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Morphology and Surface Topography of Pollen and Anthers of *Pyrus* Species[1]

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Abstract. **A survey of 18 pear species using the scanning electron microscope showed considerable variability in the size, shape and surface topography of both anthers and pollen grains. The size, shape and surface topography of anthers or anther cells did not vary directly with the size, shape and topography of pollen from the same species. The degree of similarity of individual features among species did not seem to coincide with their geographic distribution. However, the combination of pollen and anther features was unique for each species, indicating their value for taxonomic identification.**

Until recently the genus *Pyrus* had not been studied enough to describe its species adequately. Some works (8, 10) now seem to be incomplete, and a number of interspecific hybrids also are listed as primary species. Among earlier authors, Rehder (9) has most accurately grouped and described the species of *Pyrus*. Yet his treatment lacks some valid species, and he lists hybrids such as *P. bretschneideri, P. serrulata* and *P. phaeocarpa* as primary species. All *Pyrus* species are found to be regular sexual diploids (2n=34) with a high degree of self-sterility (13). This is in sharp contrast to apple (*Malus*) species, which are much more variable in chromosome number, meiotic behavior, degree of self-fertility and degree of apomixis than *Pyrus*. Yet some taxonomists continue to group both apples and pears in the genus *Pyrus*. The recent book on pollen (11) correctly shows *P. communis* pollen (p 20) but in several other instances refers to apple species as being in the genus *Pyrus*. Between 1968 and 1973 several studies (1, 2, 3, 5, 6, 7) have elucidated the phenolic chemistry of *Pyrus* and indicated its value in chemotaxonomy, although it is apparent that neither chemistry nor descriptive botany alone can provide a taxonomy of *Pyrus* consistent with the known geographic distribution of the species. Recognizing this, Challice and Westwood (4) combined 29 chemical characters with 22 botanical ones in a computerized numerical taxonomy scheme. This combined analysis indicated 21 primary species whose overall phenetic relationships agreed reasonably well with the geographic distributions of 5 species groups.

In order to explore another group of characters and determine their possible value in species characterization and taxonomy, scanning electron microscope studies were made of pollen and anthers of several *Pyrus* species. Most of the work was done while the senior author was visiting professor at Long Ashton Research Station in 1970.

Materials and Methods

Air-dried pollen was placed on adhesive tape attached to a metal stub and gold-palladium coated *in vacuo* by the usual techniques prior to viewing and photographing in a Stereoscan scanning electron microscope (SEM).

Anthers were prepared for scanning in the same way as pollen except for the first step. Fresh anthers were killed in 50% ethanol, then air-dried briefly before coating with gold-palladium. With some species, all anthers had dehisced prior to the sampling date and thus could not be sampled.

The number of samples per species varied from 8 clones to as few as 1, depending upon the number of clones flowering at Long Ashton Research Station, University of Bristol, where the work was carried out.

Results and Discussion

Pollen. Both size and shape of pollen grains were quite uniform for a given species, but differed with species (Table 1). Those distinctly shorter than the general mean were *P. amygdaliformis* Vill., *P. salicifolia* Pall., *P. betulaefolia* Bunge and *P. calleryana* Decne. Those which were notably longer

Table 1. Size and shape of pollen grains of several species of *Pyrus*.

Species	No. of clones sampled	Pollen size (μm) length	Pollen size (μm) width	L/W ratio
Europe:				
P. communis	8	44.6	24.2	1.84
P. caucasica	2	47.0	24.2	1.94
P. pyraster Borkh.	2	45.0	24.8	1.81
P. nivalis	2	47.1	23.3	2.02
P. cordata Desv.	2	44.8	23.0	1.94
Asia Minor:				
P. amygdaliformis	2	40.6	24.7	1.64
P. elaeagrifolia Pall.	1	46.8	24.5	1.91
P. salicifolia	2	42.2	23.7	1.78
North Africa:				
P. longipes	1	48.8	26.0	1.87
Central Asia:				
P. regelii	1	44.4	27.9	1.59
P. pashia	1	52.0	24.0	2.16
East Asia:				
P. pyrifolia (Burm) Nak.	2	45.8	24.1	1.90
P. hondoensis	1	45.6	26.0	1.75
P. ussuriensis	1	44.0	23.6	1.86
P. betulaefolia	1	43.4	19.8	2.19
P. calleryana	3	43.3	22.4	1.93
P. fauriei Schneid.	2	46.0	26.1	1.76
P. dimorphophylla	2	46.0	27.3	1.68
	General Mean	46.0	24.4	1.86

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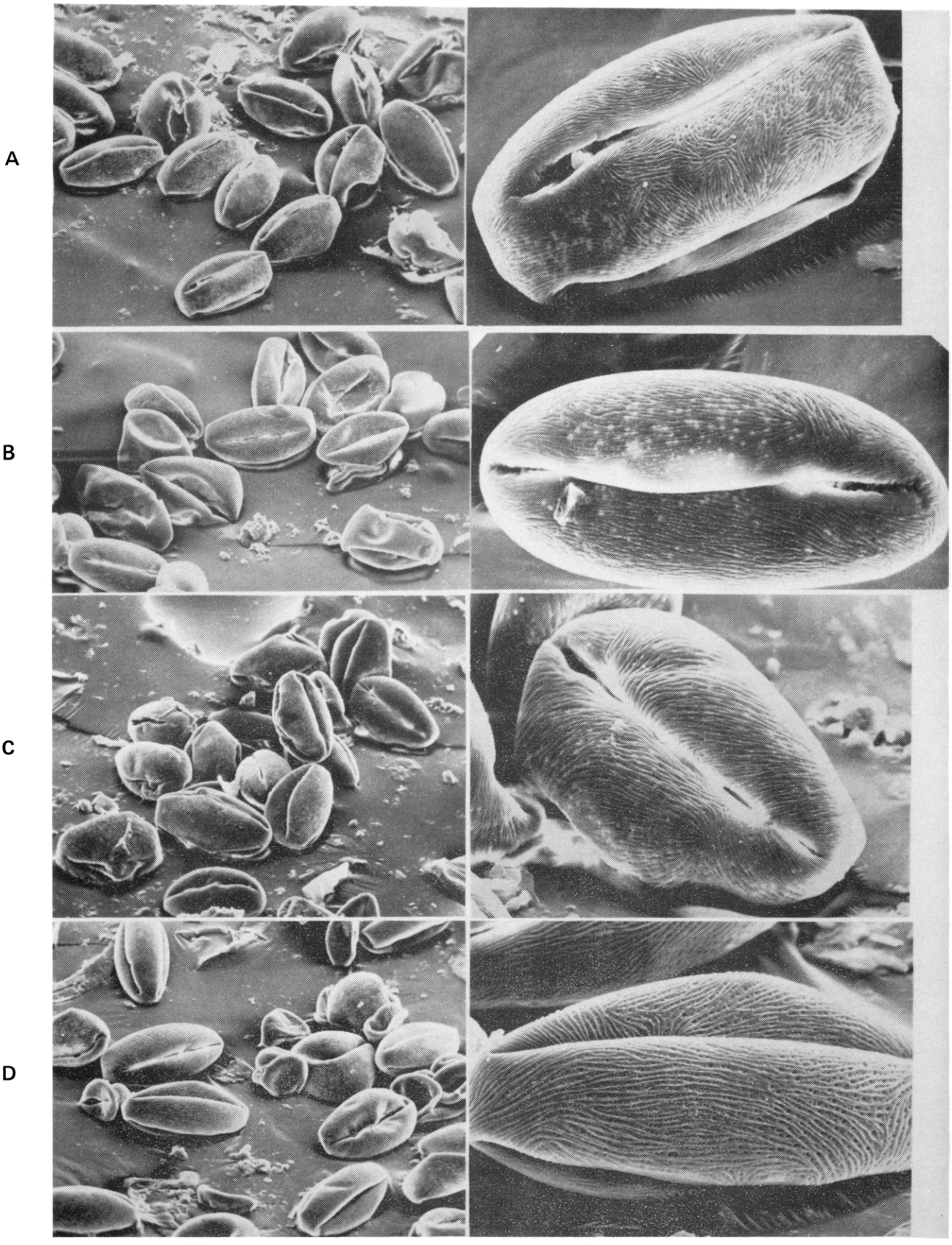

Fig. 1. Pollen morphology and surface features of relatively large fruited Asian pear species: A) *P. pyrifolia;* B) *P. hondoensis;* C) *P. ussuriensis;* D) *P. pashia.* Magnification: left ×500; right ×2,000.

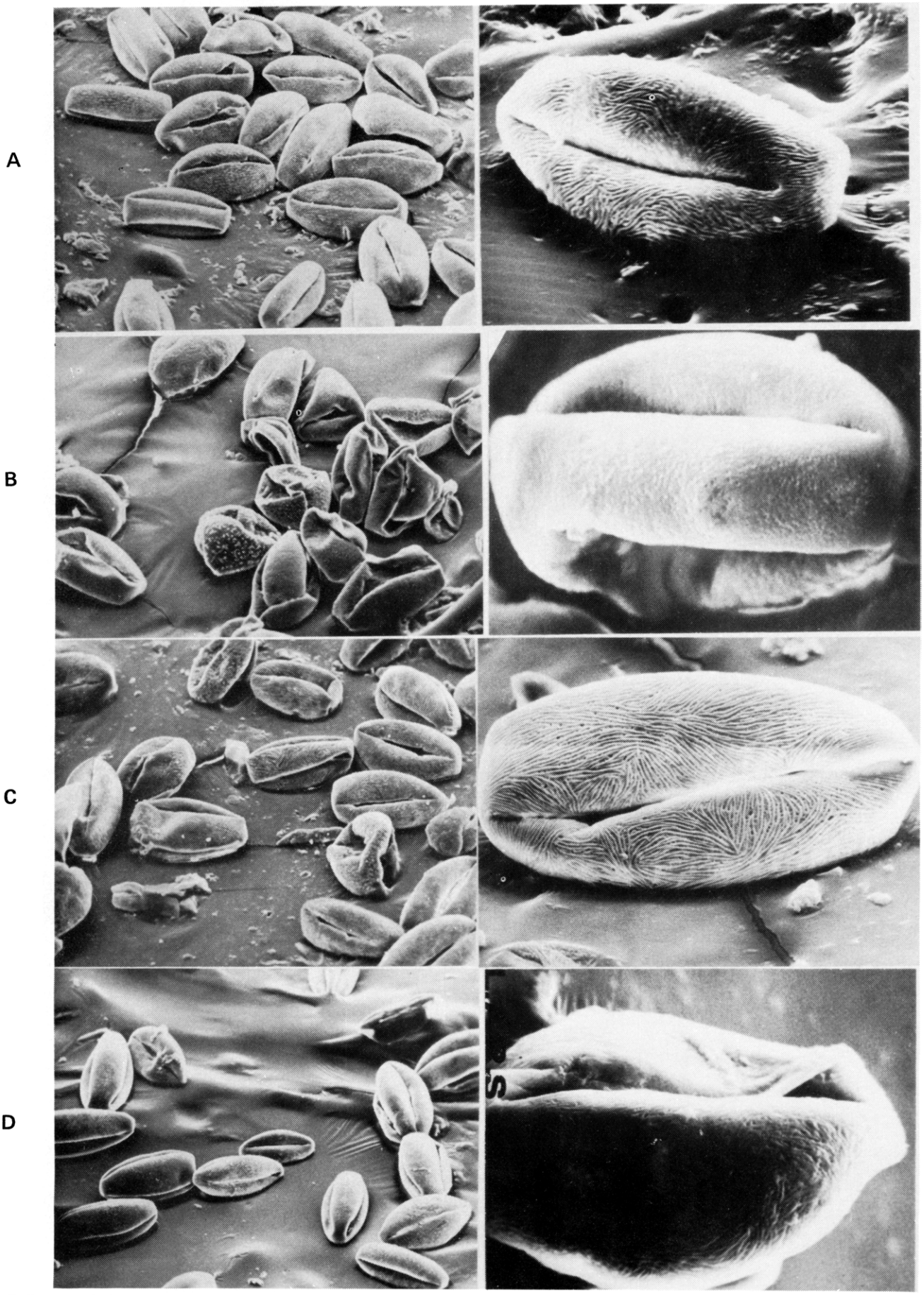

Fig. 2. Pollen morphology and surface features of the east Asian pears: A) *P. calleryana;* B) *P. dimorphophylla;* C) *P. fauriei;* D) *P. betulaefolia.* Magnification: left ×500; right ×2,000.

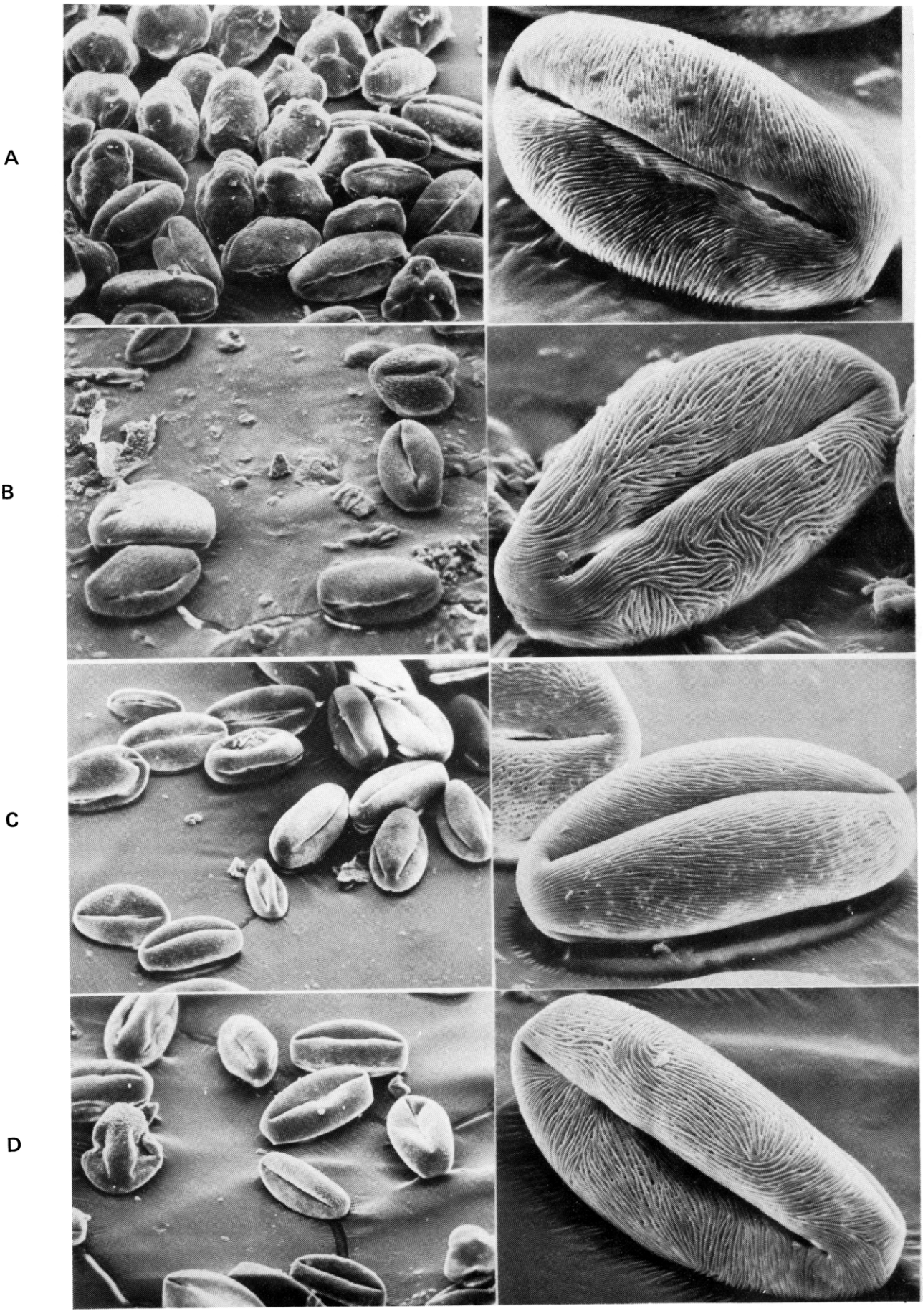

Fig. 3. Pollen morphology and surface features of some European and North African pears: A) *P. cordata;* B) *P. longipes;* C) *P. elaeagrifolia;* D) *P. nivalis.* Magnification: left ×500; right ×2,000.

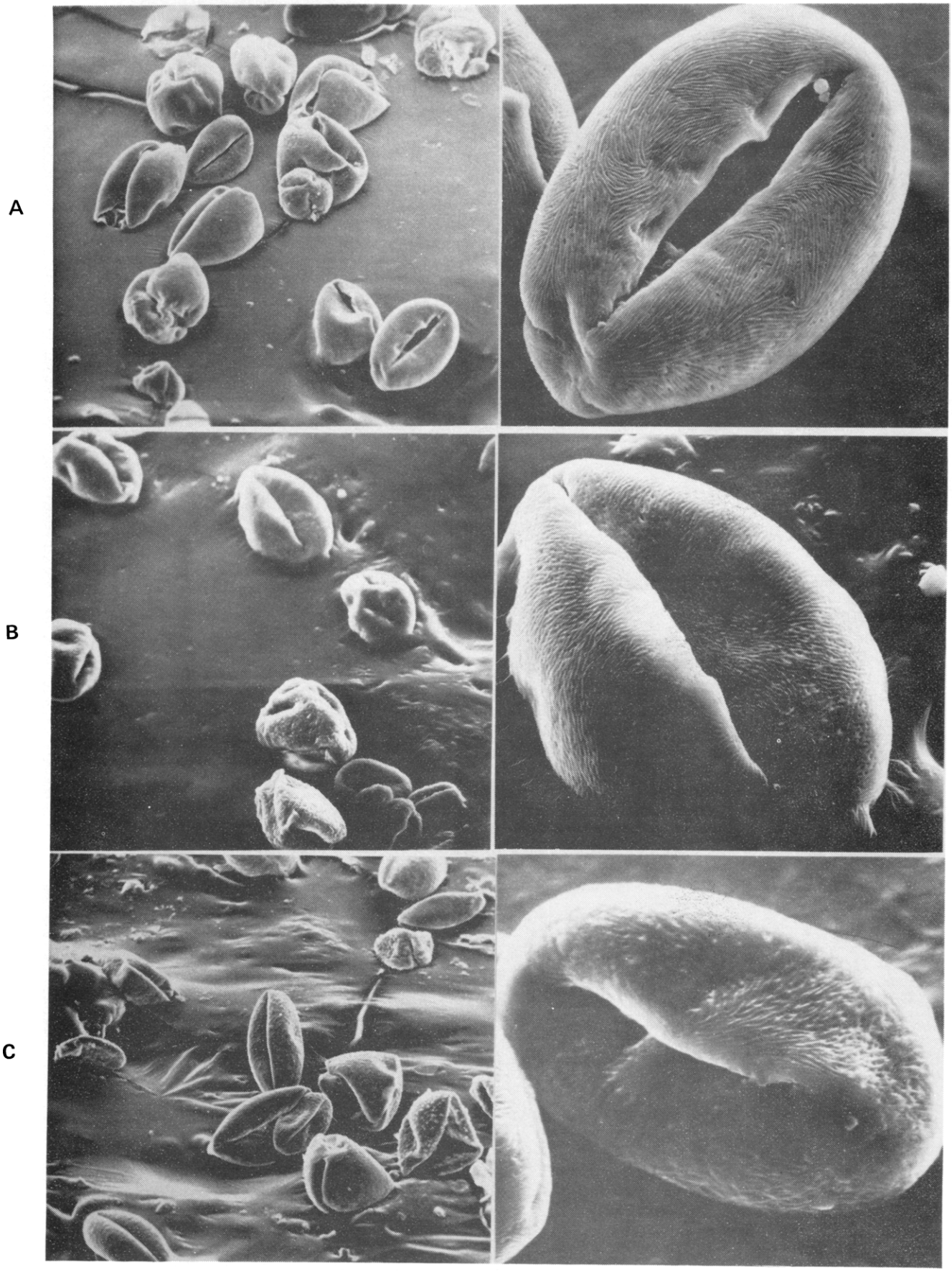

Fig. 4. Pollen morphology and surface features of some pears of Asia Minor: A) *P. regelii;* B) *P. amygdaliformis;* C) *P. salicifolia.* Magnification: left ×500; right ×2,000.

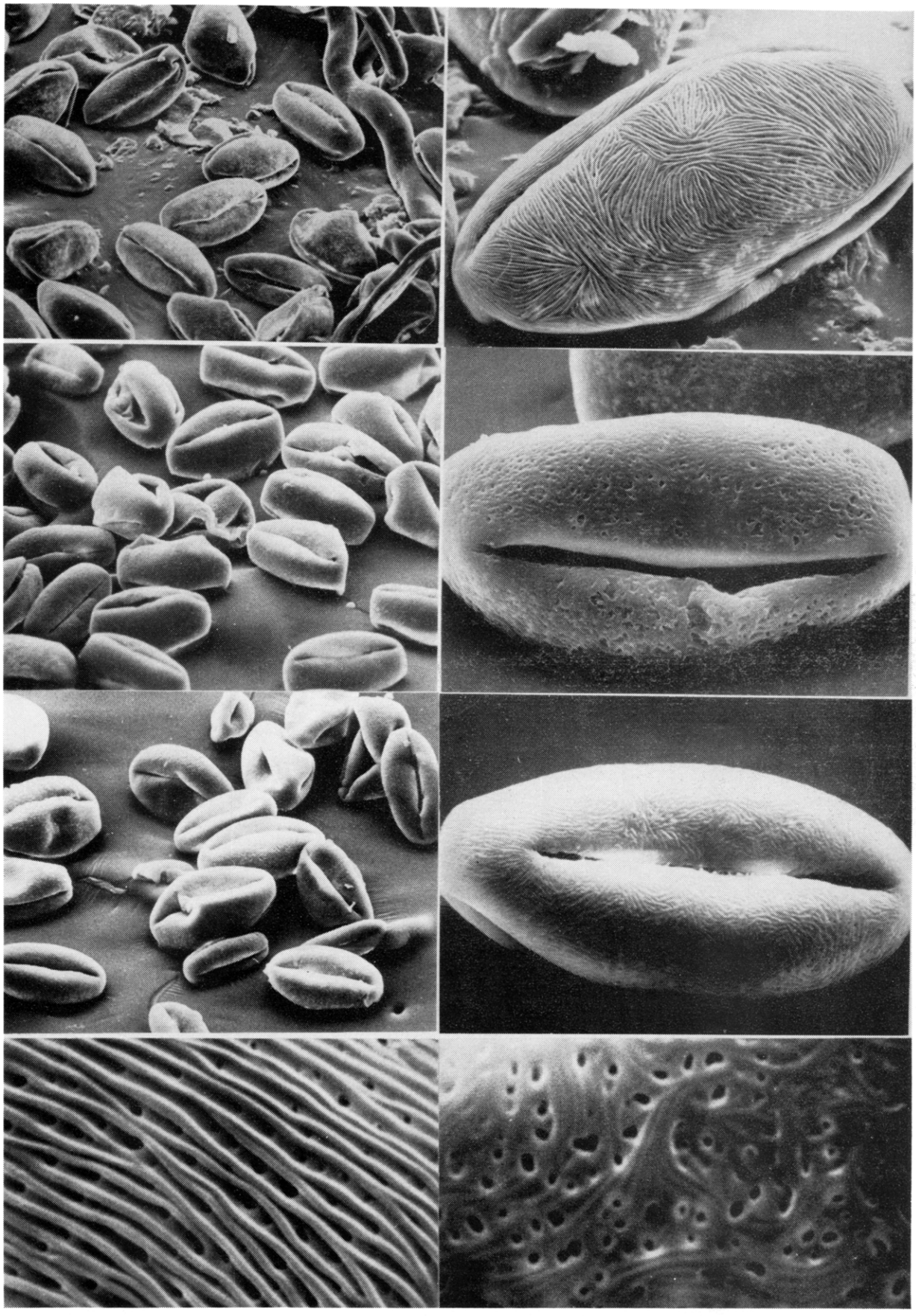

Fig. 5. Pollen morphology and surface features of some European pears: A) *P. pyraster;* B) *P. caucasica;* C) *P. communis;* D) two different clones of *P. nivalis.* Magnification A–C: left ×500; right ×2000; D) left ×10,000; D) right ×7,000.

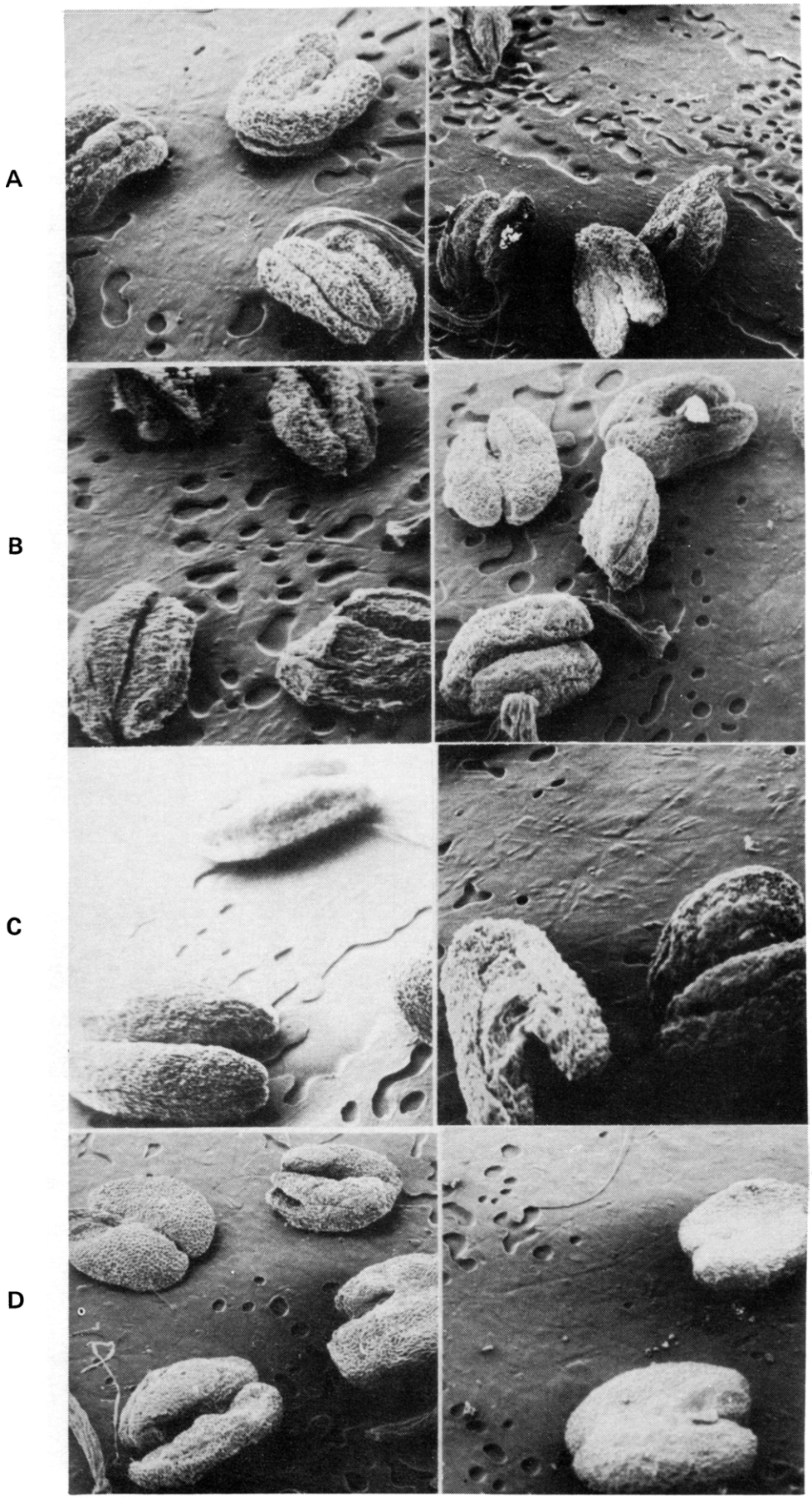

Fig. 6. Gross morphology of whole anthers of pear: A (left) *P. pyraster*, ×28; A (right) *P. communis* ×15; B (left) *P. caucasica* ×28; B (right) *P. cordata* ×27; C (left) *P. nivalis* ×28; C (right) *P. longipes* ×32; D (left) *P. calleryana* ×20; D (right) *P. betulaefolia* ×20.

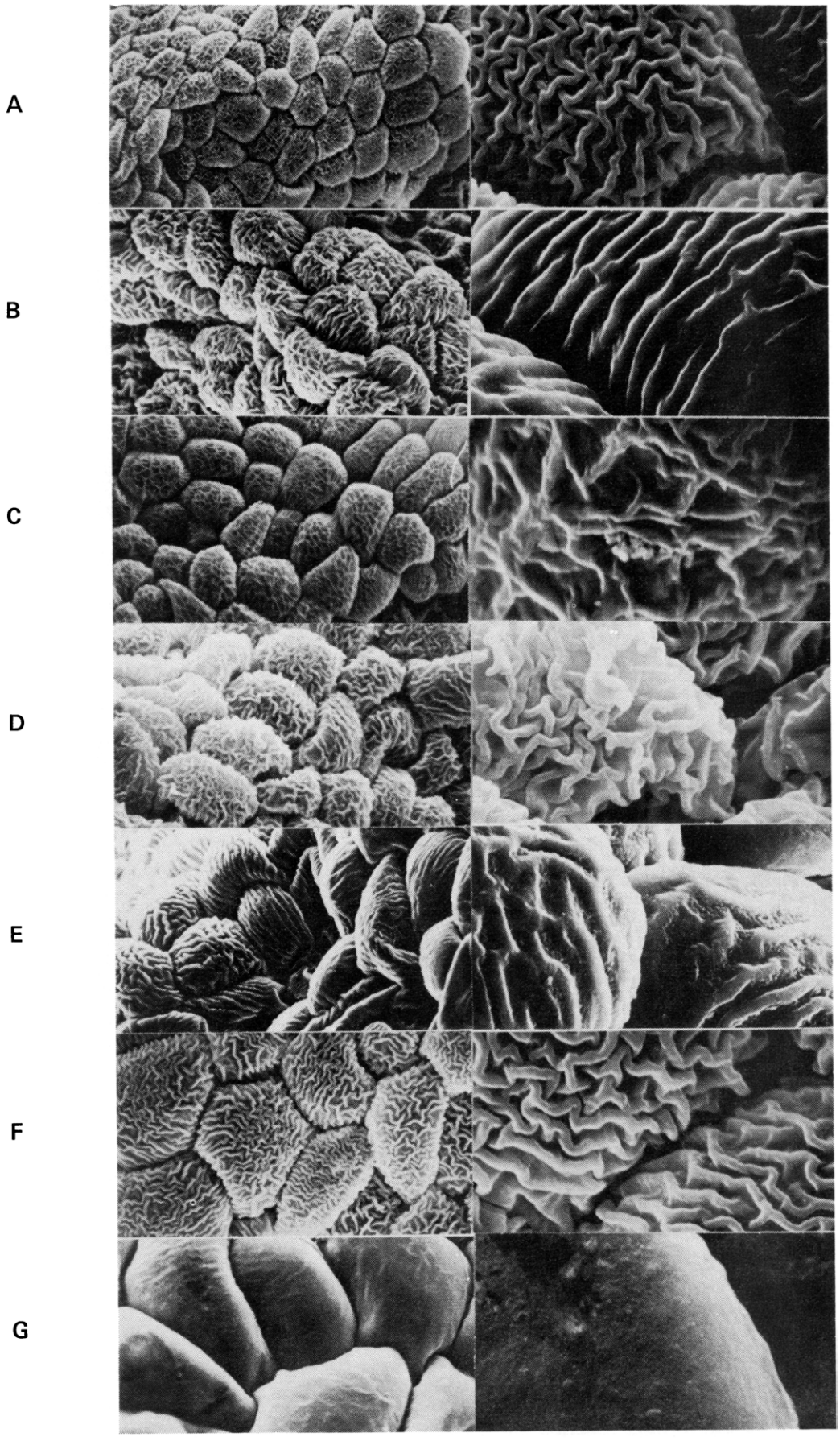

Fig. 7. Surface features of anther epidermal cells of European and Mediterranean pears: A) *P. pyraster,* left ×280, right ×2,800; B) *P. communis,* left ×400, right ×2,300; C) *P. caucasica,* left ×330, right ×3,300; D) *P. cordata,* left ×740, right ×3,000; E) *P. nivalis,* left ×210, right ×2,100; F) *P. longipes,* left ×700, right ×2,800; G) *P. salicifolia,* left ×700, right ×2,800.

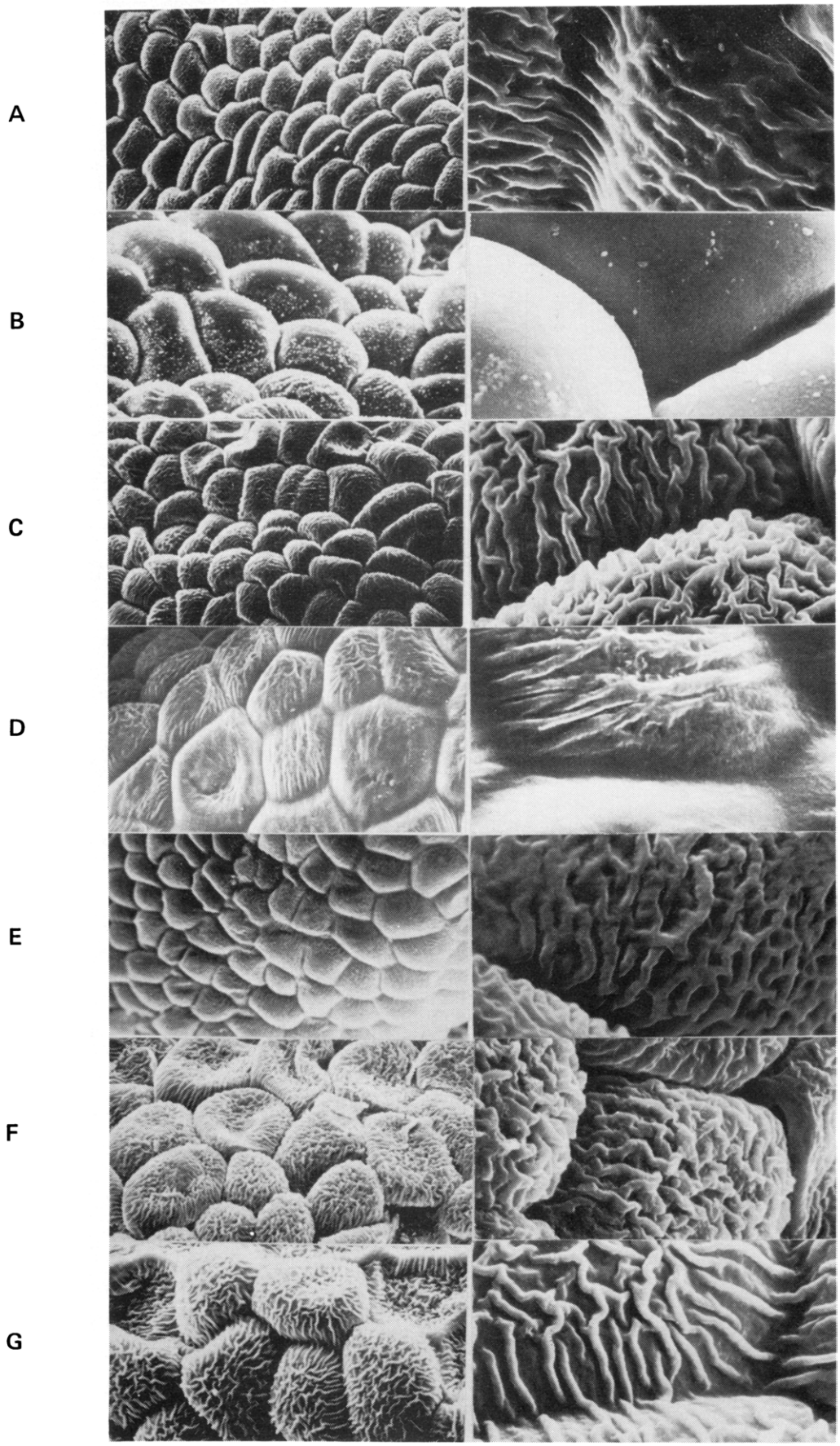

Fig. 8. Surface features of anther epidermis of Asian pears: A) *P. pashia,* left ×220, right ×2,200; B) *P. ussuriensis,* left ×580, right ×2,300, C) *P. pyrifolia,* left ×240, right ×2,300; D) *P. dimorphophylla,* left ×480, right ×1,900, E) *P. fauriei,* left ×320, right ×3,200; F) *P. calleryana,* left ×500, right ×2,000; G) *P. betulaefolia,* left ×550, right ×2,200.

than the general mean were *P. nivalis* Jacq., *P. longipes* Coss &Dur., and *P. pashia* D. Don. When length-width ratio (L/W) was used as an index of shape (Table 1), those found to have short, plump pollen were *P. amygdaliformis, P. regelii* Rehd., and *P. dimorphophylla* Mak. Those with more slender elongate pollen were *P. nivalis, P. pashia* and *P. betulaefolia.* While the pollen size and shape for clones of a given species appeared quite uniform, these factors were not related to groups of species found in specific geographic areas. Also, the L/W ratios did not indicate the subtle differences in shape seen in Fig. 1–5. For example, *P. dimorphophylla* and *P. hondoensis* Nak. & Kik. pollen grains have quite similar L/W ratios, but their specific shapes appear to be different (Fig. 1, 2).

Surface features of the exine (Fig. 1–5) were variable but in most species both pores and prominent ridges were present. Some, however, such as *P. caucasica* Fed. have pores but not ridges. *P. dimorphophylla* tends to have neither pores nor prominent ridges, but has surface pits. Individual clones of the same species tended to vary in exine features. For example, 2 clones of *P. nivalis* had strikingly different exines (Fig. 5D). Thus, it appears that exine topography will be more useful in distinguishing clones than species. Species differences seem to exist, however, based on our limited observations.

Anthers. Species differences in size and shape of whole anthers and epidermal anther cells (Table 2) show wide variations that seem unrelated either within species or among geographically related groups. For example, those with the longest anthers (*P. communis* L., *P. nivalis,* and *P. betulaefolia*) are not consistently the same ones with the longest anther cells (*P. betulaefolia, P. salicifolia* and *P. pashia*), nor is either of the groups related geographically. Similarly L/W ratios of anthers and anther cells do not vary consistently with related groups of species.

Surface topography of anther epidermis varied considerably among species (Fig. 6–8). Prominent ridges occurred with most species but *P. salicifolia* and *P. ussuriensis* Max. were nearly smooth. Although quite distinctive, such features would have to be examined for a number of individuals to determine their value as species indicators.

Taxonomic implications. The 9 measurements taken, i.e. length, width, and length/width ratios of pollen, anthers and anther cells (Tables 1 and 2), individually did not show consistent differences among geographic groups of species. In this respect, the previous numerical taxonomy study (4) was much more definitive. However, when all 9 features were considered, each species had a unique pattern. Thus, when within-species variability is minimal, these measurements could be used along with those of the leaf, stem, flower and fruit (4, 8, 9, 10, 12) for characterizing species. Other features of interest would be the surface hairs and epidermis of leaves, stems, buds and fruit. Preliminary studies by Dr. Nancy Callan (unpublished) using SEM have shown distinctive features of buds of different *Pyrus* species that will prove useful in the taxonomy of the genus.

Table 2. Size and shape of *Pyrus* anthers and anther epidermal cells.

Species	Whole anthers			Anther cells		
	Length (mm)	Width (mm)	L/W ratio	Length (mm)	Width (μm)	L/W ratio
Europe:						
P. communis	1.20	0.75	1.59	37.4	28.3	1.42
P. nivalis	1.36	0.93	1.45	23.8	18.8	1.26
P. cordata	0.88	0.62	1.40	17.3	13.2	1.31
Asia Minor:						
P. salicifolia	1.13	0.99	1.14	45.6	24.5	1.86
North Africa:						
P. longipes	1.05	0.80	1.31	31.3	24.6	1.27
Central Asia:						
P. pashia	1.06	0.75	1.41	40.7	27.3	1.49
East Asia:						
P. pyrifolia	1.05	0.80	1.31	32.6	19.8	1.64
P. betulaefolia	1.30	0.90	1.43	39.1	25.5	1.53
P. calleryana	1.10	0.75	1.46	29.3	24.0	1.22
P. fauriei	0.88	0.58	1.51	27.7	16.2	1.70
P. dimorphophylla	1.06	0.57	1.83	37.7	27.5	1.37
General Means	1.10	0.77	1.44	33.0	22.7	1.46

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