Floral structure in relation to pollination and breeding system of selected endemic *Impatiens* of Western Ghats.

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Species highlighted

- **Beautiful plants: With variously coloured flowers and peculiar floral structure.**
- **Family Balsaminaceae : Two genera- *Hydrocera* Blume & *Impatiens* L.**
- **Succulent annuals or perennials, rarely becoming shrubs or epiphytes.**
- **Great horticultural potential.**
- **India : Genus represented by 209 species.**
- **Distributed in three major centers of diversity *i*.e. Western Himalayas, Hills of North Eastern States and Western Ghats.**
- **95 species in Peninsular India, more than 82 are endemic and confined to Western Ghats. 30 species have already in threatened category including 19 critically endangered ones.**

Motivations for undertaking the study

- **Delicate structure**
- **Explosive fruits**
- **Anthropogenic pressures**
- **Habitat degradation**
- **Fluctuations in climate**
- **Low insect visitation rate**
- **Inbreeding depression**
- **Low percentage of seed germination**

- **The survival of the selected candidate species in the Western Ghats is questionable due to various biotic and abiotic factors including reproductive constraints.**

- **Majority of the *Impatiens* species are mainly reproduced by means of cross pollination. So their survivability mainly depends on pollination by the visitors.**

- **The visitation rate of the pollinators depends upon its colour, size, shape, fragrance and nectar availability.**

- **In this background, a study had been framed to analyze the relation ship between floral structure, pollination and breeding system of selected *Impatiens* in the Western Ghats.**

Species selected for the study


Impatiens grandis B.Heyne


Impatiens henslowiana Arn.


Impatiens phoenicea **Bedd.**

Impatiens platyadena **C.E.C.Fisch.**


Impatiens pulcherrima Dalzell


Impatiens trichocarpa Hook. F.


Impatiens verticillata Wight.

Study area

Western Ghats, covering an area of 1,60,000 sq.km. The northern parts and extreme southern tips are less moist, while the central and Southern Western Ghats receive heavy annual precipitation of up to 6000mm, which supports dense diverse tropical forests rich in species diversity and endemism. The mountainous configuration, high altitude, heavy rainfall and humid climate makes this tract one of the botanically richest areas of India and therefore designated as one among 34 globally recognised biodiversity hotspots in the world.

Western Ghats-Study Areas

Methodology

- Exploration trips
- Phenology
- Floral morphology
- Pollination
- Breeding experiments

Results

Morphology

- Balsams are beautifully coloured flowers with peculiar floral structure. Every species of *Impatiens* have its special type, colour and shape of floral organs.

- The floral parts (lip with spur and wing petals) are specially adapted for entomophilous pollination especially by bees and butterflies.

- **Calyx** : Sepals 5, lateral 2 sepals are green or coloured , lower 3 sepals are modified into lip with spur. In *I. coelotropis*, the lip is large, deeply succate and deep green in colour. Usually the lip is boat shaped and the spur is long and coloured.

- **Corolla** : 5 Petals. One standard petal. The lateral petals are usually bright coloured , the arrangement of wing petals act as a landing platform for bees and butterflies. Beautifully coloured/brightly coloured petals attract the floral visitors for pollination.

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- **Androecium** : The androecium has 5 stamens with short filaments and are partially fused. The dithecal tetrasporangiate anther are connivent and open either apically or laterally by means of pores or slits

- **Gynoecium** : The anthers lie as a cap above the gynoecium which has a 5 locular, syncarpous ovary with star shaped stigmas. The style is reduced. After the shedding of androecium the coherent stigma commonly spread and star shaped receptive stigmatic surface is exposed. The flowers are protandrous favouring cross pollination.

Floral characters of selected species of *Impatiens*

Floral Characters	*I. coelotropis*	*I. grandis*	*I. henslowiana*	*I. phoenicea*
Flowering period	Aug- Jan	Aug-Dec	July-Dec	July-Dec
Flower opening time	2130-2330 h	0300-0500 h	2130-0530 h	0330-0740 h
Flower type	Zygomorphic	Zygomorphic	Zygomorphic	Zygomorphic
Nectar (ul)	5.7±1.87	5.2±1.67	6.4±1.43	4.1±1.08
Flower color	Red	White	White	Brick red
No. of anthers per flower	5	5	5	5
Anther dehiscence time	Protandrous	Protandrous	Protandrous	Protandrous
Mean no. of pollens per flower	42,520	48,620	38,250	28,860
Mean no. of ovules per flower	24	26	22	14
Pollen size (µm)	38.03±2.67	36±8.6	41.31±3.08	31.06±3.37
Stigma type	Wet and non pappillate	Wet and non- papillate	Wet and non pappillate	Wet and non pappillate
Percentage of fruit set in natural condition	8%	30%	36%	10%

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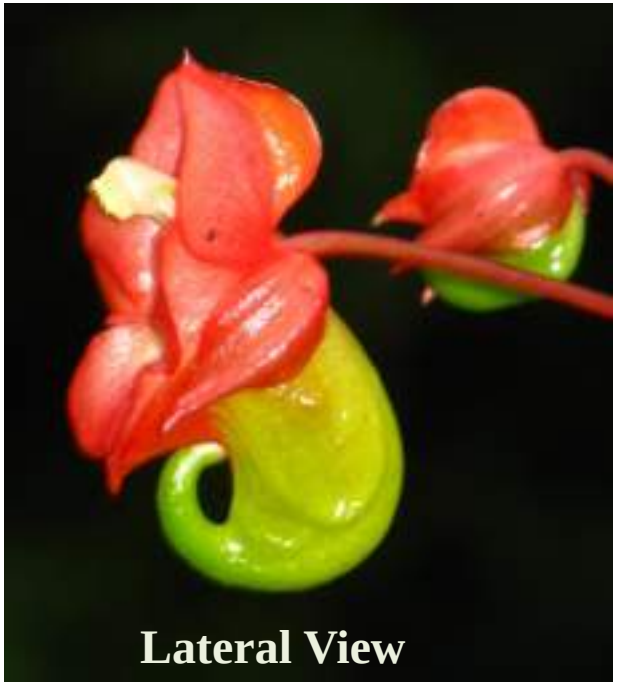
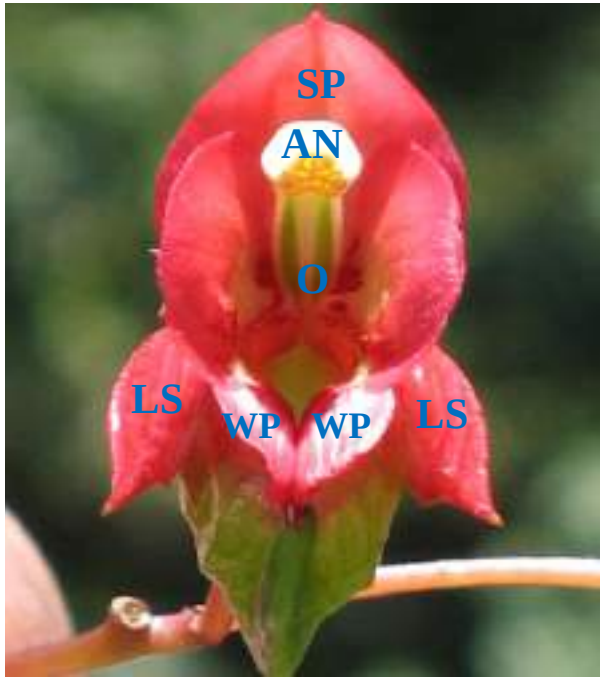
Floral Characters	*I. platyadena*	*I. pulcherrima*	*I. trichocarpa*	*I. verticillata*
Flowering period	Sep-Dec	July-Dec	July-Nov	Aug-Dec
Flower opening time	0600-0930 h	0500-0700 h	0200-0330 h	0300-0700 h
Flower type	Zygomorphic	Zygomorphic	Zygomorphic	Zygomorphic
Nectar (ul)	8.3±2.81	5.3±1.42	3.5±1.82	2.8±0.81
Flower color	Red	Pink	Pink	Scarlet red
No. of anthers per flower	5	5	5	5
Anther dehiscence time	Protandrous	Protandrous	Protandrous	Protandrous
Mean no. of pollens per flower	37,530	24800	38,280	19,400
Mean no. of ovules per flower	16	18	20	19
Pollen size (µm)	32±2.8	38.16	34±7.2	28±3.5
Stigma type	Wet and non pappillate	Wet and non-papillate	Wet and non-papillate	Wet and non-papillate
Percentage of fruit set in natural condition	34%	38%	29%	Nil


Lateral View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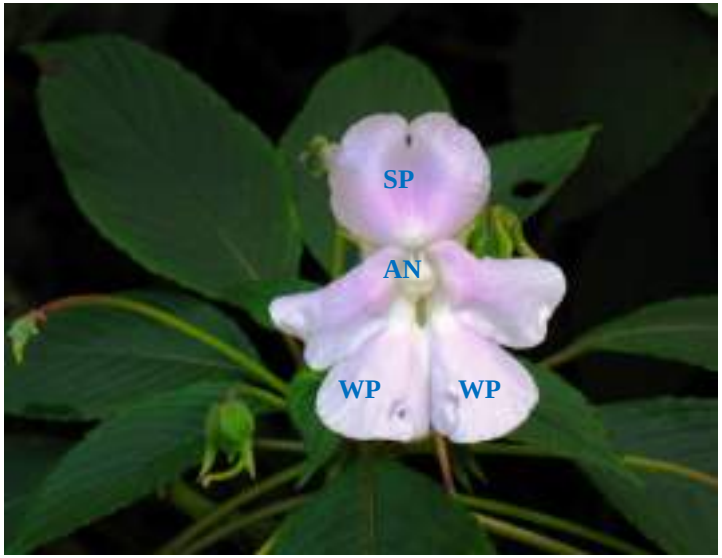
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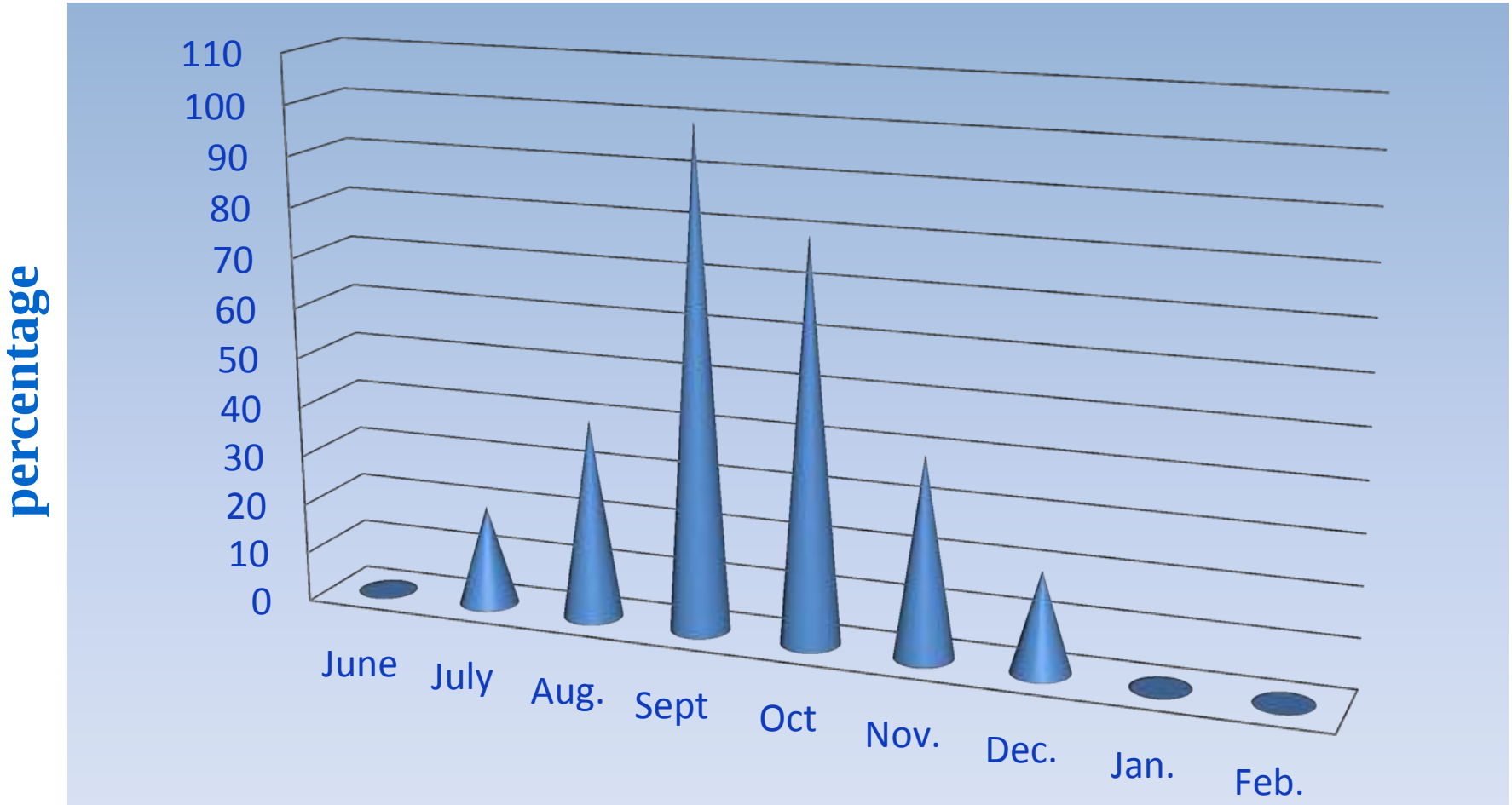
Resupination

In the majority of Impatiens, buds are positioned with the standard uppermost and the lip below them. Some flowers are born with lip above and the standard petals which are lowermost. The reversal position of flower buds occur as a result of a process called resupination. This process takes place 2-3 days before anthesis. Darwin suggested that, resupination supports pollination because the labellum assumes the position of a lower petal, so that insects can easily visit the flower.

Flowering phenology

Under the climatic conditions of Western Ghats about 90% of *Impatiens* blooms during July – December. This observation is similar to that of our candidate species also. Young seedlings of selected *Impatiens* begin to appear after the commencement of monsoon (June). Some of the high altitude balsams opens in the night (*I. coelotropis, I. henslowiana, I. grandis, I. phoenicea, I. trichocarpa*) and the rest of them bloom in the early morning. The plants were in flower for a total of 180 days in a year. The average life span of each flower is 2-4 days. Fruit development was completed between 18-20 days after pollination.

Floral phenology of *Impatiens* species



	June	July	Aug.	Sept	Oct	Nov.	Dec.	Jan.	Feb.
Series1	0	20	40	100	80	40	20	0	0

Pollination

- Honey bees, Trigona sp, Butterflies and Hawk moths are the major pollinators.
- In different climatic regions, species of pollinators are varying.
- The insects land at the front of the flower and passes through the corolla to the spur behind the sepal to collect nectar. The insects collecting nectar from the spur, its back comes in contact with the androecium. The insect comes in contact with the second time, the androecium falls off and the stigma becomes exposed. Another insect visits the flower for nectar, its back comes into contact with the receptive stigma and thus pollination takes place. Finally, the perianth falls off and the insects visit have come to cease.

Pollinators and their foraging behaviour

Sl. no	Name of the pollinator	Foraging time	Foraging nature	Foraging period (hr)	Stigma Touch
1	*Apis cerana indica* (c, pl, ph, g, v, pu, t, h)	Day	Nectar and pollen	07 30-16 00	+++
2	*Apis dorsata* (c, h, g)	Day	Nectar and pollen	09 00-13 00	++
3	*Trigona iridipennis* (g, v, t, h)	Day	Nectar and pollen	06 30-10 00	++
4	*Danaus chrysippus* (pl, ph, pu, g, h)	Day	Nectar	06 00-13 00	++
5	*Danaus genutia* (g, h, t)	Day	Nectar	07 00-09 00	++
6	*Tirumala limniace* (v, g, h, pl)	Day	Nectar	06 00-11 00	++
7	*Parantica aglea* (pu, ph, h)	Day	Nectar	07 00-16 00	++

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8	*Caprona ransonnetti* (c, h, v)	Day	Nectar	08 00-12 00	++
9	*Rpthima baldus* (pl, ph, v)	Day	Nectar	06 00-14 00	++
10	*Badamia exclamationis* (c, ph, pu)	Day	Nectar	09 00-16 00	++
11	*Macroglossum corythus* (c, h, ph, t)	Night	Nectar	22 00-24 00	++
12	*Papilio demoleus* (ph, pu, t)	Day	Nectar	06 00-16 00	++
13	*Pachliopta aristolochiae* (pl, pu, t, v)	Day	Nectar	07 00-16 00	++
13	*Pachliopta hector* (ph, pl, g, h)	Day	Nectar	06 00-17 00	++
14	*Pareronia valeria* (h, t, pu)	Day	Nectar	09 00-16 00	++
15	*Xylocopa sp.* (c)	Day	Nectar	08 00-11 00	+

+ : 10 – 15 pollens, ++ : 30-50 pollens, +++ : more than 50 pollens

C: *I. coelotropis*, g: *I. grandis*, h: *I. henslowiana*, ph: *I. phoenicea*, pl: *I. platyadena*, pu: *I. pulcherrima*, t: *I. trichocarpa*, v: *I. verticillata*

Pollinators of Impatiens grandis

Apis cerana

Trigona iridipennis

Apis dorsata

Ceratina cucurbitina

Oecophylla smaragdina

Badamia exclamationis

Pollinators of Impatiens verticillata

Apis cerana

Apis dorsata

Trigona iridipennis

Amegilla (Zonamegilla) sp.

Papilio demoleus

Unidentified bee sp

Floral visitors of *Impatiens pulcherrima*






Pollinators of I. trichocarpa, I. platyadena and I. coelotropis

Breeding experiments

- In all the selected species, fruit set was not observed in autogamous self pollination.
- In open pollination, 8-38 % fruit set was observed.
- *Impatiens coelotropis, I. henslowiana, I. phoenicea, I. platyadena, I. trichocarpa* and *I. verticillata* are exclusively xenogamous pollinated. The other species such as *I. grandis* and *I. pulcherrima* permits both geitonogamous and xenogamous pollination.
- Percentage of fruit set in manual pollination is higher than that resulting from natural pollination, which strongly indicates that some external agents are required for successful pollination.

Conclusion

- **The flowers of selected species of *Impatiens* are insect pollinated, the modification and adaptations of floral parts attract pollinators towards successful pollination. Out crossing is very significant in the pollination biology of Impatiens, which ensures better seed output.**

- **In *Impatiens*, the morphology, size and shape of the flowers may vary between the species, but the breeding system of the species is almost same. Breeding experiments demonstrated that the percentage of fruit set in manual pollination was higher than that resulting from natural pollination, which strongly indicates that some external agents are required for successful pollination.**

- **The visitation rate of the pollinators was affected by heavy rainfall, poor sunlight and humidity. In general, the number of visitors per population and visitation rate was low in the natural habitat, which leads to poor fruit set. The percentage of seed germination was also low. Their dependence on specialised habitat, a narrow environmental niche, scarcity of pollinators, poor fruit set, low percentage of seed germination could be the reasons for its limited distribution and endemism.**

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One need not be either play a role in recording or protecting biodiversity. With a spirit of care and love towards nature and a strong conservation ethic that focus protection on wilds can aim the conservation strategy to a long extant..!!!
Thank you