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Palynological study on the family pedaliaceae in Sudan

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ABSTRACT

The family Pedaliaceae is represented in Sudan by seven species belonging to four genera (Ceratotheca End., Rogeria J.Gay, Pterodiscus Hook and Sesamum L.). This study investigated the degree of evolutionary advancement for this economically and medicinally important family using palynological studies. Pollen grains are stephanocolpate,radially symmetrical, prolate to spheroidal. Aperture details are nearly uniform in all the species investigated .Colpi are long with broad ends. The exine for all the studied species has an interesting more or less similar structures & sculptures, these similarities may verify their relations at their generic level. This study confirmed the advancement of the Pedaliaceae and the importance of palynological characters in plant taxonomy. Also, close generic and specific relationships and strong resemblances were found between the studied species.

Key words*:* Pedaliaceae, Palynology, Sesamum, Sudan,Phylogenetic classification

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INTRODUCTION

The family Pedaliaceae is a small family comprising about 12 genera distributed in tropical and southern Africa ,south east Asia and tropical Australia. It is classified under the class Eudicot (dicotyledonous), order Lamiales by APG[1] . Plants of this family are generally annual or perennial herbs and rarely shrubs. The main common diagnostic features are the presence of glands , solitary flowers, gamopetalous corolla, superior 2- celled ovary (rarely inferior) and the ovary cells are often divided by false septa.

[2] stated that this family is closely related to the family Bignoniaceae and Scrophulariaceae and it shares a common ancestor with the family Convolvulaceae Order Polemonales. Very recent classification by APG[3] placed this family under the order Lamiales. This family was reported to have medicinal values, as anticancer, demulcent, emollient and laxative properties; the seeds of sesamae used for lowering cholesterol and protect liver from oxidative damage .

Pollen morphological studies of the family Pedaliaceae were conducted sporadically. The first palynological study was that described by [4], who studied the pollen grains of 15 species belonging to 11 genera from this family . He showed that they are usually 5-13 colpate , oblate – subprolate , united in tetrads in *Sesamothamnus* and *Sigmatosiphon* species. [5] described the pollen morphology of *Sesamothamnus lugardii*. [6] studied the pollen morphology of different genera including the genus *Sesamum*. [7] reported that some of the pollen grains of the family Acanthaceae are similar to those of the family Pedaliaceae.

The species *Pterodiscus ruspollii* was reported by [8] in Flora of East Tropical Africa but it was not mentioned in all studied floras in Sudan.

The genus *Sesamum* L. was described by [9].This generic name was taken by Hippocrates from the Arabic semsim [10]. This genus is represented in Sudan by four species which are *Sesamum alatum* Thonn., *S. angustifolioum* (Oliv.) Engl., *S. indicum* L. and *S. latifolium* Gillett. The last species was omitted from the flora of Sudan since it is

often miss- identified as *S. radiatum* Schumach. [11]. *Sesamum indicum* is an important cultivated crop in Sudan and it is cultivated mainly under rainfed condition . Three main varieties are planted which are: red seeded (jebele) , white seeded sesame and mixed varieties [12].

The pollen morphology of Pedaliaceae in Sudan has not been investigated at length. [13] studied the pollen grains of 320 Sudanese species in which he described only one Pedaliaceae species, which is *Sesamum alatum*. In 1998,[14] reported that *Rogeria adenophylla* exhibits significant variation in pollen morphology, which was previously reported to have homomorphic pollen grains.

The objective of this study is to evaluate the relative degree of advancement of the family Pedaliaceae and the degree of similarities between the studied species. It is the first comprehensive palynological investigations of this family in Sudan.

EXPERIMENTAL SECTION

Pollen samples for six species were obtained from Herbarium of Botany Department (KHU) or the fresh material collected from the field (The list of voucher specimen was deposited in the KHU).

The samples then were acetolysed according to standard acetolysis method for recent pollen grains [15; 16 &17]. Pollen grains were stained with basic fuchsin, and were mounted in glycerin for light microscopic (LM.)examination. LM. examination was done with a Zeiss microscope using phase contrast (ph) objective x100 magnification. LM photomicrographs were taken with a Zeiss axiomatic microscope equipped with a 35 mm automatic camera attachment, model Leitz ortho 20. The grains were measured with 3 replicates for each species under X 40 magnification using calibrated micrometer and a standard slide.

All the measurements were taken in µm, this include the dimensions of the polar axis (P), equatorial axis (E), the diameter (D) of the pollen grain, the exine thickness and the diameters of the pores . A total of six qualititative characters were recorded. Also seven quantitative characters were recorded for each sample. The terminology used is according to[15]. One type of analysis of variance was carried out here, which is one-way factorial ANOVA (completely randomized design) were calculated for the significance of the differences between all the species in the six pollen characters .

A matching similarity percentage index between the pollen grains of all the species was calculated using 12 characters.

RESULTS

Pollen class for all the studied species is stephanocolpate, spheroidal in shape and circular in polar view except in *Rogeria adenophylla* which is prolate in shape and ovate in polar view.

Aperture ; rather long colpi narrow slit –like as in *Rogeria adenophylla* & *Sesamum alatum* or boat-shaped as in *Ceratotheca sesemoides*, *Sesamum indicum* & *Sesamum latifolium* .

Exine ; in all the studied species is devoid of any out growth, tectate, tectum imperforate with distinct relatively short collumella, ektexine is thicker than the endexine undulate in *Sesamum alatum* , wavy in *Rogeria adenophylla* (Table 1 and figures 1-6).

P/E ratio verified that pollen grains for all the studied species are usually spheroid exception to *Rogeria adenophylla* pollen grain which is prolate.

The largest pollen diameter was scored for *Rogeria adenophylla* whereas the smallest pollen size was scored *for Ceratotheca sesemoides*, no sharp variation is scored for the diameter of the pollen grain of the *Sesamum* group (Table 2).

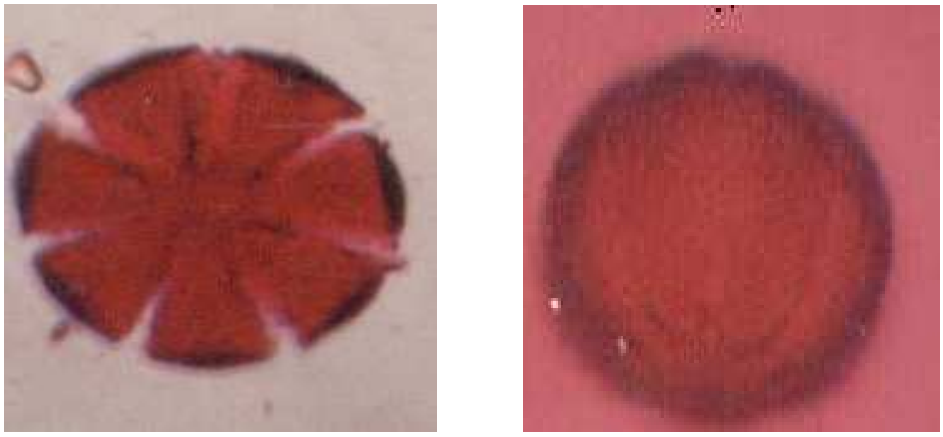
Table (1): Qualitative analysis of pollen grains of all studied Pedaliaceae species

NO	Characters/ Species	*Ceratotheca sesemoides*	*Rogeria adenophylla*	*Sesamum Alatum*	*Sesamum angustifolia*	*Sesamum indicum*	*Sesamum latifolium*
1	Shape class (P/E ratio)	Oblate spheroidal	Prolate	Prolate Spheroidal	Prolate Spheroidal	Prolate spheroidal	Prolate Spheroidal
2	Pollen class	Stephanocolpate	Stephanocolpate	Stephanocolpate	Stephanocolpate	Stephanocolpate	Stephanocolpate
3	Shape in polar view	Circular open	Ovate open	Circular open	Circular open	Circular open	Circular open
4	Shape of aperture	Boat shaped with straight Edges, tapering at both ends.	Parallel with straight to wavy Edges.Irregularly Constricted	Parallel with wavy edges	Boat shaped with traight Edges, tapering at both ends.	Boat shaped with straight Edges, tapering at both ends.	Boat shaped with straight Edges, tapering at both ends.
5	Exine structure	Structured red Tectum And thin short columellae	Structured red tectum,wavy and long columellae	Structured red Tectum, undulating long columellae	Structured red Tectum, and thin short columellae	Structured red Tectum, and thin short columellae	Structured red tectum, and thin short columellae
6	Ektexine thicker than Endexine	+	+	+	+	+	+

Table(2): Mean values (M) & standered deviations (SD) for all measurements of the pollen grains of the studied Pedaliaceae species (in *u*m)

Species		Polar axis	E Axis	Diameter	P/ E	Exine thickness	Apert L	Apert W
C. sesemoides	M	50.4000	56.7000	44.8667	0.8900	2.8000	29.0667	5.4000
	SD	1.8330	1.5426	3.5233	1.000E-02	.8000	2.6102	.9135
R..adenophylla	M	83.3333	72.0000	79.3333	1.1567	4.6667	37.6000	6.1333
	SD	2.6633	6.0399	2.2030	6.110E-02	.8327	3.6661	1.0036
S. alatum	M	71.4667	70.0000	50.1333	1.0233	4.8000	41.6333	5.3333
	SD	2.0133	2.4980	3.1070	1.528E-02	.8000	3.0139	.6110
S. angustifolia	M	66.4000	64.4000	49.4000	1.0267	4.6667	46.0000	5.8637
	SD	2.8000	3.8158	3.2187	2.082E-02	.2309	4.2143	1.6653
S. indicum	M	69.2667	69.1333	46.5333	0.9967	4.6667	36.6667	5.7337
	SD	3.1262	2.0033	4.6014	2.309E-02	.6110	3.4020	1.6136
S. latifolium	M	72.3667	71.8667	66.2667	1.0100	4.2000	37.3333	6.1333
	SD	1.8877	1.9218	4.8387	0.0000	.2000	2.8378	1.2220
Total	M	68.8722	67.3500	56.0889	1.0172	4.3000	38.0500	5.7637
	SD	10.2843	6.2178	13.2571	8.358E-02	.8951	5.9979	1.0852

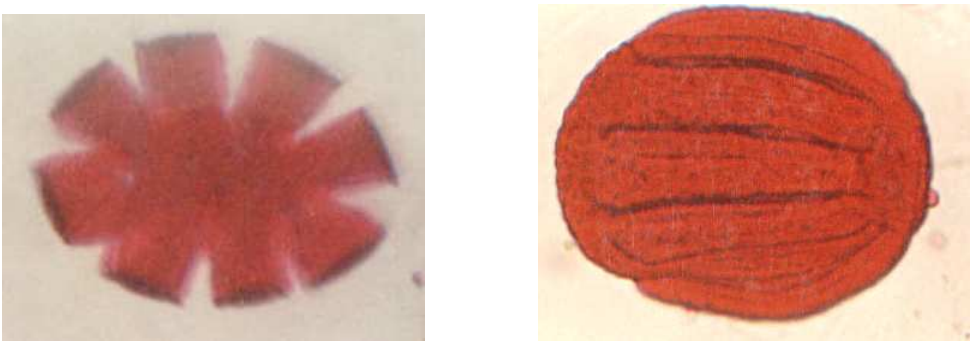
Pollen Photographs



a. Polar view b. Equatorial view

Fig.(1) *Ceratothica sesamoide*s End. 7:5tt.1,2 (1832); F.T.A. 4 (2):563 (1906); 244 (1931)

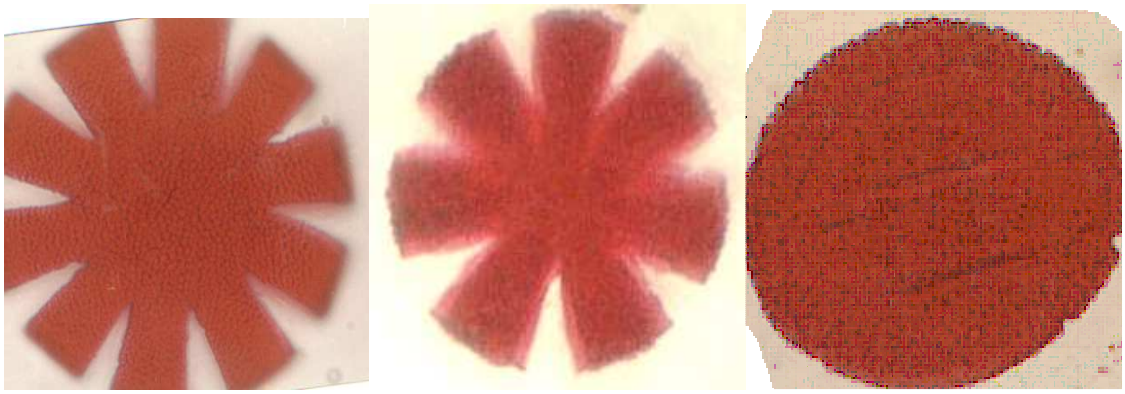
Syn. *Ceratothica melanospera* (Hchst. ex) Bernch.in Linnaen 1032841 (1842).
C. *sesamoide*s End. var *melanospera* A.D.C. In Dc.Prodx : 252 (1845)



a. Polar view b. Equatorial view

Fig(.2)*Rogeria adenophylla* J. Gay in Ann Sc. Nat jre ser.i. 457(1924) Fig, 55.

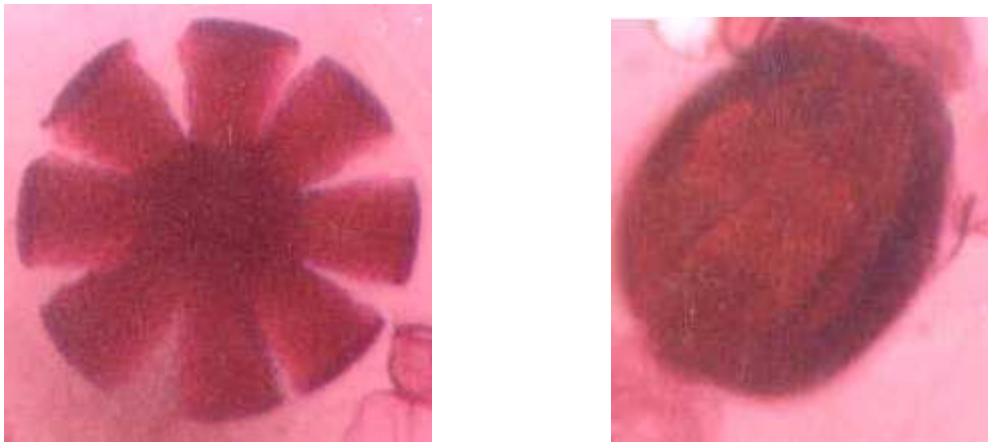
Syn. *Pedalium callaudii*. Del.& Kotschy pl. Nub 151.
Pedalium rodgeria Decene in Ann. Sc. Nat 5 ser iii 331.



a. Polar view Polar view b. Equatorial view

Fig(3)*Sesamum alatum* Thnn, In Shumaach & Thonn, Besker.Guin

Pl. (284) (1827); F.T. A. 4(2) : 559 (1900).
Syn. *Volkameria alata* (Thonn.) O. Ktze;Rev.Gen. Pl(3:247) (1893).
Sesamum subutum A. Chev.; Etud. Fl Afr. Cent Franc.1:229 (1913).

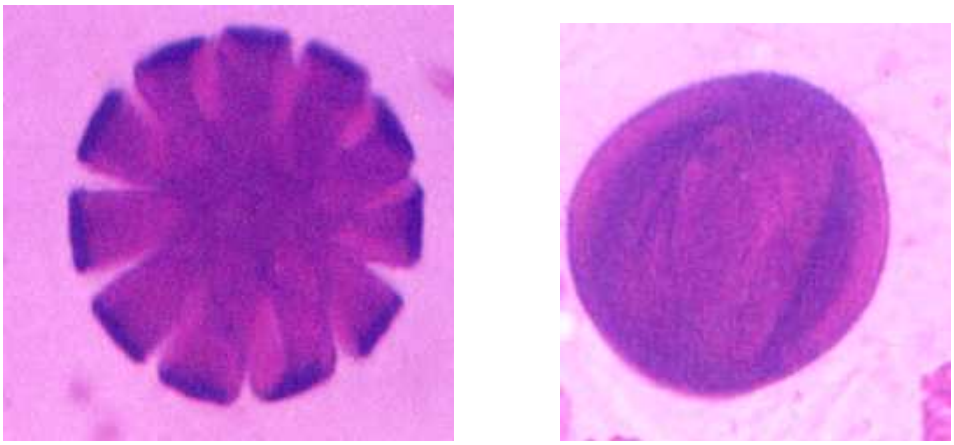


a. Polar view b. Equatorial view

FIG.(4) *Sesamum angustifolium* (Oliv) Engl. In P.O, AC:365(1805);

F.T.A. 4(2) :554(1906); F,P.N.A.2:253(1947).
Syn. *Sesamum indicum var. angustifolium* Oliv. In Trans,

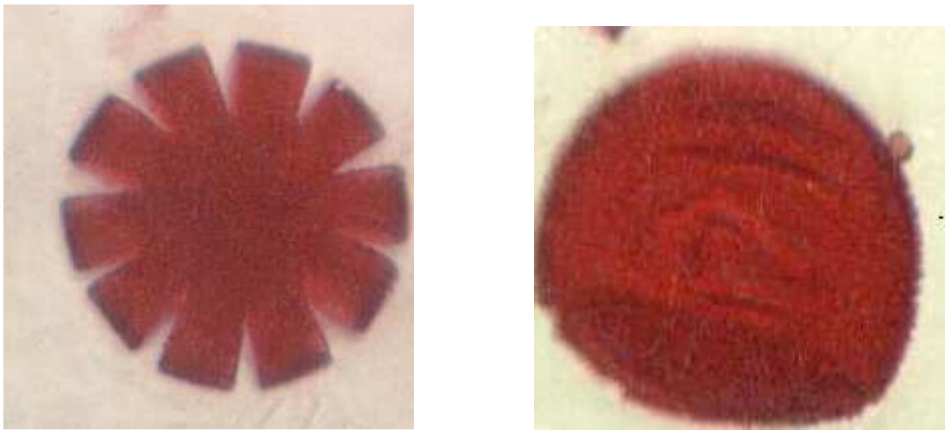
Linn. Soc. 29: 131(1875)
S. baumii Stapf in F.T.A. 4(2):554(1906).



a. Polar view b. Equatorial view

Fig.(5)*Sesamum indicum* L., Sp., ed. 1, 643(1753); P.O,AC:365(1805);

F.T.A. 4(2) :554(1931); F,P.N.A.2:253(1947).
Syn *Sesamum orientale* L. Sp., ed. 1, 643(1753);



a. Polar view b. Equatorial view

Fig.(6) ***Sesamum latifolium*** Gillet in K. B. 1953: 118 (1953)

From the analysed data; significant differences are scored for all pollen characters for the studied species with exception to aperture width (Table 3). No significant differences are scored in all the characters of *Sesamum* pollen grain with the exception to pollen diameter of *Sesamum latifolium*; which scored the highest diameter. From this point the *Sesamum* group can be considered as a homogeneous subset.

Table (3): Pollen characters of the studied Pedaliaceae species as measured by the F-ratio values of one way Anova (completely randomized design with sub sample numbers)

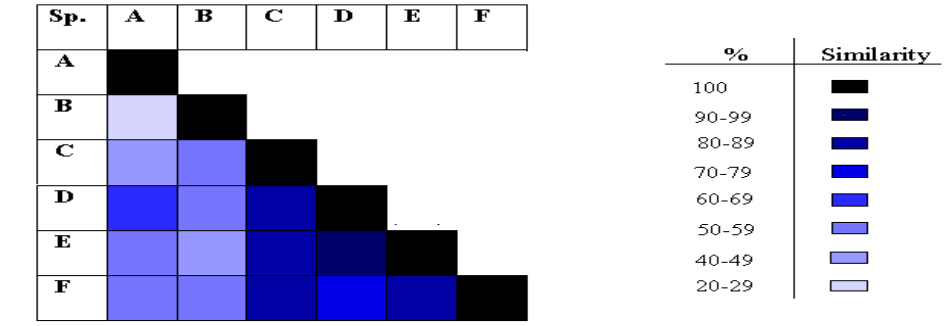
Characters	**d. f**	F. ratio	Sig.
Polar axis	**5-12**	58.066	.000*
Equatorial axis	5-12	9.355	.001*
Diameter	5-12	41.395	.001*
Exine thickness	5-12	4.298	.018*
Aperture length	5-12	8.599	.001*
Aperture width	5-12	.238	.239

**The mean differences are significant at the .05 level.*

Significant differences are scored for all the characters of the species *Ceratotheca sesemoides* pollen grains when compared to *Rogeria adenophylla* with the exception of pollen aperture width, this may verify the fact that they are heterogeneous subset.

The matching similarity index (Fig.7) between the studied species which is based on 12 characters (quantitative &qualitative) indicates high similarity of about 92- 80% between the *Sesamum* group. A low similarity of about 25% was scored between *Ceratotheca sesamoides* &*Rogeria adenophylla*.

The dendogram or the phylogenetic tree (Fig.8) stems represent the relation-ship between the species. The nearest stems represent the close relation between the Sesamum group, while again *Rogeria adenophylla &Ceratotheca sesemoides* are distant apart, and this also verify the week relation-ship between the two species.



Note: -

Sp.No.	Sp.Name
A	Ceratotheca sesemoides
B	Rogeria adenophylla
C	Sesamum alatum
D	Sesamum anquistifolium
E	Sesamum indicum
F	Sesamum latifolium

Note: -

High similarity percentage about 91.7% between Sesamum alatum, Sesamum anquistifolium and Sesamum indicum

low similarity percentage a bout 25 % between Ceratothece sesemoides and Rogeria adenophylla

Fig.(7): Matching similarity percentage between the studied species using 12 quantitative and qualitative characters in previous tables

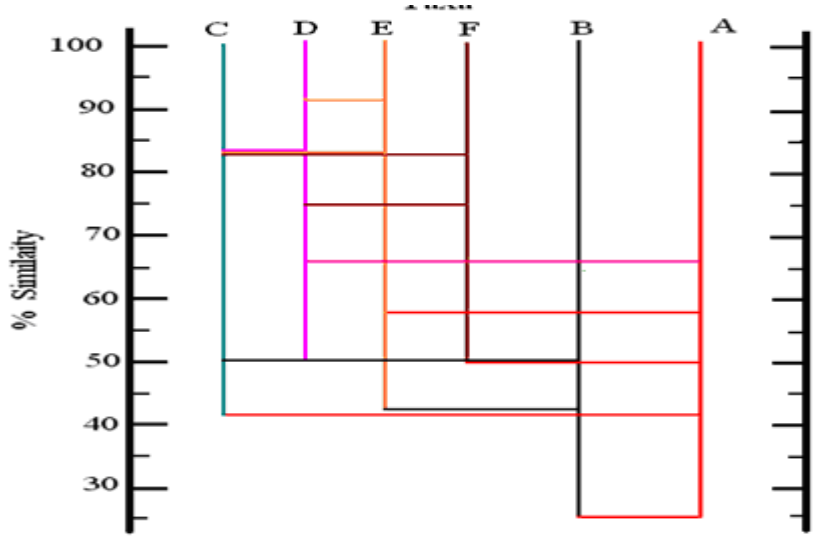


Fig (8): Dendrogram representing the hypothetical hierarchy obtained from fig (7)in hypothetical manner of Michener & Sokal (1957). ordinate indicate the magnitude of similarity coefficient at which stem join to form higher ranking taxa. Horizontal lines delimit taxa of equal ranks.

DISCUSSION AND CONCLUSION

Conspicuous pollen morphological similarities are evident from the study of pollen morphology at both generic and specific level. In general the pollen grains are stephanocolpate radially symmetrical, the shape of pollen grain varies from prolate to spheriodal. The aperture details are nearly uniform in all the species investigated, the colpi are long with broad ends. The exine for all the studied species has an interesting more or less similar structures & sculptures, these similarities may verify their relations at there generic level.

Tracing the evolutionary trends among the species under study ; it is clear that, and according to [2] who considered the pollen aperture type and taxonomic phylogenetic, the pollen grain of these species are stephanocolpate , aperturate ; aperture 7 -12 simple with tectate imperforate exine, in all the species under study the ektexine is thicker than the endexine, the collumella is distinct and sculpturing. According to [2] these characters are advanced with the exception to the simple aperture and imperforate exine, which are primitive characters compared to composite aperture and perforate exine.

The biometric analysis shows clear differences in the dimensions of the grains mainly at the generic level, no sharp variation is recorded between the *Sesamum* group and this may verify the work of [18] who stated that pollen grains of the same species and of closely related species tend to be alike if the environmental factors are uniform & the degree of their similarity is a measure of their closeness relation-ships. [19] also held the same opinion & remarked that such similarities in characters appear to be due to closeness from the phylogenetics stand point. *Rogeria adenophylla* & *Ceratotheca sesemoides* showed large differences in most of the pollen characters and this may verify their week relationship at the specific level.

The biometric studies also confirmed the work of [20], who compared the size of the pollen grain to the flowers size, he found that there is a remarkable tendency of the size of the pollen grains to decrease with the reduction of the flowers size. This fact is well represented in *Rogeria adenophylla* & *Sesamum alatum* with relatively large sized flowers & pollen grains compared to *Ceratotheca sesemoides* with small sized flowers & pollen grains.

From the study of pollen grain morphology it is also evident that these species are stenopalynous forming a strong assemblages of genera belonging to one advanced dicotyledonous family.

Comparing pollen grains characters resulted from the study of this family with the family Bignoniaceae cited in literatures , it is evident that there is a strong palynological similarities between them, this confirmed the work of[4] and [2] who stated that these two families are closely related.

It can be stressed that the present study has shown the usefulness of pollen morphological characters suggesting specific relation-ship among the species investigated and support the contention as the classification at the specific level is well correlated with pollen morphology . Also it must be remembered that the pollen characters are subjected to parallelism convergence & probably by reversal as are other characters employed by taxonomist.

Lastly it may be pointed out that as this family is of economic and medicinal importance in the Sudan, only little information is available on this family, this is specially concerning their palynology and cytogenetics. No group is at the present time known to be working actively on this family. It is necessary to organize immediately survey and collection expeditions to the region of their occurrence.

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