Physiology of Fruit Trees

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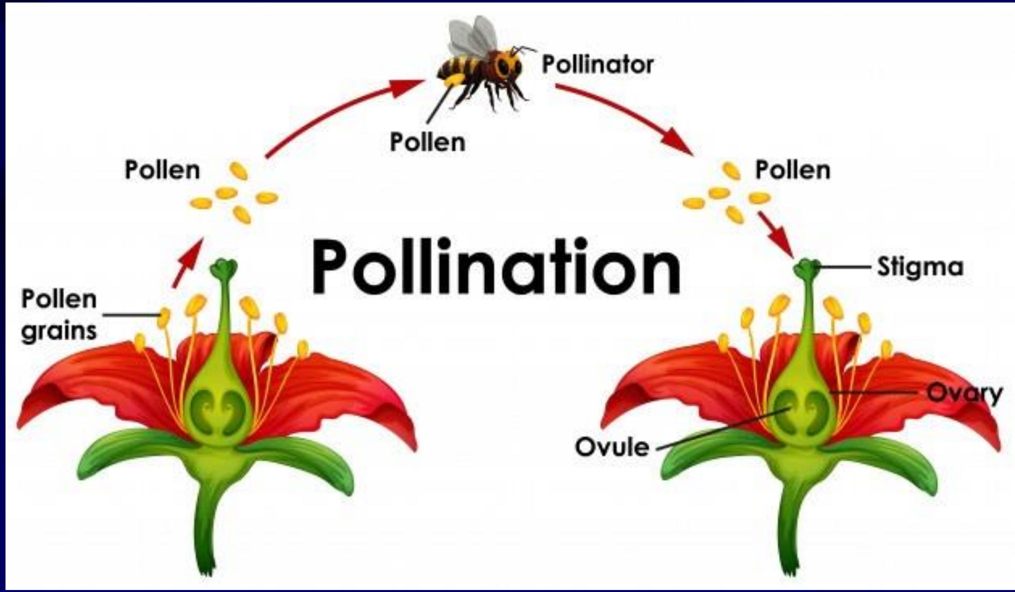
Pollination

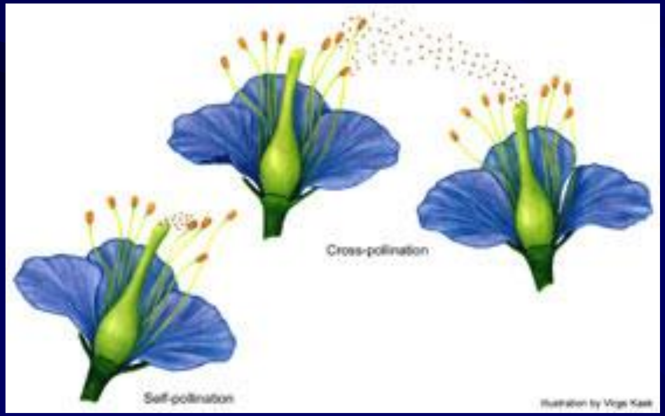
- Pollination is the transfer of pollen from the male part of the flower to the female part of the flower
- A pollinizer is a plant that provides pollen
- A pollinator is the biotic agent that moves the pollen, such as bees



- The pollination process involves:
  - Prevention of Flower Abscission (Auxin)
  - Fertilization and Zygote Production

- Some types of fruit trees may be pollinated with their own pollen and are considered **self-fruitful** (may need another tree of same variety) or **self-pollinating** (no need for a separate pollinizer). [apricots, European plums/prunes, sour cherries, peaches and nectarines]

- Other types of trees require pollen from a different variety of the same type of tree and are considered **self-unfruitful** or **self-incompatible**. [apples, pears, most sweet cherries, and most Japanese plums, almond]



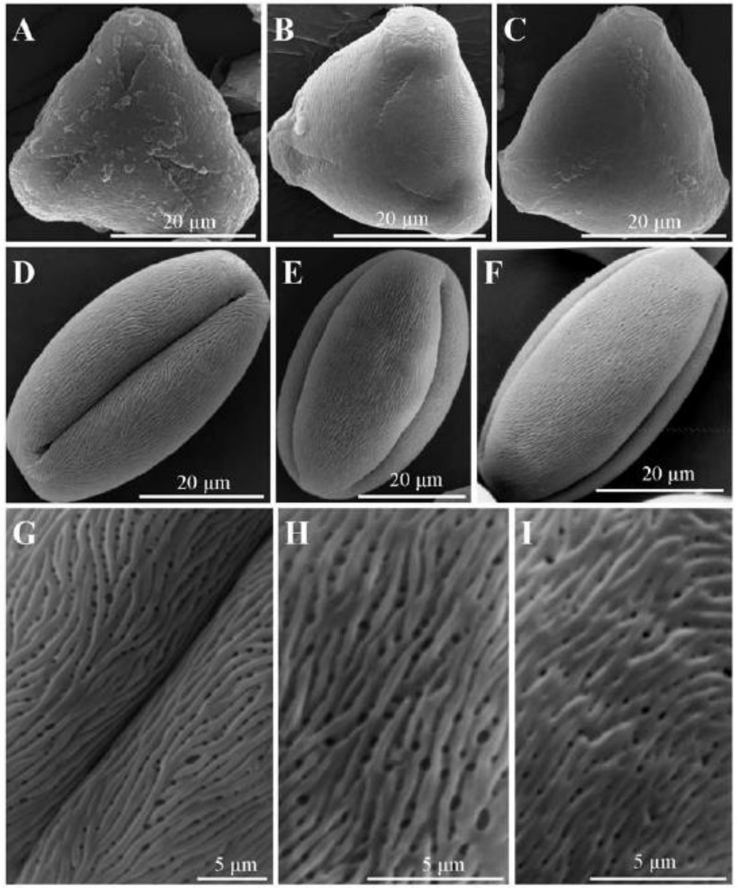


Fig. 1 A–I. Pollen grains of *P. armeniaca*: 'Harcot' (A, D, G), 'Early Orange' (B, E, H), and 'Wczesna z Morden' (C, F, I): A–C – polar view, D–F – equatorial view, G–I – detail of the exine surface, perforations in the tectum are visible

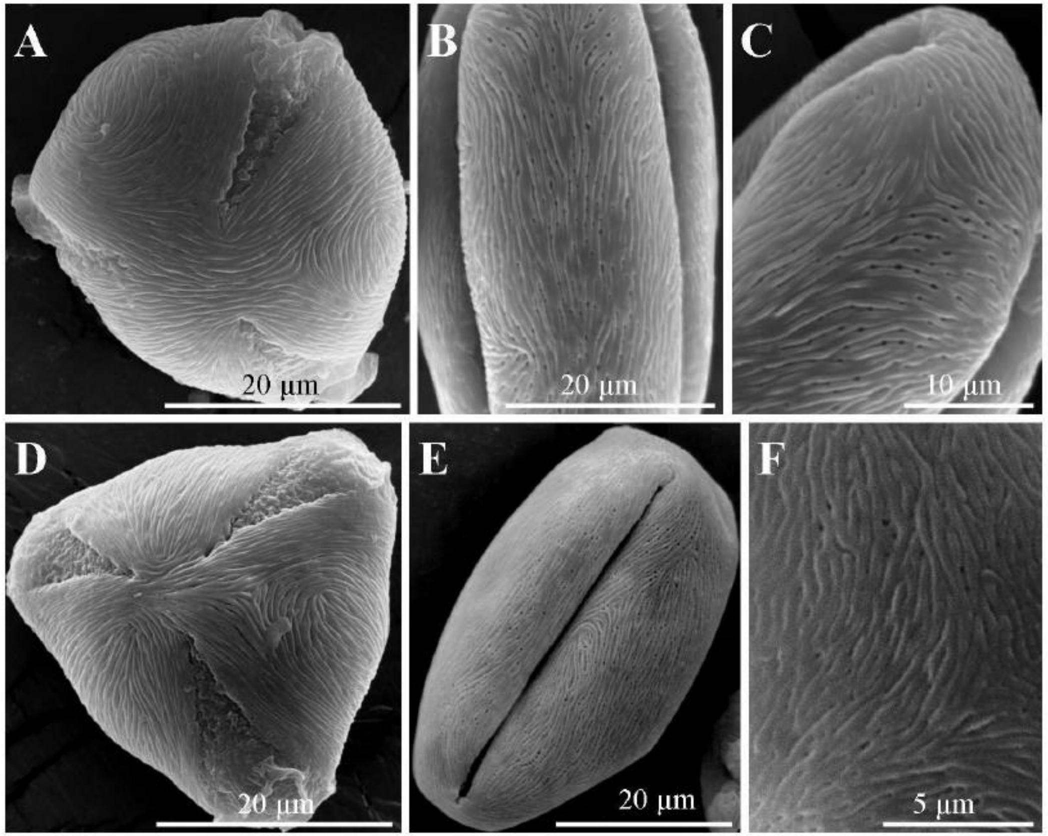
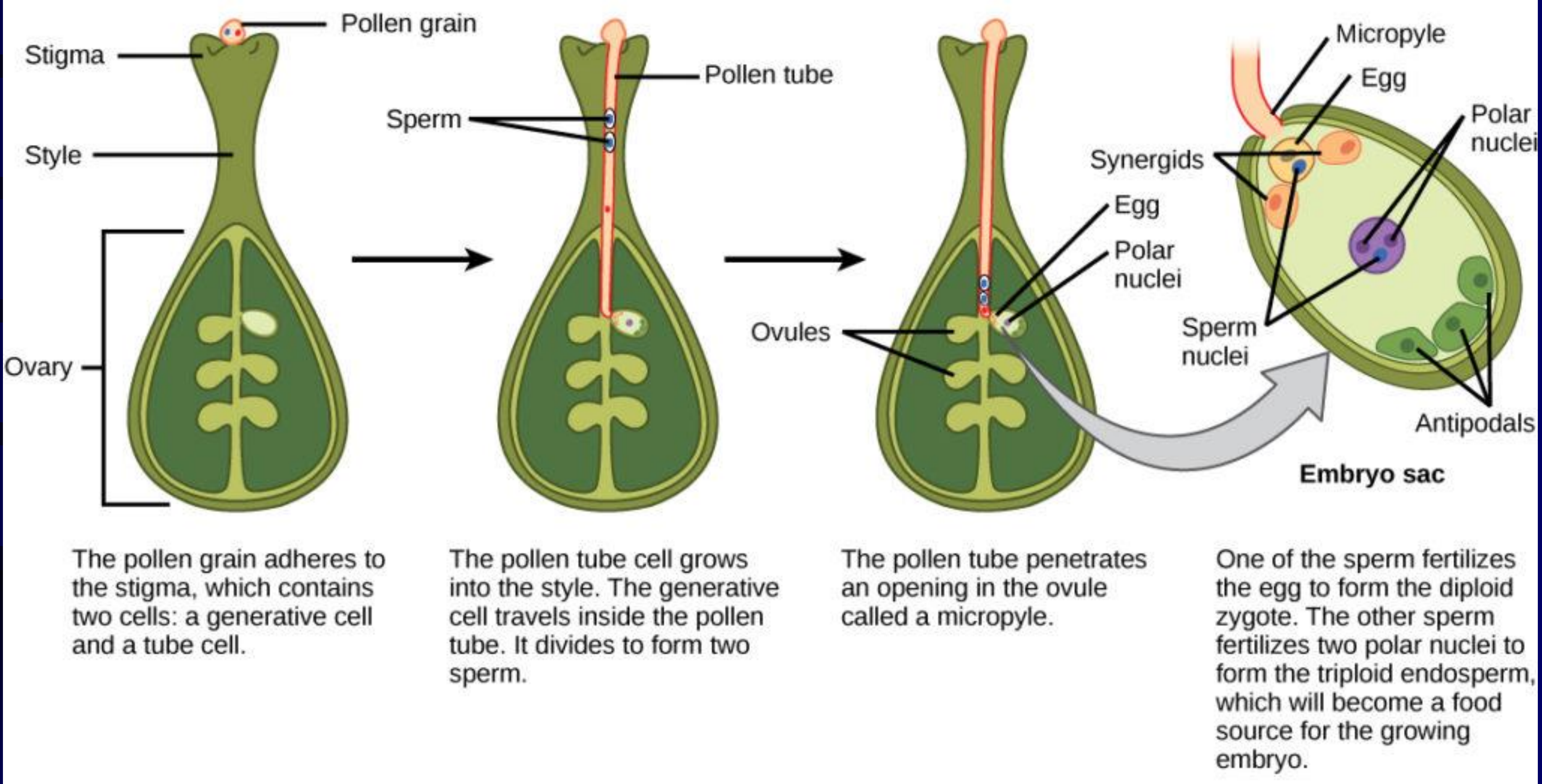


Fig. 2 A–F. Pollen grains of *P. persica* 'Redhaven' (A–C) i 'Veecling' (D–F): A, D – polar view, B, E – equatorial view, C, F – detail of the exine surface, perforations in the tectum are visible

Number of pollen in each anther: Apple (Average 3500, Golden Delicious 6000- Winesap 400)
Plum (400-1800); Peach (700-3000)

Temperature: (Red Astrachan 20°C, Cox Orange 32°C)


Pollen grain
Stigma
Style
Ovary
Sperm
Pollen tube
Ovules
Egg
Polar nuclei
Micropyle
Egg
Polar nuclei
Synergids
Sperm nuclei
Antipodals
Embryo sac
The pollen grain adheres to the stigma, which contains two cells: a generative cell and a tube cell.
The pollen tube cell grows into the style. The generative cell travels inside the pollen tube. It divides to form two sperm.
The pollen tube penetrates an opening in the ovule called a micropyle.
One of the sperm fertilizes the egg to form the diploid zygote. The other sperm fertilizes two polar nuclei to form the triploid endosperm, which will become a food source for the growing embryo.

Xenia and Metaxenia

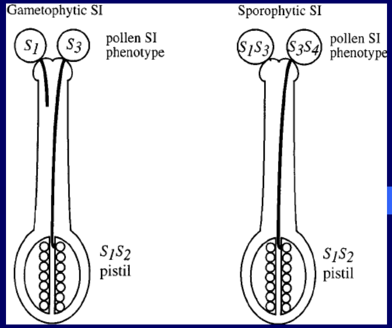
Xenia is the effect of pollen on seed characteristics (Date, Pistachio, Almond)

Bitterness in almond: content of the cyanogenic diglucoside amygdalin (SS, Ss, ss)

Metaxenia is the effect of pollen on fruit characteristics (Pistachio)

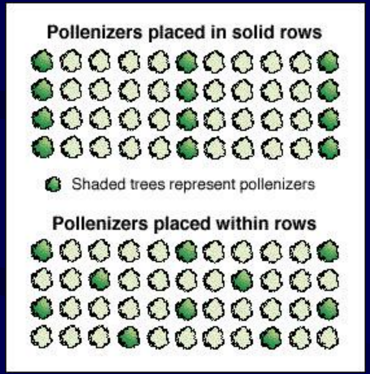
<u>Factor affecting the pollination</u>

- Pollen Incompatibility (<u>Gametophytic </u>in Rosaceae, Sporophytic)



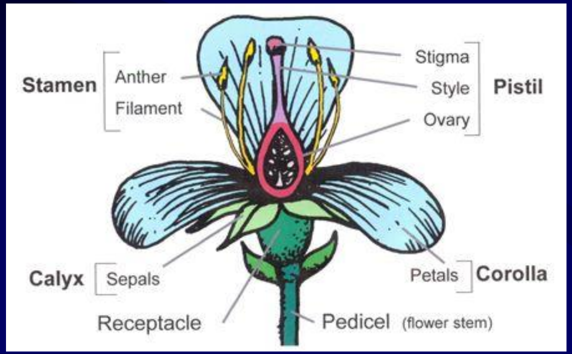
- Pollen viability

- Pollinizer placement



- Weather condition (rainfall, sun light, wind)

- Flower structure



Flower structure

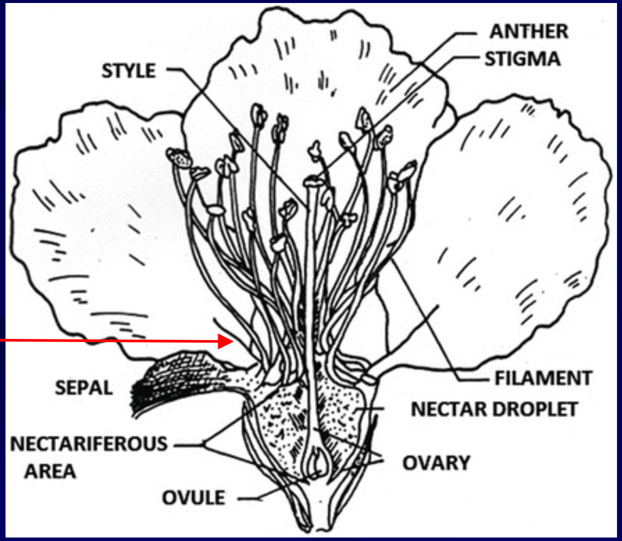
- Top Working
- Side Working

Side Working

Top Working

Apple Cultivars	Top working (%)
Winesap	100
Rome Beauty	93
Jonathan	90
Golden Delicious	85
Granny Smith	65
Red Delicious	50

Basal gap



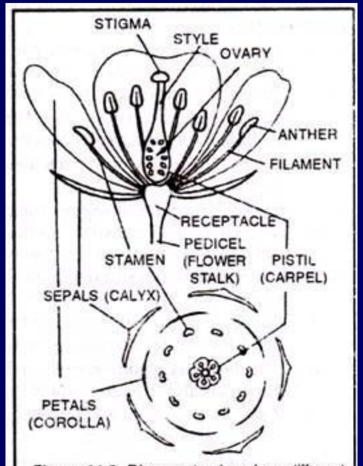


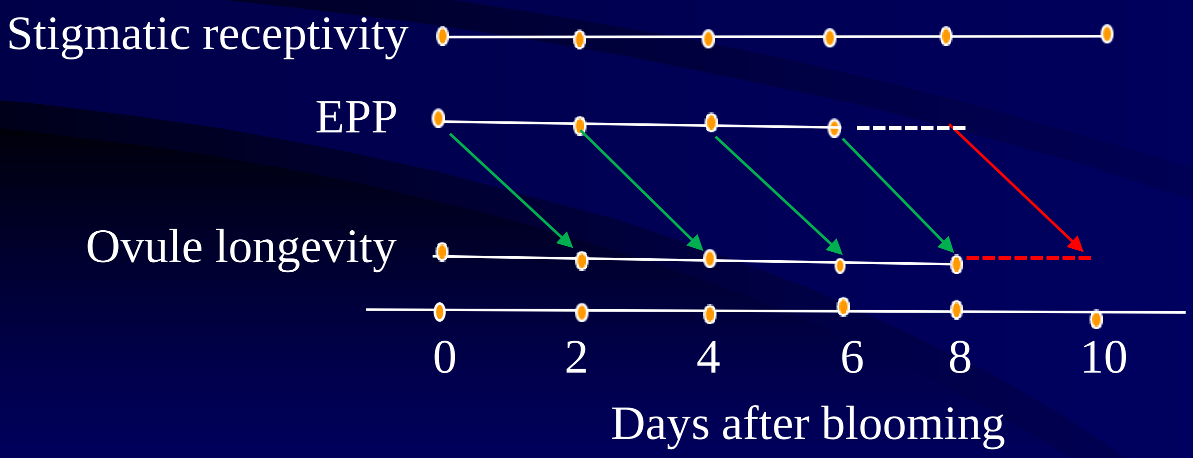
Figure 11.2 Diagram to show how different parts of a flower are represented in graphic form (*i.e.*, in a floral diagram).

Effective Pollination Period (EPP)

EPP described by R. R. Williams (1965)

The effective pollination period (EPP): The number of days during which pollination is effective in producing a fruit

EPP = The ovule longevity - The time lag between pollination and fertilization



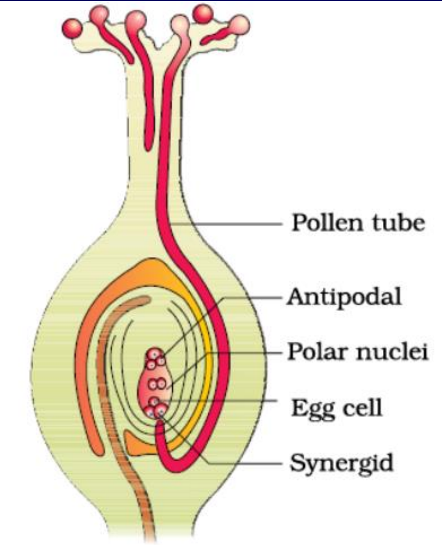


Table 1

Literature records of EPP duration for apple cultivars in different locations. Whenever the limiting factor (*) and/or its duration was recorded it has been indicated

Cultivar	Location	EPP (day)	Limiting factor			Reference
			SR[a]	PTG[b]	OL[c]	
Epicure	Long Ashton (UK), 1964	2				Williams (1966)
	Long Ashton (UK), 1965	2				Williams (1966)
Ribston Pippin	Long Ashton (UK), 1964	2				Williams (1966)
	Long Ashton (UK), 1965	2				Williams (1966)
Rosemary Russet	Long Ashton (UK), 1964	2				Williams (1966)
	Long Ashton (UK), 1965	2				Williams (1966)
Lord Lambourne	Long Ashton (UK), 1964	4				Williams (1966)
	Long Ashton (UK), 1965	2				Williams (1966)
Jonathan	Long Ashton (UK), 1965	5				Williams (1966)
Fortune	Long Ashton (UK), 1965	4				Williams (1966)
	Long Ashton (UK), 1965	2				Williams (1966)
Scarlet Pimpernel	Long Ashton (UK), 1964	9				Williams (1966)
	Long Ashton (UK), 1965	9				Williams (1966)
Stirling Castle	Long Ashton (UK), 1964	4				Williams (1966)
	Long Ashton (UK), 1965	1				Williams (1966)
Cox's Orange Pippin	Long Ashton (UK), 1964	5				Williams (1966)
	Long Ashton (UK), 1965	2				Williams (1966)
Rev. W. Wilks	Long Ashton (UK), 1964	9				Williams (1966)
	Long Ashton (UK), 1965	1				Williams (1966)
Egremont Russet	Long Ashton (UK), 1964	2				Williams (1966)
	Long Ashton (UK), 1965	3				Williams (1966)
Cneddar Cross	Long Ashton (UK), 1964	5				Williams (1966)
	Long Ashton (UK), 1965	7				Williams (1966)
Laxton's Superb	Long Ashton (UK), 1964	9				Williams (1966)
	Long Ashton (UK), 1965	6				Williams (1966)
Worcester Pearmain	Long Ashton (UK), 1964	7				Williams (1966)
	Control (Long Ashton, 1965)	2	5	7	9*	Williams (1965)
	Summer nitrogen application (Long Ashton, 1965)	6	9	7	12*	Williams (1965)

[a] Stigma receptivity.
[b] Pollen tube growth.
[c] Ovule longevity.

Table 4

Literature records of EPP duration for apricot, peach, plum and kiwi cultivars in different locations. Whenever the limiting factor (*) and/or its duration was recorded it has been indicated

Crop	Cultivar	Location	EPP (days)	Limiting factor			Reference
				SR[a]	PTG[b]	OL[c]	
Apricot	Goldrich	Pullman (USA), 1972	8				Toyama (1980)
		Pullman (USA), 1978	6				Toyama (1980)
	Rival	Pullman (USA), 1975	7				Toyama (1980)
	P63-265	Pullman (USA), 1976	8				Toyama (1980)
	P63-265	Pullman (USA), 1978	5				Toyama (1980)
	Gitano	Murcia (Spain)	4	*			Burgos et al. (1991)
	Velazquez Fino	Murcia (Spain)	4	*			Burgos et al. (1991)
	Velazquez Tardio	Murcia (Spain)	2	*			Burgos et al. (1991)
	Moniqui Fino	Murcia (Spain)	2			*	Burgos and Egea (1993)
Peach	J.H. Hale	Pullman (USA), 1973	7				Toyama (1980)
		Pullman (USA), 1974	10				Toyama (1980)
		Pullman (USA), 1976	10				Toyama (1980)
	Earlihale	Pullman (USA), 1973	9				Toyama (1980)
		Pullman (USA), 1974	12				Toyama (1980)
Plum	Monsieur Hâtif	Belgium, 1985	>10				Keulemans and Van Laer (1989)
		Belgium, 1986	6			*	Keulemans and Van Laer (1989)
	Bleue de Belgique	Belgium, 1985	>10				Keulemans and Van Laer (1989)
		Belgium, 1986	3			*	Keulemans and Van Laer (1989)
Kiwi	Hayward	Ceolini di Fontanafredda (Italy)	3				Galimberti et al. (1987)
	Hayward	Villaviciosa (Spain)	4	4*	3	>7	González et al. (1995a,b)

[a] Stigma receptivity.
[b] Pollen tube growth.
[c] Ovule longevity.

Parameters determining the EPP

1- Stigmatic receptivity: Ability of the stigma to support pollen germination

- Degeneration of stigmatic papillae
- Production of secretion on surface stigma (Identification of pollen grain, not nutrition → Autotrophic)

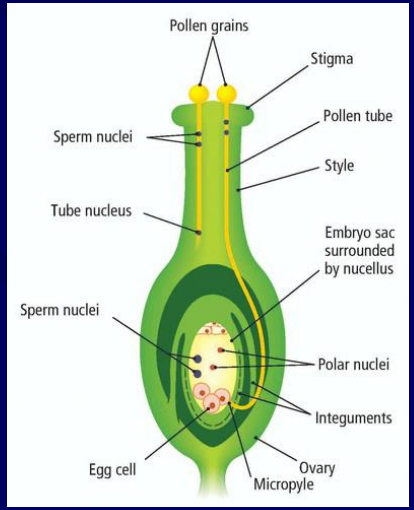
2- Pollen tube kinetics

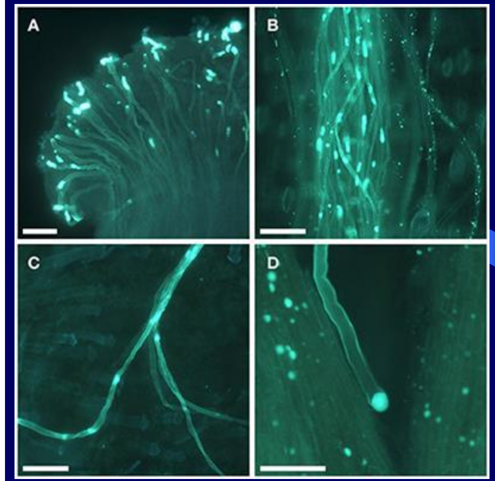
Pollen tube growth → Caused that ovary produced secretion

In stigma → Identification of pollen grain

In style → Nutrition; Produced a canal; Repair of damaged cells; Degeneration of stigma cell

→ Induced pistil maturation





3- Ovule longevity (In next pages)

Pollen tube kinetics

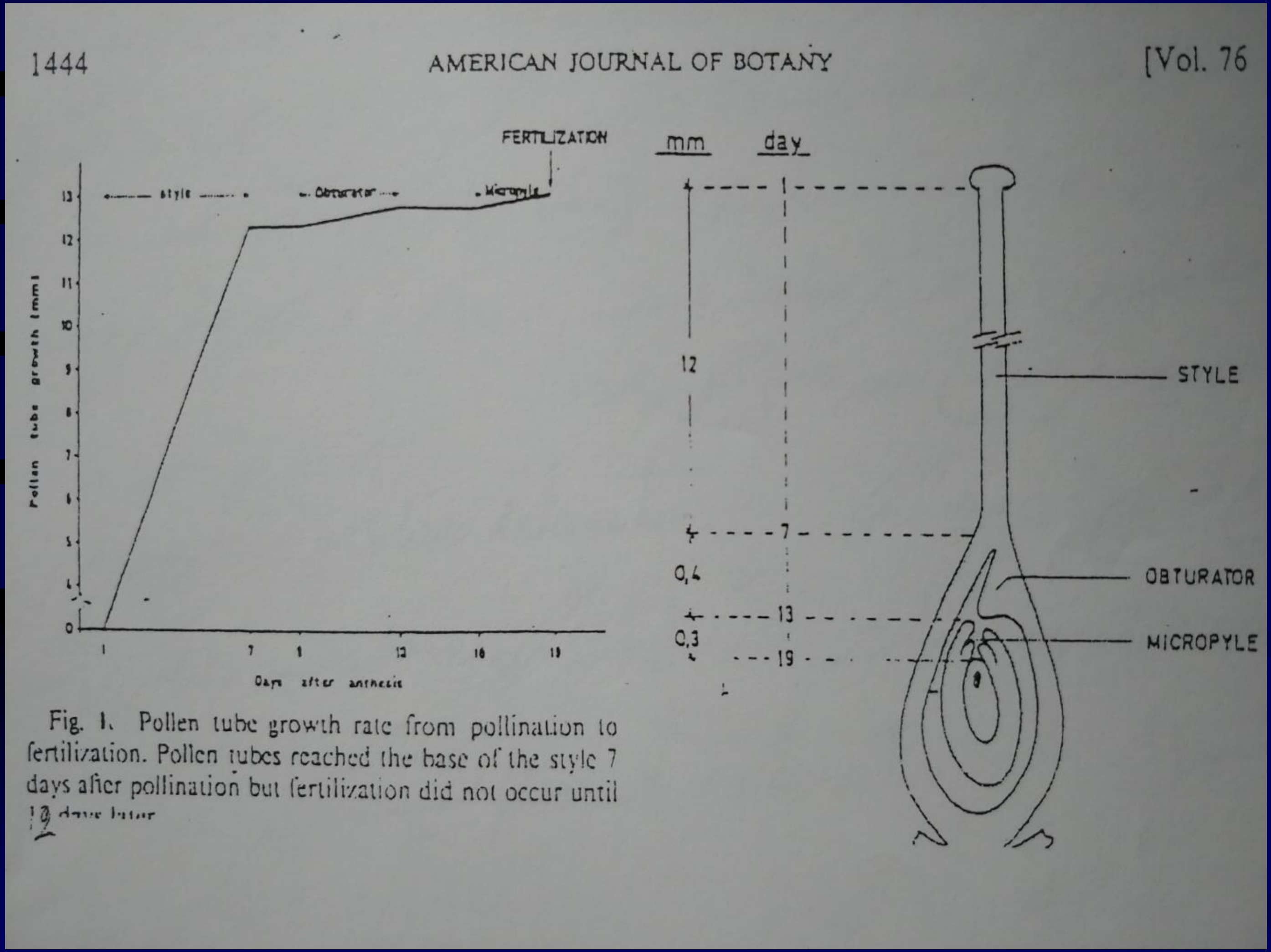

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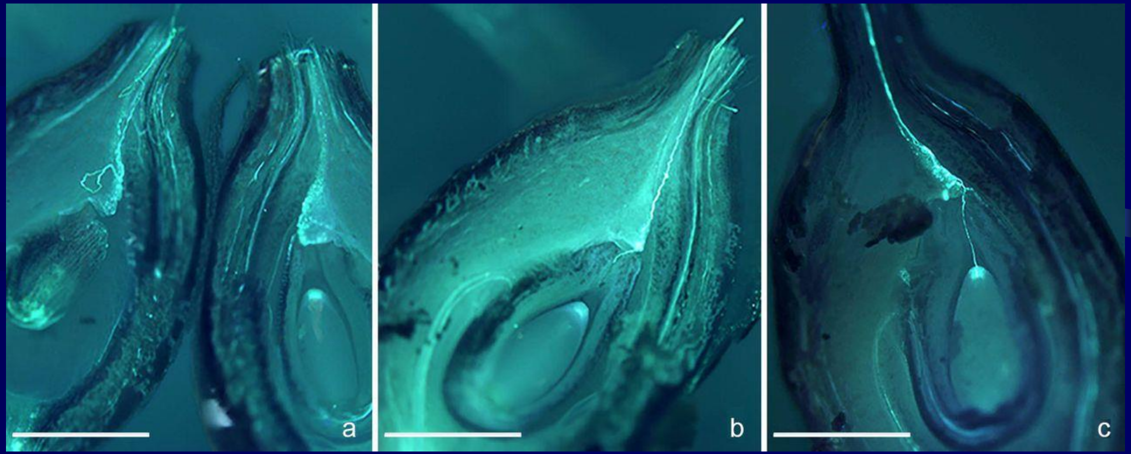
Fig. 1. Pollen tube growth rate from pollination to fertilization. Pollen tubes reached the base of the style 7 days after pollination but fertilization did not occur until 12 days later



Parameters determining the EPP

3- Ovule longevity

Abnormalities include:
- Incomplete development of ovule structures in sour cherry
- Abnormalities in ovule or embryo sac development during flowering in almond
- Ovule degeneration both in pre and post-fertilized stage in ‘Comice’ pear

Factor affecting the EPP

a) Temperature (pollen tube growth rate, pistil development rate)

b) Flower quality

Flower size

Flower strength

Nutritional status

Tree and wood age

Branch orientation

Management practices (Fertilization, Pruning, light)

c) Chemical treatments

Growth regulators: ethylene and ethylene inhibitors (Amino-ethoxy vinyl glycine)

Nutritional status: boron and polyamines (as nitrogen sources)