

FOLIAR EPIDERMAL STUDIES IN ROSACEAE II: PRUNUS

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A B S T R A C T

Foliar epidermal structure of 16 species of *Prunus* is described in this paper and its taxonomic significance is discussed.

INTRODUCTION

Earlier Jain and Singh (1974 b), have described the leaf epidermal structure of some species of *Pyrus* and also discussed their taxonomic significance. This is the second paper of the series which deals with 16 species of *Prunus*.

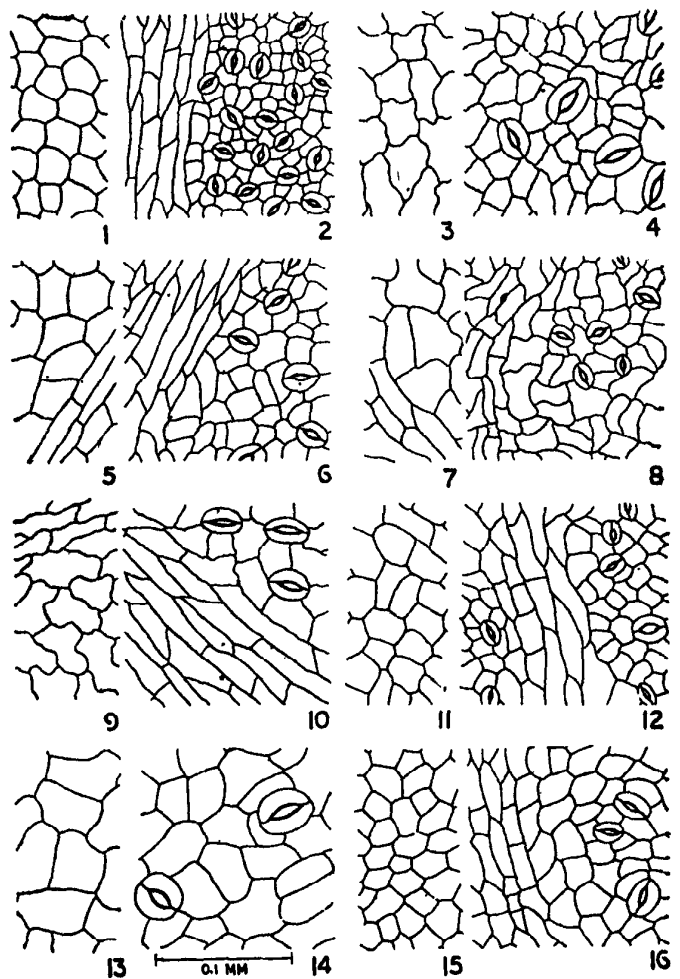
MATERIALS AND METHODS

The dried leaves of the species investigated (Table I) were procured from the Herbarium of the School of Plant Morphology, Meerut College, Meerut. The epidermal peels were removed from the apical, middle and basal parts of the mature leaves following the technique given by Boulos and Beakbane (1971) and stored in 70% ethanol. They were stained in 1% aqueous solution of Safranin O and mounted in glycerin.

OBSERVATIONS

Epidermal characters observed in the various species of *Prunus* are recorded in Table I. However, a general account of some salient features is given below:

Epidermis: The cells of the upper epidermis are usually polygonal (*P. armeniaca*, *P. cerasifera*, *P. cornuta*, *P. domestica*, *P. laurocerasus*, *P. persica*, *P. serotina*, *P. virginiana*) (Figs. 1, 5, 11, 13, 17, 19, 21), polygonal to isodiametrical (*P. nepalensis*) (Fig. 15), polygonal to irregular (*P. amygdalus*, *P. cerasoides*, *P. padus*) (Fig. 7) or irregular (*P. avium*, *P. depressa*, *P. penasylvanica*, *P. nigra*) (Figs. 3, 9) with straight, arched, un-



Figs. 1-16. Epidermal structure in *Prunus* species. Figs. 1, 2. Upper and lower epidermis respectively of *P. armeniaca*. Figs. 3, 4. Upper and lower epidermis respectively of *P. avium*. Figs. 5, 6. Upper and lower epidermis respectively of *P. cerasifera* var. *pissardii*. Figs. 7, 8. Upper and lower epidermis respectively of *P. cerasoides*. Figs. 9, 10. Upper and lower epidermis respectively of *P. depressa*. Figs. 11, 12. Upper and lower epidermis respectively of *P. domestica* sub sp. *institia*. Figs. 13, 14. Upper and lower epidermis respectively of *P. laurocerasus*. Figs. 15, 16. Upper and lower epidermis respectively of *P. nepalensis*.

TABLE I
Epidermal features in *Prunus* species

Sl. No.	Name of Species	Place of collection	Upper Epidermis				Lower Epidermis					
			Epidermal cells	Costal area	Striations	Rosette crystals	Trichomes	Epidermal cells	Costal area	Striations	Rosette crystals	Trichomes
1.	<i>P. amygdalus</i> (Tourn.) Linn.	Meerut	Polygonal or irregular, arched on sinuous, mucilaginous.	Indistinct	+	+	—	Polygonal or irregular, arched or sinuous.	Indistinct	+	+	—
2.	<i>P. armeniaca</i> Tourn. ex Mill.	Dehradun	Polygonal, arched, highly mucilaginous, papillose.	Conspicuous	+	—	—	Polygonal, arched, mucilaginous.	Prominent	+	—	—
	<i>P. avium</i> Linn.	Burlington, New England	Irregular, sinuous, highly mucilaginous, granular waxy covering.	Conspicuous	+	—	—	Polygonal, undulate, mucilaginous.	Conspicuous	+	—	—
4.	<i>P. cerasifera</i> Ehrh. var. <i>pissardii</i> Koch	Dehradun	Polygonal, arched, mucilaginous, papillose, pegs not distinct.	Prominent	+	+	Short, conical, unicellular, thin walled, on coastal area.	Polygonal or irregular arched or sinuous, mucilaginous, slightly papillose, pegs indistinct.	Prominent	+	+	Unicellular, filiform, relatively thick walled on coastal area.
5.	<i>P. cerasoides</i> Don	Garhwal	Polygonal or irregular, arched or sinuous, mucilaginous.	Prominent	—	+	Short, unicellular, stiff, thick walled with narrow lumen, on coastal area.	Polygonal or irregular, sinuous, mucilaginous.	Prominent	+	—	Short, unicellular, thick walled, with narrow lumen, on coastal area.
6.	<i>P. cornuta</i> Wall.	Mussoorie	Polygonal, arched or undulate, mucilaginous.	Faintly differentiated	+	+	—	Polygonal, arched mucilaginous, highly papillose.	Prominent	+	+	—
7.	<i>P. depressa</i> Pursh.	Hartland, New England	Irregular, sinuous, mucilaginous.	Conspicuous	+	—	Short, unicellular, on main vein area only.	Irregular, undulate mucilaginous.	Conspicuous	+	—	—
8.	<i>P. domestica</i> sub sp. <i>institia</i> (L.) Sch.	Meerut	Polygonal, arched, faintly mucilaginous, slightly papillose.	Faintly differentiated	+	+	Short unicellular, conical, thick walled with narrow lumen, on coastal area only.	Polygonal, arched or sinuous.	Prominent	+	+	Short, unicellular, conical, thick walled, with narrow lumen, on coastal area.

Contd.

9. <i>P. laurocerasus</i> (Tourn.) M. Roem.	Ootacamund	Polygonal, arched or sinuous, highly papillose, pegs prominent, aggregated, waxy covering over the surface.	Indistinct	-	-	-	Polygonal or irregular, arched or sinuous, highly papillose, pegs prominent, aggregated waxy covering over the surface.	Indistinct	-	-	-
10. <i>P. nepalensis</i> Hort. ex G. Koch.	Sika, Nepal	Polygonal or isodiametrical, arched, mucilaginous, papillose, pegs not distinct.	Conspicuous	-	-	-	Polygonal, arched, mucilaginous, slightly papillose.	Prominent	-	-	-
11. <i>P. nigra</i> Ait.	Barton, New England	Irregular, arched, mucilaginous.	Conspicuous	+	-	-	Highly papillose.	Prominent	+	-	-
12. <i>P. padus</i> Linn.	Sika, Nepal	Polygonal or irregular, arched or sinuous, mucilaginous.	Conspicuous	+	-	-	Polygonal, arched or wavy, mucilaginous.	Prominent	+	+	-
13. <i>P. pennsylvanica</i> Linn.	Morristown, New England	Irregular, undulate.	Indistinct	+	-	-	Polygonal, or irregular, undulate.	Prominent	+	+	Filiform, unicellular, thin walled, on coastal area.
14. <i>P. persica</i> (Tourn.) Mill.	Meerut	Polygonal, arched.	Indistinct	-	-	-	Polygonal, arched.	Conspicuous	-	+	Unicellular, filiform, thick-walled with narrow lumen, on coastal area.
15. <i>P. serotina</i> Ehrb.	Brookfield, New England	Polygonal, straight or arched.	Conspicuous	+	-	Filiform, unicellular, thin-walled, on coastal area.	Polygonal, straight or slightly arched.	Conspicuous	+	-	Filiform, unicellular, thin-walled, on coastal area.
16. <i>P. virginiana</i> Linn.	Jrasburg, New England	Polygonal, slightly undulate.	Indistinct	+	-	Short, conical, unicellular, thin-walled, on coastal area.	Irregular, slightly sinuous, mucilaginous.	Conspicuous	+	-	Absent

- = absent, + = present.

TABLE II
Mean values and their standard deviations of size of stomata in various groups in *Prunus* species.

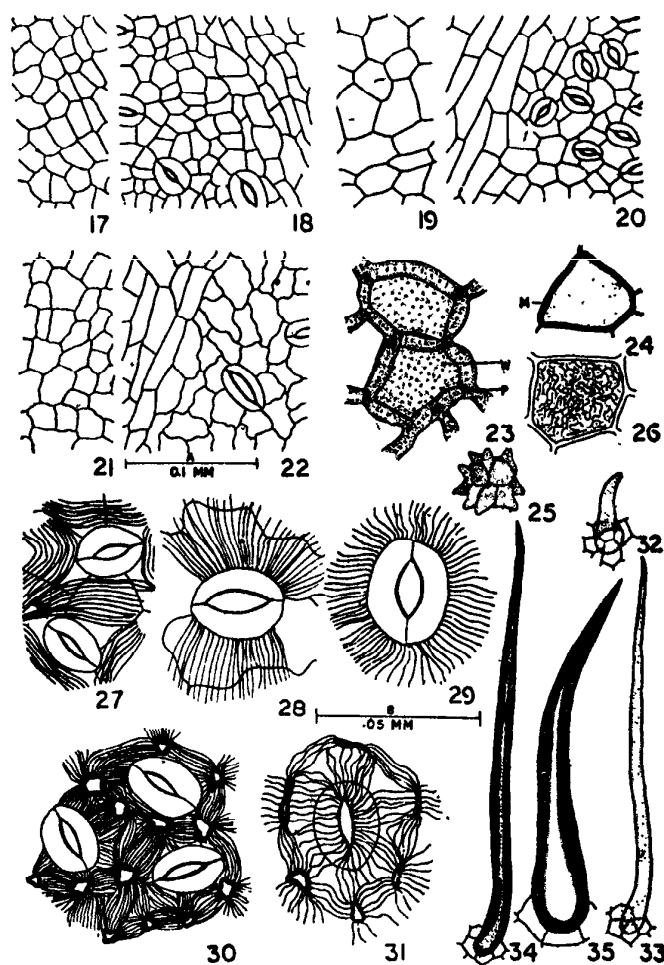
Sl. No.	Name of species	*Average No. of stomata per sq. mm	Size of stomata (Length × Breadth) in μ m				
			Group I	Group II	Group III	Group IV	Group V
1.	<i>P. amygdalus</i>	352	12.4 ± .81 × 9.0 ± .55	14.6 ± .21 × 11.6 ± .45	—	—	—
2.	<i>P. armeniaca</i>	740	6.2 ± .21 × 5.4 ± .23	8.2 ± .55 × 6.6 ± .36	11.6 ± .45 × 8.4 ± .48	—	—
3.	<i>P. avium</i>	216	9.0 ± .81 × 6.7 ± .31	11.5 ± .83 × 8.7 ± .70	14.7 ± .74 × 10.1 ± .53	18.5 ± 1.12 × 11.8 ± .61	—
4.	<i>P. cerasifera</i> var. <i>pissardii</i>	606	6.8 ± .36 × 6.4 ± .53	10.5 ± .98 × 7.7 ± .60	13.7 ± .33 × 8.6 ± .31	16.2 ± .11 × 10.6 ± .10	—
5.	<i>P. cerasoides</i>	364	8.3 ± .71 × 6.4 ± .76	10.9 ± .41 × 7.5 ± .62	—	—	—
6.	<i>P. cornuta</i>	240	6.1 ± .53 × 5.1 ± .37	11.2 ± .95 × 8.1 ± .70	16.7 ± .69 × 11.0 ± .37	—	—
7.	<i>P. depressa</i>	160	12.7 ± .84 × 10.9 ± .44	17.4 ± .64 × 13.5 ± .61	—	—	—
8.	<i>P. domestica</i> subsp. <i>institia</i>	400	10.2 ± .55 × 6.7 ± .36	—	—	—	—
9.	<i>P. laurocerasus</i>	132	16.9 ± .78 × 13.3 ± .41	—	—	—	—
10.	<i>P. nepalensis</i>	272	9.2 ± .82 × 6.7 ± .48	11.8 ± 1.12 × 8.9 ± .78	15.4 ± .14 × 10.0 ± .54	—	—
11.	<i>P. nigra</i>	184	18.2 ± .41 × 15.4 ± .53	22.2 ± .34 × 16.5 ± .77	—	—	—
12.	<i>P. padus</i>	604	8.5 ± .60 × 6.4 ± .60	11.4 ± .50 × 8.6 ± .90	15.1 ± .70 × 10.5 ± .30	—	—
13.	<i>P. pensylvanica</i>	432	8.7 ± .45 × 5.9 ± .46	11.3 ± .54 8.9 ± .77	15.5 ± .73 × 10.3 ± .29	—	—
14.	<i>P. persica</i>	204	14.1 ± .45 × 9.7 ± .44	16.4 ± .38 × 11.4 ± .42	—	—	—
15.	<i>P. serotina</i>	576	9.3 ± .99 × 6.4 ± .46	11.4 ± .80 × 8.7 ± .46	13.9 ± .33 × 11.0 ± .28	—	—
16.	<i>P. virginiana</i>	240	5.1 ± .60 × 4.3 ± .54	7.8 ± 1.01 × 6.1 ± .50	10.8 ± .33 × 7.7 ± .46	13.8 ± .82 × 9.4 ± .86	17.8 ± .80 × 11.2 ± .64

*Mean of 10 values.

dulate or sinuous anticlinal walls. An aggregated or granular waxy covering is present on the leaf surface in *P. laurocerasus* (Fig. 23) and *P. avium* respectively. The cells are usually mucilaginous (Fig. 24) except in *P. persica*, *P. pensylvanica*, *P. serotina* and *P. virginiana*. The cells are usually nonpapillose but for *P. armeniaca*, *P. cerasifera*, *P. domestica*, *P. laurocerasus* and *P. nepalensis* where certain peg-like thickenings are present on the anticlinal walls. The thickenings are very prominent in *P. laurocerasus*, where the projections are usually sharply wedge-shaped and are present at the junctions of the cell-walls (Fig. 23). The costal area is usually prominent or conspicuous except in *P. amygdalus*, *P. laurocerasus*, *P. persica*, *P. pensylvanica* and *P. virginiana* where it is indistinct.

The cells of the lower epidermis are polygonal to irregular with straight, arched, undulate or sinuous anticlinal walls (Figs. 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22). The cells are mucilaginous or non-mucilaginous. They are slightly papillose (*P. cerasifera*, *P. nepalensis*) or highly papillose (*P. cornuta*, *P. laurocerasus*, *P. nigra*). In the latter, distinct peg-like thickenings are present on the anticlinal walls of the epidermal cells. But for *P. amygdalus* and *P. laurocerasus*, the costal area is prominent or conspicuous and consists of elongated cells.

Stomata: The leaves are hypostomatic in all the species investigated. The stomata are usually confined to intercostal area, however, occasionally a few stomata may also be present in costal area (*P. armeniaca*, *P. avium*, *P. depressa*, *P. domestica*, *P. padus*, *P. pensylvanica*). The stomata are surrounded by a variable number of epidermal cells which are not distinct from the other cells of the epidermis, thus being ranunculaceous (Vesque, 1889) or anomocytic (Metcalf and Chalk, 1950). The guard cells are kidney-shaped and are at the level of the epidermal

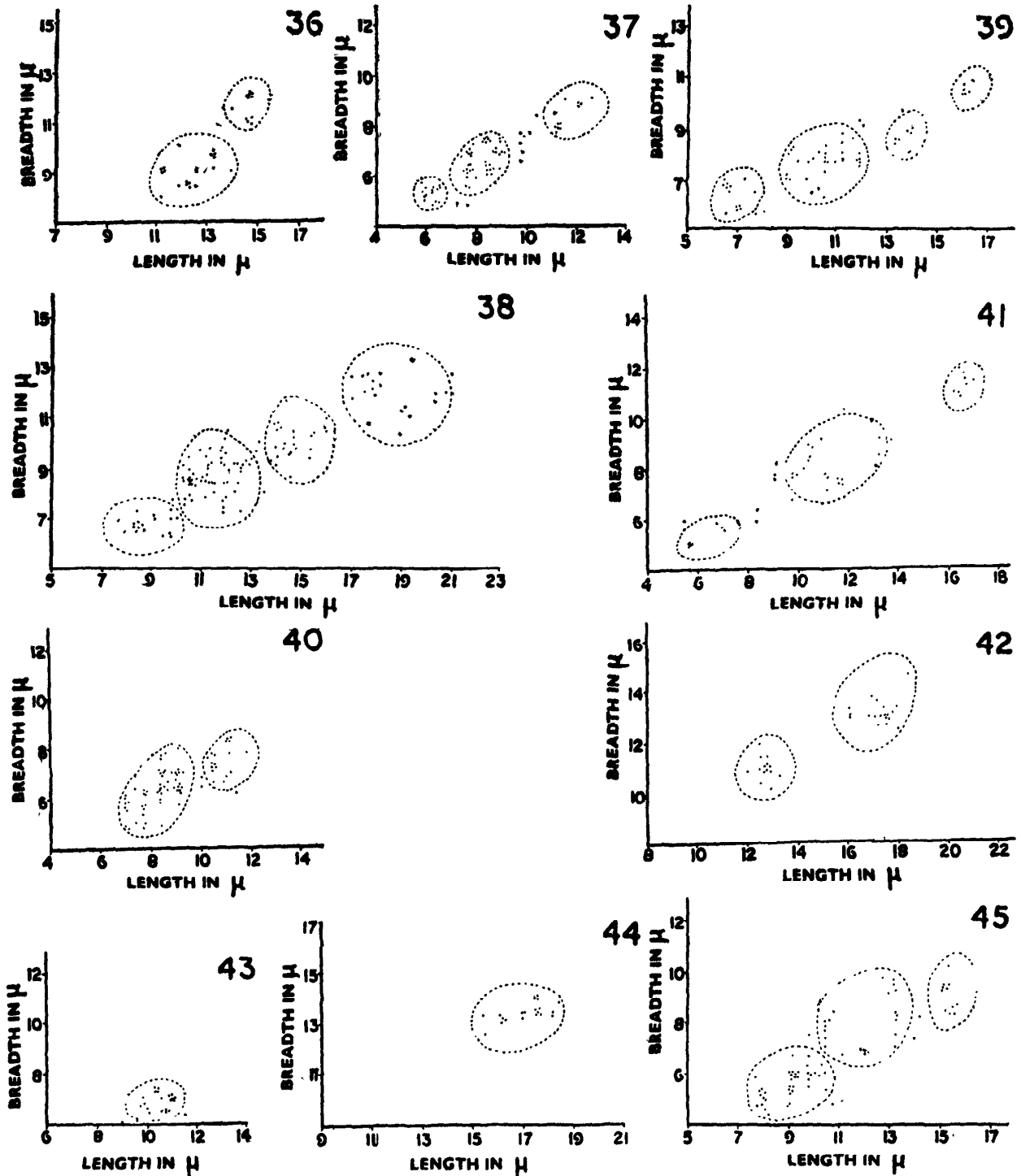


Figs. 17-35. Epidermal structures in *Prunus* species.

Figs. 17,18. Upper and lower epidermis respectively of *P. persica*. Figs. 19,20. Upper and lower epidermis respectively of *P. serotina*. Figs. 21,22. Upper and lower epidermis respectively of *P. virginiana*. Fig. 23. A few cells from the upper epidermis of *P. laurocerasus* showing aggregated waxy covering over the surface and peg-like cuticular thickenings at the junction walls. Fig. 24. A cell from upper epidermis of *P. armeniaca*. Note mucilage deposition on the walls. Fig. 25. A rosette crystal from the cell of the upper epidermis of *P. amygdalus*. Fig. 26. A cell from the upper epidermis of *P. laurocerasus* showing complicated relief pattern of the striae on the surface. Fig. 27. Lower epidermis of *P. cerasifera* var. *pissardii*, striae flow out throughout the general surface and their centre of radiation is not traceable. Fig. 28. Lower epidermis of *P. virginiana*. Striae flow out in two lateral groups from the outer walls of the guard cells. Fig. 29. Lower epidermis of *P. padus*. Striae flow out all around from the outer walls of the guard cells. Fig. 30. Lower epidermis of *P. cornuta*. Striae flow out from certain cuticular peg-like thickenings of the walls and they cover whole surface except guard cells. Fig. 31. Lower epidermis of *P. nigra*. Striae flow out from certain cuticular peg-like thickenings of the walls and they cover whole surface including guard cells. Fig. 32. Short conical, unicellular trichome of *P. virginiana*. Fig. 33. Unicellular filiform, thin walled trichome of *P. pensylvanica*. Figs. 34,35. Unicellular filiform, thick-walled trichomes of *P. persica* and *P. cerasoides* respectively.

cells except in *P. virginiana*, where they are slightly sunken. The stomata are usually one to many cells apart and may be larger, smaller or equal to the size of the epider-

mal cells. Except for *P. domestica* and *P. laurocerasus* all the other species investigated show stomatal polymorphism and the stomata fall into two to five groups on the



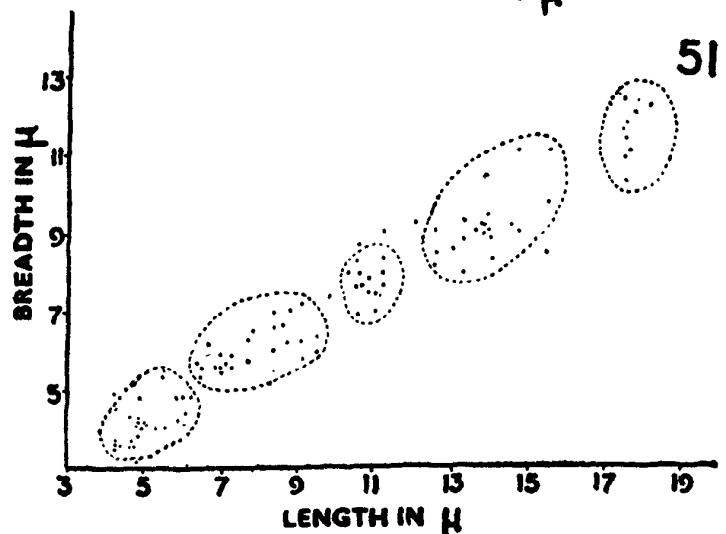
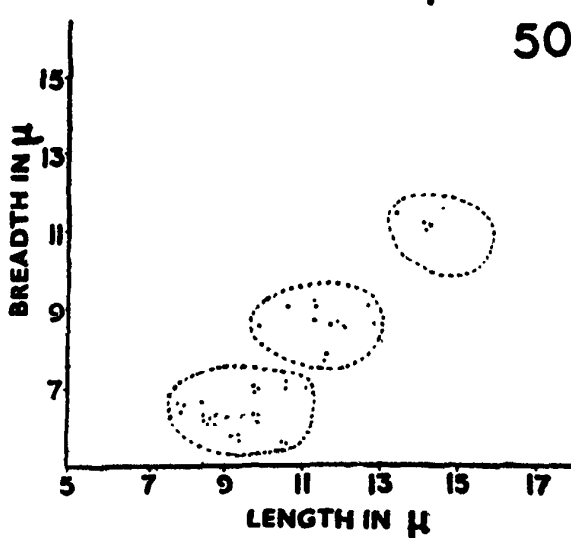
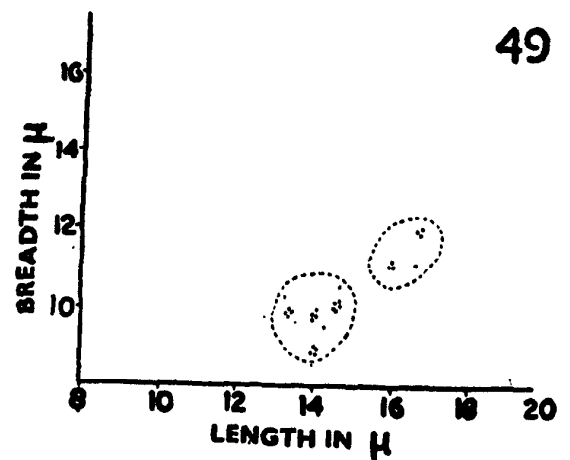
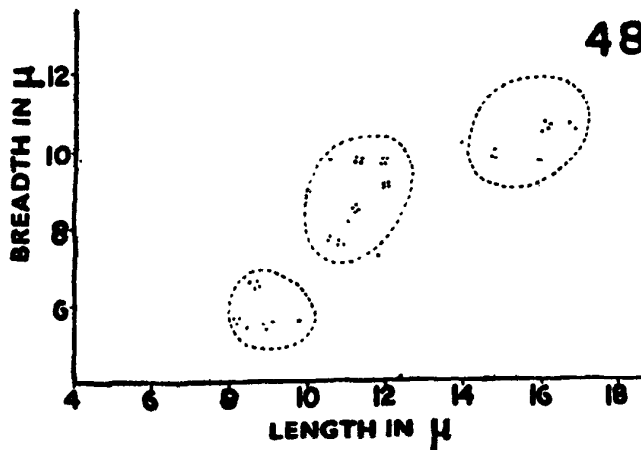
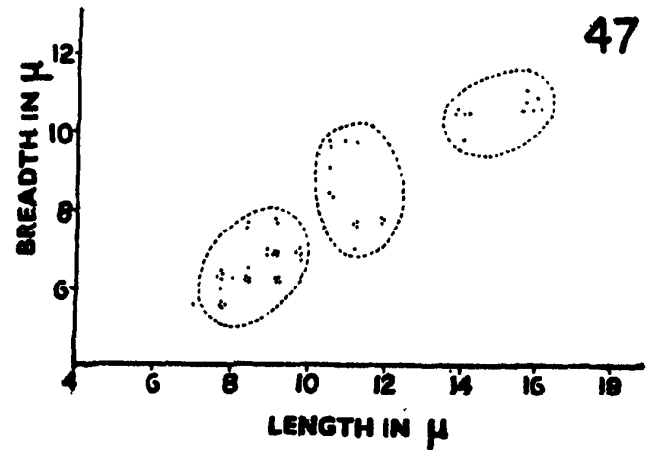
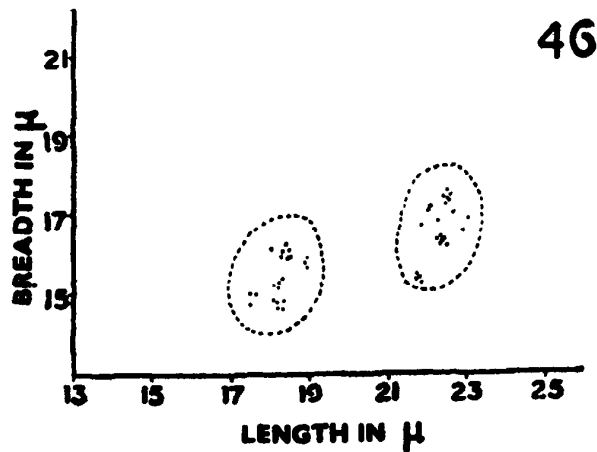
Figs. 36-45. Showing various groups of stomata in *P. amygdalus*, *P. armeniaca*, *P. avium*, *P. cerasifera* var. *pissardii*, *P. cerasoides*, *P. cornuta*, *P. depressa*, *P. domestica* subsp. *institia*, *P. laurocerasus*, *P. nepalensis* respectively. Stomata fall in two to four distinct groups but for *P. domestica* subsp. *institia* and *P. laurocerasus* where all stomata fall in a single group.

basis of variations in their size (Figs. 36-51).

Striations: The surface of the cuticle is either smooth (*P. laurocerasus*, *P. persica*) or show various patterns of striations. On the upper surface, cuticular striations form a complicated relief pattern (Fig. 26) in surface view (Priestly, 1943). In those species

where costal area is distinct, the striations are regular and parallel to the direction of the orientation of the long axis of the individual cells of the costal area. However, in inter-costal area, they are made up of irregularly curved lines. In either case, the centre of radiation is not traceable.

On the lower surface too, the cuticle shows



Figs. 46-51. Showing various groups of stomata in *P. nigra*, *P. padus*, *P. pennsylvanica*, *P. persica*, *P. serotina* and *P. virginiana* respectively. Stomata fall in two to five distinct groups.

varying patterns of striations. In *P. armeniaca* and *P. cerasifera*, the striae are prominent in the intercostal area. They are made up of irregularly curved lines, strongly covering the whole surface except for the guard cells of the stomata, and giving wrinkled appearance to the cuticular surface (Fig. 27). In the second group of species the striae are profuse and extend in all directions from the outer walls of the guard cells with their radiating centres at frequent intervals (Fig. 29). Either they cover a large area (*P. avium*, *P. domestica*) or extend only up to one or two cells of the epidermis (*P. depressa*, *P. padus*, *P. penasylvanica*). In the third group of species the striae flow out from the stomata in two lateral groups and extend over one or two cells (*P. amygdalus*, *P. cerasoides*, *P. virginiana*, *P. serotina*) (Fig. 28) or several cells of the epidermis (*P. avium*, *P. padus*). The striations arise in all directions from certain peg-like cuticular thickenings in *P. cornuta* and they cover the whole surface but for guard cells (Fig. 30). The striations in *P. nigra* are similar to those of *P. cornuta*, but in the former they also cover the guard cells (only stomatal aperture is left uncovered) (Fig. 31).

Rosette crystals: Solitary or clustered crystals (Fig. 25) of calcium oxalate are found in the cells of both upper and lower epidermis (*P. amygdalus*, *P. cerasifera*, *P. cornuta*, *P. domestica*, *P. cerasoides*) or only of lower epidermis (*P. padus*, *P. persica*). They are either restricted to the cells of the intercostal area (*P. cerasifera*, *P. cerasoides*, *P. padus*) or are present in the cells of both intercostal and costal area (*P. domestica*).

Trichomes: The trichomes may be present on both the surfaces of the leaf (*P. cerasifera*, *P. cerasoides*, *P. domestica*, *P. serotina*) or are confined only to the upper (*P. depressa*, *P. virginiana*) or lower surface (*P. persica*, *P. penasylvanica*) only. They are invariably non-glandular, unicellular,

filiform with thin or thick walls (Figs. 33-35). However, short unicellular, conical trichomes have been observed in *P. cerasifera*, *P. domestica* and *P. virginiana* (Fig. 32). The trichomes are invariably present on the costal area but in *P. depressa* they are restricted to mid-rib and its main branches.

DISCUSSION AND CONCLUSIONS

Epidermal characters are considered as having considerable potential in systematics and may also aid in phylogenetic interpretations. (Bureau, 1864; Edwards, 1935; Prat, 1932, 1960; Walter, 1953; Borrill, 1961; Stace, 1961, 1965 a, b,; 1969 a, b, 1973; Ramayya and Rajagopal 1968, 1971; Jain and Singh, 1974 a, b, etc.). Epidermal features, such as the outline of the epidermal cells in surface view, the structure of stomata, the distribution and size of crystals and the nature and size of hairs have been used by Gyhr (1930) for microscopical identification of the leaves of some Rosaceae having medicinal properties. Recently the authors (Jain and Singh, 1974 b) have also drawn a key for the microscopical identification of the species of *Pyrus* on the basis of such characters. Metcalfe and Chalk (1950) also pointed out that cuticular features are of value in specific and to certain extent in generic diagnosis in Rosaceae.

Several variations have been observed in the outline of epidermal cells, cuticular striations, the structure of stomata and the nature of trichomes present on the leaves of various species of *Prunus* investigated. The cells of the epidermis are polygonal to irregular with straight, arched, undulate or sinuous anticlinal walls. The costal area is either indistinct or distinct and composed of elongated cells. A waxy covering is present on the leaves of *P. laurocerasus* and *P. avium* only. The cells are mucilaginous or non-mucilaginous and with or without papillae. The stomata are confined to the lower surface of the leaf and are surrounded by a variable number of epidermal cells.

But for *P. domestica* and *P. laurocerasus*, all the other species investigated show stomatal polymorphism. Polymorphic stomata have recently been reported by the authors in some other Rosaceae (Jain and Singh, 1974 b).

Metcalf and Chalk (1950) have reported that the lack of simple uniseriate clothing hairs on the vegetative parts is the characteristic feature of the family Rosaceae. The trichomes present on the leaves of *Prunus* are invariably non-glandular, unicellular, short, conical or filiform with thin or thick walls. They are confined to the costal area only.

The importance of cuticular striations has been emphasized by Stace (1961). They are also of much significance in the species of *Prunus* investigated, and show the following three patterns: 1. Centre of striae not traceable (Fig. 27); 2. Striae flow out all around or in two lateral groups from the outer walls of the guard cells (Figs. 28, 29); 3. Striae flow out from certain peg-like cuticular thickenings on the walls of the epidermal cells (Figs. 30, 31).

On the basis of the foliar epidermal characters, the following key has been drawn to differentiate the sixteen species of *Prunus* investigated:

Striations absent.		
Trichome absent.		
Costal area indistinct	...	1. <i>P. laurocerasus</i>
Costal area distinct	...	2. <i>P. nepalensis</i>
Trichome present	...	3. <i>P. persica</i>
Striations present.		
Striations restricted only to the lower surface	...	4. <i>P. cerasoides</i>
Trichome absent.		
Costal area indistinct	...	5. <i>P. amygdalus</i>
Costal area distinct.		
Rosette crystals absent.		
Centre of striae-radiation is not traceable	...	6. <i>P. armeniaca</i>
Striae flow out from the stomata in two lateral groups	...	7. <i>P. avium</i>
Striae flow out from certain peg-like thickenings and cover the guard-cells	...	8. <i>P. nigra</i>
Rosette crystals present.		
Striae arise from certain peg-like thickenings, present on the anticlinal walls	...	9. <i>P. cornuta</i>
Striae arise from the guard cells of stomata	...	10. <i>P. padus</i>
Trichome present.		
Trichome present on upper surface only.		
Striae flow out all around from stomata	...	11. <i>P. depressa</i>
Striae flow out in two lateral groups from stomata	...	12. <i>P. virginiana</i>
Trichome present on lower surface only	...	13. <i>P. pensylvanica</i>
Trichome present on both the surfaces.		
Centre of striae radiation is not traceable	...	14. <i>P. cerasifera</i>
Striae flow out all around from stomata	...	15. <i>P. domestica</i>
Striae flow out in two lateral groups from stomata	...	16. <i>P. serotina</i>

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*Not seen in original.