

# Vivipary in *Syzygium occidentale* (Bourd.) Gandhi (Myrtaceae), a Vulnerable Riparian Tree Species of the Western Ghats

Anoosh Varghese<sup>1,2</sup> and A.K. Sreekala<sup>1</sup>

<sup>1</sup>Division of Conservation Biology, Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Palode, Thiruvananthapuram, Kerala-695562

<sup>2</sup>University of Kerala, Thiruvananthapuram, Kerala-695033

## ABSTRACT

The germination of seeds within the fruit while attached to the mother plant is referred to as vivipary and is not a common phenomenon. Viviparous germination is often regarded as an adaptive strategy developed by riparian/marshy/halophytic plants to ensure the establishment of seedlings in the altered habitat. The present study is the report of vivipary from *Syzygium occidentale*. This is the first report of vivipary in the family Myrtaceae.

**Key words:** Germination, phenology, riparian habitat, seed, vivipary

**Author for correspondence:** Anoosh Varghese, e-mail: anooshvarghese@gmail.com

## Introduction

*Syzygium occidentale* (Bourd.) Gandhi is a vulnerable riparian tree species, endemic to the southern Western Ghats of Kerala and is distributed up to an altitude of 700 m MSL. The common associates include *Ochlandra travancorica* (Bedd.) Gamble, *Lophopetalum wightianum* Arn., *Madhuca longifolia* (J. Koenig ex L.) J.F. Macbr., *Hopea parviflora* Bedd., *Calophyllum apetalum* Willd., *Holigarna arnottiana* Hook.f., *Memecylon talboltianum* Brandis, *Xanthophyllum arnottianum* Wight, *Humboldtia vahliana* Wight, and *Garcinia wightii* T. Anderson (Shareef, 2014). *S. occidentale* is enlisted as 'vulnerable' in IUCN red list and the species is facing severe threat of population reduction owing to many reasons ranging from anthropogenic activities to poor seedling establishment. The study that covers pollination syndromes and reproduction mechanism of *S. occidentale* points out the need for conservation of species which is at the verge of habitat loss (Varghese & Sreekala, 2017)

*S. occidentale* is reported to be pollinated by several means, such as myrmecophily (ant-pollination), anemophily (wind-pollination) and melittophily (bee-pollination). It undergoes both self- and cross-pollination, but fruit set is maximum with xenogamy (pollination by flowers of a different plant) (Kuriakose et al., 2018).

While studying the reproductive biology of the species, we observed an instance of vivipary in *Syzygium*

*occidentale*. This is the first report of vivipary in this species and the family Myrtaceae.

## Materials and Methods

*Syzygium occidentale* is a perennial which prefers a riparian habitat and often occurs in rock crevices of shallow streams. Phenological observations, covering both the vegetative and reproductive events, were recorded at fortnightly intervals in a total of three populations — two populations on Chittar river basin (SOC1 n = 21; SOC2 n = 28) and one at Athirappilly river basin (SOA2 n = 32) for a period of 2 years (2018 and 2019). Special attention was given to the fruiting phenology of the species. Direct observations were made and photo-graphically documented.

The seeds collected from 71 trees distributed in the three different populations were pooled and seeds were randomly chosen for the seed studies. Seed weight, size, moisture content, viability and germination percentage (n=15 seeds) were studied as per protocols of the International Seed Testing Association, ISTA (2008).

## Results

There are many riparian species of *Syzygium* occurring in India, such as *S. chavaran* (Bourd.) Gamble, *S. bourdillonii* (Gamble) Rathkr. & Nair (Bachan, 2010). However, *S. occidentale* is the only species that grows in the middle of shallow streams and in the crevices of rocks. The plant was found at altitudes less than

700 m MSL on sandy loam soil. The average rainfall of the Chittar site is 1761 mm and that of Athirappilly site is 1692 mm. The average temperature is 26.9°C in Chittar site and 25.7°C in Athirappilly. The elevation of the Chittar and Athirappilly sites are 60 and 120 m MSL respectively (Table 1).

### Phenology

*S. occidentale* is a small tree that grows up to a height of 7m. The plant is evergreen and the leaf flushing is vigorous following the monsoons and leaf drop occurs throughout the year (Fig. 1A). Flowering of *S. occidentale* begins in the last week of December and extends up to the first week of April and reaches the peak in the last week of February. The flowering period extends up to 150 days in a year and the average life span of each flower is 2-3 days (Fig. 1B). The flower bud takes 30-40 days from initiation to full bloom. The flowers are produced on terminal or rarely lateral cymose inflorescence in dichotomously divaricate pattern. Flowers open in the evening between 1800 and 2000 hrs. Anthers dehisce before anthesis, so may be characterized as protandrous. On the second day of anthesis, all the stamens abscise, but the gynoecium and persist and gradually develops into fruit. The calyx persists in the fruit.

### Fruit and seed characters

After the successful pollination with the aid of insects like ants, honey bees, butterflies etc and wind (Varghese & Sreekala, 2017; Kuriakose et al., 2018), the inferior ovary develops into a berry (Fig. 1C). Fruits take around a month for their maturation and turn green to pinkish green on ripening. The fruits became mature by last week of May, with the onset of the Southwest monsoon. The fruit is a berry and contains one seed, which is recalcitrant in nature (Fig. 1D). The per

cent moisture content of the seed at the time of fruit dispersal was  $47.55 \pm 6.13$ . Seeds started germinating by the third day after sowing and continued up to the seventh day. Germination percentage was  $88.33 \pm 4.41$ . The cotyledons and embryo of most of the 15 seeds tested ( $91.1\% \pm 10.2$ ) were viable (stained pink with tetrazolium chloride, TTC) (Table 2).

### Vivipary

We monitored three populations in two localities (two in Chittar River basin, SOC1 & SOC2) and one in Athirappilly (SOA1), among which the populations located at Chittar river basin exhibited vivipary (Fig. 1E, F). A total of 71 plants distributed in both the study sites were monitored during the period and in the first year of observation (2018), we noted that a single individual exhibit viviparous germination in population SOC1 (n = 21). In the second year of observation (2019), the same plant again exhibited vivipary. In addition, two individuals in the second population SOC2 (n = 28) in the same site also exhibited vivipary. From the field observations over these two years, four instances of vivipary were documented. No viviparous individuals were observed in the third population (SOA1) in Athirappilly. These observations point to the presence, though rare, of vivipary in *S. occidentale*.

### Discussion

*S. occidentale* has been treated variably as rare or rare/endangered (Mohanani et al., 1984; Ahmedullah & Nayar, 1986; Vajravelu, 1988; Nayar, 1992, 1996). Based on these data, IUCN (2019) enlisted it as a vulnerable species. According to these studies, the habitat of the plant is repeatedly subjected to anthropogenic activities and floods. In addition, a low level of seedling establishment accelerates the decline in population size.

The germination of seeds within a fruit while the fruit is still attached to the parent plant is called vivipary.

**Table 1. Geographical co-ordinates, elevation, rainfall and temperature of the study sites.**

| Geographical attributes | Chittar river banksite<br>Agasthyamala<br>Biosphere Reserve | Athirappilly river<br>bank site<br>Athirappilly<br>forest Range |
|-------------------------|---|---|
| Latitude                | 08° 45' N   | 10° 28' N   |
| Longitude               | 77°01' E  | 76° 54' E   |
| Altitude(m ASL)         | 60  | 120   |
| Temperature (°C)        | 26.9°C  | 25.7°C  |
| Rainfall (mm)           | 1761 mm   | 1692 mm   |

**Table 2. Seed characters of *Syzygium occidentale***

| Seed characters              | Observations            |
|------------------------------|-------------------------|
| Seed nature                  | Recalcitrant            |
| Seed moisture content        | $47.55 \pm 6.13\%$      |
| Seed viability               | $91.11 \pm 10.18\%$     |
| Seed germination             | $88.33 \pm 4.41\%$      |
| Seed conductivity            | $8.047 \pm 1.003 \mu S$ |
| Dehydrogenase activity (DHA) | $2.691 \pm 1.008$       |



**Figure 1.** Fruit development and vivipary of *Syzygium occidentale*. (A) Habit. (B) Flower. (C) Fruiting stage. (D) Seeds. (E) Viviparous germination. (F) Potted seedlings.

The phenomenon of vivipary is rare in angiosperms; only about 143 genera and 195 species exhibit vivipary, which accounts less than 0.1 % of the total flowering plants (Cota-Sánchez & Abreu, 2007). Vivipary is of common occurrence in many mangrove taxa (Pannier & Pannier, 1975; Das et al., 2001). It is also reported from non-mangrove taxa like Cactaceae, Asteraceae, Liliaceae, Asparagaceae, Poaceae, and Zingiberaceae (Karmakar et al., 2019; Bora & Bhattacharya, 2018). For the first time, the present study reports vivipary in *Syzygium occidentale* (Myrtaceae).

Vivipary is a biological adaptation that successfully establishes juvenile plants under hostile environment conditions (Farnsworth, 2000). Occurrence of vivipary from specific populations was also reported in species like *Ophiorrhiza succirubra* King ex Hook.f. (Bora & Bhattacharya, 2018). It would be interesting to continue observations on *S. occidentale* to determine whether the occurrence of vivipary in this species is related to its riparian habitat.

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