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Studies on Seed Morphometry of Epiphytic Orchids from Western Ghats of Karnataka

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ABSTRACT: Seed morphometry and Scanning Electron Microscopic studies on 10 species of epiphytic orchids from Western ghats of Karnataka are presented. All the presently investigated taxa are different in their seed surface characters including size, shape, visibility of embryo, testa cells and structure, curvature and ridges. Seed colours range from pale yellow to yellow, brown and white. Variation between maximum and minimum in the length/width ratio of seed is discussed. Data on the seed volume show that higher seed volume is the result of both greater length and width. Maximum width of testa cell and seed volume are found in *Cymbidium bicolor*. Variations in seed and embryo volume and percent air space could exist among the different taxa of orchids. The volume of the embryo changes during its developments from zygote to seedling. Increase in the percentage of air space is due to increase in the cell length of the testa. Seeds with higher percentage of air space get dispersed over wide geographical areas.

KEY WORDS: Air space, *Cymbidium bicolor*, Scanning Electron Microscope, Orchids, Seed Morphometry.

INTRODUCTION

The taxonomic importance of the seed characteristics was first pointed out by Clifford and Smith (1969). Dressler (1981) has proposed several classificatory schemes for orchids based on conventional micro morphological characteristics. Seed morphology serves as a source of systematic character to circumscribe sub-generic groups or hypothetical relationships among species within a genus (Mathews and Levins, 1986; Ness, 1989; Vij *et al*., 1992; Larry, 1995; Augustine *et al.*, 2001). The morphological characteristics of the seeds not only serve as taxonomical markings but also serve in deducing phylogenetic relationships (Barthlott, 1976). The morphometric characters of seeds are ever challenging to the taxonomic and phylogenetic issues that would be a great help both in academic as well as in applied ventures (Rani *et al*., 1993; Augustine *et al*., 2001).

As the seeds of orchids are the smallest among the seeds produced by flowering plants, it is difficult to study their structural details with an ordinary optical microscope (Arditti *et al*., 1980). The seeds of orchids vary in size, morphology, structures, colour, and finer details. The seed size varies from 150 to 6000 μm and in majority of taxa the range is from 300-800 μm (Molvray and Kores, 1995). Molvray and Kores (1995) have also brought to light that the seeds vary in shape from filiform to fusiform, clavate to ellipsoidal and sometimes

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prominently winged. In some cases the seed is covered by a hard coat but in most cases the seed coat is papery in texture and loosely surrounds the embryo. The number of cells that forms the testa varies greatly among the different species, ranging from 2 to 20 cells (Molvray and Kores, 1995). The size of the cells may be uniform or some cells may be appreciably larger or smaller in areas such as medial region or chalazal end (Augustine *et al*., 2001). The walls of the testa can be smoother or reticulated. If reticulation is present, the patterns may be diverse. The seeds are without any stored food or endosperm, and enclose analyzed undifferentiated embryos with in a transparent seed coat. Testa and embryos of different taxa of the Orchidaceae may vary in their size, shape, colour and the ratios between their volumes (Arditti *et al*., 1980 and Augustine *et al*., 2001).

Barthlott and Ziegler (1981) have published a comprehensive work on the seed coat morphology of orchids. In their survey, they have recognized 20 different seed types based on overall seed shape, relative elongation of some cells in the seed coat, height and sculpturing of walls and features of wall adhesion zones, between adjacent cells including the presence of intercellular gaps and beading. Vij *et al.* (1992) have reported seed characteristics in 53 species of orchids including their taxonomic significance.

Orchids are represented by 125 genera and 1500 species in India. In South India there are 70 genera and 250 species recorded (Abraham and Vatsala, 1981). There are very few reports in India on orchid seed morphometry. Only few taxa of orchids have been investigated so far (Vij *et al.*, 1992; Rani *et al.,* 1993; Augustine *et al*., 2001). The present work deals with the morphological characteristics of seeds, like seed dimension, fine structure of testa, reticulation of seed coats and pores on the walls of testa cells and embryo dimensions of 10 species of epiphytic orchids.

MATERIALS AND METHODS

The mature seeds from ten orchid species were freshly collected from the naturally dehiscing capsules during the year 2000-2002 from the Western ghats of Karnataka (Table 1).

Table 1. Orchid species collected from different areas in Western ghats of Karnataka.

Sl. No. Name of the species	Localities	Time of fruiting
1. *Aerides maculosum* Lindl.	Sakaleshpur, Hassan District	August to September
2. *Bulbophyllum mysoernse* (Rolfe) J. J. Smith	Talacauvery, Kodagu district	September to November
3. *Coelogyne breviscapa* Lindl.	Sakaleshpur, Hassan District	August to September
4. *Cymbidium bicolor* Lindl.	Kushalanagar, Kodagu district	October to November
5. *Eria dalzellii* (Dalz.) Lindl.	Bhagavathi forest, Sringeri, Chikamagalur District	August to September
6. *Liparis elliptica* Wt.	Bhagamandala, Kodagu district	September to November
7. *Oberonia ensiformis* (Rees) Lindl.	Talacauvery Kodagu district	November to December
8. *Pholidota pallida* Lindl.	Virajpet, Kodagu district	November to December
9. *Vanda parviflora* Lindl.	Madekeri, Kodagu district	October to November
10. *Xenikophyton smeeanum* (Reichb. f.)	Kumrahally, Hassan District	October to November

The seeds of all the above taxa were processed for Scanning Electron Microscope studies following the methods of Haridasan and Mukerjee (1993). The seed samples were fixed for two hours at room temperature in 2.5% Glutaraldehyde prepared in 0.2 M Cacodylate buffer (pH 7.2). They were dehydrated in graded ethyl alcohol: acetone series. Finally they were dried in a critical point dryer (EMS 850) using CO_2 as a transition fluid. Critically dried samples were mounted on to copper stubs and were gold coated for five minutes. The prepared specimens were examined and were photographed on a JEOL 100 CXII ASID 4D model SEM at 20 kV.

Width and length were measured under a light microscope with micrometer at the longest and widest axis of the seed. Seeds were exhibit different forms, therefore, seed volumes were calculated using the formula $2\,[(^{W}/_{2})^{2}\,(^{1}/_{2}L)\,(1.047)]$, where W= Width, L = seed length, $1.047 = {}^{\pi}/_{3}$ (Arditti *et al.*, 1980). Orchid embryos are elliptical in cross section and therefore their volume was calculated by using the formula $4/3\ \pi ab^{2}$, where a = ½ its length and b = ½ its width.

RESULTS AND DISCUSSION

Seed color

Since the seeds of orchids are microscopic, it is very difficult to find out the color of seeds when they are in smaller numbers. When the capsules dehisce exposing millions of seeds, colour of seeds could be discerned. Generally, the colour of seeds in the presently investigated orchids ranges from pale yellow to yellow, brown and white (Table 2).

Table 2. Measurement data of seeds.

Name of the species	Color	Length (mm)	Width (mm)	L/W	Seed volume $mm^3 \times 10^{-3}$	Average length of testa cells (μm)	Average width of testa cells (μm)	Average number of testa cells
Aerides maculosum	Brown	0.2130 ± 0.0161	0.0840 ± 0.0120	2.54	0.3933	89.92	7.70	2.70
Bulbophyllum mysorense	Golden yellow	0.1740 ± 0.0141	0.0735 ± 0.0096	2.37	0.2460	100.76	17.82	1.87
Coelogyne breviscapa	Light yellow	0.9675 ± 0.1183	0.1305 ± 0.0135	7.41	4.3127	150.26	30.80	10.76
Cymbidium bicolor	Yellow	0.7500 ± 0.0232	0.2460 ± 0.0238	3.05	11.8800	145.20	50.95	8.30
Eria dalzellii	White	0.1920 ± 0.0130	0.1110 ± 0.0120	1.73	0.6192	188.76	31.24	1.90
Liparis elliptica	Pale Yellow	0.1875 ± 0.0100	0.0670 ± 0.0075	2.80	0.2203	88.66	18.04	3.50
Oberonia ensiformis	Pale Yellow	0.2400 ± 0.0177	0.0810 ± 0.0730	2.97	0.4121	114.00	17.11	3.00
Pholidota pallida	Pale Yellow	0.4815 ± 0.0345	0.1050 ± 0.0116	4.59	1.3895	144.45	23.62	6.20
Vanda parviflora	Brown	0.1950 ± 0.0116	0.0810 ± 0.0073	2.41	0.3348	77.35	11.88	2.73
Xenikophyton smeeanum	Brown	0.2745 ± 0.0190	0.0975 ± 0.0075	2.82	0.6830	158.40	20.94	5.81

± Standard deviation

Seed shape

Earlier works on the shape of the seeds in orchids has been reviewed by Barthlott and Ziegler (1981). They have listed 20 different types of seeds based on shape, testa cells, length and sculpturing of cells and presence of intercellular gaps and beading.

Scanning Electron Microscopic studies reveal that the seeds of all the species of orchids examined in the present work are very minute but differences do exist in the shapes and in the size of seeds. The seeds of *Bulbophyllum mysorense* are transparent, short, spindle to oblong with blunt ends. Testa cells are with marginal clavated ridges, which are smooth on the outer face. Their cells are longitudinally oriented looks like twisted rope (Fig. 1). Augustine *et al.* (2001) have recorded fusiform, spindle and narrowly ellipsoidal shaped seeds in the species of *Bulbophyllum*. The seeds of *Aerides maculosum* vary in their shape from a crescent shape to the broadly ellipsoid nature (Fig. 2) as in *Aerides multiflora* (Vij *et al.,* 1992). The seeds of *Coelogyne breviscapa* are spindle with curvature. Embryo distinct, presents in the centre oriented to long axis. Longitudinal elevated ridges form on the flat smooth surface of the testa cells (Fig. 3). However, Vij *et al.* (1992) have recorded filamentous shaped seeds in *Coelogyne elata*. Variations in the seed shape can, therefore, be used as additional taxonomic markers for species identification. In *Cymbidium bicolor* the seeds are transparent, spindle-shaped with visible embryo located in the centre. Testa cells are longitudinally oriented with irregular rectangles. The blisters of testa cells are projected outwards with sharp points (Fig. 4). This feature has not found in rest of the presently investigated taxa. Vij *et al.* (1992) have reported fusiform and filamentous shaped seeds in *Cymbidium aloifolium* and *C. lancifolium*. In case of *Eria dalzellii,* the seeds are oblong and they look like miniature dates. Testa cells are longitudinally oriented with deep grooves (Fig. 5). In *Liparis elliptica* seeds are irregularly shaped, transparent and embryo is not distinct. Testa cells are longitudinally oriented and irregular. Ridges are elevated and surface is blunt (Fig. 6). The seeds of *Oberonia ensiformis* are short, oblong and elliptical. Embryo is not distinct. Testa cells are longitudinally oriented rectangle, irregular and elongated. Ridges are with flat surface and a hollow groove in the centre (Fig. 7). In *Pholidota pallida* the seeds are elongated, curved and spindle-shaped. Testa cells oriented longitudinally and are highly irregular, ridges are elevated with flat and shallow groove (Fig. 8). The seeds of *Vanda parviflora* are small, oblong or elliptical. Testa cells are longitudinally oriented. Rectangles are not distinct (Fig. 9). In *Xenikophyton smeeanum* the seeds are small and oblong. Testa cells are longitudinally oriented, ridges are close and look like twisted rope (Fig. 10). In the present investigation, the seeds of *Coelogyne breviscapa* and *Pholidota pallida* exhibit an intrageneric uniformity of shape. The utility of seed shapes is apparent in commenting upon the taxonomic status of *Spiranthes australis* and *S. sinensis* (Vij *et al*., 1992). Elliptical shaped seeds in *Aerides maculosum, Oberonia ensiformis* and *Vanda parviflora* of the present work possibly reflects closer affinities between these genera. Dressler (1974) considered the sub-tribe Epipogieae as a connecting link between the tribe Orchideae and Neottioid members. Vij *et al*. (1992) suggested a closer affinity between *Herminium lanceum* with the genus *Habenaria* species based on seed morphometry. In the present work, a closer affinity is made between *Aerides maculosum* and *Xenikophyton smeeanum* in respect to twisted rope like testa cells.

Length/Width (L/W) ratio

According to Arditti *et al*. (1980) and Augustine *et al*. (2001) length/width ratio provides some very important data on the relative degree of truncation of the seeds in orchids. In the present work, length/width ratio has been observed in 10 species of orchids. The maximum

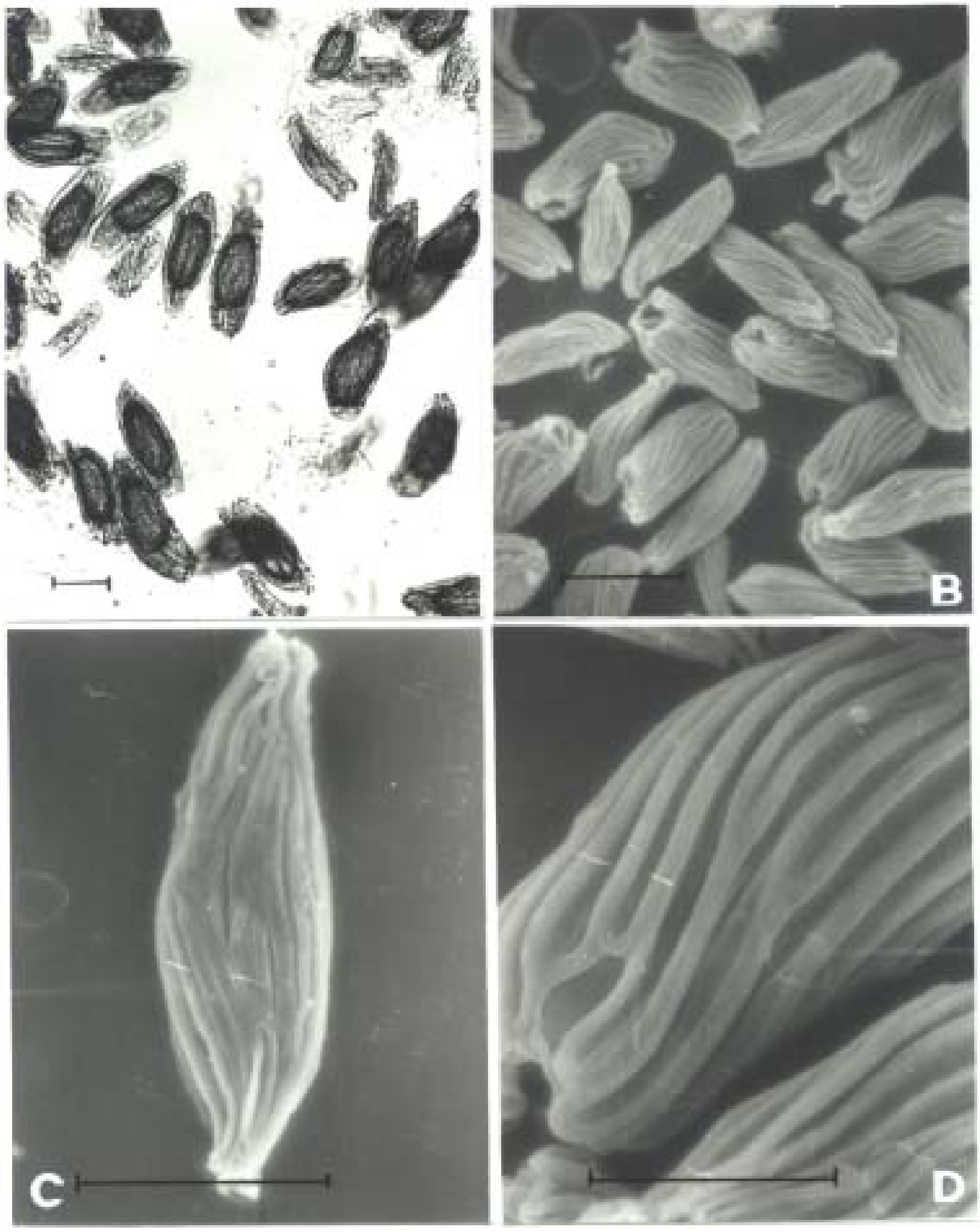

Fig. 1. Microscopic and Scanning Electron Microscopic photographs of *Bulbophyllum mysorense*. A: Seeds under the high power of microscope. Bar = 20 µm. B: A few seeds under Scanning Electron Microscope. Bar = 20 µm. C: A seed under high magnification. Bar = 4 µm. D: Part of the testa under high magnification. Bar = 2 µm.

L/W ratio was observed in *Coelogyne breviscapa* (7.41). The minimum was observed in the least truncated seeds of *Eria dalzellii* (1.73). Between the above two extremes, there is a complete range of length/width ratio for other taxa studied in the present work (Table 2). Length/width ratio of *Aerides maculosum* (2.54), *Coelogyne brevis-capa* (7.41), *Cymbidium bilocor* (3.05) and *Eria dalzelli* (1.73) of the present work are more close to the corresponding L/W ratio of *Aerides multiflora* (2.88), *Coelogyne ochracea* (7.62), *Cymbidium aloifolium* (3.55) and *Eria spicata* (2.22), respectively (Vij *et al*., 1992).

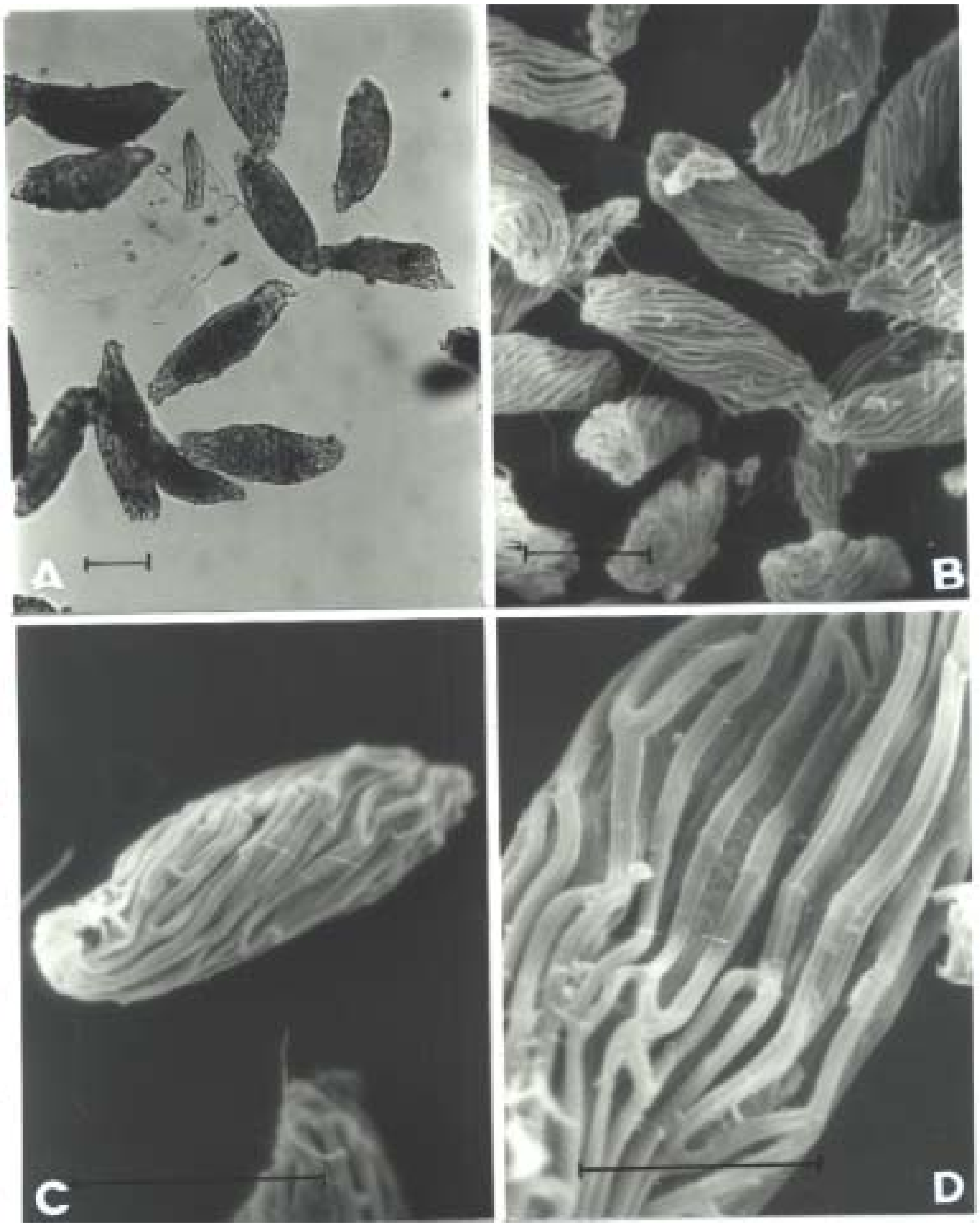

Fig. 2. Microscopic and Scanning Electron Microscopic photographs of *Aerides maculosum.* A: A few seeds under the high power of microscope. Bar = 20 µm. B: Seeds under Scanning Electron Microscope. Bar = 20 µm. C: A seed under high magnification. Bar = 4 µm. D: Part of the testa highly magnified to show details. Bar = 2 µm.

Augustine *et al*. (2001), in their work on *Bulbophyllum* species, have observed that the maximum length/width in *Bulbophyllum leopardianum* (5.12). The least truncated and the minimum was observed in *Bulbophyllum caudatum* (1.74). In the present work, *Bulbophyllum mysorense* has an L/W ratio of 2.37. In this character, it is more close to *Bulbophyllum rothschildianum* (2.02), *B. striatum* (2.15) *B. tricorni* (2.15) and *B. griffithii* (2.33) (Augustine *et al*., 2001). The degree of seed truncation can be used to differentiate between species in the genera *Aerides, Bulbophyllum, Coelogyne, Cymbidium* and *Eria* (Table 2).

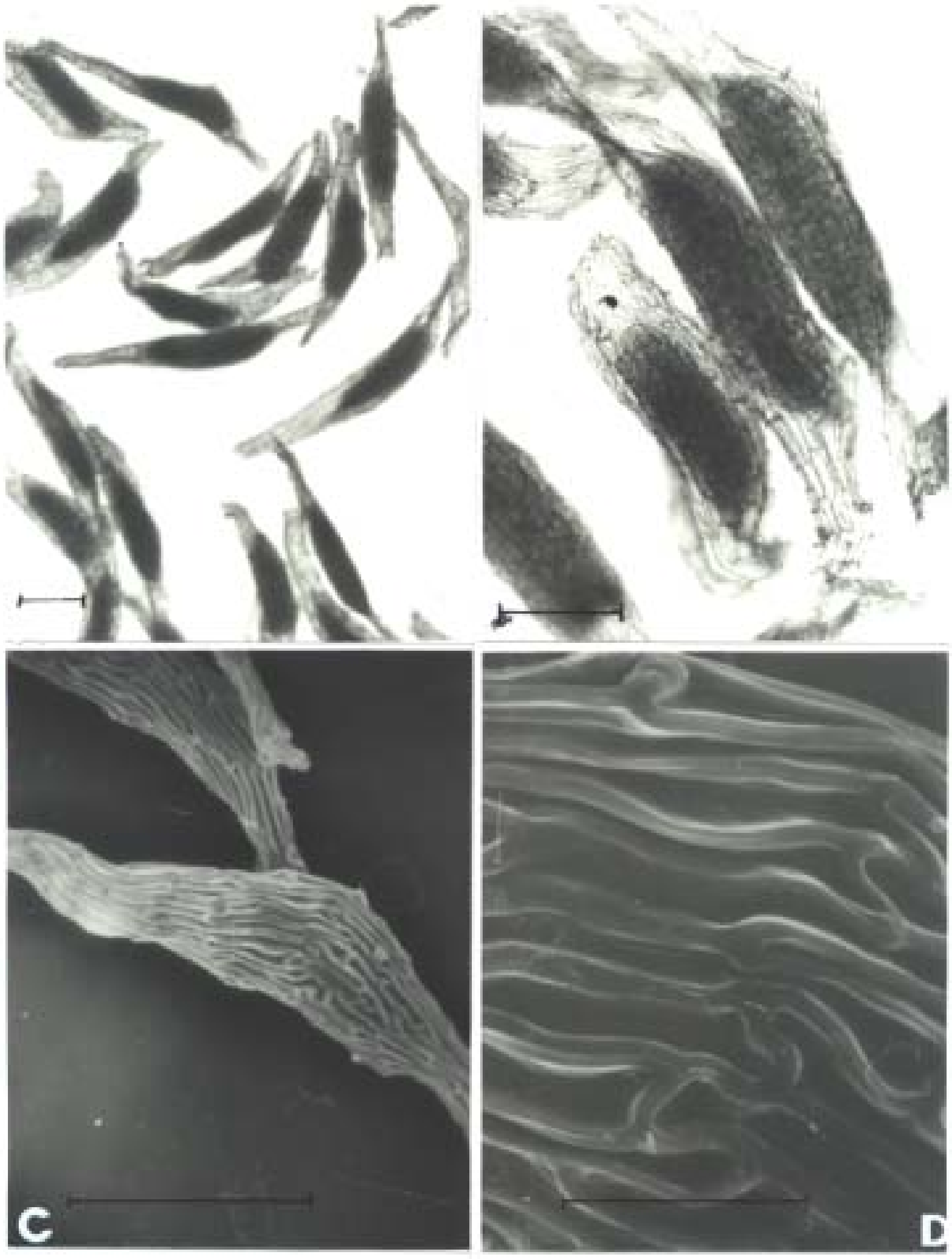

Fig. 3. Microscopic and Scanning Electron Microscopic photographs of *Coelogyne brevis- capa.* A: Few seeds under the high power of microscope. Bar =100 µm. B: Enlarged view of a few seeds under microscope. Bar = 100 µm. C: A few seeds under Scanning Electron Microscope. Bar = 25 µm. D: Testa cells under high magnification. Bar = 5 µm.

Seed volume

According to Arditti *et al*. (1979), the seed volume in orchids is a reflection of the size of the seeds. Therefore, studies to understand the seed volume are very important. In the present work, seed volume ranges from 0.2203 mm^3 x 10^{-3} to 11.8800 mm^3 x 10^{-3} (Table 2). The higher seed volume is noticed in *Cymbidium bicolor* (11.8800 mm^3 x 10^{-3}). This is followed by the seeds of *Coelogyne breviscapa* (4.3127 mm^3 x 10^{-3}) and *Pholidota pallida* (1.3895 mm^3 x 10^{-3}). Rest of the taxa (*Aerides maculosum, Bulbophyllum mysorense, Eria dalzellii, Liparis*

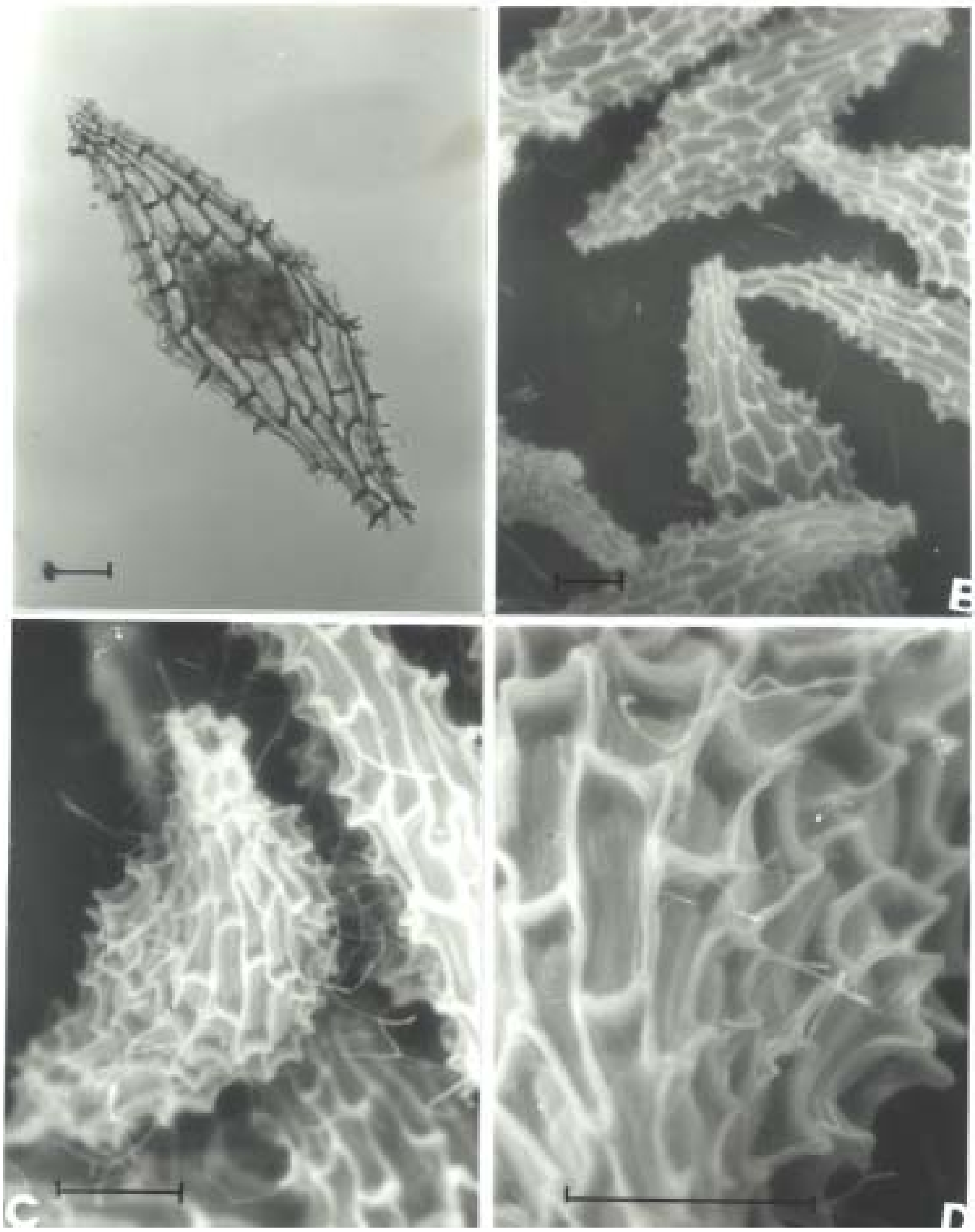

Fig. 4. Microscopic and Scanning Electron Microscopic photographs of *Cymbidium bicolor.* A: A seed under the high power of microscope. Bar = 80 µm. B: A few seeds under Scanning Electron Microscope. Bar = 80 µm. C: Enlarged view of the testa under Scanning Electron Microscope. Bar = 40 µm. D: Part of the testa under high magnification. Bar = 16 µm.

elliptica, Oberonia ensiformis, Vanda parvi- flora and *Xenikophyton smeeanum*) has seeds of lesser volume and smaller size (Table 2).

In the species of *Bulbophyllum,* the higher seed volume is found to be the result of a greater width rather than length of the testa (Augustine *et al*., 2001). In the present work also, the seeds of *Cymbidium bicolor* that have greater width have the higher seed volume.

With reference to the seed length, the seeds of *Coelogyne breviscapa* stand foremost. The seed length, in this case, is 0.9675 mm. The rest of the orchid taxa have seeds that are less

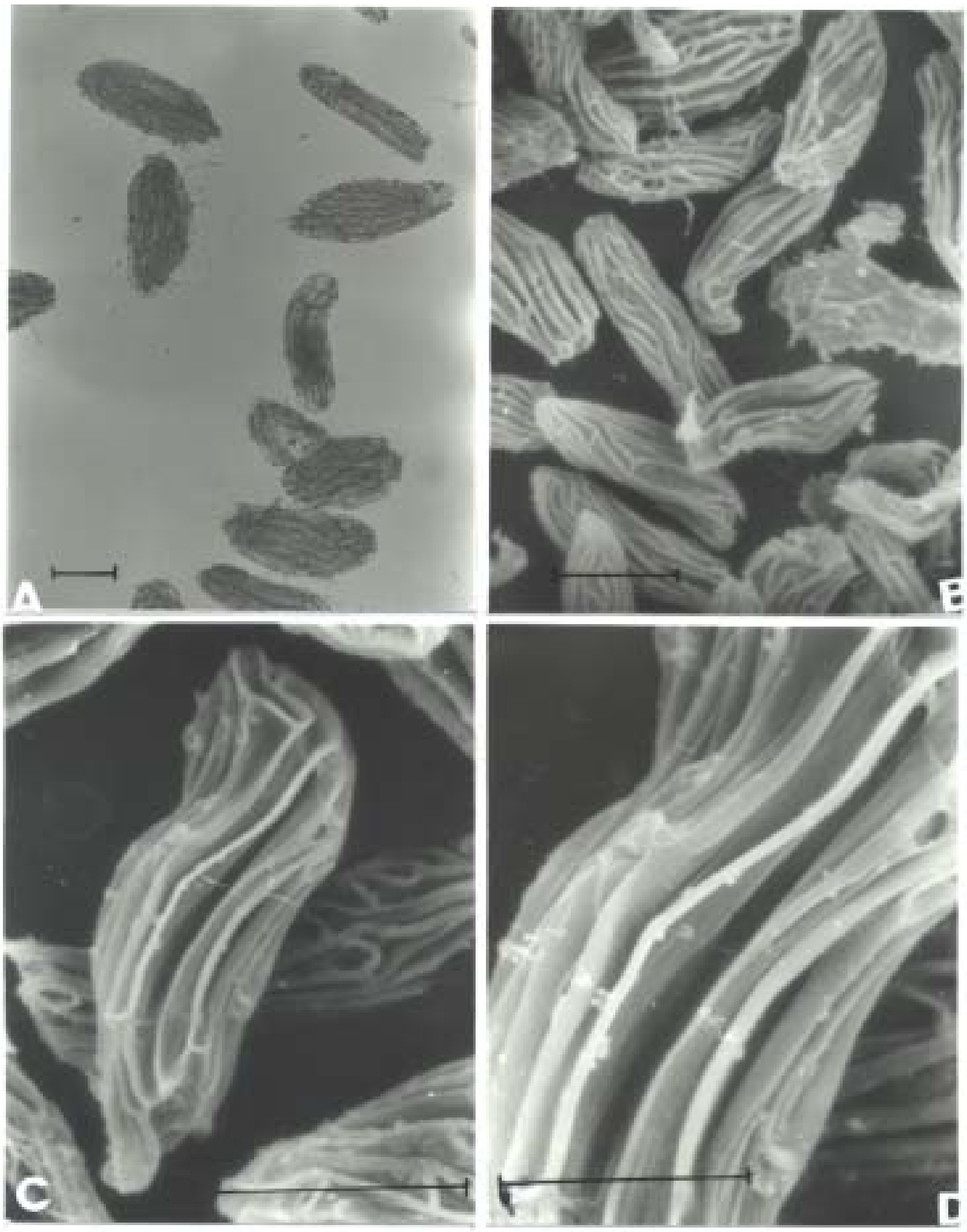

Fig. 5. Microscopic and Scanning Electron Microscopic photographs of *Eria dalzellii.* A: A few seeds under the high power of microscope. Bar = 20 μm. B: A few seeds under Scanning Electron Microscope. Bar = 20 μm. C: Enlarged view of seeds. Bar = 4 μm. D: Part of the testa under high magnification. Bar = 2 μm.

than 1 mm in their length (Table 2). The smallest seeds with shorter length are the seeds of *Bulbophyllum mysorense* (0.1740 mm). The seeds of *Bulbophyllum* species are also less than 1 mm in length (Augustine *et al.*, 2001).

Average number of testa cells

The testa cells at maturity are transparent with variously lignified wall. Their size, shape and wall thickening pattern have been employed has useful taxonomic parameters in species identification (Healey *et al.*, 1980). The average numbers of testa cells in the longest axis of the seeds of *Coelogyne breviscapa* are 10.76. This is followed by *Cymbidium bicolor* (8.30)

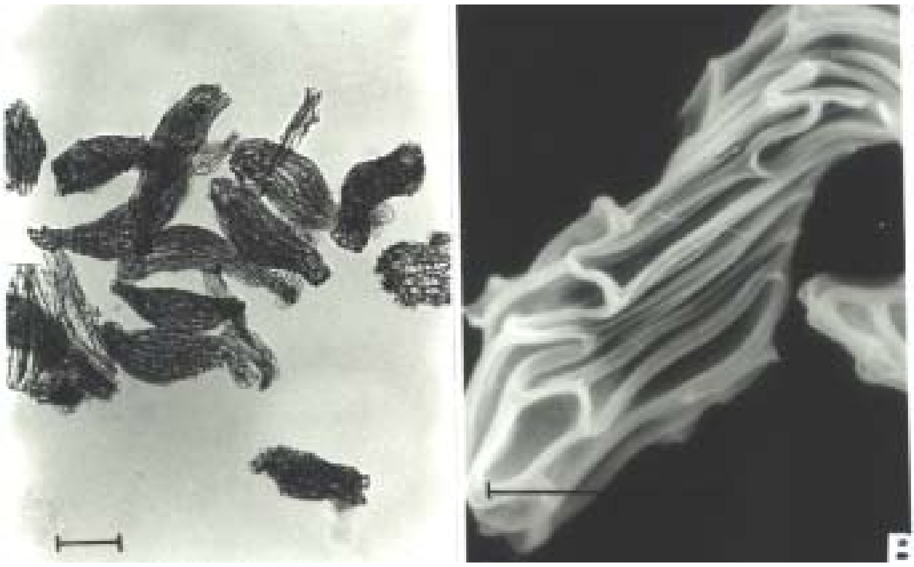

Fig. 6. Microscopic and Scanning Electron Microscopic photographs of *Liparis elliptica.* A: A few seeds under the high power of microscope. Bar = 20 μm. B: Part of the testa highly magnified. Bar = 2 μm.

and *Pholidota pallida* (6.20). The least numbers of testa cells are found in *Bulbophyllum mysorense* (1.87). The longest testa cell is found in *Eria dalzelli*i (188.76 μm) and shortest testa cell is observed in *Vanda parviflora* (77.35 μm). The testa cell of greatest width is observed in *Cymbidium bicolor* (50.95 μm). Whereas the cells of smallest width is found in *Aerides maculosum* (7.70 μm). Therefore, Healey *et al.* (1980) and Augustine *et al.* (2001) are justified in using seed morphometry selectively to find out phylogenetic relationship in orchids. Based on the length of testa cells Vij *et al.* (1992) classified into three categories. They are long (>200 μm), intermediate (>100 μm - 200 μm) and short (up to 100 μm). In the present investigation, *Bulbophyllum mysorense, Coelogyne breviscapa, Cymbidium bicolor, Eria dalzellii, Oberonia ensiformis, Pholidota pallida,* and *Xenikophyton smeeanum* are the intermediate group. Whereas, the *Aerides maculosum, Liparis elliptica* and *Vanda parviflora* have short length testa cells.

Measurement data of embryo

The colour of embryos in the present species varies from brown, yellow, golden yellow to pale yellow. Golden yellow embryos are recorded in *Bulbophyllum mysorense*. Pale yellow embryos characterized in *Cymbidium bicolor*. Brown embryos are common in *Aerides maculosum*.

Variation has also been observed with reference to length, width and L/W ratio. Length/Width ratio was observed in its maximum in *Coelogyne breviscapa* (3.30). On the other hand, the L/W ratio of embryos in *Bulbophyllum* and *Pholidota pallida* is 2.00. L/W ratio of embryos in rest of the taxa ranges from 1.46 to 2.43 (Table 3).

According to the Healey *et al*. (1980) the embryos in orchids tend to be uniform in size within a genus. This work is strongly supported by Augustine *et al*. (2001) in the species of *Bulbophyllum*. But the work of Arditti *et al*. (1980) has brought to light that large variations in seed and embryo volumes and percent air space could exist among different populations of the same species. Healey *et al*. (1980) have shown that the volume of the embryo varies from genus to genus. Thus the embryos of *Platanthera* are larger in volume than those of *Piperia*. Augustine *et al*. (2001) conclude that the embryo size does not change appreciably during

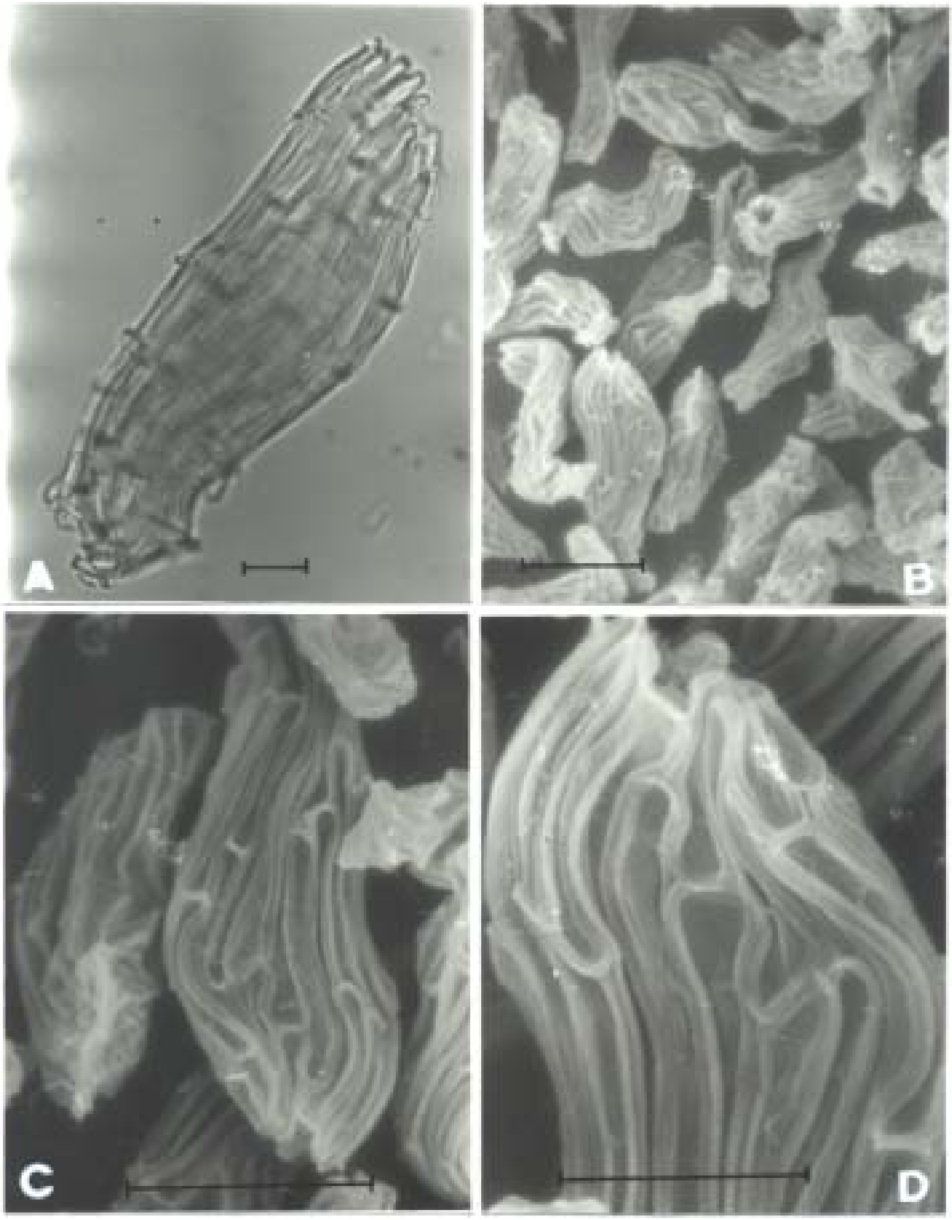

Fig. 7. Microscopic and Scanning Electron Microscopic photographs of *Oberonia ensiformis*. A: Few seeds under the high power of microscope. Bar = 25 μm. B: Seeds under Scanning Electron Microscope. Bar = 25 μm. C: Seeds under high magnification. Bar = 5 μm. D: Part of the testa under high magnification. Bar = 2.5 μm.

maturation. In the present work, it has been consistently observed in all the 10 taxa that the volume of the embryo changes during the development of the seed. Young seeds have small, undifferentiated embryos where the mature seeds from the dehisced capsules have embryos of a larger volume. Apparently Augustine *et al*. (2001) may be referring to the stages of seeds just before dehiscence and at the stage of dehiscence. Ontogenetic aspects have to be taken in to consideration in addition to observing the changes in size, shape and volume, which change inevitably during later stages of differentiation. These morphogenetic events form a fascinating aspect in the orchid seed development and morphometry. In fact, Augustine *et al.* (2001) admit that in most cases considerable variation can exist in the orchid seed and embryo volume.

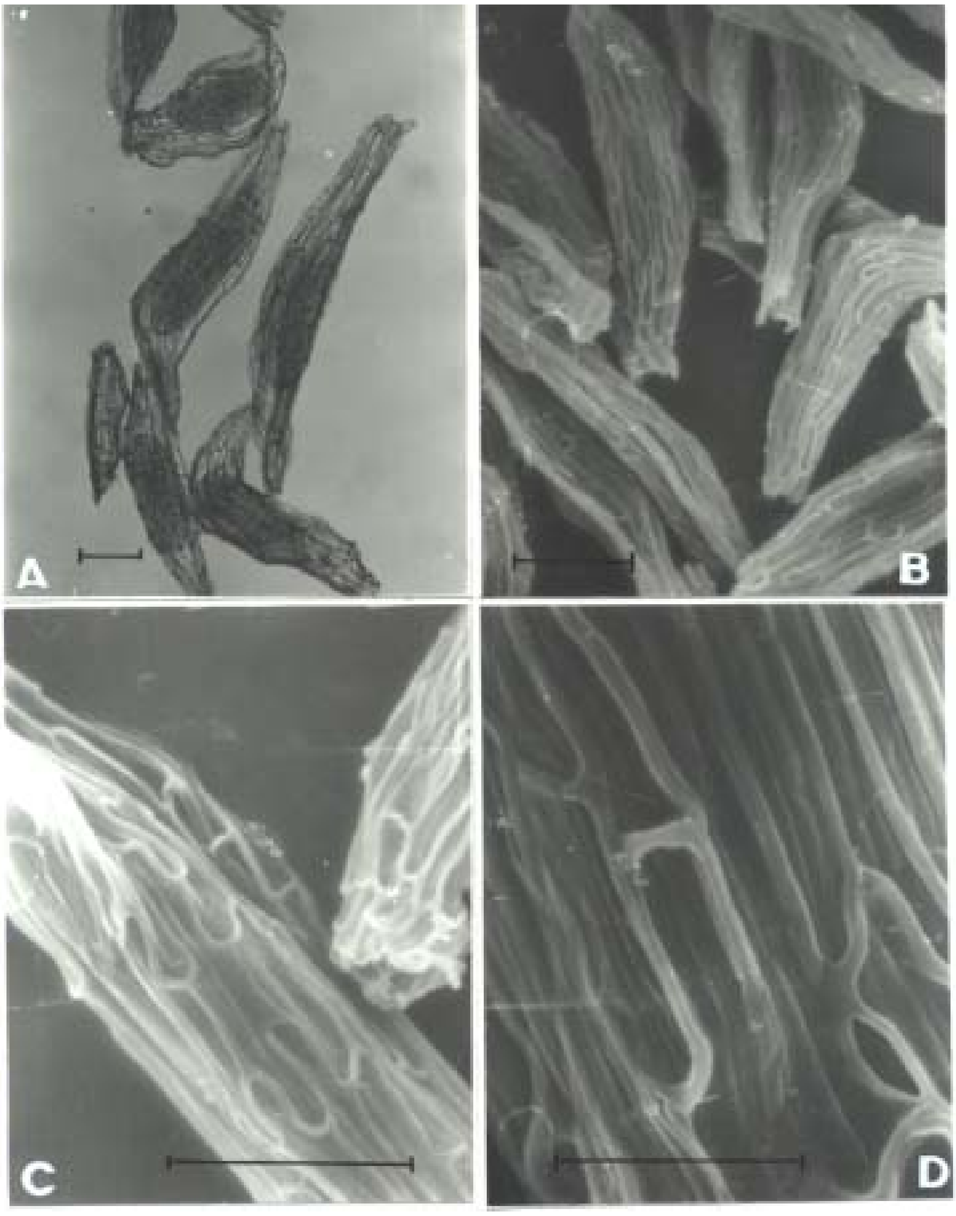

Fig. 8. Microscopic and Scanning Electron Microscopic photographs of *Pholidota pallida.* A: A few seeds under microscope. Bar = 50 µm. B: Seeds under Scanning Electron Microscope. Bar = 50 µm. C: Part of the testa enlarged. Bar = 10 µm. D: A small part of the testa under high magnification. Bar = 5 µm.

The embryo in the seeds of orchids generally occupies a very small portion of the seed, but in species of *Bulbophyllum* the embryo is large and it occupies a major part of the seed (Augustine *et al.*, 2001). The seeds of *Coelogyne breviscapa* (2.2690 mm^3 x 10^{-3}) and *Cymbidium bicolor* (1.6289 mm^3 x 10^{-3}) have the embryos of a larger volume (Table 3).

Seed volume to embryo volume

Seed volume to embryo volume presents some interesting observations. In the species of *Bulbophyllum, Coelogyne, Liparis, Oberonia, Vanda,* and *Xenikophyton* seed volume to embryo volume never crosses two (Table 3). But in the case of *Cymbidium bicolor* measurements go up to 7.29. This is followed by *Aerides maculosum* (4.95) and *Pholidota*

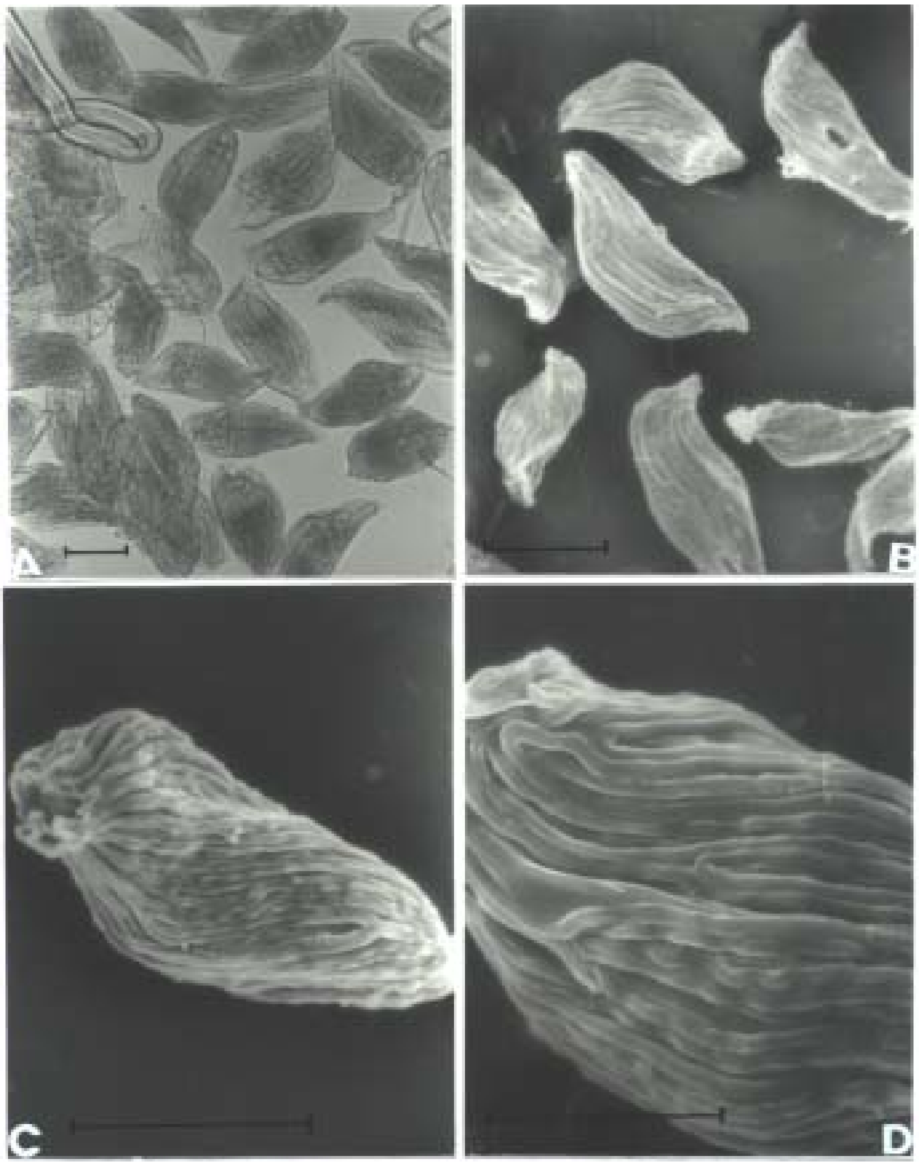

Fig. 9. Microscopic and Scanning Electron Microscopic photographs of *Vanda parviflora.* A: Seeds under the high power of microscope. Bar = 20 µm. B: A few seeds under Scanning Electron Microscope. Bar = 20 µm. C: An enlarged view of a seed under Scanning Electron Microscope. Bar = 4 µm. D: Part of the testa under high magnification. Bar = 2 µm.

pallida (2.64). The orchid seeds are small in weight; they are adapted for wind dispersal and belong to category of flyers. They contain undifferentiated embryo within a loose testa and the air filled space between the testa. Consequently seeds with higher ratio of seed volume/embryo volume are expected to more buoyant than those with a lower ratio of seed volume/embryo volume. In the present investigation, a direct correlation was apparent between the seed buoyancy and distribution pattern. The ratio of seed volume/embryo volume of *Aerides maculosum*, *Cymbidium bicolor* and *Pholidota pallida* shows more than two. They are widely distributed species in Western ghats of Karnataka. Higher percentage of air space also noticed in these three orchid taxa. In the rest of the orchid taxa the ratio of seed volume/embryo volume is less than two and also significantly decrease in their air space. This shows that they are restricted or localized distribution in Western ghats of Karnataka.

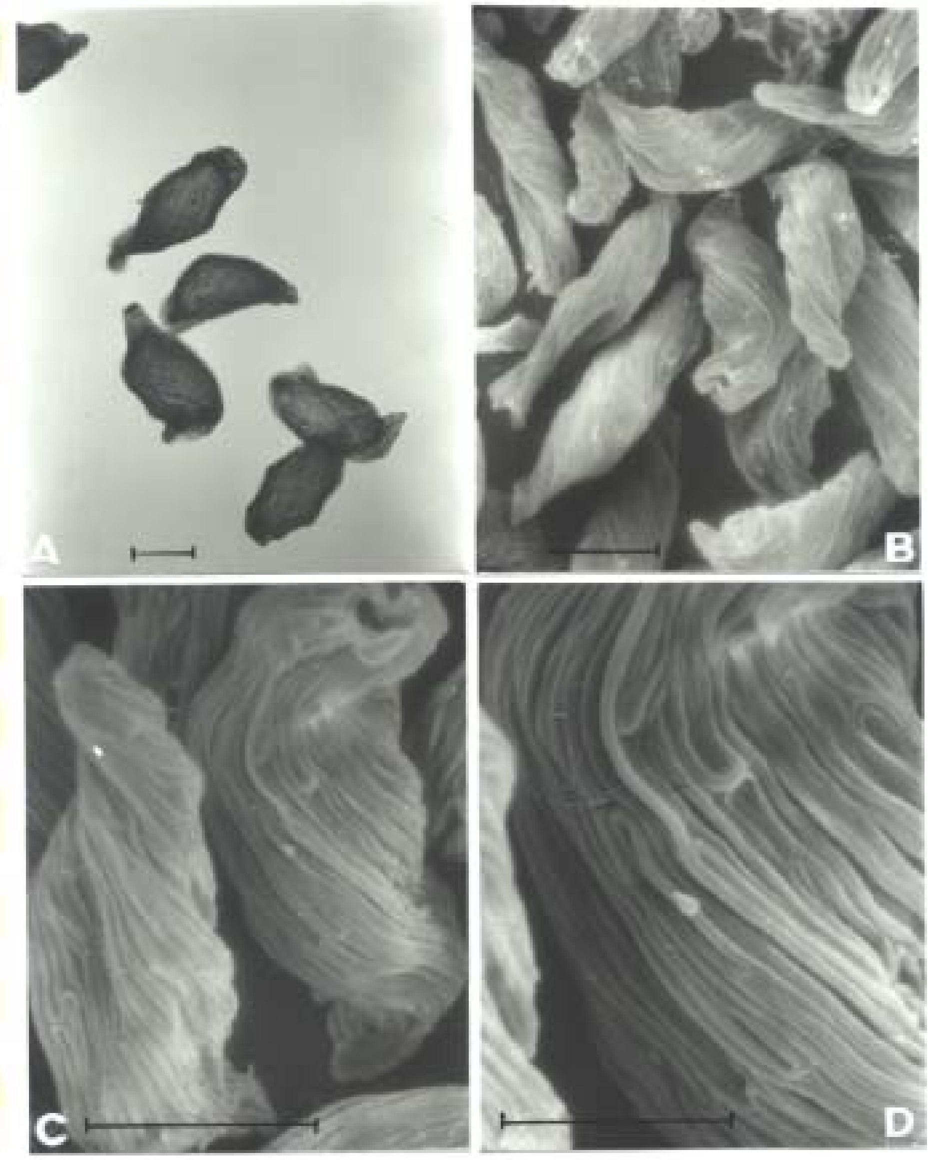

Fig. 10. Microscopic and Scanning Electron Microscopic photographs of X*enikophyton smeeanum.* A: Seeds under the high power of microscope. Bar = 30 µm. B: Seeds under Scanning Electron Microscope. Bar = 30 µm. C: Seeds under high magnification. Bar = 6 µm. D: Part of the testa highly enlarged. Bar = 3 µm.

Air space

In the present work, the seeds with maximum percentage of air space were noticed in *Cymbidium bicolor* (86.29), *Aerides maculosum* (79.79), *Pholidota pallida* (59.63) and *Coelogyne breviscapa* (47.39). These orchids are widely distributed in the Western ghats. This has an impact on the phytogeo-graphical distribution of the taxa. The seeds with minimum percentage of air space in the present work have a restricted range of distribution when compared to above taxa.

Air space in the seeds of orchids is of great morphological interest. During maturation, in the seeds of the capsules, there is an increase in percent air space. Increase in the air space is due to an increase in the cell length of the testa and not because of an increase in the number of cells in the seed coat.

Table 3. Measurement data of embryo.

Name of the species	Colour	Length (mm)	Width (mm)	L/W	Volume $mm^3 \times 10^{-3}$	Seed volume/ embryo volume	Air space (%) (seed vol.-embryo vol.)/ seed vol. x 100
Aerides maculosum	Brown	0.0750 ± 0.0094	0.0450 ± 0.0094	1.67	0.0795	4.95	79.79
Bulbophyllum mysorense	Golden yellow	0.1050 ± 0.0167	0.0525 ± 0.0117	2.00	0.1515	1.62	38.41
Coelogyne breviscapa	Yellow	0.3615 ± 0.0426	0.1095 ± 0.0150	3.30	2.2690	1.90	47.39
Cymbidium bicolor	Pale yellow	0.1960 ± 0.0170	0.1260 ± 0.0099	1.56	1.6289	7.29	86.29
Eria dalzellii	Yellow	0.1230 ± 0.0190	0.0840 ± 0.0099	1.46	0.4543	1.36	26.63
Liparis elliptica	Pale yellow	0.1020 ± 0.0900	0.0585 ± 0.0080	1.74	0.1827	1.21	17.07
Oberonia ensiformis	Yellow	0.1035 ± 0.0105	0.0660 ± 0.0073	1.57	0.2360	1.75	42.73
Pholidota pallida	Pale yellow	0.0870 ± 0.0112	0.0435 ± 0.0080	2.00	0.0861	2.64	59.39
Vanda parviflora	Pale yellow	0.1110 ± 0.0073	0.0570 ± 0.0060	1.95	0.1887	1.77	43.64
Xenikophyton smeeanum	Light yellow	0.1785 ± 0.0141	0.0735 ± 0.0080	2.43	0.5048	1.35	26.09

± Standard deviation

Earlier authors (Arditti *et al*., 1980; Augustine *et al*., 2001) have emphasized the significance for the presence of air space in the seeds of orchids. The seed biology of orchids are made very interesting because of the presence of air space, which makes the seeds light and buoyant. This is useful in the anaemochory and the phytogeographical distributional aspects of the orchids. In fact, very light and buoyant seeds with a greater percentage of air space may get dispersed over wide geographical areas and the seeds with minimum air space as in *Bulbophyllum rothschildianum* may get confined to a few narrow local patches (Augustine, *et al*., 2001). Therefore, if such species become endangered, conservational measures become more difficult.

In view of the above, Augustine *et al.* (2001) strongly feels that the information on seed morphometry would be very useful in solving the problems of taxonomy, phylogeny, phytogeography and seed biology.

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印度 Karnataka 西部山區附生蘭種子之形態測量

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摘　　要

本文利用掃描電子顯微鏡觀察印度 Karnataka 西部山區 10 種附生蘭種子之形態並加以測量。這些種均具有不同的種子表面特性，包括種子大小、形態、胚的活力、種皮構造、彎曲度與稜線等等。種子顏色從淡黃到黃色、棕色與白色都有。種子的長寬比之大小變異亦加以討論。種子的體積乃是由種子的長與寬所決定。*Cymbidium bicolor* 有最大的種皮細胞寬度與種子體積。不同種類之間的種子與胚之體積與空氣所佔有的百分比都有一些變異。氣室比例之所以增加乃是因為種皮之細胞長度增加，種皮氣室所占比例高者有助於種子之散佈。

關鍵詞：氣室、蕙蘭、掃描電子顯微鏡、蘭花、種子形態測量。

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