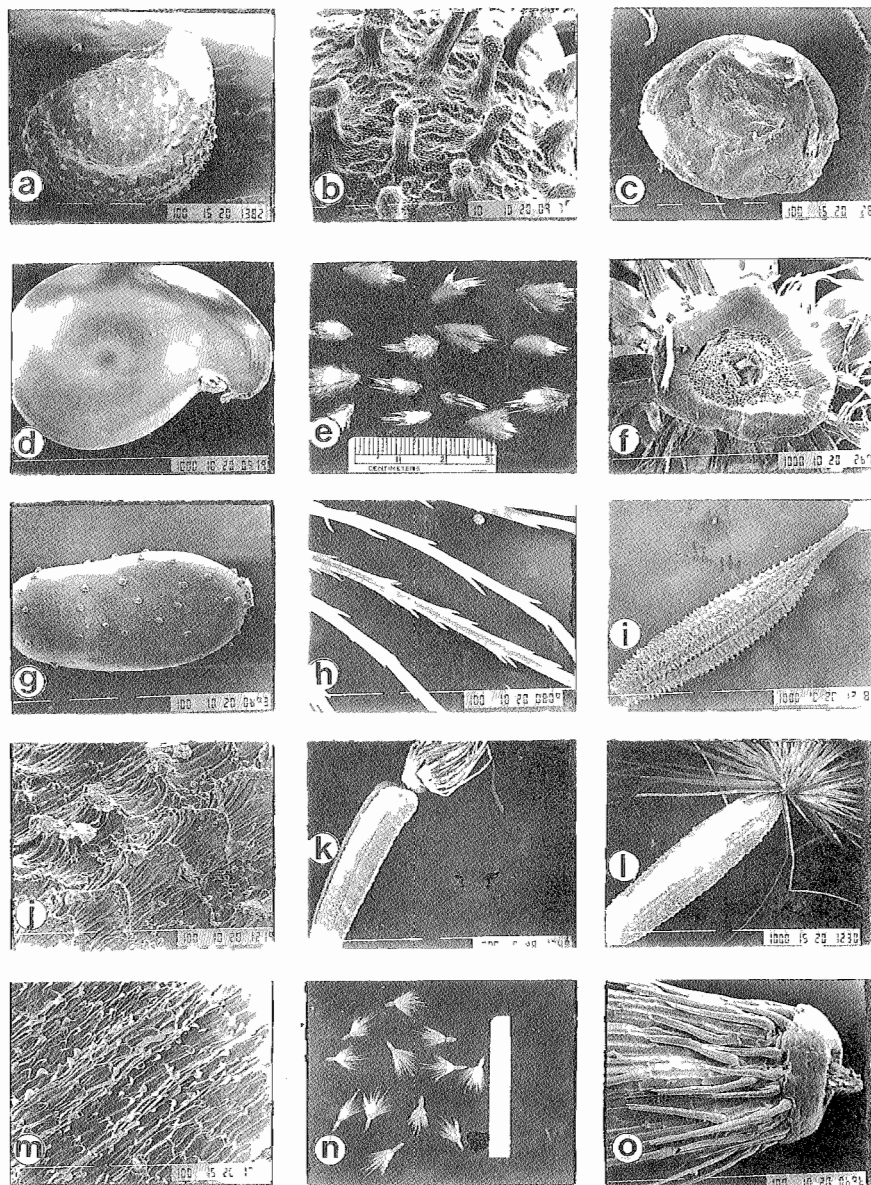


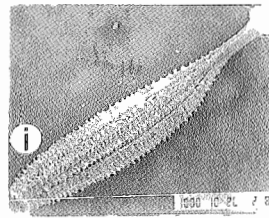
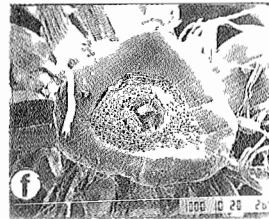
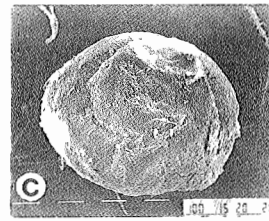
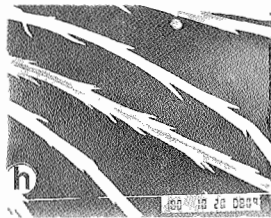
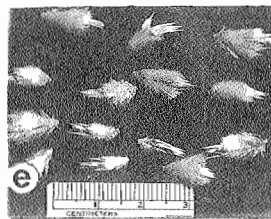
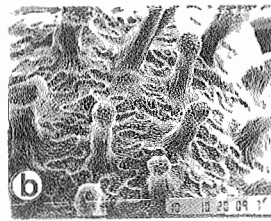
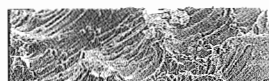
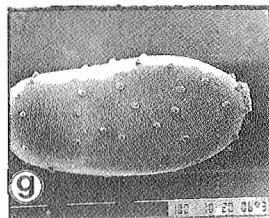
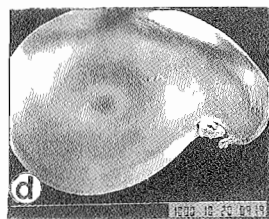
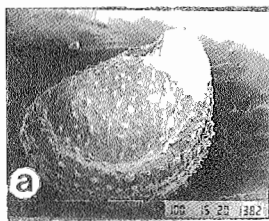
Fig. 2. Scanning micrograph; *Spargula diandra*: a, entire seed; b, surface pattern; *Salsola baryosoma*: c, entire seed; *Suaeda fruticosa*: d, entire seed; *Dicoma tomentosa*: e, cypselas; f, base of the cypsela showing carpodium; *Gnaphalium americanum*: g, cypsela; h, pappus; *Lactuca remotiflora*: i, cypsela; j, surface pattern; *Launea nudicaulis*: k, cypsela (disc floret); l, cypsela (ray floret); m, surface pattern of ray floret cypsela; *Oligocheila ramosa*: n, cypsela; *Pluchea arguta*: o, base of the cypsela showing carpodium (Figs. a, c, g, h, j, m, o, white bar = 1000 µm; Fig. b, white bar = 10 µm; Fig. d, f, i, k, l, white bar = 1000 µm).

(Table 1 Contd.)

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit		Seed/Cypsela Description	
					Min.	Max. Ave.		
31. <i>Sonchus oleraceus</i> L. Voucher: Capamonzze, 10.2.87, <i>M. Qaiser</i> s.n.	3.26 ± 0.06 9.6 ± 0.3	0.9 ± 0.03 2.8 ± 0.06	—	0.0004	—	—	Cypsela narrowly obovate, compressed with distinct longitudinal groove running from apex to base, brown; surface areolate with distinct elongated rectangles; carpodium not distinct however, some lobe like structures are present; pappus very sparsely scabrate (Fig. 3f).	
32. <i>Triadax procumbens</i> L. Voucher: Karachi University Campus, 29.11.86 <i>Razia Ahmed</i> 24.	2.5 ± 0.2 6.5 ± 0.13	0.7 ± 0.01 6.76 ± 0.15	—	0.001	—	—	Cypsela linear-cylindrical densely pilose; carpodium basal, solid, circular in appearance; pappus composed of several setae, setae plumose (Feather Like)	
33. <i>Cressa cretica</i> L. Voucher: Karachi University Campus, 25.11.86, <i>Razia Ahmed</i> 61.	2.5 ± 0.03	1.9 ± 0.05	0.48 ± 0.013	0.0044	1	1	1	Seeds oblong-obovate, brown ± striated with sparse reticulation, hilum basal, ovate in out line (Fig 3g).
34. <i>Cuscuta hyalina</i> L. Voucher: Agriculture Institute, Karachi University Campus, <i>Razia Ahmed</i> 125	1.02 ± 0.06	0.98 ± 0.05	0.18 ± 0.00	0.0008	4	4	4	Seeds sub-circular, shining yellow; surface areolate, areola-irregular, unequal in size and shape; hilum basal, linear-oblong in out line (Fig. 3h).
35. <i>Ipomoea pes-caprae</i> (L.) R.Br. Voucher: Paradise Point, 21.10.86, <i>Razia Ahmed</i> 46	11 ± 0.2	9.2 ± 0.11	1 ± 0.00	0.127	4	4	4	Seeds oblong-broadly ovate, densely tomentose, hairs brown; dorsal face convex; hilum sub-basal, on ventral surface, broadly-ovate in out line.

(Table 1 Contd.)

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit		Seed/Cypselas Description
					Min.	Max. Ave.	
36. <i>I. pestigridis</i> L. Voucher: Darsano Chano, 24.1.87, Razia Ahmed 73.	5.72 ± 0.11	5.4 ± 0.1	1 ± 0.006	0.051	4	4	Seeds broadly oblong, obovate, mustard yellow with a convex dorsal face and subsequently bilobed at the ventral face; surface striatoareolatus (with irregular squares) which are further traversed with fine striation; hilum sub-basal, on ventral face, circular in out line (Fig. 3i).
37. <i>I. indica</i> Stapf Voucher: Physiology Department, Karachi University Campus, 5.6.87, Razia Ahmed 96.	3.4 ± 0.06	2.3 ± 0.04	0.3 ± 0.00	0.0064	4	4	Seeds oblong-ovate, moderately hairy; greyish black; surface finely reticulate, reticulation almost equal in size and shape, ± elevated; hilum sub-basal, present on ventral face, circular in out line.
38. <i>Seddera latifolia</i> Jaub. & Spach, Voucher: Capmonze, 21.10.86 Razia Ahmed	2.1 ± 0.02	1.05 ± 0.003	0.24 ± 0.001	0.0016	2	2	Seeds ovate, dark brown, surface distinctly areolate, areola ± equally delimited and rectangular oval in shape; hilum basal, circular in out line (Fig. 3j).
39. <i>Farsitia jacquemontii</i> Hook. f. et Thoms., Voucher: Karachi University, 1.7.87, Abrar Husain s.n.	3.8 ± 0.1	2.8 ± 0.1	0.12 ± 0.00	0.00024	5	14	Seeds orbicular, compressed, yellowish brown, winged; areolate, areola forming polygons of irregular size; hilum marginal, circular in out line (Fig. 3k-l).
40. <i>Momordica balsamina</i> L. Voucher: Darsano Chino 24.1.87, Razia Ahmed 84.	10.5 ± 0.2	6.5 ± 0.11	—	0.095	10	10	Seeds oblong-obovate, compressed greyish yellow in colour with carmine red aril; surface verruculose and marked with raised sinuous ridges which usually delimit ± elliptic area, distinctly grooved on the lateral faces; hilum inconspicuous.



(Table 1 Contd.)

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit		Seed/Cypselas Description	
					Min.	Ave.		
41. <i>Andrachne aspera</i> L. Voucher: Karachi University, 23.10.86, <i>Razia Ahmed</i> , s.n.	1.5 ± 0.005	1 ± 0.002	0.08 ± 0.00	0.0006	4	4	4	Seeds ± ovate, brown, with concave raphe; areolate, each areola marked with distinct longitudinal striations and ± regular in shape; hilum sub-terminal, circular in outline.
42. <i>Euphorbia indica</i> Lamk. Voucher: Karachi University, 7.6.87, <i>Razia Ahmed</i> 122.	1.63 ± 0.00	0.59 ± 0.00	0.05 ± 0.00	—	4	4	4	Seeds oblong; grey, areolate, but areola some what deep; sub-circular in outline, almost equal in size; hilum basal, circular in outline.
43. <i>Asparagus dumosus</i> Baker Voucher: Capemonze, 21.10.86, <i>Razia Ahmed</i> 44.	2.9 ± 0.034	2.78 ± 0.04	0.12 ± 0.001	0.017	1	4	2.6	Seeds ± circular, plano-convex, shining black areolate, areola hexagonal in shape ± equal in size; hilum basal-marginal ± dumbbell shaped (Fig. 3m-n).
44. <i>Dipcadi erythraeum</i> Webb, & Berth., Voucher: Karachi University Campus 31.3.87, <i>Saood Omer</i> s.n.	7.6 ± 0.24	7.3 ± 0.2	0.14 ± 0.002	0.0114	5	7	6	Seeds, ± circular, compressed, lumpy black, areolate, areola ± rectangular in shape; hilum marginal, ± circular in outline.
45. <i>Hibiscus intermedius</i> A. Rich., Voucher: Institute of Business Administration, Karachi University Campus, 21.5.87, <i>Razia Ahmed</i> 114.	2.1 ± 0.03	2.5 ± 0.04	0.12 ± 0.03	0.004	16	18	17.6	Seeds reniform, densely tomentose, with unicellular brownish black hairs, arising in a group 4-7; hilum broadly linear in outline (Fig. 3 o & 4a).
46. <i>Malvastrum coromendelianum</i> (L.) Garke Voucher: Agriculture Institute, Department of Botany, University of Karachi, 26.12.86 <i>Razia Ahmed</i> 72.	1.5 ± 0.03	1.3 ± 0.04	0.12 ± 0.002	0.0014	1	1	1	Seeds reniform, grey, brown; surface ± areolate, areola ± rectangular in shape, traversed by small transverse ridges; hilum lateral, crescentic in shape (Fig. 4b).

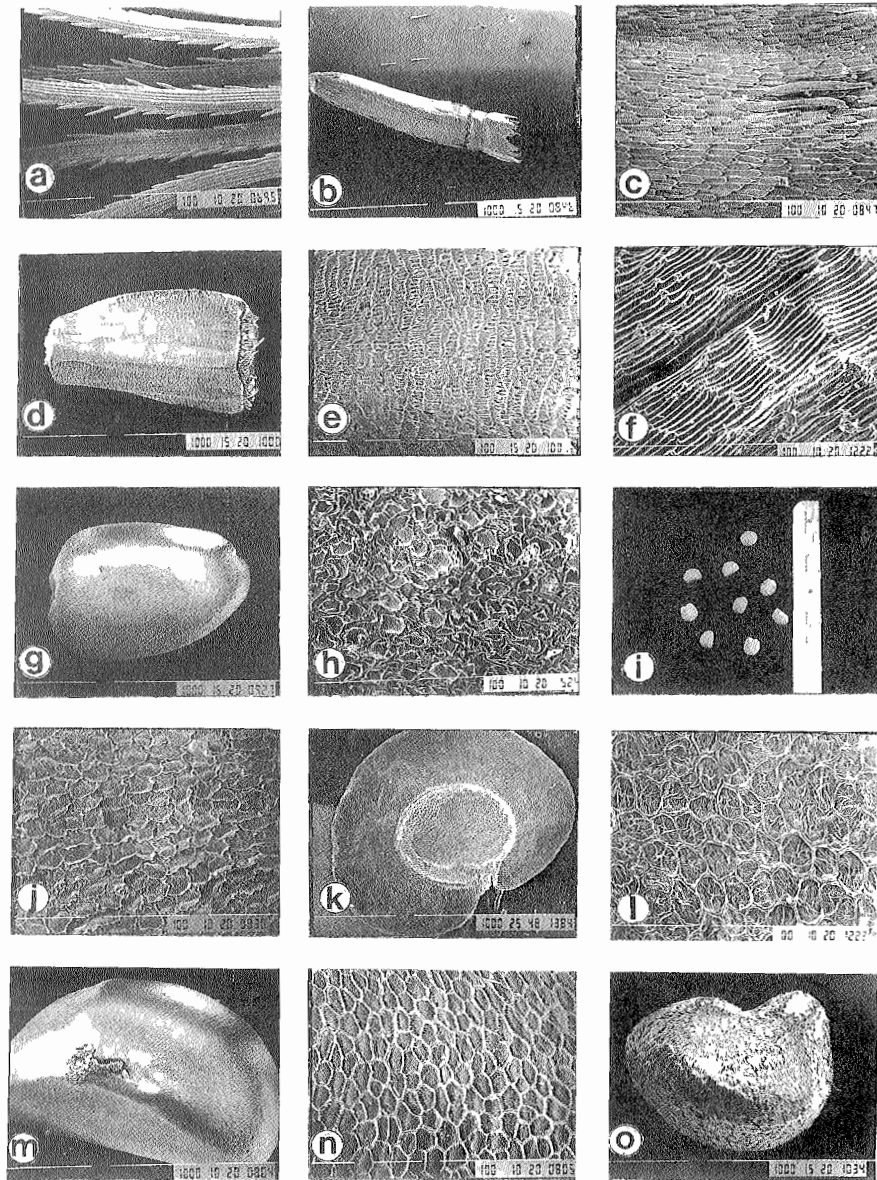


Fig. 3. Scanning micrographs: *Pluchea arguta*: a, pappus; *Pulicaria angustifolia*: b, Cypselas; c, surface pattern; *Cichorium intybus*: d, cypselas; e, surface pattern; *Sonchus oleraceus*: f, surface pattern; *Cressa cretica*: g, seeds; *Cuscuta hyalina*: h, surface pattern; *Ipomoea pestegridis*: i, seeds; *Seddera latifolia*: j, surface pattern; *Farsetia jacquemonti*: k, seeds; l, surface pattern; *Asparagus dumosus*: m, seed showing hilum; n, surface pattern; *Hibiscus intermedius*: o, seed (Figs. a, c, e, f, h, j, l, n, white bar = 100 µm, Figs. b, d, g, k, m, o, white bar = 1000 µm).

(Table 1 Contd.)

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit		Seed/Cypselas Description	
					Min.	Ave.		
47. <i>Senra incana</i> Cav. Voucher: Karachi University Campus, 29.11.86, <i>Razia Ahmed</i> 27,	1.5 ± 0.1	2.63 ± 0.07	0.78 ± 0.011	0.0018	4	6	5.5	Seeds oblong-reniform, moderately hairy, hairs brown, unicellular; surface areolate; hilum lateral, oblong in out line.
48. <i>Mimosa harnata</i> Willd, Voucher: Chemistry Department, Karachi University, 6.10.86, <i>Razia Ahmed</i> 65.	6.1 ± 0.05	5.5 ± 0.06	0.16 ± 0.002	0.039	5	8	6.5	Seeds circular-orbicular, compressed, brown; surface finely psilate; hilum marginal-basal, circular in out line; lens obovate-dumbbell shaped, dark brown confluent with hilum (Fig. 4c).
49. <i>Prosopis glandulosa</i> Torr. Voucher: Karachi University Campus, 16.7.87, <i>Razia Ahmed</i> 121.	5.8 ± 0.06	3 ± 0.09	0.29 ± 0.007	0.028	4	20	10.95	Seeds elliptic-ovate, compressed, brown; surface finely psilate; hilum marginal- basal, oblong-circular; lens deltoid, white, confluent with hilum.
50. <i>Glinus lotoides</i> L. Voucher: Thatta, 24.1.87, <i>Razia Ahmed</i> 90.	0.36 ± 0.006	0.53 ± 0.011	0.06 ± 0.0008	0.00005	± 125	± 288	± 224	Seeds reniform, maroon coloured, stipheolate arilate, aril shining white; tuberculate, tubercles longitudinally arranged in sequence; hilum lateral, circular in out line (Fig. 4d)
51. <i>Alhagi maurorum</i> Baker Voucher: Sajawal, 18.4.87, <i>Razia Ahmed</i> 120.	2.06 ± 0.03	2.3 ± 0.06	0.3 ± 0.011	0.0048	4	12	69	Seeds ± reniform with a truncate end, dull- brown, and besets with dull black small spots; surface psilate; hilum lateral, circular in out line; lens deltoid, dark brown in colour, confluent with hilum.



(Table 1 Contd.)

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit			Seed/Cypseta Description
					Min.	Max.	Ave.	
52. <i>Astragalus fatimensis</i> Hochst. ex Blatt. Voucher: Capmonze, 21.10.86, Razia Ahmed 48.	1.06 ± 0.01	1.25 ± 0.02	0.08 ± 0.004	0.00015	3	3	3	Seeds reniform, dark brown; sparsely pitted, pits shallow; hilum lateral, sunken in groove; circular in out line; lens deltoid, brown, confluent with hilum.
53. <i>Crotalaria ternatea</i> L. Voucher: Botany Department, Karachi University, 25.11.86, Razia Ahmed 62.	4 ± 0.04	6.5 ± 0.14	0.5 ± 0.023	0.0432	5	13	8.2	Seeds oblong, shining black, surface shortly striated with some what elevated striations forming an irregular pattern; hilum lateral, oblong-circular in out line, covering by some what whitish membranous structure; lens inconspicuous (Fig. 4e).
54. <i>Crotalaria burhiga</i> -Ham. Ex. Benth. Voucher: Capmonze, 21.10.1986 Razia Ahmed 48a.	2.5 ± 0.06	3.5 ± 0.03	0.2 ± 0.001	0.0062	4	4	4	Seeds reniform, brown, besets with green spots; areolate, areola small, rectangular; hilum lateral, circular, sunken in a groove; lens deltoid, light brown, confluent with hilum.
55. <i>Indigofera articulata</i> Gouan Voucher: Karachi University Campus, Surayya Khatoon s.n.	1.3 ± 0.04	1.7 ± 0.011	0.5 ± 0.002	0.0018	2	3	2.5	Seeds ± circular, shining greenish brown, surface psilate; hilum lateral-central, circular in out line, lens deltoid, dark brown, confluent with hilum.
56. <i>Indigofera caerulea</i> Roxb. Voucher: Karachi University Campus Surayya Khatoon s.n.	2.2 ± 0.02	2.1 ± 0.02	0.12 ± 0.001	0.0069	2	3	2.5	Seeds sub-circular, greenish brown, surface very shortly striated with some what elevated striation forming an irregular pattern; hilum lateral-central, circular in out line; lens deltoid, brown in colour, confluent with hilum.

(Table 1 Contd.)

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit		Seed/Cypselae Description	
					Min.	Ave.		
57. <i>I. oblongifolia</i> Forssk. Voucher: Capernonze, 24.10.86, <i>Razia Ahmed</i> 30.	1.23 ± 0.04	1.56 ± 0.04	0.48 ± 0.006	0.0018	4	12	8	Seeds oblong, bright yellow, surface with small ridges along with few shallow depressions; hilum lateral, broadly elliptic-circular, lens ovate-deltoid near the hilum but not confluent with it.
58. <i>Melilotus alba</i> Desr. Voucher: Botany Department, Karachi University Campus 5.6.87, <i>Razia Ahmed</i> 101.	2	2.5	0.2	0.0034	1	2	1.5	Seeds heteromorphic, reniform, plano-convex (in case of 2 seed/fruit) or biconvex (in case of 1 seed/fruit); brownish yellow, tuberculate, tubercles large, rounded ± equal in size; hilum lateral-central, circular; lens oblong, not confluent with hilum, dark brown in colour. (Fig. 4f-g).
59. <i>Melilotus indicus</i> (L.) All. Voucher: Botany Department University of Karachi, 5.6.87 <i>Razia Ahmed</i> 97.	2 ± 0.029	2.5 ± 0.024	0.2 ± 0.00	0.0034	1	1	1	Seeds reniform-orbicular, brownish yellow; surface pitted, tuberculate in between the pits tubercles are small somewhat rounded, ± equal in size; hilum lateral-central, circular in out line; lens linear-lanceolate, light brown in colour, confluent with hilum (Fig. 4h).
60. <i>Rynchosia capitata</i> (Heyne ex Roth) DC. Voucher: Geography Department, University of Karachi, 21.5.87, <i>Razia Ahmed</i> 115.	6.5 ± 0.07	3.01 ± 0.05	0.97 ± 0.011	0.037	2	2	2	Seeds oblong, brown with distinct off-white patches; arilate, aril thin membranous; caruncle stiped; surface pattern finely but sparsely reticulate; hilum basal, oblong in out line; lens inconspicuous.

(Table 1 Contd.)

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit		Seed/Cypselas Description	
					Min.	Ave.		
61. <i>R. minima</i> (L.) DC. Voucher: Zoology Department, Karachi University, 10.8.87, <i>Razia Ahmed</i> 129.	2.8	3.68	0.46	0.014	2	3	2.5	Seeds oblong-reniform, light green, beset with blackish-brown spots; surface areolate, areola $\pm$ polygon in shape; hilum lateral, oblong-circular in out line; lens deltoid, dark-brown, confluent with hilum (Fig. 4c).
62. <i>R. pulverulena</i> Stocks. Voucher: Zoology Department, Karachi University, 7.10.86, <i>Razia Ahmed</i> 5.	3.2	4.29	0.9	0.02	2	4	3.5	Seeds oblong-reniform, slightly compressed; yellow with distinct light green patches, surface pattern with irregularly elevated small ridges forming some what reticulate pattern; hilum lateral-marginal, circular in out line; lens oblanceolate, blackish brown confluent with hilum.
63. <i>Taverniera cuneifolia</i> Am. Voucher: Capmonze, 21.10.86, <i>Razia Ahmed</i> 42.	1.7	2.6	0.12	0.0046	1	1	1	Seeds reniform, slightly compressed, yellow; $\pm$ psilate; hilum lateral, $\pm$ sunken in a groove, circular in out line; lens deltoid, light yellow, confluent with hilum.
64. <i>T. lappacea</i> (Forssk.) DC. Voucher: Capemonze, 21.10.86 <i>Razia Ahmed</i> 45.	2.15 $\pm$ 0.05	2.6 $\pm$ 0.06	0.16 $\pm$ 0.004	0.006	2	10	6.25	Seeds oblong-reniform, biconvex, brownish green, surface finely psilate; hilum lateral, sunken in a groove, circular in out line; lens deltoid-linear, brown, confluent with hilum.
65. <i>Vicia sativa</i> L. Voucher: Botany Department, Karachi University, 10.4.87, <i>Razia Ahmed</i> 104.	2.4 $\pm$ 0.03	2.98 $\pm$ 0.04	0.21 $\pm$ 0.04	0.016			6.28	Seeds rounded-rectangular, dark greenish grey and distinctly marked with dark greyish brown spots; surface verrucose warts similar in size and shape with flat heads, hilum lateral $\pm$ circular; lens linear, white, confluent with hilum (Fig. 4j).

(Table 1 Contd.)

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit		Seed/Cypselia Description
					Min.	Ave.	
66. <i>Polygala erioptera</i> DC. Voucher: Karachi University Campus, 19.11.86, <i>Razia Ahmed</i> 19.	2.6 ± 0.07	1.3 ± 0.06	0.15 ± 0.004	0.0006	1	1	Seeds narrowly oblong-spindle shaped, black, densely hairy (hairs are easily removed); carunculate, caruncle bilobed, yellow; surface pattern with small warts; hilum basal, circular-oblong in out line (Fig. 4k).
67. <i>Polygonum barbatum</i> L. Voucher: Kalri Lake, Thatta District, 10.4.87, <i>Anjum Perveen</i> 247.	2.03 ± 0.04	1.6 ± 0.02	0.2 ± 0.011	0.00012	1	1	Seeds dimorphic; some were broadly ovate, compressed with persistent style, black; surface psilate/ hilum basal-marginal, circular Other seeds broadly ovate, trigonous, without style, black; surface ± psilate; hilum basal, irregularly circular with some white tissue (Fig. 4l).
68. <i>Rumex dentatus</i> L. Voucher: Kalri Lake, 10.4.87, <i>Anjum Perveen</i> 248.	2.01 ± 0.03	1.23 ± 0.02	0.21 ± 0.07	0.002	1	1	Seeds ovate, trigonous, shining brown; central part of the seed ± psilate, however, ± areolate along with the edges and hilum surface; hilum basal, ± triangular with some white tissue.
69. <i>R. vesicarius</i> L. Voucher: Dean's Office, Karachi University Campus, 8.4.87, <i>Surayya Khatoon</i> .	2.1 ± 0.03	1.3 ± 0.02	0.21 ± 0.007	0.0019	1	1	Seeds broadly ovate, trigonous, shining brown, central part of seed ± rugosus and areolate along with edges; hilum basal, irre- gularly circular with white tissue (Fig. 4m).
70. <i>Ochradenus baccatus</i> Del. Voucher: Karachi University Campus, 1.1.87, <i>Razia Ahmed</i> 78.,	0.99 ± 0.02	1.2 ± 0.03	0.08 ± 0.003	0.0005	3	9	6.21 Seeds reniform, brown, surface favolatus or alveolatus; hilum lateral, sunken in a groove, circular in out line (Fig. 4 o).

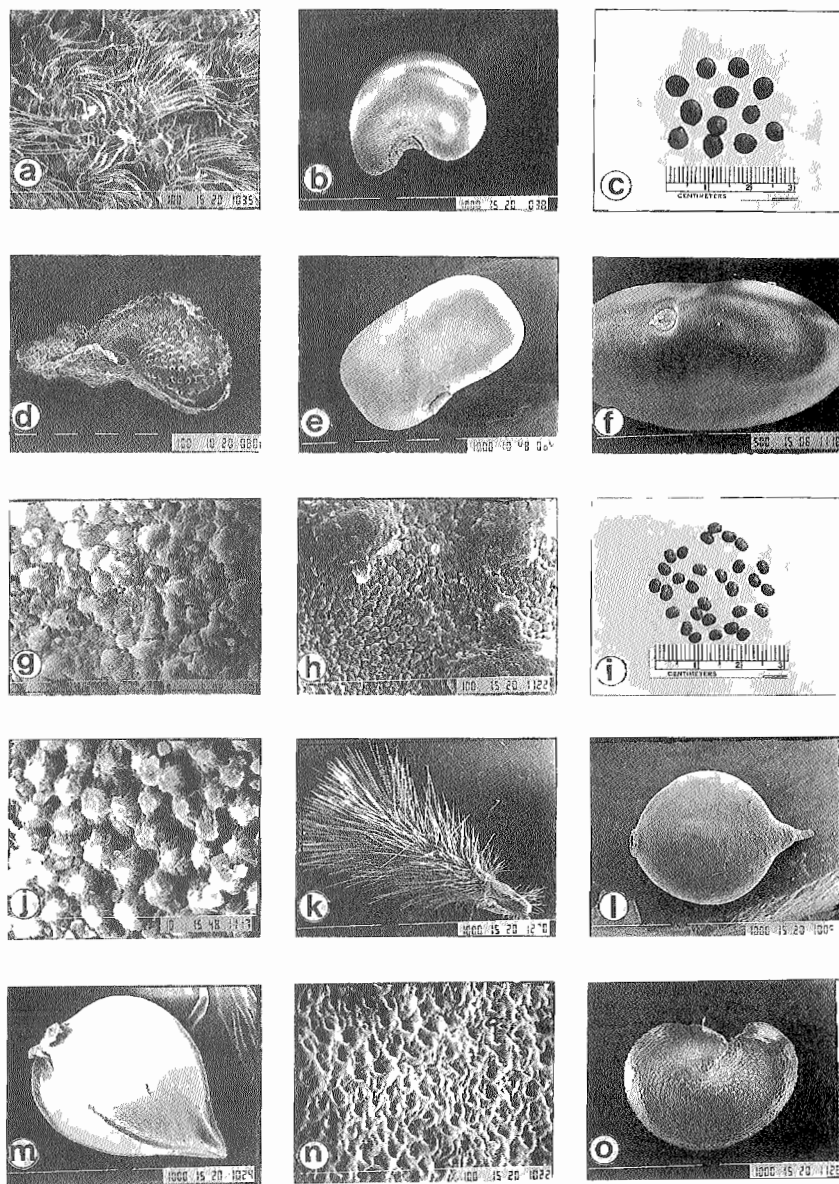


Fig. 4. Scanning micrographs: *Hibiscus intermedius*: a, surface pattern; *Malvastrum coromandelianum*: b, seed; *Mimosa hamata*: c, seeds; *Glinus isitoides*: d, seed showing strophiole; *Clitoria ternatea*: e, seed showing hilum; *Melilotus alba*: f, seed showing hilum; g, surface pattern; *M. indica*: h, surface pattern; *Rhynchosea minima*: i, seeds; *Vicia sativa*: j, surface pattern; *Polygala erioptera*: k, entire showing caruncle; *Polygonum barbatum*: l, entire seed showing hilum; *Rumex vesicarius*: m, seed; *Salvadora persica*: n, surface pattern; *Ochradenus baccatus*: o, entire seed (Fig. a, d, h, n, white bar = 100  $\mu$ m; b, c, k, l, m, o, white bar = 1000  $\mu$ m; j, white bar = 10  $\mu$ m and f white bar = 500  $\mu$ m).

(Table 1 Contd.)

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit			Seed/Cypselae Description
					Min.	Max.	Ave.	
71. <i>Salvadora persica</i> L. Voucher: Sajawal, 18.4.87, Razia Ahmed 109.	4.42 ± 0.08	4.29 ± 0.05	0.4 ± 0.004	0.014	1	1	1	Seeds broadly obovate-circular, golden brown, besets with distinct black spots; surface alveolatus, ridges ± elevated, hilum sub-basal, circular in out line (Fig. 4n).
72. <i>Schweinfurthia papilionacea</i> (Burr. f.) Boiss. Voucher: Karachi University Campus 26.12.86, Razia Ahmed 70.	2 ± 0.04	1 ± 0.06	— —	0.0003	35	79	77	Seeds obovate, truncate at both-ends, acutely winged, shining black; surface with protuberance like structure and protuberance of the wing are bigger in size, hilum diffused (Fig. 5a-b).
73. <i>Nicotiana plumbaginifolia</i> Viv., Voucher: Karachi University Campus, 3.4.87, Saood Omer s.n.	0.48 ± 0.007	0.31 ± 0.004	0.04 ± 0.00	0.0001	----	not counted	----	Seeds oblong, brown, surface pattern irregularly striated; hilum lateral-sub basal, circular in out line. (Fig. 5d).
74. <i>Withania somnifera</i> (L.) Dunal, Voucher: Botany Department, University of Karachi, 20.11.86, Razia Ahmed 22.	1.75 ± 0.03	1.75 ± 0.04	0.13 ± 0.001	0.0014	20	32	27.8	Seeds sub-pyriform-reniform compressed brownish yellow; surface reticulate-foveolate; hilum marginal with in a notch, linear-narrowly ovate in out line (Fig. 5e-f).
75. <i>Sphenoclea zeylanica</i> Gaertn., Voucher: near Thatta, 7.7.87, Razia Ahmed 128.	+ 0.48	+ 0.19	± 0.04	± 0.0002	± 201	± 402	± 279.2	Seeds oblong, brown, surface pattern with elevated longitudinal striation and short transvers striation forming some what areolate structure, each areolae ± pitted-punctate, hilum basal, circular in out line (Fig. 5g-h).

(Table 1 Contd.)

Name of taxa/ Voucher specimens	Length mm	Breadth mm	Length/ diameter of hilum mm	Average weight gm	Number of Seeds/Fruit		Seed/Cypselas Description	
					Min.	Ave.		
76. <i>Corchorus depressus</i> (L.) Voucher: Karachi University Campus, 5.6.87, <i>Razia Ahmed</i> 95.	1	0.7	0.08	0.0002	40	49	45.54	Seeds oblong, angular, obliquely truncate at both ends, grey; surface reticulately striated; hilum lateral, circular in out line.
77. <i>Grewia villosa</i> Willd. Voucher: Capemonze, 21.10.86, <i>Razia Ahmed</i> 41.	3.25	4	0.8	0.011	1	1	1	Seeds oblong-obovate, ± compressed, greyish-white; surface psilate; hilum marginal-sub basal, key hole like in out line.
78. <i>Priva cordifolia</i> (L.F.) Druce Voucher: Institute of Business Administration, 25.4.87, <i>Razia Ahmed</i> 108.	4.56 ± 0.06	3.1 ± 0.06	0.21 ± 0.008	0.015	2	2	2	Seeds oblong, plano-convex, brown; surface echinate, echines straight, densely barbelate-scabrate; hilum ventral-sub basal, circular in out line (Fig. 5i).

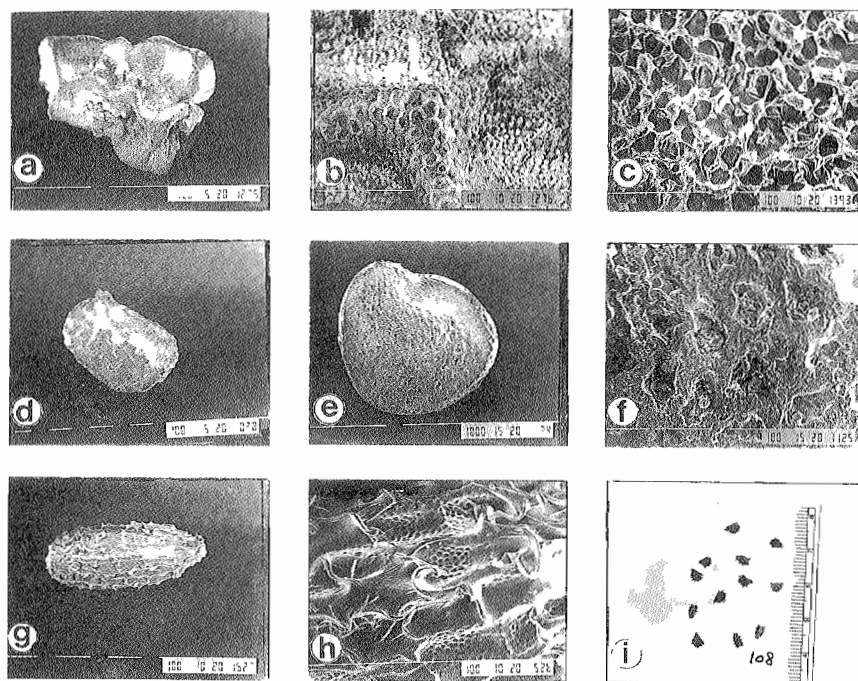


Fig. 5. Scanning micrographs: *Schweinfurthia papilionacea*: a, seed; b, surface pattern; *Euphorbia indica*: c, surface pattern; *Nicotiana plumbaginifolia*: d, seeds; *Withania somnifera*: e, seed; f, surface pattern; *Sphenoclea zeylanica*: g, seed; h, surface pattern; *Priva cordifolia*: i, seeds (Figs. a, 1, white bar = 1000  $\mu\text{m}$ ; fig. b, d, f, g, white bar = 100  $\mu\text{m}$ ).

(Duke, 1969). Different structures like strophiole in *Glinus lotoides* and caruncle in *Rhynchosia capitata* and *Polygala erioptera* were observed.

Seeds of most of the members of the families viz., Acanthaceae, Aizoaceae, Amaranthaceae, Capparidaceae, Chenopodiaceae, Cruciferae, Malvaceae, Papilionaceae and Resedaceae were orbicular, suborbicular and reniform; while in the members of Asclepiadaceae, Boraginaceae, Caryophyllaceae, Convolvulaceae, Cucurbitaceae, Euphorbiaceae, Polygalaceae, Sphenocleaceae and Tiliaceae, the seeds were oblong, ovate and obovate. Seeds belonging to the family Caesalpiniaceae (2 genera) were spherical and wedge shaped. The seeds of *Asparagus dumosus*, *Limeum indicum*, *Melilotus albus* (in case two seeds/fruit), *Priva cordifolia* and *Trichodesma indicum* var. *amplexicaule* were plano-convex. Gilbert (1977), indicated a great variation in the shape of the seeds in different genera of Cucurbitaceae. However this contention could not be tested as only one species of Cucurbitaceae was studied. Seeds of *Mimosa hamata*, *Prosopis glandulosa* and *Cassia senna* were compressed. Musil (1963), observed that the seeds of Mimosaceae and Caesalpiniaceae tend to be elongated and flattened, the two phases being plane or only



slightly rounded. His observations were more or less in agreement with our findings except in *Caesalpinia bunduc* where spherical seeds were present. Seeds of *Dipcade erythraeum* were compressed and lumpy. In Compositae cypselas were mostly linear and spindle shaped except in *Dicoma tomentosa* and *Gnaphalium americanum* where ovate, oblong-elliptic cypselas were found.

The comose and alate (winged) seeds were found in *Calotropis procera* (Asclepiadaceae) and *Farsetia jacquemontii* (Cruciferae) respectively. Corner (1954) regarded alate and comose characters as clearly derived adaptations. Most of the members of Compositae were crowned with pappus except in *Echinops echinatus* in which epappose cypselas were present. Seven taxa viz., *Dicoma tomentosa*, *Gnaphalium americanum*, *Launaea nudicaulis*, *L. resedifolia*, *Pluchea arguta*, *Pulicaria angustifolia* and *Tridas procumbens* could readily be distinguished from the other members of Compositae by cypselas hairs which are present in most of the taxa except in *Cichorium intybus*, *Lactuca remotiflora*, *Oligochaeta ramosa* and *Sonchus oleraceus*. The presence or absence of carpopodium is a characteristic feature of this family. In *Echinops echinatus*, *Gnaphalium americanum*, *Pluchea arguta*, *Pulicaria angustifolia* and *Tridas procumbens*, carpopodium was present, however, absent from the rest of the members.

Seeds with rough surface were more frequent (88%) than psilate surface. Few species with psilate surface like *Alhagi maurorum*, *Caesalpinia bunduc*, *Indigofera articulata*, *Limeum indicum*, *Mimosa hamata*, *Prosopis glandulosa*, *Taverniera cuneifolia* and *T. lappacea* were observed. Brennan (1967) and Shahbaz (1971) observed distinct or reduced areoles in the seeds of Mimosaceae and in *Cassia* species, but their findings could not be validated as the seeds of Mimosaceae (2 species) were psilate while the seeds of *Cassia senna* were distinctly striated but not areolate. Seeds with rough surface were usually provided with different types of ornamentations for instance areolate, tuberculate, verrucose, reticulate, longitudinal striations, pitted, wart and protubrance. However, areolate surface pattern was fairly common. According to Jones & Safa (1982) the ornamentation of seed coat was fairly constant in one plant but varies within and between the population probably due to outbreeding.

The study of surface pattern plays an important role in the identification of closely related taxa. In the genus *Heliotropium* various species could easily be delimited on the basis of different type of surface pattern (Table I). However, on the other hand sometimes unrelated taxa may have similar type of surface pattern as observed in *Asparagus dumosus* (Liliaceae) and *Seddera latifolia* (Convolvulaceae).

The seeds of some taxa like *Calotropis procera*, *Ipomoea pes-caprae*, *I. sindica*, *Hibiscus intermedius*, *Ruellia tuberosa*, *Senra incana* and *Polygala erioptera*, had hairs all over while in *Heliotropium europium*, *H. ramosissimum* and *H. strigosum* hairs were restricted to the dorsal surface only.

Significant variation in the size and weight of the seeds were also observed. Largest seed size (20.1x19.5mm) with heaviest weight (1.96gms) were found in *Caesalpinia bunduc* (a large shrub) whereas smallest seeds were observed in small herbaceous species such as *Glinus lotoides*, *Gnaphalium americanum*, *Spergularia diandra*, *Sphenoclea zeylanica* (0.36 - 0.6x0.19 - 0.53mm) with lowest weight (0.000015 - 0.00005 gms) (Table 1). Eames (1961) has also pointed out that small seeds are associated chiefly with herbaceous plants while large size often seems to be correlated with the tree habit. Leguminosae exhibits a remarkable variation in seed size (20.1 - 2.2x19.5 - 2.1mm). Variability of seed size in the same species may be a hereditary character but it is also largely influenced by the competition for food (Salisbury, 1942). On the other hand Harper *et al.*, (1970) (fide Galen 1985) considered that seed size is less responsive to environmental condition than seed number. Salisbury (1942) also pointed out that seed number and size are often negatively correlated at an interspecific level. The shape and circumference of seeds were partially governed by the number of seeds (Gunn, 1970). The present investigation also indicated a negative correlation in the number and size of the seeds (Table 1). Large-medium size seeds were common in Cucurbitaceae, Malvaceae and Papilionaceae.

Hilum character seemed to be diagnostically important in the identification of several taxa, Presal (1843-1844) used relative hilum length as a diagnostic character and subdivided the genus *Vicia* into subgenera. Leckene (1966) also delimited 24 Vetch species occurring in meadows and pastures of European Russia. In the present studies the hilum was found to be either absent or not conspicuous. However, where the hilum was present than the following shapes were recognized viz: circular, linear, oblong, ovate, triangular, key holes and crescentic.

Circular seeds were found to be most frequent whereas key hole shape, linear-ovate and triangular shapes were rare and restricted to *Grewia villosa*, *Withania somnifera* and *Rumex dentatus* respectively (Table 1). Some species like *Calotropis procera*, *Momordica balsamina* and *Trichodesma indicum* var. *amplexicaule*, were without prominent hilum; whereas *Schweinfurthia papilionacea* had a diffused hilum. Nasir (1985) mentioned that in the seeds of *Androsace* hilum was obscure. Musil (1963) reported that in the seeds of Mimosaceae and Caesalpinaceae, the hilum was very small, inconspicuous and located at one end of the seed. He had also observed that Cucurbitaceae hilum was not very distinct and usually linear-lanceolate. Our observation are also in accordance with Musil (1963) that in Mimosaceae the hilum was very small as compared to their seed circumference. In contrast the seeds of Convolvulaceae, Caesalpinaceae and Papilionaceae showed very prominent hilum.

Musil (1963) and Gunn (1969) reported the presence of a central groove in most members of Papilionaceae. We have also observed similar conditions in Papilionaceae where the hilum was located in a central groove.

Two hilum positions viz., lateral and marginal seemed to be more common than basal and terminal position. Lateral hilum was fairly common in the members of Papilionaceae and marginal hilum was frequent in Chenopodiaceae as in *Atriplex stocksii* and *Haloxylon recurvum*. In Boraginaceae lateral-basal aveolae (point of attachment) were also observed, which was a characteristic feature of this family (Table 1).

Lens was observed only in the seeds of Caesalpiniaceae, Mimosaceae and Papilionaceae. The lens character has been variously used by several workers like Gunn (1970) and Gunn & Branes (1971) in the taxonomy of Leguminosae. Four different shapes of lens viz., circular, obovate dumbbell shaped, deltoid and linear, have been recognized (Table 1). It has also been observed that lens colour was mostly brown in the seeds of *Alhagi maurorum*, *Astragalus fatmensis*, *Crotalaria burhia*, *Indigofera articulata*, *I. caerulea*, *I. oblongifolia*, *Melilotus albus*, *M. indicus*, *Rhynchosia minima*, *R. pulverulenta*, *Taverniera lappacea* and *Mimosa hamata* whereas yellow in *Caesalpinia bunduc*, *Taverniera cuneifolia* and white in *Vicia sativa* and *Prosopis glandulosa*. Gunn (1970) classified 100 species of *Vicia* on the basis of seed circumference; relative hilum length, shape, length and position of lens and reported that the seeds of *Vicia sativa* were beset with brown circular lens but our observation indicated that lens of *Vicia sativa* was linear and white in colour. It has been observed that in the seeds of *Caesalpinia bunduc* lens was conspicuous but not confluent with hilum whereas in the seeds of Mimosaceae and Papilionaceae lens was conspicuous and confluent with hilum except in *Indigofera oblongifolia* in which the lens was very close to hilum but not clearly confluent with it. However, in certain species of leguminous seeds, lens was inconspicuous as in *Cassia senna*, *Clitoria ternatea* and *Rhynchosia capitata*.

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