

SEM studies in the fruit morphology of some species of Resedaceae from Egypt

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Fruit morphological features of 13 species belonging to four genera: *Caylusea* A. St. Hill., *Ochradenus* Delile, *Oligomeris* Cambess., and *Reseda* L. in Egypt have been studied by light microscopy and scanning electron microscopy (SEM). The SEM of fruit surfaces revealed a remarkable topographic diversity of these apparently simple structures. Stomata are striking features of the fruit surfaces. The cuticle has prominent striations which vary from random, radiate, and reticulate to parallel or a mixture of these patterns. SEM of fruit surface showed marked variations between the studied taxa at both generic and specific level. Thus, the fruit surface as seen by SEM could provide useful additional characters in delimitation of the resedaceous species. An identificatory key based on the fruit surface feature is provided.

Key words: Cuticular deposition - Fruit surface – Resedaceae – SEM.

Introduction

Resedaceae is a small natural and well defined family of herbs and small shrubs, consisting of six genera and about 75-80 species. Its distribution is in the Northern Hemisphere, mainly in the warm regions with special restriction to the dry places around the Mediterranean Sea (Heywood 1979; Mabberley 1997). In Egypt, Resedaceae is represented in wild flora by five genera: *Caylusea* A. St. Hil., *Ochradenus* Delile, *Randonia* Coss., *Oligomeris* Cambess., and *Reseda* L. Different authors urged about the number of the species recorded in Egypt: Montasir and Hassib (1956)

recognized 13 species, Täckholm (1974) enumerated 16 species where she considered *Reseda lutea* L. and *R. petrovichiana* Müll. Arg. as two distinct species, whereas El Hadidi & Fayed (1994) and Boulos (1999) recognized 15 species and considered *Reseda lutea* and *R. petrovichiana* as one taxon (*Reseda lutea* L.) This family has been taxonomically treated in different studies; the most noteworthy are those of Abdallah (1967), Abdallah & De Witt (1978), Mitra & Mitra (1979), Miller (1984), Ishak *et al.* (1992) and El-Naggar (2002).

In relation to the fruit, although some morphological features are frequently used in the keys of floristic studies, detailed data are not usually included. SEM facilitates the observation of structures that are difficult to observe by other means. Several authors (e.g. Juan *et al.*, 1996; Blanca & Diaz de la Guardia, 1997) have demonstrated the importance of SEM in the study of the surface features of fruits.

As regards the Resedaceae and as far as the authors are aware, no literatures on the taxonomic significance of fruit surface pattern as seen by SEM are cited. Accordingly, this work deals with the fruit surface features of 13 species of Resedaceae in an attempt to evaluate the taxonomic importance of these micro-characters and provide a key to distinguish the species examined.

Materials and Methods

Fruit samples of each studied species were collected either from their habitat or from the herbarium specimens kept in the herbaria of Alexandria University, the Agricultural Museum (CAIM), Cairo University (CAI) and of Suez Canal University (Table 1). The study of the fruit surface pattern was carried out by SEM.

For SEM studies, dried mature fruits were placed on stubs, coated with a thin layer of gold then scanned and photographed at 15 KV with JEOL JSM 5300 SEM at the Electron Microscope Unit, Alexandria University. The terminology used here concerning the description of fruit surface pattern basically follows Barthlott (1981) and Stearn (1992), that of cuticle was adopted after Olowokudejo (1985), and that for stomatal description after Metcalf & Chalk (1950) and Noorma & David (1996).

Table (1). Collection data of the investigated specimens

No	Taxon	Localities and Herbarium
1	<i>Caylusea hexagyna</i> (Forssk.) M.L. Green	Burg El Arab, Mariut. 11.03.2002. Herbarium of Alexandria University.
2	<i>Ochradenus baccatus</i> Delile	Eastern desert: Wadi Hagul, 25.02.1994, Herbarium of Alexandria University.
3	<i>Oligomeris linifolia</i> (Vahl ex Hornem.) J. F. Macbr.	40 km. east of Mersa Matruh, 26.02.1979, Herbarium of Alexandria University.
4	<i>Reseda alba</i> L.	Burg El Arab, Mariut, 11.03.2002, Herbarium of Alexandria University.
5	<i>Reseda arabica</i> Boiss.	Burg El Arab, Mariut, 25.01.1989, Herbarium of Alexandria University.
6	<i>Reseda decursiva</i> Forssk.	Burg El Arab, Mariut, 11.03.2002, Herbarium of Alexandria University.
7	<i>Reseda lutea</i> L.	Mersa Matruh, 2.03.1979, Herbarium of Alexandria University.
8	<i>Reseda luteola</i> L.	Near Salum, Libya, 18.03.1955, Herbarium of Agricultural Museum.
9	<i>Reseda muricata</i> C. Presl	North Sinai, 07.06. 1997, Herbarium of Suez Canal University.
10	<i>Reseda orientalis</i> (Müll.Arg.) Boiss.	East Mediterranean region, February 1943, Cairo University Herbarium.
11	<i>Reseda phyteuma</i> L.	Wadi El Habs between 23.03.1974, Mersa Matruh and Agiba, Cairo University Herbarium.
12	<i>Reseda pruinosa</i> Delile	Eastern desert: Mersa Alam, 15.02.1998, Herbarium of Alexandria University.
13	<i>Reseda urnigera</i> Webb.	Wadi El Arish, North Sinai, 4.04.1935, Herbarium of Agricultural Museum.

Results

The fruits of the examined taxa were either berry or capsule; open at the apex and bear small sessile and well separated dry stigmas around the rim. The fruit size ranged from 3.2-19.3 X 1.7-6.2 mm and their shape are variable.

The fruit surface was characterized by the presence of stomata, micro relief formed by the epidermal cell walls and micro-ornamentation of the cuticle. The general characteristics of the fruits for each species investigated were given in Table (2), and the fruit surface patterns were illustrated in Figures (1- 22).

Trichomes and stomata

Long unicellular striated trichomes were noticed on the fruit surface of *Caylusea hexagyna* (Figs. 1, 2) while they were totally absent in the rest of the examined species. Stomata were distributed randomly over the fruit surfaces. They appeared circular in *Ochradenus baccatus* (Fig. 14) and elliptical in outline in the rest of the species. Stomata may be superficial (almost level with the surface) in *Reseda decursiva*, *R. pruinosa* and *R. urnigera*, raised above in *Caylusea hexagyna*, *Ochradenus baccatus*, *Reseda arabica*, *R. muricata* and *R. orientalis*. However, sunken stomata were spread over the fruit surface of the rest of the species examined.

A cuticular rim around the stomata was observed in all the studied taxa, except in *Reseda lutea* (Fig. 10). Interestingly, a peculiar and distinctive stoma with double outer rim (Fig. 18) was observed on the fruit surface of *Reseda pruinosa*.

Surface relief

The epidermal cells collectively form various patterns: reticulate, scalariform, runcate or ribbed. The epidermal cells in surface view were either isodiametric or elongated in outline. The anticlinal walls were straight in *Reseda lutea*, *R. luteola*, *R. pruinosa* and *R. urnigera*, undulate in *R. orientalis* and *Caylusea hexagyna* or curved in the remaining species. The relief of the cell boundaries was raised in *Caylusea hexagyna*, *Reseda arabica*, *R. decursiva*, *R. muricata*., *R. orientalis*, *R. pruinosa* and *R. urnigera*; or indicated by channels as in *Oligomeris linifolia*, *Ochradenus baccatus*, *Reseda alba* L., *R. lutea*, *R. luteola*., and *R. phyteuma* L.

Cuticular deposition

Barthlott *et al.* (1998) considered the cuticular deposition as the obligatory final layer of the cuticle. In the present work, the surface of the epidermal cells exhibited a micro-ornamentation referred to as cuticular striations or cuticular fold patterns in all the studied taxa.

The recorded distribution patterns of striae were as follows:

- Type (1):** The cuticular deposition was in the form of dense random undulate striae as in *Caylusea hexagyna* (Figs. 1 & 2).
- Type (2):**, The cuticular deposition was in the form of tight sharply angled V-shaped curved parallel striae as in *Reseda alba* (Fig. 3).
- Type (3):** The cuticular deposition was in the form of sparsely net work striae as in *Reseda decursiva*, and a complicated net work as in both *Oligomeris linifolia* and *R. arabica*. (Figs. 4-8).
- Type (4):** The cuticular deposition occurred on the periclinal walls in the form of mixture of radiate and densely net work striae as in *Reseda lutea* and *R. orientalis* (Figs. 9-12).
- Type (5):** The cuticular deposition was in the form of mixture of long undulate parallel and random striae. The parallel striae were either continuous over several cells as in *Ochradenus baccatus*, *Reseda luteola*, *R. muricata*, and *R. pruinosa*, or discontinuous in *R. phyteuma* and *R. urnigera*. (Figs. 13-22).

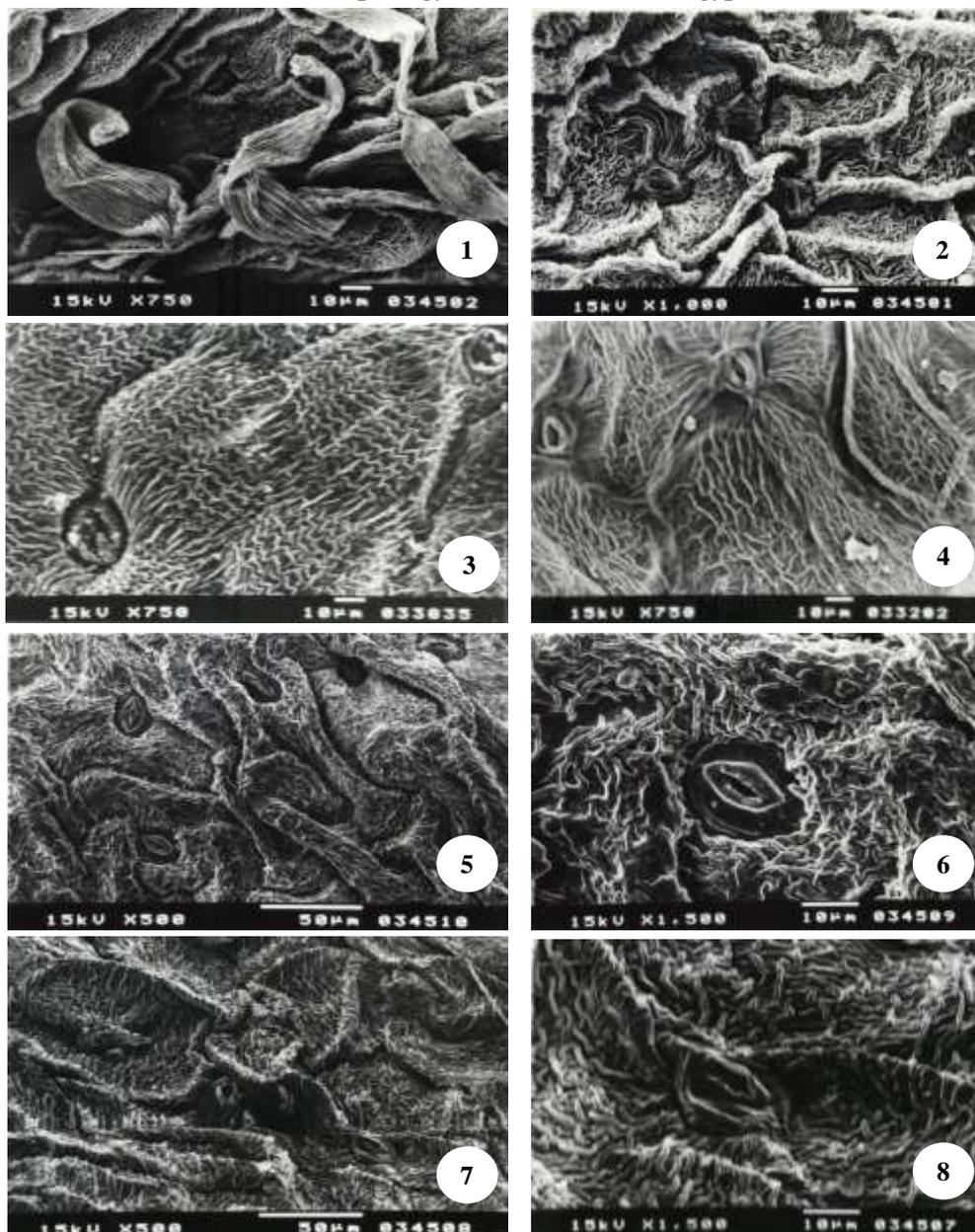
Discussion

The separation of the resedaceous taxa has long been done on the basis of exomorphic structural information. This has been met sometimes with difficulties because of the close macro-morphological similarities exhibited by species. The micro-morphological characters are more conservative and presented to solve arguments where close exomorphic resemblance exists between some taxa.

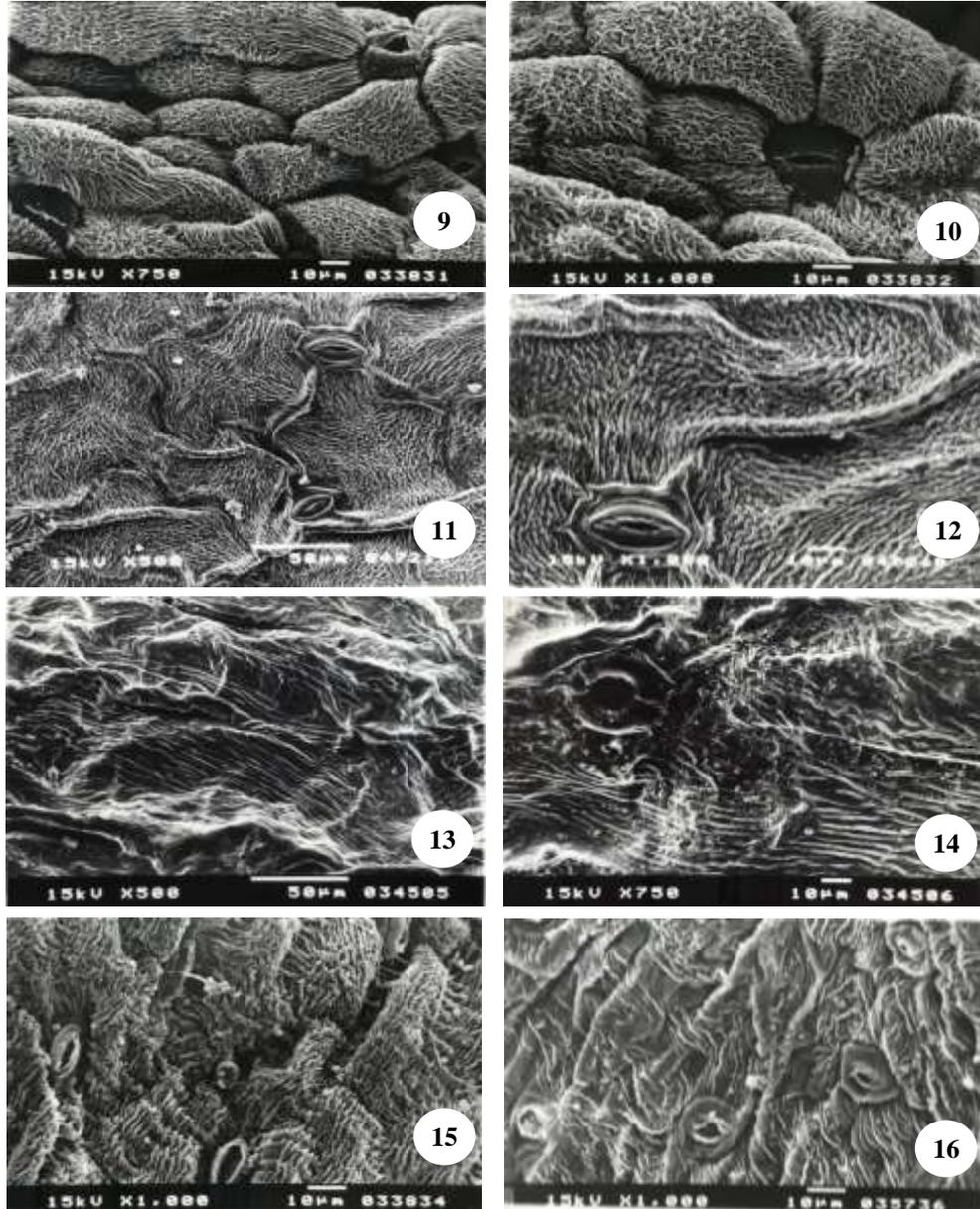
The fruit morphology, especially the micro-morphological features as sculpture characters, has proved to be valuable in the process of taxa delimitation (Rocio *et al.*, 1997, 1999; Usha *et al.* 2003 and Al-Nowihi *et al.* 2003).

In the present work, the observation of the fruit surface using SEM has revealed valid characters such as: stomata features, trichomes, over all surface appearance, shape of epidermal cells, ornamentation of the anticlinal walls and the cuticular striation patterns over the periclinal walls.

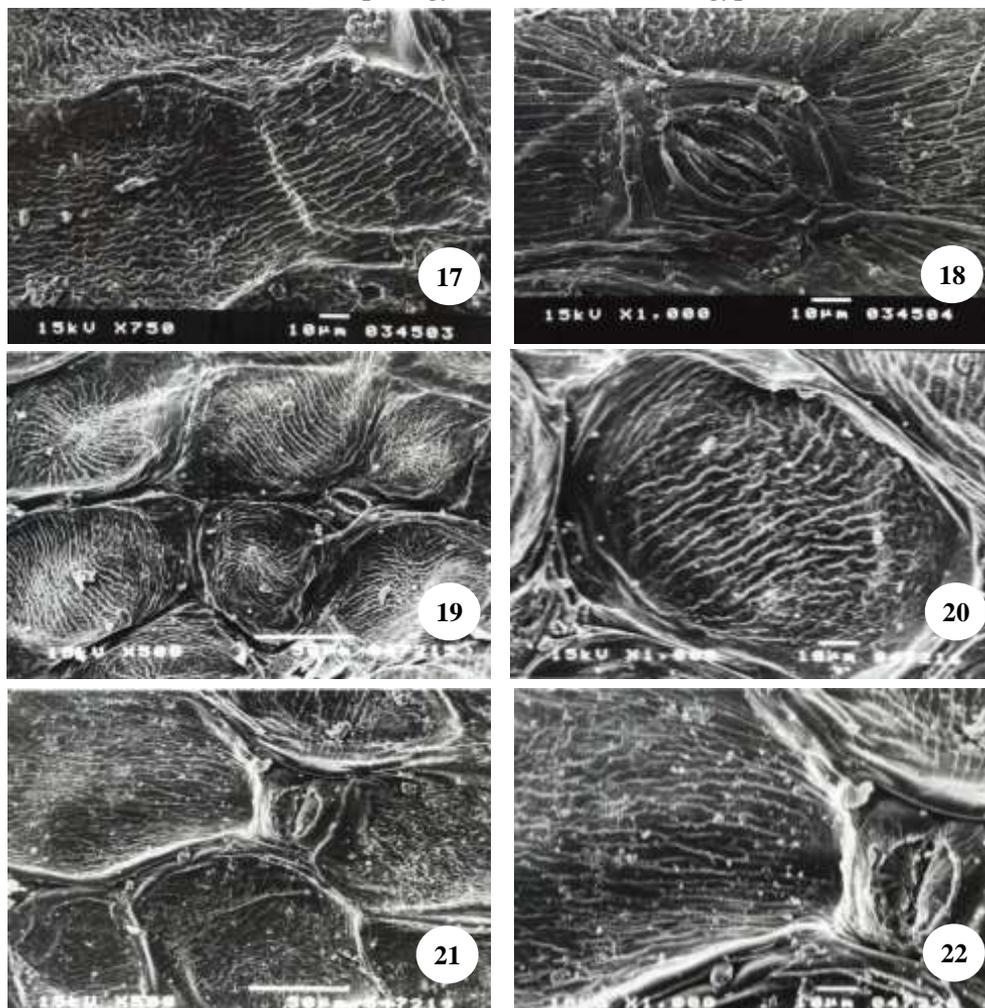
Caylusea hexagyna could be delimited from the rest of the studied species by the presence of long, unicellular, striated trichomes spread over its fruit surface. At the same time, *Ochradenus baccatus* could be distinguished by the ribbed sculpture of fruit surface and the rounded shape stomata.



Figures (1-8): Scanning Electron Micrographs of fruit surface
 (1, 2) *Caylusea hexagyna* (3) *Reseda alba* (4) *Reseda decursiva*
 (5,6) *Oligomeris linifolia* (7, 8) *Reseda arabica*



Figures (9-16): Scanning Electron Micrographs of fruit surface
 (9, 10) *Reseda lutea* (11,12) *Reseda orientalis* (13,14) *Ochradenus baccatus*
 (15) *Reseda luteola* (16) *Reseda muricata*



Figures (17-22): Scanning Electron Micrographs of fruit surface
 (17, 18) *Reseda pruinosa* (19, 20) *Reseda phyteuma* (21,22) *Reseda urnigera*

Concerning the genus *Reseda*, the SEM of fruit surface showed a wide range of variation in the sculpture characters of its species. The fruits of *Reseda luteola* and *R. muricata* have scalariform surface appearance whereas those of the remaining species showed reticulate appearance. Moreover, the cuticular striation patterns are variable within the genus, and can be used as a valuable character in differentiation of *Reseda* species. In this respect, Culter (1982) used this character to separate between *Aloe* species Doaigey & Harkiss (1991) found it applicable for *Antirrhinum* species and Al-Nowihi *et al.* (2003) used this character for the delimitation of *Brassica* species.

Based on the present results, *Reseda* could be considered to a certain extent as a heterogeneous taxon. This is in agreement with El-Nagger (2002) who on the basis of the pollen morphology claimed that.

Conclusively, it has been observed from this study that apart from the shape and size of the fruit the distinctive features of the fruit surface could provide additional taxonomic characters with much potential value and could be valuable in the identification and delimitation of the investigated taxa at both the generic and specific level. However, like all other taxonomic evidence, fruit micromorphological features must be interpreted with great circumspection.

So far as the data of the present work are concerned, the subsequent key based on the fruit surface characters is provided to enable the different species of Resedaceae to be distinguished.

Key of the species studied based on fruit micro morphological attributes

- 1A. Fruit surface papillose..... *Caylusea hexagyna*
- 2A. Fruit surface glabrous
 - 1B. Surface pattern ribbed*Ochradenus baccatus*
 - 2B. Surface pattern scalariform
 - 1C. Anticlinal wall raised*R. muricata*
 - 2C. Anticlinal wall channeled
 - 1D. Cuticular deposition long parallel striae..... *R. luteola*
 - 2D. Cuticular deposition dense network striae*Oligomeris linifolia*
 - 3B. Surface pattern reticulate
 - 1E. Anticlinal wall channeled
 - 1F. Cuticular deposition radiate and V-shaped parallel striae*R. alba*
 - 2F. Cuticular deposition radiate and dense network striae*R. lutea*
 - 2E. Anticlinal wall raised

- 1G. Stomata raised
 1H. Cuticular deposition dense network striae.....*R. arabica*
 2H. Cuticular deposition radiate and
 dense network striae..... *R. orientalis*
 2G. Stomata sunken.....*R. phyteuma*
 3G. Stomata at the same level
 1I. Anticlinal wall smooth.....*R. urnigera*
 2I. Anticlinal wall striated
 1J. Cuticular deposition radiate and
 sparsely network striae..... *R. decursiva*
 2J. cuticular deposition parallel and random striae ... *R. pruinosa*

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