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# Reproductive capacity and seedling survivability of *Streptocaulon sylvestre* Wight - an endangered and endemic plant of Eastern India

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## Abstract

*Streptocaulon sylvestre* Wight [Asclepiadaceae] is a little known prostate Critically Endangered and endemic suffrutescent plant. Attempt was made to examine the reproductive capacity and seedling survivability on aiming to clarify its possible regeneration problems. The results revealed its very low reproductive capacity. This was due to very low seed output and low germination percentage of the species in soil. Moreover, the percentage of seedling mortality was much higher than the survivability. The aggressive capacity of this species was also lowest as both the reproductive capacity and seedling survivability were lower. Reproduction by vegetative means (stem and root cuttings) was also tested but with no success. The species never produce any adventitious root from nodes or internodes.

**Keywords:** Reproductive capacity, seed output, aggressive capacity, seedling survivability.

## INTRODUCTION

In the last couple of centuries the earth's biological diversity has been threatened by various anthropogenic activities leading to the extinction of numerous plant and animal species. This rate of extinction or species loss is growing faster as each day passes. The resulting loss of biodiversity will have serious impact on the world's environment and if the human aspirations are not brought in the line with the earth's carrying capacity, be assured that we are heading for an ecological disaster. It is estimated that nearly one tenth of the world's phytodiversity is seriously threatened and is at the verge of extinction (Singh & Chowdhary 2002). In recent years threatened species and its conservation has become the most important and burning topic for the sustainable environment management on this planet.

*Streptocaulon sylvestre* Wight (Asclepiadaceae) is a Critically Endangered and endemic (Das 1996; Kadir 2001; Kadir & Das 2002) species. It is a small suffrutescent prostrate plant with milky latex and at present, it is restricted within the campus of the University of North Bengal (88º 212 E Longitude and 26º 432 N Latitude) in the foot-hills of Darjeeling Himalaya in Eastern India. It grows only in herbland habitat under grasses with no or very low grazing within the campus of the University. So far, only four floras, (i) *Flora of British India* (Hooker 1883), (ii) *Bengal Plants* (Prain 1903), (iii) *The Botany of Bihar and Orissa* (Haines 1921-25) and (iv) *Flora of Bhutan* ( Grierson & Long 1999) have reported this species, based on nearly same set of specimens from CAL .

The species is now Critically Endangered and to be extinct on any day after any type of modification of its natural habitat within the campus of the University. Realizing this threat, it is now very much essential to find out the difficulties in its propagation and dispersal. Because the mode of reproduction, formation of flowers and then fruits, structure and number of fruits, number of seeds per fruit, the seasons of flower and fruit formation, reproductive capacity, seedling survivability etc are important aspects in the life cycle of a plant which greatly influence the success of a species among the members of the community in regeneration and survival for generations. Environment is greatly responsible for bringing about the initiation of flower and fruit formation. Even after effective pollination and fertilization the environment affects fruit formation to certain extent. Thus the objective of this study was to examine the seed output, reproductive capacity, aggressive capacity and seedling survivability of *Streptocaulon sylvestre* Wight aiming to clarify the possible regeneration problems of the species.

## MATERIALS AND METHODS

Mature fruits of *Streptocaulon sylvestre* Wight were collected from the campus of the University of North Bengal, where it is growing now, in the months of November and January during 1998 to 2000. For the determination of fruit characters fruits from 30 plants were collected separately at random and counted separately. Shape, size, length and circumference of each fruit were recorded. All the seeds from each fruit of each plant were collected, counted and after air drying stored properly. In addition, number of total plants, number of flower producing plants and number of fruits producing plants were observed and counted at every 15 days for one year in marked areas.

Reproductive capacity was determined by calculating the average seed output per plant and average percentage of seed germination. To determine the percentage of germination and percentage of survival of seedlings, four nursery bed of 1.0 m x l. 0 m were prepared. Seeds were sown at the rate of 50 per plot during June and watered to maintaining appropriate moist condition, depending on the need. Observation on seedling emergence was recorded daily for 20 days. Number of saplings present, ten weeks after sowing was counted and the percentage survival of seedlings and their vegetative growth were calculated. The following formula as given by Salisbury (1942) was used for calculating the reproductive capacity.

$$\text{Reproductive Capacity} = \frac{\text{Average seed output of a plant X\% of germination}}{100}$$

Average Seed output = Average number of fruits per plant X Average number of seeds per fruit.
Percentage of Survivability of seedling was calculated by using the following formula.

$$\text{\% Survivability of seedlings} = \frac{\text{Number of saplings present}}{\text{Number of seedlings produced}} \text{ X } 100$$

The following formula was employed to find out the percentage of Mortality of seedlings.

$$\text{\% Mortality of seedling} = \frac{\text{Number of deaths of seedlings}}{\text{Number of seedlings produced}} \text{X}100$$

The Aggressive Capacity was calculated as per the following formula described by Reddy & Aruna (1997).

$$\text{Aggressive Capacity} = \frac{\text{Reproductive capacity x \% Survivability of seedlings}}{100}$$

## RESULTS AND DISCUSSION

The results of the investigation on different parameters are shown in Tables 1 – 3. During investigation it was observed that a pair of follicles generally developed from a pair of free ovaries of syncarpus pristil of *Streptocaulon sylvestre* Wight. But in many cases only one follicle develop and the other remain abortive.

The fruits were graded into three size classes: *large*, *medium* and *small*. All the three types of fruits were generally produced in separate plants. Average number of fruits per fruit-producing plant was only 4.73 ± 0.68. Like fruits, seeds of S. *sylvestre* were also of three types: large, medium and small sized. However, all of these three types were provided with a tuff of white and silky coma.

**Table 1:** Fruit Characteristics of *Streptocaulon sylvestre* Wight

| Parameters | Fruit Size | | |
|---|---|---|---|
| | **Large** | **Medium** | **Small** |
| 1. Fruit type | Follicle | Follicle | Follicle |
| 2. Fruit Size | Large | Medium | Small |
| 3. Fruit Shape | Nearly oblong, tapering from middle to tip, slightly narrowed towards the base. | Oblong, tapering from middle to tip, slightly narrowed towards the base. | Oblong to elliptic, tapering from middle to tip , narrowed towards the base. |
| 4. Length of fruit (cm) | 7.78 ± 0.45 | 6.00 ± 0.11 | 3.58 ±0.16 |
| 5. Middle circumference of fruit (cm) | 3.12 ±0.11 | 3.82 ± 0.07 | 2.84 ± 0.15 |
| 6. Fruits per fruit bearing plant | 3.80 ± 0.37 | 4.60 ± 1.12 | 5.80 ± 1.74 |
| 7. Seeds per fruit | 32.47 ± 2.35 | 41.73 ± 4.23 | 20.65 ± 1.47. |
| 8. Seeds per fruit bearing plant | 123.40 ± 12.47 | 192.00 ± 57.13 | 119.80 ±37. 67 |
| 9. Size of produced seeds | Large | Large & Medium | Medium & Small |

**Table 2:** Reproductive capacity and seedling survivability of *Streptocaulon sylvestre* Wight

| Sl. No | Parameters | Results |
|---|---|---|
| 1. | Percentage of flower producing plants | 92.00 ±3.74 % |
| 2. | Percentage of fruit producing plants | 9.21 ± 0.97 % |
| 3. | Average number of fruits (large, medium & Small) per plant | 0.435 ±0.06 |
| 4. | Average number of fruits per fruit producing plant | 4.73 ± 0.68 |
| 5. | Average number of seeds per fruit | 30.64 ± 2.64 |
| 6. | Average seed output per plant | 13.35 ± 2.14 |
| 7. | Average seed output per fruit producing plant | 145.06 ±23.23 |
| 8. | Percentage of damage of seeds | 8.52 |
| 9. | Seed germination period | May to August |
| 10. | Germination | Epigeal |
| 11. | Number of cotyledons | 2 – 4 |
| 12. | Length of cotyledon (15 days old) | 1.0 – 1.7 cm |
| 13. | Breadth of cotyledon | 0.5 – 0.8 cm |
| 14. | Germination percentage of seeds (Large, medium & small ) in soil | 54.00 ± 2.58 % |
| 15. | Reproductive capacity of plant | 7.209 |
| 16. | Reproductive capacity of fruit producing plant | 78.33 |
| 17. | Percentage of survivability of seedlings | 40.46 ± 3.46 % |
| 18. | Percentage of mortality of seedlings | 59.53 ± 3.46 % |
| 19. | Aggressive capacity of plants | 2.916 |
| 20. | Aggressive capacity of fruit producing plants | 31.69 |

Results reveal that the seed output of *S. sylvestre* was very low, although the average number of seeds per fruit was 30.64± 2.64. The average seed output of this plant was 13.35± 2.14. This was due to very low fruit producing capacity of the plant population. It was observed that 92.00 ± 3.74% plants produce flowers, but only 9.21 ±0.97% plants produce fruits. It flowered during March to February reaching a peak between March & May. The rate of flowering and the number of flowers was not equal in different months. Flowering however occurred more or less round the year and started at the middle of dry season and continued through the monsoon, up to the end of winter. Fruiting period was also ranged from March to February. Highest number of mature fruits

was found during December and January. Average number of fruits per plant was 0.435 ± 0.06, although each fruit bearing plant produced average 4.73 ± 0.68 fruits. Average seed output of each fruit producing plant was 145.06 ± 23.23.

This suffrutescent plant produce flowers and fruits once in a year and after ripening of fruits the aerial shoot died and underground part remain dormant for a short period of around one or two months. So, the reproductive capacity of *S. sylvestre* is very low. The reproductive capacity of the population was 7.209/plant. However, the reproductive capacity of fruit producing plant was 78.33/ plant. This was due to very low seed output and low germination percentage in soil. Water content in soil might be the probable cause of low germination (Kadir 2001). Reproduction by vegetative part (stems and roots) was tested but was not successful. The species never produce any adventitious root from nodes or internodes. It reproduces exclusively sexually by means of seeds which takes place annually and never reproduces asexually.tive capacity of fruit producing plant was 78.33/ plant. This was due to very low seed output and low germination percentage in soil. Water content in soil might be the probable cause of low germination (Kadir 2001). Reproduction by vegetative part (stems and roots) was tested but was not successful. The species never produce any adventitious root from nodes or internodes. It reproduces exclusively sexually by means of seeds which takes place annually and never reproduces asexually. Plants establish or derive from seeds during November to February by the death of most of the areal parts. However, all branches of all plants never die. When in one hand most of the plants entering the phase of dormancy, few individuals continued to produce small new shoots, which in turn, also produce flowers. It starts sprouting from the hidden underground perennating organ during February to June followed by vigorous growth. Even immediately after artificial burning of the vegetation it sprouted in March and April. After seed germination, a plant takes minimum three years for fruiting.

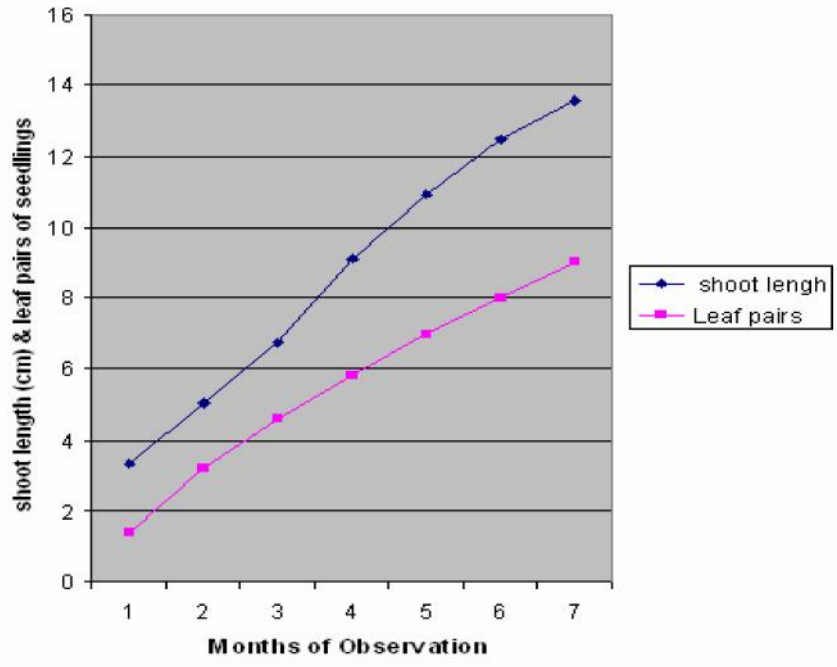


**Fig. 1:** Growth dynamics of seedlings of *S. sylvestre*

In this study it was also observed that the percentage of seedling mortality of *S. sylvestre* was higher than the percentage of seedling survivability which was 59.53 ± 3.46% and 40.46 ± 3.46%, respectively. The aggressive capacity of this species was also lowest as both the reproductive capacity and seedling survivability was lower. The aggressive capacity of average population was 2.916 and fruit bearing plants was 31.69

Salisbury (1942) mentioned that the seed output in a particular habitat may be an important factor in determining the occurrence as well as frequency or abundance of a species in natural conditions. Ambasht & Ambasht (1996) noted that several environmental factors influence the seed output of an individual plant but, above all, biotic factors are the most important. In *S. sylvestre*, it was observed that during fruit formation some unknown flower infecting fungi and insects damage the embryos at a very young stage leading to the inhibition of fruit development. In spite of that herbivores generally remove the top of grassland plants giving little chance for the flower to develop fruit. Grazing animals, mostly cows and goats also trample these plants. Another probable cause of low fruit formation might be the pollination problem which was largely governed by the morphology of flower with regard to the position and time of maturity of the anthers and stigmas, season of flowering, wind movement and biotic agents of pollination (insects).

Salisbury (1942) noted that reproductive capacity indicates the potential for population growth. The reproductive capacity of a species is as much a characteristic as any other specific features and is of considerable ecological interest. It is also important in seedling establishment. In this case, low reproductive capacity of S. *sylvestre* indicates the lowest degree of a abundance and frequency and also the lowest growth potential of this plant. A number of Indian weeds, grasses and forest trees have been investigated for their seed output and percentage germination which depicted their reproductive capacity. Nelivigi (1962) and Sant (1962, 1963, 1965) presented such values for a number of grasses and forbs. Paria & Sahoo (1981) reported the reproductive capacity of certain weed species growing in the vicinity of Calcutta.

Fenner (1985) noted that a seedling is considered to be fully established when it has become effectively independent of its seed reserves. Mayer & Poljakoff-Mayber (1975) mentioned that the germinating seed must first of all establish anchorage by the root in soil and ensure commencement of water and solute absorption. Root growth ensuring water supply, seedling vigour in piercing the soil surface and the ability to begin photosynthesis are some of the factors which ensure the establishment, especially of the seedlings. The hazards faced during the process of seedling survivability comprise the last of the hurdles which the plant has to negotiate in the process of regeneration through seed. The major hazards are desiccation and burial of the seedling. In addition, biotic factor such as competition, predation and disease also play their role in seedling survivability.

Misra (1992) noted that frost, drought, grazing, trampling and fungal infections are some of the most important factors which influence seedling mortality. In S. *sylvestre* absence of early dormancy (Kadir 2001) allowed rapid germination of dispersed seeds to a favourable condition which was uncongenial to seedling survivability. Shortly after germination the seedling might be exposed to extremes of many environmental factors. In April and May temporary rainfall favoured rapid germination of seeds which subsequently experience dryness or water stress around seedling roots causing permanent damage. On the other hand during June to September heavy rainfall washed off the seeds and young seedlings of this species which might be another important reason for seedling mortality. The influence of biota on seedling survivability might also be there. The soft and delicate young root needs to bear hard and granular soil through which it made its way. A large variety of unknown soil fauna and microorganism also damaged soft roots. Moreover, grazing animals cause maximum damage to seedlings of *S. sylvestre* both by browsing and trampling in natural habitat. All the factors discussed above, together, lead to high rate of seedling mortality.

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