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An Ecological Study of Alstonia Venenata R.Br. (Apocynaceae: Rauvolfioideae) and Cryptolepis Buchanani R.Br. ex Roem. & Schult. (Apocynaceae: Periplocoideae)

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Abstract

Alstonia venenata and *Cryptolepis buchanani* with shrubby habit occupy different locations but both bloom during summer season. *A. venanata* flowers facilitate autonomous autogamy. Butterflies and honey bees visit the flowers during forenoon period and effect self- and cross-pollination. *C. buchanani* flowers are unattractive to the flower visitors any fruit set is exclusively a function of autonomous autogamy. In both species, fruit is a paired follicle which sheds seeds when dry and the seeds thus liberated are dispersed by wind.

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1. Introduction

The family, Apocynaceae has 5,100 species placed in five subfamilies, namely, Apocynoideae, Asclepiadoideae,

Periplocoideae, Rauvolfioideae and Secanomoideae (*Nazar et al. 2013; Endress et al. 2014*). In India, nearly 30 genera with more than 60 species of this family have been documented (*Jones and Luchsinger 1987*). The genus *Alstonia* has 45 species distributed in subtropical and tropical Central America, Africa, Southeast Asia, Polynesia and Australia. The genus is named after Prof. C. Alston, a distinguished botanist at Edinburgh University (*Orwa et al. 2009*). In this genus, only *A. scholaris* is reported by many authors throughout its distribution range. In recent years,*A. scholaris* is used as an important tree species as an ornamental or avenue tree in Indian cities. It is an evergreen hermaphroditic tree species displays facultative autogamy and pollinated by different species of insects. Anonymous websites report that *Alstonia venenata* is documented as a common plant species in South India.*Thomas et al. (2016)* reported that *A. venenata* is an evergreen shrub and distributed throughout Peninsular India. Tribal communities use its stem and root bark, fruits and leaves in traditional medicine. It is also used in Ayurveda. *Venkatesh and Sreelakshmi (2019)* reported that *A. venenata* is a rare species distributed in Karnataka, Kerala and Maharashtra. These authors also scientifically validated the use of stem bark and leaves of *A. venenata* as an anti-venom drug. *Kumananda and Saikia (2003)* reported that *Cryptolepis buchanani* is used traditionally to cure bone fracture by tribals in Arunachal-Assam border area. These authors also noted that the stem of this plant species is used to treat arthritis, muscle and joint pain in traditional medicine. *Nitin et al. (2018)* reported that *Cryptolepis buchanani* is a larval host plant for the nymphalid butterflies, *Danaus chrysippus* L., *Euploea core* Cramer and *Parantica aglea* Stoll in India. *Balachandran et al. (2014)* reported that the nymphalid butterfly, *Danaus chrysippus* visits the flowers of *C. buchanani* in coastal lateritic terrain of Uttara Kannada in Karnataka.*Thomas et al. (2022)* mentioned that the nymphalid butterfly, *Parthenos sylvia* is the pollinator of *C. buchanani* in Malappuram District of Kerala. The information available on *Alstonia venenata* and *Cryptolepis buchanani* is very fragmentary concerning the floral biology, pollination and fruit aspects. With this backdrop, the present study was attempted to provide information on ecological aspects of sexual reproduction in *A. venenata* and *C. buchanani* based on field studies.

2. Material and Methods

Alstonia venenata and *Cryptolepis buchanani* are shrubby species which occupy different locations in Araku valley region of Eastern Ghats of Andhra Pradesh State. Field studies were carried out during March-June 2023. The flowering season, flower details, flower sexual status, pollination, fruiting and seed dispersal aspects were recorded at field sites only. Twenty five flowers from five trees were used for each species to record flower details. Foraging activity of flower visitors was recorded only on *A. venenata* and hence observations on foraging visits of flowers visitors were confined to this plant only. Foraging visitors were were recorded while they were visiting the flowers during daytime from morning to evening for five consecutive days. Simultaneously, their landing position and forage collection behaviour were recorded. Twenty fruits were used for each plant species to record fruit characters. Seed dispersal mode was also observed for both the plant species in the field.

3. Observations and Discussion

Alstonia venenata is a large delightful shrub with stem/trunk enveloped with grayish brown bark. It grows at low to mid

elevations of Eastern Ghats of Andhra Pradesh. At Araku, the present study site, this plant species is a natural constituent that grows along the slopes of the forest. Leaves are simple, lanceolate, membranous with slight wavy edges and presented in whorls of 3-7 towards the stem ends. The flowering occurs during April-May. The flowers are presented in corymbose cymes at the tips of branches. They are milky white, pedicellate with five ovate sepals, tubular corolla tipped with five lobes and hairy inside the tube. The stamens are five with distinct filaments tipped with ovate anthers, totally free from the pistil and positioned slightly below the corolla throat. The pistil apex is slightly below the level of anthers; the ovary is glabrous and covered with an indumentum.

In *A. venenata*, the milky white flowers are open after sunrise and remain in place for 1 or 2 days (Figure 1a). Anther dehiscence occurs by longitudinal slits after anthesis. The placement of pistil in relation to the position of stamens facilitates the occurrence of autonomous autogamy and additionally vector-mediated self- and cross-pollination. Fruits are stalked, pendulous and paired 2-angled follicles tapering at their ends. The follicles produce several smooth seeds with a tuft of hairs at the end. Locals mentioned that fruits and woody roots are used to treat skin diseases, leprosy, snake and scorpion bites, fever and syphilis.

Solomon Raju et al. (2021) reported that *Alstonia scholaris* with much-branched terminal compound compact umbels produce profuse flowering. The flowers produce pungent odour which enhances their attraction to the flower visitors which play an important role in pollination. In this study, *A. venanata* is also a profuse blooming species and its white flowers with the production of odour are very attractive to different insect species. *Chauhan and Nisha* (2018) documented that *A. scholaris* shows anthesis during late evening time. *Solomon Raju et al.* (2021) reported that *A. scholaris* buds initiate opening process before sunset and continue until late evening time. In this study, *A. venenata* shows anthesis during early morning hours and the flowers begin to receive visits almost immediately and through the day. Different authors reported on the pollinators of *A. scholaris.* It is pollinated by insects (*Mondal et al. 1998*), butterflies and bees (*Pratap et al. 2013*) and by honey bees, wild bees, wasps, ants, butterflies and moths (*Chauhan and Nisha 2018*). In this study, *A. venenata* flowers attract butterflies and honey bees; the former by uncoiling their proboscis probe the flowers for nectar collection while the latter possessing short-tongue collect only pollen situated at the corolla throat. Since the flowering occurs during summer season, the white corolla begins to show signs of color fading quickly making them unattractive to the intended flower-foragers and hence the foragers restrict their foraging activity to forenoon session only. The function of autonomous autogamy and vector-mediated pollination collectively contribute to the natural fruit set rate which is very low when compared to the flower production rate at inflorescence/branch/plant level. Therefore, *A. venenata* with flexible functional facultative xenogamous system and entomophily is able to produce limited fruit set rate but it is compensated by the production of several seeds in each fruited flower. The follicle break apart shedding seeds into the air which are further carried away by wind. In *A. scholaris* also, fruits are 2-follicled with many seeds which disperse by self-explosion and wind but only dry season enables seeds to be carried away by wind (*Solomon Raju et al. 2021*).

Cryptolepis buchanani is a large woody climbing shrub with rope-like stem enclosed with purplish-red bark which peels off in papery flakes. The leaves are elliptic, glabrous and shining with acute apex. Flowers are greenish-yellow and borne in short axillary umbellate cymes (Figure 1b, c). The calyx is ovate with acute succulent lobes. The corolla is short-tubed

with linear to lance-like greenish-yellow petals forming salverform shape. The corona lobes are inserted at or near the middle portion of corolla tube; the corona is free from filaments which are narrow above and broad below. The anthers with pollen tetrads are united and fused with stigma head forming gynostegium. The pollen translators are spathulate and situated on the upper surface of style head. The ovary is bicarpellary and bilocular syncarpous with numerous ovules on axile placentation. The nectar is secreted at the flower base which requires the forager to display skill to access it. The fruit is a paired follicle, widely divaricate and lanceolate and each follicle produces numerous brownish, ovate and compressed comose seeds. The follicle break apart shedding seeds into the air which are further carried away by wind.

C. buchanani flowers are open after sunrise and remain in place for 2-3 days. They were never visited by flower foragers during the observation period which could be relatable to their repulsiveness and high ambient temperature due to summer season. Accordingly, follicle production rate is negligible to the flower production rate at plant level and the production of follicles is exclusively a function of occurrence of autonomous autogamy. But, *C. buchanani* is reported to be visited by a nymphalid butterfly, *Danaus chrysippus* in coastal lateritic terrain of Uttara Kannada in Karnataka by *Balachandra et al. (2014)* and pollinated by a nymphalid butterfly, *Parthenos sylvia* in Malappuram District of Kerala *(Thomas et al. 2022).* This state of information indicates that there is a need for full-fledged studies to understand the reproductive ecology of *A. venenata* and *C. buchanani* with reference to the flowering season when flower-foragers are usually scanty and visit the flowers which are appropriate for them as sources of nectar and/or pollen. Therefore, the information documented in this paper is expected to be useful for future workers to take up detailed studies in this direction on the plant species stated above due to their use in traditional medicine.

Figure 1. a. *Alstonia venenata* – flowering phase, b. & c. *Cryptolepis buchananii.*

4. Conclusions

Alstonia venenata and *Cryptolepis buchanani* occupy different locations but both bloom during summer season. Field study indicates that autonomous autogamy is functional in *A. venanata* but butterflies and honey bees visit the flowers to collect forage during which they effect pollination. In this species, the fruit set is a function of autonomous autogamy and entomophily. *C. buchanani* flowers unattractive to the flower visitors and it is reflected in the low fruit set rate which is

exclusively a function of autonomous autogamy. In both plant species, fruit is a paired follicle and each follicle produces several to numerous seeds according to the production rate of ovules in flowers. Anemochory is functional in both plant species.

Statements and Declarations

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Author Contributions

All three authors contributed equally regarding manuscript work and production.

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Conflicts of Interest

The authors declare that there are no conflicts of interest.

Ethical Approval

Not applicable

Informed Consent

Not applicable

Data materials availability

All data associated with this study are present in the paper

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