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Short Communication

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On the reproductive biology of *Salacia fruticosa* Wall. ex M.A. Lawson - an endemic medicinal plant of the Western Ghats, India

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Abstract: *Salacia fruticosa* Wall. ex M.A. Lawson, an endemic species was studied for the reproductive biology as this species showed reduced fruit set and natural regeneration. The stigma-anther proximity, an extremely low number of pollen grains, a short period of pollen viability, a sparse incidence of pollinators, protandrous and facultative autogamous nature of the flowers and a low percent in fruit set were identified as biological constraints for the species. The incidence of seed pest was added to the poor seed and seedling bank and accelerated rarity process of the species.

Keywords: Endemic, ex situ conservation, insect-pest, medicinal plant, overexploitation, reproductive biology, *Salacia fruticosa*.

Salacia L. belonging to the family Celastraceae, consists of about 200 species worldwide, distributed in tropical America, Africa and Asia (Mabberley 2008) of which 21 species are reported from India (Ramamurthy & Naithani 2000). Out of this, 15 species are reported from peninsular India and eight species from Kerala itself (Udayan et al. 2012). The true raw drug, *Ekanayakam* (Malayalam) / *Pitika* (Sanskrit) is extracted from *Salacia reticulata* Wight, however, the species is so rare and sparse for raw drug collection in situ. The *Salacia oblonga* Wall. ex Wight & Arn., *S. fruticosa* Wall. ex M.A.Lawson and *S. chinensis* L. are the substitutes used and all of them are overexploited and facing a high threat in their habitats (Chithra et al. 2010).

Salacia fruticosa is a woody climbing shrub, endemic to Western Ghats, distributed in the evergreen and semi evergreen forests and also in the plains. It has anti hyperglycemic properties (Venkateshwarlu et al. 2009). Endemism and fragmented distribution, over exploitation, poor fruit set and seed infestation have led to the study of reproductive biology of the plant in order to understand the reproductive constraints of the species.

Material and Methods

Periodic dynamic changes in reproductive phenological phases of the species *Salacia fruticosa* were monitored and recorded on a day to day basis at KFRI, Peechi with respect to bud initiation, development, anthesis, pollination behavior etc. as per the methods suggested by different authors (Faegri & Pijl 1979; Armstrong & Drummond 1984; Sreekala et al. 2008;

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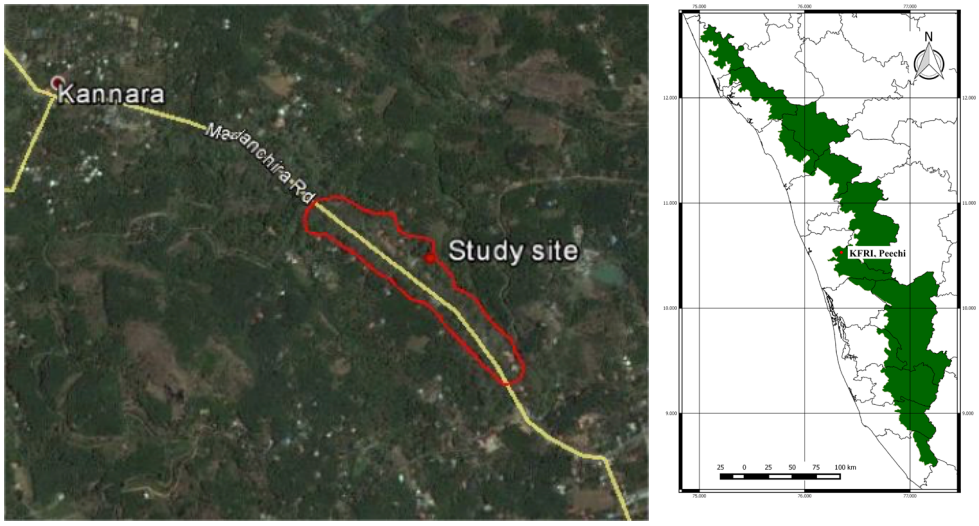

Figure 1. Map showing the study site

Jose & Pandurangan 2012, 2013). Stigma receptivity was determined by the physical appearance of stigma such as turgidity, shine and oily appearance and it is confirmed by using hydrogen peroxide (H_2O_2) (bubble formation). The pollen-ovule ratio was worked out as per the method suggested by Cruden (1977). Pollen fertility test was carried out using Acetocarmine staining method (Sharma & Sharma 1980). Pollen germination was carried out with 15% sucrose solution. Bagging experiment was conducted for evaluating the pollination behavior.

Study area

The study was carried out in a population of *S. fruticosa* growing in the medicinal garden of the Kerala Forest Research Institute, Peechi, situated between 10.529^{0}N & 76.348^{0}E (Fig.1).

Results

In *Salacia fruticosa,* the flower bud takes one week to reach the full bloom stage. The opening of the flower takes place from 11.00–12.00 hr. The flowers are protandrous as the anther dehisces at 10.00hr while the stigma is receptive only at 11.00hr. The stigma was found to be receptive for about 30 hours. Each flower has three anthers and 3-celled ovaries with 1 (rarely 2) ovules in each cell. Pollen grains are liberated through longitudinal slits of the anther. A single anther contains ~105 pollen grains, thus one flower comprises around ~315 pollen grains. Hence, pollen-ovule ratio was worked out as 105 pollens per ovule (105:1). The pollen grains are globose in nature and having 13µm in diameter. Nearly 92% pollen grains are found viable and 87% pollen germination was recorded at the time of anthesis. The pollen viability and germination was found to decrease and a drastic decline was recorded after three hours from anthesis though the stigma was found receptive for 30 hours. After around one-&-half months the fruits attain maturity and the percentage of fruit set was found to be 25% (detailed floral characters are given in Table 1 & Image 1). The emasculated flowers with artificial pollination as well as flowers which are polybagged (with big holes) were found to be inefficient

Table 1. Reproductive characters of *Salacia fruticosa*

Floral Characters	Findings
Flowering period	Throughout the year
Flower type	Pentamerous, bisexual, actinomorphic
Flower colour	Yellow
Flower opening time (anthesis)	11.00–12.00 hr
Floral nature	Protandrous
Anther dehiscence mode	Longitudinal slit
Anther dehiscence time	10.00hr
Average no. of pollens/anther	105
Mean no. of pollen grains/ flower	315
Mean no. of ovules/flower	3
Pollen shape	Globular, smooth
Stigma receptive time and period	11.00hr onwards (up to 30 hours)
Pollen - Ovule ratio	105:1
Pollen diameter	13 µm
Pollen fertility	92.3%
Fruit development period	45 days
Percentage of fruit set	25%

Image 1 . Reproductive biology of *Salacia fruticosa*. A - A twig with fruit; B–C - Flower development; D - Fruit and Seed infestation by Caterpillars; E - Infested fruit cut open showing consumed seeds and pulp. © K. Subin

for fruit set, that underlines the autogamous nature of the species. Majority of the fruits on maturity were found to be infested and the seeds were consumed by the caterpillars of the adult butterfly, *Bindahara moorei* Fruhstorfer. About 70–80 % matured fruits were infested by this insect.

Discussion and Conclusion

Knowledge of reproductive biology particularly the anthesis, pollen and stigma viability, nature of pollination and fruit set are essential to understand the causes of rarity of the species. The dehiscence of anthers and release of pollen grains prior to the receptivity of stigma is considered as an indicator for promoting facultative autogamy in the species. The low number of pollen grains, i.e., 105 pollen/anther was found to promote cross pollination through insects but the incidence of pollinators during blooming time was negligibly sparse. A low count of pollens and a sparse incidence of pollinators are limiting the species from both anemophily and entomophily. According to Cruden (1977), plants with pollen–ovule ratio lying between 31.9 to 396 support facultative autogamy and signifies the above observations in the species.

Depending upon the population history and reproductive features of the species, reduced pollinator service may have several negative impacts on the plant population including reproductive failure (Jennersten 1988) or decreased effective population size through reduced gene flow and increased selfing (Bawa 1990). These altered reproductive patterns may cause less of genetic diversity and/or reduced progeny fitness due to inbreeding depression (Jain 1976; Barrett & Kohn 1991). Self fertile individuals, however, may be at a selective advantage in some particular habitats, if outcrossing is disfavored because plant density is low or if pollinators

are scarce or cross pollination is inadequate (Jain 1976; Lloyd 1980).

Even though the stigma receptive for 30 hours, the drastic decline of pollen viability within three hours after anthesis reduces chances for effective pollination. The bagging experiment also underlines the chances for self pollination in the species. The low rate of pollination reduced fruit set to 25% in the species. The insect-pest incidence and its extent of damage on the seed and seedling output accelerate endangerment of the species in the near future.

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