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# Palynological Studies of Some Species in the Genus *Astragalus* L. (Leguminosae) in Egypt

**Shokry Ibrahim Saad and Wafaa Kamal Taia**

*Botany Department, Faculty of Science, Alexandria University, Alexandria, Egypt*

ABSTRACT. Pollen grains of twenty seven species of Egyptian *Astragalus* were studied, using LM, SEM and TEM. Pollen morphology of *Astragalus* tends to be rather uniform. The majority of species have tricolporate grains of medium size, with a microreticulate exine. Evolutionary trends within the genus have been observed. One trend is from subprolate to prolate and another shows increase in pollen size. The present results show also a correlation between pollen morphology and habitat. Xerophytic species usually have a thick tectum with narrow lumina. In addition to this, the pores are covered by thick apertural membranes in the form of bridges or plugs. On the other hand, mesophytic species have a thinner tectum and thin pore membranes. By plotting P/E against P, four pollen types can be distinguished. These types can be related to established taxonomic groupings.

*Astragalus* is one of the largest genera in the family Leguminosae, with about two thousand species and a wide distribution all over the world, especially the temperate region, with the largest centre of distribution in South-West Asia. The morphology of *Astragalus* species has been the subject of attention from many scientists for a long time ago. Of these are Linnaeus (1753) De Candolle (1802), Bunge (1868 and 1869) and recently Ali (1973) and Agerer-Kirchhoff (1976 and 1977).

In Egypt there are 37 species of *Astragalus* growing wild. They vary in habit from small herbs to spiny shrubs, perennials or annuals (Täckholm 1974). According to their morphological characters, Täckholm grouped them into three sections based on habit, type of inflorescences and fruit structure. Many species are separated by elusive and frequently unreliable characters.

The aim of the present work is to ascertain whether pollen morphology can provide information for accurate identification of the different species of *Astragalus* and to supplement the taxonomic work done by Täckholm (1974) on the flora of Egypt.

## Materials and Methods

Pollen grains of 27 species of *Astragalus* were removed from herbarium specimens at Cairo University Herbarium. Table (1) lists these taxa with the names of collectors, locations, dates, numbers and geographical distributions abbreviations used are as follows:

C. = Cairo, C.-AL. = Cairo-Alexandria road, C.-Sz. = Cairo-Suez road, D. = Deserts of Egypt, Da. = The Arabian Desert, Di. = The Isthmic Desert, GE. = Gebel Elba, M. = The Mediterranean coastal strip, Mma. = The Western Mediterranean coastal region, MP. = The Eastern part. N. = The Nile region including the Delta, the valley and Faiyom, O. The oasis of the Libian Desert, R. = The Red Sea coastal region, and S. Sinai proper.

*Light Microscopy* (LM): The pollen samples were acetolyzed according to the procedure outlined by Erdtman (1960); mounted in glycerine jelly, examined and measured with Meopta microscope. The measurements, given in this work, are the means of at least ten well developed pollen grains.

*Scanning and transmission electron microscopy* (TEM & SEM): The methods, adopted in this work, for electron microscopy are those of Nilsson *et al.* (1977).

## Results

### *Shape*

Most of the species of *Astragalus* studied in this work are prolate. P/E varies from 1.4 as in *A. acinaciferus* to 1.8 as in *A. hispidulus.* Some species have subprolate pollen grains where P/E falls between 1.2 in *A. vogelii* and 1.3 in *A. trigonus* (Table 2).

### *Size*

The polar axis in the species of *Astragalus,* studied in this work, varies from 23.2 μm in *A. vogelii* to 37.5 μm in *A. boeticus,* whereas the equatorial axis varies from 14.4 μm in *A. eremophilus* to 25.7 μm in *A. fresenii* (Table 2).

### *Apertures*

The pollen grains of *Astragalus* are generally described as zonotricolporate, provided with lolongate or circular ora. The colpi are equally spaced around the equator. The ratio between the colpus length and the polar axis C/P varies from 0.6 in *A. vogelii* to 0.8 in *A. schimperi* (Table 2). The pore (os) is covered by an

**Table 1.** List of *Astragalus* species studied in the present work

| No. | Species | Collector and date | Locality and number | Georg. Dist. |
|---|---|---|---|---|
| 1. | *A. acinaciferus* Boiss. | Täckholm & Boulos 1976 | Azraq Oasis 9090 | Di. & S. |
| 2. | *A. alexandrinus* Boiss. | A. Soliman 1978 | Sinai, St. Cathrin | M. & Di. |
| 3. | *A. annularis* Forssk. | Täckholm 1962 | Sz.-Cairo road, 212 | M. & Di. |
| 4. | *A. asterias* Stev. ex Ledeb. | Boulos 1974 | Wadi Ruewishid, 6940 | M. & Di. |
| 5. | *A. boeticus* L. | M.I. Naguib 1958 | Sidi Morsi, Tripoli | M. & Di. |
| 6. | *A. bombycinus* Boiss. | Täckholm 1974 | Slaboukh area | Di. & S. |
| 7. | *A. callichrous* Boiss. | Täckholm 1961 | C.-Al, Desert Road 637 | Di. |
| 8. | *A. corrugatus* Bert. | Täckholm & Kassas 1952 | Kharga & Dakhla 267 | Di. & S. |
| 9. | *A. eremophilus* Boiss. | Täckholm & Kassas 1961 | Wadi El-Gemal 303 | O., Da., GE, S. |
| 10. | *A. fresenii* Decne. | Täckholm & Kassas 1961 | S. Wadi El-Arich 403 | S. |
| 11. | *A. gyzensis* Del. | Maksad 1962 | Johra III | Mma., Di. & S. |
| 12. | *A. hamosus* L. | A. et Schiv. 1908 | Al-Kuwayfyah 2025 | M. & Di. |
| 13. | *A. hispidulus* DC. | Boulos 1968 | Carlton Station III | O., S., M., Di. |
| 14. | *A. kahiricus* DC. | Migahed 1968 | S., R. Road | Mp., Di. |
| 15. | *A. mareoticus* Del. | Boulos & Imam 1972 | C.-Sz. Road 1405 | Mma., & Da. |
| 16. | *A. palaestinus* Eig. | Dawud Al Eisawi 1974 | Ras Salt 1074 | S. |
| 17. | *A. peregrinus* Vahl. | Boulos 1968 | Slonta Gabal Akhdar | M., Di. & S. |
| 18. | *A. schimperi* Boiss. | Boulos 1968 | C.-Sz. Road 197 | Da. & S. |
| 19. | *A. sieberi* DC. | El-Mahdi 1963 | Fac. Pharm. Gard. 135 | Di. & S. |
| 20. | *A. sinaicus* Boiss. | Halwagy & Maksad 1965 | Jahra Road, Kuwait 57 | Di. & S. |
| 21. | *A. sparsus* Del. ex Decne | Hassib 1940 | Sinai, W. Isla. 1306 | Di. & S. |
| 22. | *A. spinosus* Muschl. | Osborn & Helmy 1965 | C.-Sz. Road 3 | Di., Mma. & S. |
| 23. | *A. tomentosus* Lam. | Kassas 1951 | Rafah 43 | Di. & M. |
| 24. | *A. tribuloides* Del. | Boulos 1967 | Sidi El Masri 1748 | O., M., D. & S. |
| 25. | *A. trigonus* DC. | Osborn & Helmy 1966 | C.-Sz. Road 29031 | O., Di. & S. |
| 26. | *A. trimestris* L. | Täckholm 1928 | S. Rafah 137 | M. |
| 27. | *A. vogelii* Bornm. | Täckholm & Kassas 1961 | Red Sea Coast 717 | N., O., R. & S. |

**Table 2.** Summary of palynological features of the studied species of *Astragalus*

| No. | Species | Shape 1 | Pollen grain size in μm | | | Colpus | Pore | | | Exine | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | P 2 | E 3 | P/E 4 | C/P 5 | L 6 | T 7 | S 8 | Or 9 | V.E. 10 |
| | **Vogelii Group** | | | | | | | | | | |
| 1 | *A. tomentosus* | subprolate | 23.1-24.2 (23.5) | 16.5-20.9 (19.1) | 1.2 | 0.7 | 4.4 | – | – | + | – |
| 2 | *A. trigonus* | subprolate | 20.9-26.4 (24.4) | 16.5-20.9 (18.4) | 1.3 | 0.7 | 4.8 | – | – | + | – |
| 3 | *A. vogelii* | subprolate | 20.9-25.3 (23.2) | 17.6-22.0 (20.0) | 1.2 | 0.6 | 1.8 | + | + | + | – |
| | **Sieberi Group** | | | | | | | | | | |
| 4 | *A. acinaciferus* | prolate | 23.1-25.0 (23.9) | 16.5-18.7 (17.6) | 1.4 | 0.6 | 3.9 | + | + | + | – |
| 5 | *A. annularis* | prolate | 25.3-30.8 (28.9) | 16.5-20.9 (19.2) | 1.5 | 0.7 | 3.5 | + | + | + | + |
| 6 | *A. corrugatus* | prolate | 26.4-28.6 (27.7) | 18.7-19.8 (19.1) | 1.5 | 0.7 | 5.3 | – | + | + | – |
| 7 | *A. eremophilus* | prolate | 20.0-22.0 (21.0) | 12.1-15.4 (14.4) | 1.4 | 0.7 | 3.3 | – | + | + | + |
| 8 | *A. mareoticus* | prolate | 26.4-29.7 (22.0) | 18.7-20.9 (15.7) | 1.4 | 0.7 | 5.4 | + | + | + | – |
| 9 | *A. schimperi* | prolate | 26.4-27.5 (26.8) | 15.4-18.7 (17.6) | 1.5 | 0.8 | 4.8 | + | + | + | – |
| 10 | *A. sieberi* | prolate | 25.2-26.4 (26.5) | 16.5-18.7 (18.4) | 1.4 | 0.6 | 4.4 | + | + | + | + |
| 11 | *A. sparsus* | prolate | 26.4-29.7 (28.0) | 18.7-20.9 | 1.4 | 0.7 | 5.4 | + | + | + | – |
| 12 | *A. tribuloides* | prolate | 26.4-29.7 (27.5) | 14.3-18.7 (16.8) | 1.5 | 0.7 | 3.6 | + | + | + | – |
| | **Palaestinus Group** | | | | | | | | | | |
| 13 | *A. alexandrinus* | prolate | 27.5-35.2 (31.0) | 19.8-22.0 (21.2) | 1.5 | 0.7 | 2.8 | + | + | + | – |

**Table 2.** (Contd.)

| No. | Species | Shape | Pollen grain size in μm | | | Colpus | Pore | | | Exine | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | P 2 | E 3 | P/E 4 | C/P 5 | L 6 | T 7 | S 8 | Or 9 | V.E. 10 |
| 14 | *A. asterias* | prolate | 28.6-33.0 (31.1) | 18.7-19.8 (19.5) | 1.5 | 0.7 | 4.8 | + | + | + | – |
| 15 | *A. gyzensis* | prolate | 27.5-34.1 (32.0) | 19.8-24.2 (23.0) | 1.4 | 0.7 | 5.4 | – | + | + | – |
| 16 | *A. hamosus* | prolate | 29.7-35.2 (32.7) | 19.8-24.2 (22.6) | 1.4 | 0.7 | 3.9 | – | + | + | – |
| 17 | *A. kahiricus* | prolate | 31.9-35.2 (33.8) | 23.1-26.4 (24.3) | 1.4 | 0.6 | 5.4 | + | + | + | + |
| 18 | *A. palaestinus* | prolate | 29.7-33.0 (31.1) | 19.8-22.0 (20.4) | 1.5 | 0.7 | 4.9 | – | + | + | – |
| | **Peregrinus Group** | | | | | | | | | | |
| 19 | *A. boeticus* | prolate | 35.2-41.8 (37.5) | 19.8-23.1 (21.7) | 1.7 | 0.7 | 4.7 | + | + | – | – |
| 20 | *A. bombycinus* | prolate | 28.6-36.3 (32.6) | 16.5-20.9 (21.7) | 1.7 | 0.7 | 3.3 | + | + | – | – |
| 21 | *A. callichrous* | prolate | 28.6-31.9 (30.4) | 16.5-19.8 (17.8) | 1.7 | 0.8 | 5.1 | + | + | + | – |
| 22 | *A. fresenii* | prolate | 34.3-40.2 (37.2) | 24.2-26.4 (25.7) | 1.5 | 0.7 | 6.8 | – | + | + | – |
| 23 | *A. hispidulus* | prolate | 28.6-30.9 (30.2) | 15.4-17.6 (16.2) | 1.8 | 0.7 | 2.1 | – | + | + | – |
| 24 | *A. peregrinus* | prolate | 30.8-37.4 (34.1) | 17.6-25.3 (21.0) | 1.6 | 0.7 | 5.2 | + | + | + | – |
| 25 | *A. sinaicus* | prolate | 29.7-33.0 (31.8) | 16.5-18.7 (17.3) | 1.8 | 0.6 | 4.2 | – | – | + | – |
| 26 | *A. spinosus* | prolate | 33.0-36.3 (35.9) | 20.9-24.2 (22.2) | 1.6 | 0.6 | 4.2 | + | – | + | – |
| 27 | *A. trimestris* | prolate | 28.6-34.1 (32.0) | 17.6-22.0 (20.4) | 1.6 | 0.6 | 4.2 | + | – | + | – |

ordinary thin membrane as in *A. hamosus* and *A. trigonus* or a thick one in the form of a bridge, formed by the extension of the lateral margins of the colpus, as in *A. fresenii* (Pl. I, Fig. 3) and *A. palaestinus* (Pl. I, Fig. 4) or a plug-like body, as in *A. schimperi* (Pl. I, Fig. 2). The pore is either lolongate as in *A.* tomentosus or approximately circular as in *A. vogelii.*

### *Sporoderm Stratification*

*Exine*

*Sculpture:* TEM micrographs show that the surface of the tectum may be smooth as in *A. boeticus* (Pl. II, Fig. 3), undulate as in *A. peregrinus* (Pl. III, Fig. 1) or covered by pyramidal-shaped ridges as in *A. bombycinus* (Pl. III, Fig. 3).

*Structure:* The ectexine in *Astragalus* pollen grains is semitectate and most of the species have a microreticulate tectum with irregular meshes, in which the lumina $< 1.0$ μm as in *A. corrugatus* (Pl. I, Fig. 1). In some species the tectum has perforations $< 1.0$ μm in diameter placed between the areas of the tectum which are $> 1.0$ μm, and described as tectum perforatum (Praglowski and Punt 1973), as in *A. boeticus* (Pl. I, Fig. 6). Some species as *A. sieberi* (Pl. I, Fig. 5) have verrucate processes in the lumina. The columellae vary in thickness in the different species. In *A. palaestinus* they are thin about I/3 the thickness of the tectum (Pl. II, Fig. 1). In *A. peregrinus* (Pl. III, Fig. 2) and *A. bombycinus* (Pl. III, Fig. 3) they are thicker, about half the thickness of the tectum. In *A. boeticus* (Pl. II, Fig. 3) they are as thick as the tectum. The foot layer is usually distinguishable in the mesocolpial regions and becomes very thin towards the colpi. It varies in thickness in the different species.

*Endexine*

The endexine (MEDINE *sensus* Saad) is thin in both the mesocolpia and apocolpia, increasing considerably in thickness towards the colpi (Pl. II, Fig. 4) TEM micrographs show a contrast in electron density between the medine and both the ectexine and the intine, agreeing with the medine concept (Saad 1963).

*Intine*

TEM micrographs show clearly the intine as continuous electron transparent layer. In most of the species the intine is undulating into the layer beneath.

Table 2 is the summary of the main palynological characters of the twenty seven species of *Astragalus* studied in this work. These characters are:

1. Shape of the pollen grain.
2. Polar axis (P).

3. Equatorial axis (E) in μm.
4. Ratio between (P) and (E) P/E.
5. Ratio between colpus length (C) and polar axis (P) C/P.
6. Pore length in μm.
7. Pore type (T); covered by membrane (=), bridge (−) or plug (+).
8. Pore shape (S); lolongate (−) or circular (+).
9. Tectal ornamentation: microreticulate (+) or tectum perforatum (=).
10. Presence of verrucate processes in the lumina (V.E.): (+) or absent (−).

The results, of the present study, show that there are large areas of overlap among the different species of *Astragalus,* which virtually prevent the utilization of these characters for specific identification, especially at the light microscope level. The high resolution power provided by the SEM and TEM microscopes demonstrates both structural and sculptural features, not observable under the light microscope, in addition to some minor semi-qualitative differences in sculptural detail.

By plotting the height of the polar axis (P) against P/E for the different pollen grains (Fig. 1), the studied species can be divided into the following four pollen types:

1. *Vogelii type*

Pollen grains subprolate of small size, where P/E varies from 1.2 to 1.3. Polar axis varies from 23.2 to 24.4 μm and equatorial axis from 18.7 to 20.0 μm. Ora covered by thin membrane and the tectum is microreticulate. This morphotype comprises three species namely *A. tomentosus, A. trigonus* and *A. vogelli.* Pollen grains of *A. vogelii* have very narrow pores (1.8 μm diameter), while those of the other two species are wider (4.4 & 4.8 μm).

2. *Sieberi type*

Pollen grains prolate with P/E 1.4-1.5 and polar axis 21.0-29.0 μm. This morphotype comprises 9 species, four of which have verrucate processes in the lumina of the tectum namely: *A. annularis, A. eremophilus, A. sieberi* and *A. sparsus.* The other species namely *A. acinaciferus, A. corrugatus, A. mareoticus* and *A. schimperi* lack these processes and, except for *A. corrugatus* which has bridged ora, have plugged ones.

3. *Palaestinus type*

Pollen grains prolate with P/E 1.4-1.5 as the previous type but larger in size. Polar axis ranges between 30 and 32 μm. This morphotype comprises six species: *A. alexandrinus, A. asterias* and *A. kahiricus* which have pollen grains with plugged ora, *A. gyzensis* and *A. palaestinus* with bridged ones, and *A. hamosus* which has pores covered by thin membranes.

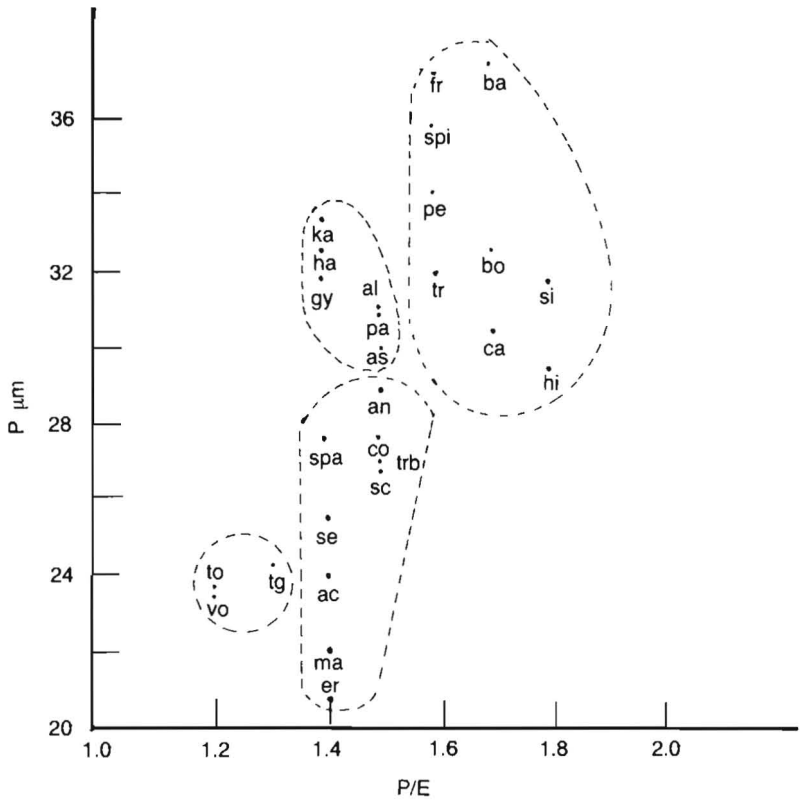


**Fig. 1.** Scattered diagraim showing the relation between P and P/E.

## Abbreviations

| | | | |
|---|---|---|---|
| ac. | *A. acinaciferus* Boiss. | al. | *A. alexandrinus* Boiss. |
| an. | *A. annularis* Forssk. | as. | *A. asterias* Stev. ex. Ledeb. |
| ba. | *A. boeticus* L. | bo. | *A. bombycinus* Boiss. |
| ca. | *A. callichorus Boiss.* | co. | *A. corrugatus* Bert. |
| gy. | *A. gyzensis* Del. | fr. | *A. fresenii* Decne. |
| hi. | *A. hispidulus* DC. | ha. | *A. hamosus* L. |
| ma. | *A. mareoticus* Del. | ka. | *A. kahiricus* DC. |
| pe. | *A. peregrinus* Vahl. | pa. | *A. palaestinus* Eig. |
| spa. | *A. sparsus* Del. ex. Decne. | sc. | *A. schimperi* Boiss. |
| se. | *A. sieberi* DC. | spi. | *A. spinosus* Muschl. |
| to. | *A. tomentosus* Lam. | si. | *A. sinaicus* Boiss. |
| tr. | *A. trimestris* L. | tg. | *A. trigonus* DC. |
| vo. | *A. vogelli* Bornm. | trb. | *A. tribuloides* Del. |

### 4. *Peregrinus type*

Pollen grains prolate with P/E 1.6-1.8, and polar axis ranges from 30 to 37.0 µm (Table 2). This morphotype comprises 9 species. *A. boetieus* and *A.*

*bombycinus* have pollen grains with tectum perforatum while the other species have microreticulate ones. On the other hand *A. callichrous, A. peregrinus, A. spinosus* and *A. trimestris* have plugged ora while pollen grains of *A. fresenii, A. hispidulus* and *A. sinaicus* have bridged ones.

## Discussion

Pollen grains of *Astragalus* are predominantly radially symmetrical, prolate with a circular amb. The majority of species have tricolporate middle size grains (23-38 μm), with a microreticulate tectum.

Although the pollen morphology of *Astragalus* tends to be of rather uniform type, a few trends are evident within the species, such as:

1. Change in shape from subprolate to prolate.
2. Increase in pollen size.

As to the first trend, only three species (*Astragalus vogelii, A. tomentosus* and *A. trigonus*) out of the twenty seven, studied in this work, have subprolate pollen grains. These species have also the smallest polar axes (23.3-25.4 μm), suggesting that they are probably less developed.

Increase in grain size is a general trend among the pollen grains of *Astragalus* species. This trend has been described in a number of genera and families by various authors like Wodehouse (1928), Van Campo (1966a,b), Nair (1970) and Walker (1975). The annual species of *Astragalus* (Täckholm 1974) have generally bigger pollen grains than the perennials. Of the eighteen annual species, fifteen have their axes 27.0 μm or more, while five out of nine perennials have their polar axes less than 27.0 μm. *Astragalus sieberi* and *A. trigonus* which are spiny shrubs (Täckholm 1974) have the smallest pollen grains, 24.0 and 25.0 μm respectively. These results support the statement that the annual plants are generally more developed than the perennials.

The presence of such diverse pollen morphology among *Astragalus* species, such as the thickness of the tectum and the nature of the aperture, raises the fundamental question of adaptive value, *i.e.* the correlation between habitat and pollen morphology. The presence of a thick tectum with narrow lumina, accompanied by protected pores, make some species of *Astragalus* like *A. bombycinus, A. palaestinus* and *A. peregrinus* suitable for xerophytic habitats. The ecological distribution of these species, as mentioned by Täckholm (1974), indicates that they occur in Sinai and the Isthmic Desert. On the other hand, species which occur around the Mediterranean basin like *A. hamosus, A. trigonus*

and *A. tomentosus* have thinner tectum and thin pore membrane. On the other hand, *A. schimperi* which has the biggest plugs protecting the ora (Pl. I, Fig. 2) is a villous plant, completely covered by spreading hairs and occurs in Sinai, Arabian and Isthmic Deserts (Täckholm 1974).

The columellar ektexine, found in most *Astragalus* pollen grains, occurs widely in Papilionoideae as mentioned by Stainier and Horvat (1978), Ferguson and Strachan (1982) and Ferguson & Skvarla (1983). Ferguson (1984) mentioned that the columellar ektexine is the original and the granular is derived. In support of his view, he mentioned that granular ektexine is generally accompanied by thick endexine (medine), which he considers an advance stage in sporoderm stratification phylogeny. Saad, working on *Linum,* Linaceae, Scitamineae and Plantago pollen grains (Saad 1961, 1962, 1966 and 1986) emphasized the reverse. Walker (1976) mentioned that the columellae have evolved internally, within the exine, *via* the sequence: pollen atectata-amorphous to atectate-granular to tectate-granular to tectate-columellar. On the other hand, the columellate ektexine is found to start as granular elements which later disappear (Ehrlich 1960). This phenomenon was emphasized by many authors like Sitte (1963), Rowley (1962) and Afzelius (1956).

As to the thick endexine which accompanies the granular ektexine, Saad (1972) dealing with "Palynology in relation to phylogeny and "Sporoderm stratification"; Saad (1986) concluded that clear and well developed lamellated medine (endexine) is considered a primitive character in the pollen wall phylogeny, while its reduction indicates advancement. In support of this concept, columallar ektexine has been found generally associated with colporate pollen grains as mentioned by many authors like Stainier and Horvat (1978) who found that pollen grains of *Phaseolus ritensis,* which have columellar exine, are tricolporate; while *Vigna frutescens bruchneri* has pollen grains with granular exine and triporate. Porate pollen might have evolved from colpate form by reduction (Saad 1972) as well as from colporate one.

The existence of granular infratectal ektexine in some morphologically specialized tribes as mentioned by Ferguson and Strachan (1982), does not imply that their pollen grains are also specialized. The microperforate nature of the tectum found in *Indigofera* pollen grains is an adaptive character associated with the adverse environmental conditions (Tropical Africa). Microperforate granular ektexine precedes the microperforate columellar one, as indicated by Walker (1976). It is noteworthy that Guinet and Lugardon (1976) showed that pollen grains of *Acacia* spp. with colporate apertures have columellar ektexine, while those with furrows or pseudo-furrows have granular ones. Undoubtedly the colporate aperture is more advanced than the colpate (furrowed) one.

The plugged and bridged ora found in some *Astragalus* pollen were not recorded in Papilionoideae before. Plugged ora were described by Ghazaly (1982)

in *Leontodon autumnalis* (Compositae).

By plotting P against P/E (Fig. 1) for the different *Astragalus* pollen grains, four palynological types can be distinguished, by means of which one can differentiate between some of the morphologically related species.

Correlating the four types of *Astragalus* with the sections of Zohary (1972) for the Palaestinian species, there is some agreement between the devised types and those of Zohary, based on morphological characters. Section *Ankylobus* of Zohary includes *A. callichorus* and *A. hispidulus* which are morphologically similar as well as palynologically. Also *A. sieberi* and *A. sparsus* are included in section *Okyglotis* of Zohary and type *Palaestinus*. On the other hand, some species which are morphologically similar are palynologically different, like *A. palaestinus* and *A. bombycinus*. The first species is related to *Palaestinus* type while the second to *Peregrinus* type.

The tricolporate pollen grain with reticulate ektexine, which is the common type of *Astragalus* species is found in many of the genera throughout the subfamily Papilionoideae like *Lathyrus, Pisum* and *Lens* (Ferguson 1984).

In a large genus such as *Astragalus*, with about two thousand species and a wide distribution all over the world, when biological affinities extend beyond the boundaries given in various treatments, it is clear that pollen morphology may aid in determining relationships and phylogeny.

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## Plate I

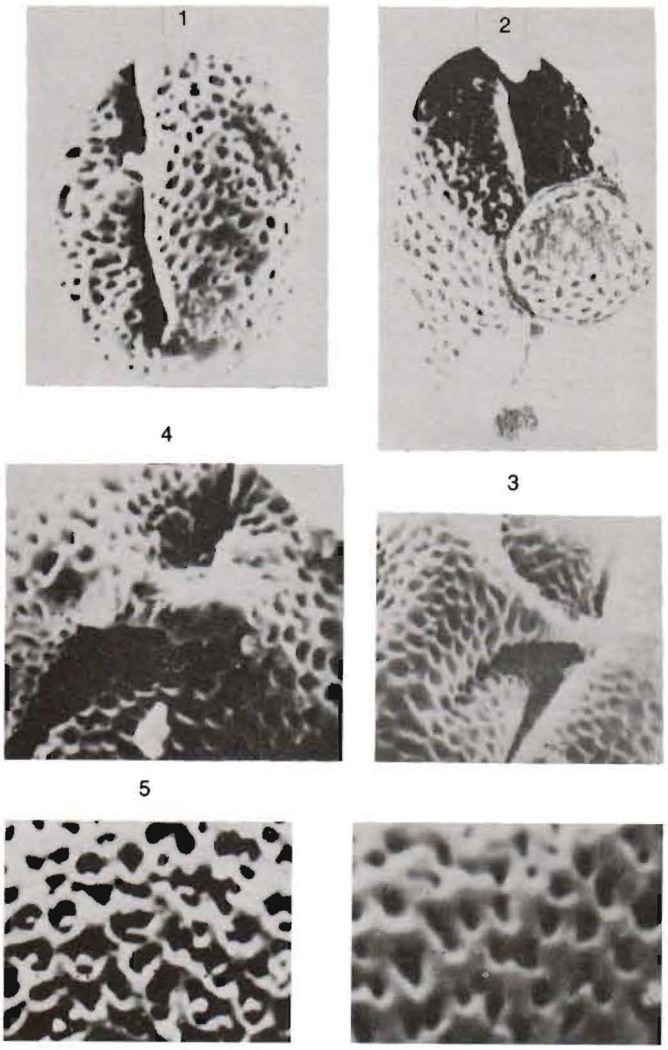


**Fig. 1.** *Astragalus corrugatus* Bert. (SEM × 10000) showing bridged os and microreticulate exine.

**Fig. 2.** *Astragalus schimperi* Boiss. (SEM × 5000) showing very big plug on os and microreticulate exine.

**Fig. 3.** *Astragalus fresenii* Decne (SEM × 5000) showing bridged os.

**Fig. 4.** *Astragalus palaestinus* Eig. (SEM × 10000) showing bridged os.

**Fig. 5.** *Astragalus sieberi* DC (SEM × 1000) showing verrucate processes in the lumina.

**Fig. 6.** *Astragalus boeticus* L. (SEM × 1000) showing tectum perforatum exine.

## Plate II

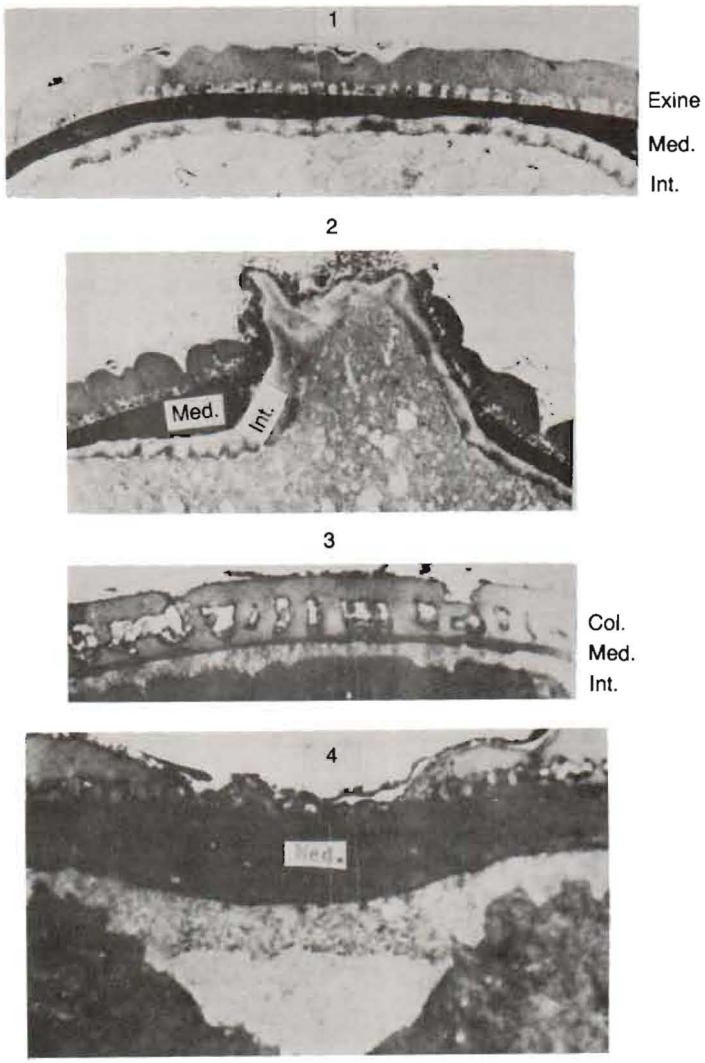


**Fig. 1.** *Astragalus palaestinus* Eig. (TEM × 8000) showing very thick tectum, thick medine (endexine) and undulating intine.

**Fig. 2.** *Astragalus palaestinus* Eig. (TEM × 8000) showing very thick medine under colpus and undulating intine.

**Fig. 3.** *Astragalus boeticus* L. (TEM × 10000) showing thick bacula, medine and intine.

**Fig. 4.** *Astragalus boeticus* L. (TEM × 10000) showing very thick medine under colpus and the triangular intinous area.

## Plate III

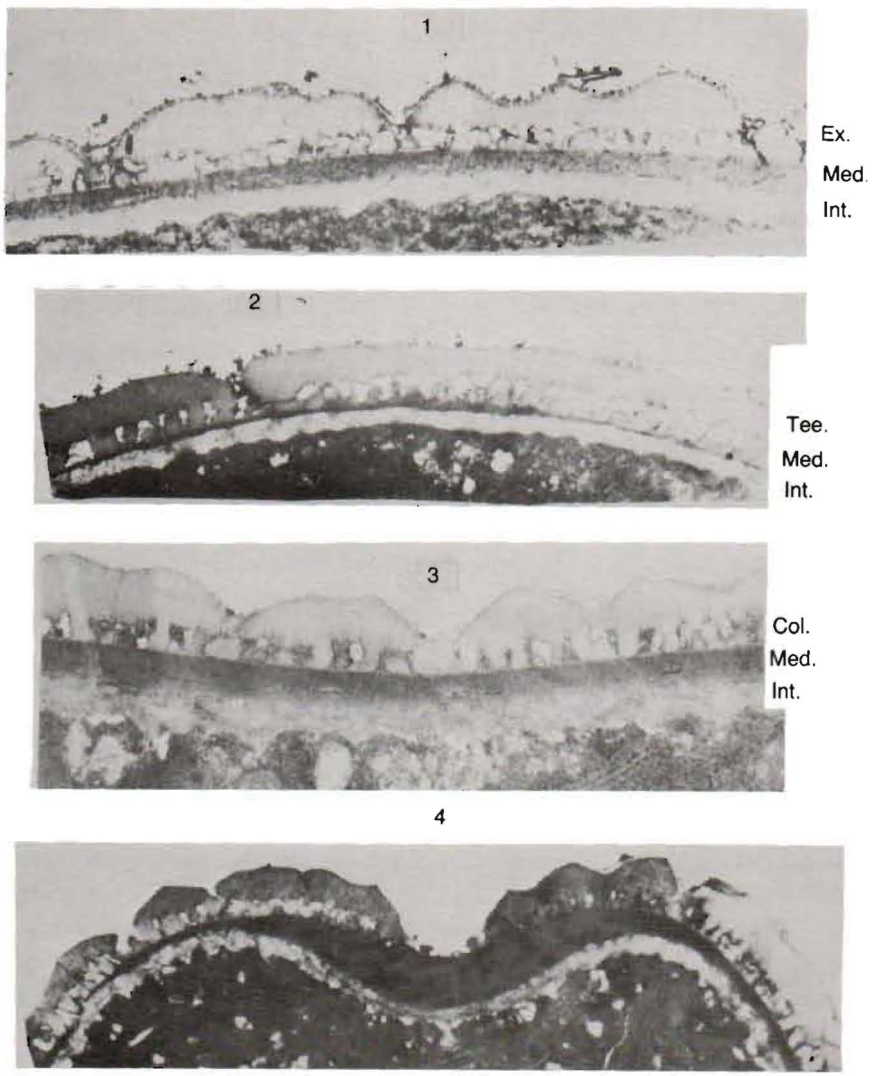


**Fig. 1.** *Astragalus peregrinus* Vahl. (TEM × 10000) showing perforate exine, medine and intine.

**Fig. 2.** *Astragalus peregrinus* Vahl. (TEM × 10000) showing thick tectum, medine (endexine) and intine.

**Fig. 3.** *Astragalus bombycinus* Boiss. (TEM × 10000) showing pyramidal-shaped ridges, columellae, medine and intine.

**Fig. 4.** *Astragalus bombycinus* Boiss. (TEM × 8000) showing thick medine under colpus and thin exine.

# دراسات بالينولوجية للجنس استراجلس

**شكري إبراهيم سعد و وفاء كمال طايع**

قسم النبات ـ كلية العلوم ـ جامعة الإسكندرية ـ الإسكندرية ـ مصر

تمت في هذا البحث دراسة حبوب اللقاح لسبع وعشرين نوعاً للجنس استراجلس الممثلة في الفلورا المصرية، باستخدام الميكرسكوب الضوئي والإلكتروني ويعتبر هذا الجنس متجانساً حيث إن شكل وتركيب حبوب اللقاح لأنواعه المختلفة تميل إلى التشابه فهي إما أهليليجيه أو بيضية، كما أن لكل حبة ثلاث فتحات إثبات يتوسط كل منها ثقب مغطى أما زخرفة السطح الخارجي فتتراوح ما بين الشبكي والمثقب، كما يتراوح طول المحور القطبي ما بين ٢٣، ٣٨ ميكرون والمحور الاستوائي ما بين ١٦، ١٤ ميكرون.

وقد أمكن استنتاج الاتجاهات التطورية لحبوب لقاح هذا الجنس وهي: التغير في شكل حبوب اللقاح من الشكل الأهليليجي إلى الشكل البيضاوي؛ اختزال طول فتحات الإنبات بالنسبة للمحور القطبي؛ ازدياد حجم حبوب اللقاح؛ وتغير زخرفة السطح الخارجي من الشبكي إلى الشبكي الدقيق إلى المثقب.

كما أدت هذه الدراسة إلى تمييز خمس مجموعات من حبوب اللقاح في هذا الجنس اعتمادا على الصفات السابق ذكرها؛ وهذه المجموعات هي:

* **مجموعة فوجيلياى *Vogelii*** :

تتميز هذه المجموعة بحبوب لقاح أهليجية وتتراوح نسبة طول المحور القطبي إلى المحور الاستوائي ما بين ١,٢ ـ ١,٣، وتضم هذه المجموعة ثلاثة أنواع.

* **مجموعة سيبري *Sieberi*** :

وتتميز أنواع هذه المجموعة بحبوب لقاح بيضية كبيرة الحجم وتتراوح النسبة بين المحور القطبي والمحور الاستوائي ما بين ١,٤ ـ ١,٥، وتضم هذه المجموعة ثمانية أنواع.

* **مجموعة فلسطين *Palaestinus*** :

وتتميز أنواع هذه المجموعة بحبو لقاح بيضية كبيرة الحجم وتتراوح النسبة بين المحور القطبي والمحور الاستوائي ما بين ١,٤ ـ ١,٥، وتضم هذه المجموعة ثمانية أنواع.

* **مجموعة هيسبديولس *Hispidulus*** :

وتتميز أنواع هذه المجموعة بحبوب لقاح بيضية متوسطة الحجم وتتراوح النسبة بين المحور القطبي والمحور الاستوائي ما بين ١,٦ ـ ١,٨، وتضم هذه المجموعة نوعين.

* **مجموعة بريجرينس *Perigrinus*** :

وتتميز أنواع هذه المجموعة بحبوب لقاح بيضية كبيرة الحجم وتتراوح النسبة بين المحور القطبي والمحور الاستوائي ما بين ١,٦ ـ ١,٨، وتضم هذه المجموعة ستة أنواع.

بمقارنة الصفات البالينولوجية لحبوب اللقاح مع الصفات المورفولوجية لهذه النباتات والمذكورة في موسوعة الدكتورة تكهلم اتضح تشابه بعض الأنواع في كل من الصفات المورفولوجية والبالينولوجية بينما تتشابة بعض الأنواع الأخرى في الصفات المورفولوجية ولكنها تختلف اختلافاً جوهرياً في صفاتها البالينولوجية. كما وجد أن الصفات البالينولوجية لبعض الأنواع تتفق مع الصفات المورفولوجية التي أجراها زهيري على الأنواع المصرية الممثلة في الفلورا الفلسطينية. بهذه الدراسة يمكن التفرقة بين بعض الأنواع المصرية المتشابهة مورفولوجيا.