Sapria Himalayana

The Indian Cousin of World's Largest Flower

Dipankar Borah and Dipanjan Ghosh

Sighting *Sapria* in the wild is a lifetime experience for a botanist. Because this rare, parasitic flowering plant is one of the lesser known and poorly understood taxa, which is on the brink of extinction. In India, *Sapria* is only found in the forests of Namdapha National Park in Arunachal Pradesh. In this article, an attempt has been made to document the diversity, distribution, ecology, and conservation need of this valuable plant.

Introduction

It was the month of January 2017 when we decided for a field trip to Namdapha National Park along with some of our plant lover mates of Department of Botany, Rajiv Gandhi University, Arunachal Pradesh. After reaching the National Park, which is somewhat 113 km away from the nearest town Miao, in Arunachal Pradesh, the forest officials advised us to trek through the nearest possible spot called Bulbulia, a sulphur spring. After walking for 4 km, we observed some red balls on the ground half covered by litter. Immediately we cleared the litter which unravelled a ball like pinkish-red flower bud. Near to it was a flower in full bloom and two flower buds. Following this, we looked in the 5 m radius area, anticipating a possibility to encounter more but nothing was spotted. It was the only possible population we could locate throughout that trek in that part of the forest, situated half-way to the sulphur spring. For the next two days, we had several trips through other parts of the National Park, but no more populations of these flowers were observed.

We were informed by the forest guide that he too had noticed this peculiar specimen, but only at two locations. One was where we

Dipankar Borah has just completed his MSc in Botany from Rajiv Gandhi University, Arunachal Pradesh, and is now pursuing research in the same department. He specializes in Plant Taxonomy, though now he focuses on Conservation Biology, as he feels that taxonomy is nothing without conservation.

Dipanjan Ghosh teaches Botany at Joteram Vidyapith, Bardhaman. He is also a popular science writer and science educator associated with various governmental and non-governmental organizations in India and abroad.

Keywords
Sapria, holoparasite, Namdapha, rare angiosperm, threat, conservation.

found it, while the other was 6 km away from the first spot and showed huge blooming in comparison to the first area. As time and people didn't permit us to enter into that area, we left our efforts to track it down.

Later we came to learn that those peculiar structures were actually parts of a very rare plant called *Sapria*. *Sapria* needs special attention due to its botanical characteristics and a very restricted distribution around the world. In India, it was first reported from the tropical wet evergreen forests of Mishmi bills in Lohit district by a British botanist William Griffith in 1847 and subsequently from Aka Hills in Kameng district by an Irish botanist and forest officer Norman Loftus Bor in 1938. Both these locations are in Arunachal Pradesh in the Eastern Himalayas – a biodiversity hotspot [1]. Once, it was also distributed in Assam, Manipur, and Meghalaya [2]. But presently, there are no reports of the occurrence of the species in any of these states. Outside India, *S. himalayana* has been reported only from Thailand where it is known as 'Hermit's Spittoon' [3].

Sapria himalayana

Sapria himalayana Griffith. is a host-specific parasitic angiosperm. It is better to call it a holoparasite[1] belonging to the family Rafflesiaceae, that derives all of its fixed carbon and nitrogen from the host plant. Some of the most unusual and spectacular parasitic plants like *Rafflesia* also belong to this family (see also later in *Box* 1). *Sapria* represents the extreme manifestation of the parasitic mode, being completely dependent on its host plant for water, nutrients, and products of photosynthesis. The vegetative tissue of *Sapria* consists of microscopic strands, called haustoria, which ramify through the root tissues, i.e., the xylem and the phloem of host plants. *S. himalayana* is most likely to be annuals. The flowering and fruiting occurs during winter, usually from December to February. Flowering shoot is short, erect and unbranched. The flowers are about 20 cm across, dioecious, unisexual, and bright red in colour covered with sulphur-yellow

[1] An obligate parasitic plant that gets all of its nutrition from the host plant.

Sapria represents the extreme manifestation of the parasitic mode, being completely dependent on its host plant for water, nutrients, and products of photosynthesis.

Box 1. World's Largest Flower

Devil's Betelnut Box or Corpse Flower (*Rafflesia arnoldii* R. Br.) is a rare, parasitic, rootless, and leafless plant endemic to Southeast Asian islands of Sumatra and Borneo. The plant has the largest known individual flower in the world.

The main body of *Rafflesia* resides inside the host plant. The only visible parts are its flowers which emerge through the host plant's bark as compact buds and later transform into fruits. The flowers are unisexual, i.e., male or female, up to 1 m in diameter, and reddish brown in colour with white spots. Each flower consists of five lobes inserted on a cup-like structure. In the centre of the cup there is a column with a disc. The anthers (in case of male flower) or styles (in case of female flower) are situated beneath the disc. The fruits are berries with minute seeds.

The flower of *Rafflesia arnoldii* is an iconic symbol of the Southeast Asian rainforest, and is often used to symbolise the rich biodiversity of the region's forests.

Figure A. *Rafflesia* (*Rafflesia arnoldii*) – World's largest flower looks gorgeous, but smells awful, perhaps that explains why people do not bring it home (Photo: Nurul Iman Supardi).

spots (*Figure* 1). They appear above the ground and emit a putrid odour. Buds are globose and have white and pink bracts (*Figure* 2). The flower remains in bloom for 2–3 days after which it slowly dehisces, becomes dark in colour, and subsequently decomposes. Fruits are swollen and crowned with perianth. The seeds are of the size of grape fruits and blackish brown in colour.

Sapria flower has an unpleasant odour which in turn indicates the possibility of the presence of some pollinating agents in the vicinity. It has been assumed that flies pollinate these plants while

Figure 1. Flower of *Sapria himalayana* Griffith., in its natural habitat in Namdapha (Photo: Dipankar Borah).

Figure 2. A globose bud of *Sapria* prior to bloom on the forest floor (Photo: Dipankar Borah).

rodents help in seed dispersal. But the pollination and seed dispersal patterns as well as the agents involved in these processes have not yet been documented.

Cousins – Parity and Disparity

Parasitic organisms have evolved from free-living ancestors independently in most of the major lineages of prokaryotes and eu-

karyotes. However, the evolutionary shift to an advanced parasitic lifestyle has been associated with the degeneration of morphologies and genomes [4]. Rafflesiaceae as this family is now recognized in the strict sense includes only the large-flowered genera, the sister clades *Rafflesia*, *Rhizanthes*, and *Sapria*, which have been placed with the Euphorbiaceae (one of the largest representative family of plants in the tropics) in the order Malpighiales (with poinsettias, violets, and passion flowers). *Rafflesia*, *Rhizanthes*, and *Sapria* possess the most reduced vegetative body among all angiosperms. They do not have readily identifiable roots and only a highly modified mycelium-like body consisting of a strand of cells plus the bracts that precede their flowers. At the same time, members of Rafflesiaceae also produce the world's largest flowers. Paradoxically, all the close photosynthetic relatives (*Figure* 3) of Rafflesiaceae possess minute flowers. Interpretations of their peculiar morphology are problematic and have resulted in great confusion regarding both the evolutionary affinities of the group and the development of their remarkable body plan [5].

Interpretations of the peculiar morphology of members of Rafflesiaceae are problematic and have resulted in great confusion regarding both the evolutionary affinities of the group and the development of their remarkable body plan.

Rafflesia and *Sapria* are superficially very similar in having a conspicuous floral chamber – a partially occluded space confined by the perianth[2] where the reproductive organs are present. In *Rafflesia*, the perianth includes five perianth lobes appear to be sepals and a congenitally fused petal whorl, which comprises the diaphragm that forms the roof of the chamber. Both perianth whorls serve protective and attractive functions. The central column – fusion product of perianth lobes and the diaphragm – is expanded to form a central disk, and a ring-like structure is also present at the base of the central column (*Figure* 4). In contrast, *Sapria* has two free whorls each with five perianth lobes, corresponding to the sepal and the petal whorls, respectively. *Sapria* also possesses a diaphragm which arises between the perianth and the androecium[3]. Moreover, the central column and disk of *Sapria* are not as robust as in *Rafflesia*. Likewise, the constricted basal portion of the central column is narrower than in *Rafflesia* but is wider in female *Sapria* flowers than in male flowers [5]. In addition, ramenta (chaffy scale-like outgrowths) line the perianth

[2] Non-reproductive part of a flower, consisting of calyx and corolla, especially when the two whorls are very similar or fused.

[3] Male part of the flower.

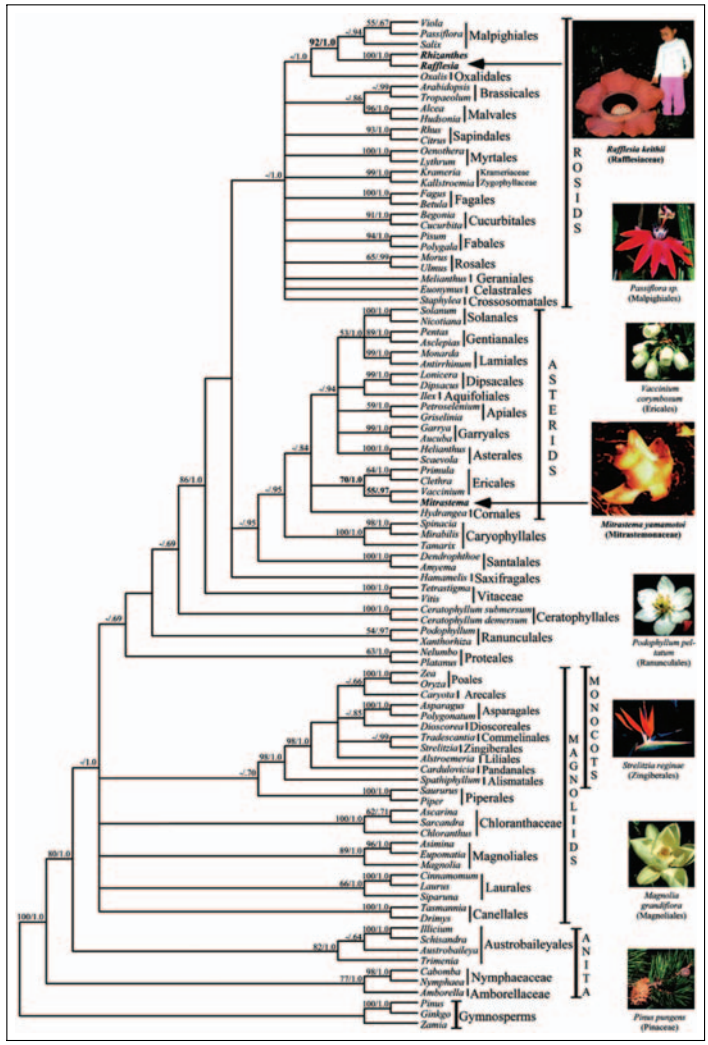

Figure 3. Barkman, *et al*., present results of a phylogenetic analysis of 95 species of seed plants designed to infer the position of *Rafflesia* in an evolutionary context using the mitochondrial gene matR (1,806 aligned base pairs). Overall, the estimated phylogenetic tree is highly congruent with independent analyses and provides a strongly supported placement of *Rafflesia* with the order Malpighiales. This is the strict consensus tree from an unweighted parsimony analysis of matR mtDNA sequences (number of trees = 61,911, tree length = 2,464, consistency index = 0.5657). Bootstrap support (BS) from the parsimony analysis is listed before the slash, and posterior probabilities (PP) from the Bayesian analysis are listed after the slash for all nodes receiving support of ≥ 50 (0.5). When present, a dash represents BS < 50. Images of representative species are shown for heuristic purposes.

tube and grooves are at the base of the central disc in *Rafflesia*, whereas ramenta are on top of the diaphragm and grooves line the perianth tube in case of *Sapria*. The anthers are multilocular in *Rafflesia* and tetrasporangiate in *Sapria*. Thus, despite their superficial similarities, the floral chambers are constructed differently in these two cousin genera [5].

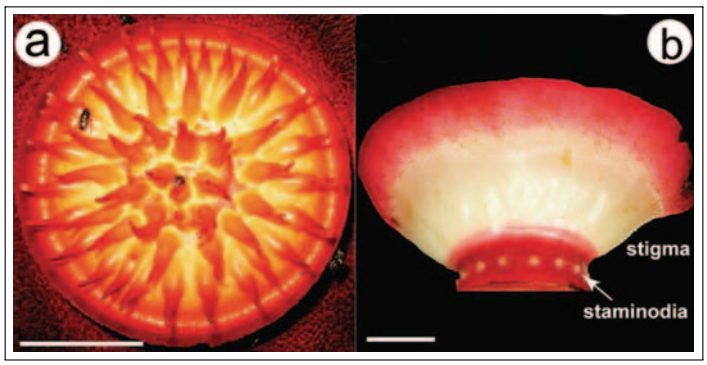

Figure 4. Interior details **(a)**. Top view of central disk in *Rafflesia*. Note processes and carrion fly pollinators (Bar: 10 cm). **(b)**. The central disk is seen from the side in female *Sapria* (Bar: 1 cm). Dotted lines indicate the stigmatic surface (Photo: Reproduced from Davis, *et al*., *American Journal of Botany* [5]).

Ecological Notes

Namdapha National Park and Tiger Reserve (*Figure* 5), located in Changlang District of Arunachal Pradesh with a total area of 1985 square kilometer (177 square kilometer in buffer zone and 1808 square kilometer in the core area), is endowed with a conglomeration of different climatic regimes, which supports a remarkable diversity of both plant and animal species (*Figure* 6). The Namdapha protected area has been the only known refuge of *Sapria himalayana* in the post-independent India. Earlier in 1996, *Sapria* was spotted only from the 40th mile area of the Namdapha National Park [6]. In 2003, the plant was again encountered in two specific habitats in the park, one in an undisturbed primary forest at Hornbill and the other in a disturbed secondary forest at Zero Camp [7]. However, currently there are no signs of its existence in these places. Our observation was the third sighting record of *Sapria* in Namdapha. From the distribution pattern in respect of time, it may be assumed that the occurrence of *Sapria* is sporadic . But practically, it may not be true because *Sapria* can only be spotted in the flowering season and as it prefers to grow in a shady and humid environment with plenty of litter in the forest floor, it becomes very tough to locate it in its natural habitat.

Sapria generally grows in patches. The patch size ranges between 5 m^2 and 16 m^2 approximately. Each patch includes living and dead flowers as well as those in bud stage. Successively, fruits are

Sapria can only be spotted in the flowering season and as it prefers to grow in a shady and humid environment with plenty of litter in the forest floor, it becomes very tough to locate it in its natural habitat.

Figure 5. Map of Namdapha National Park and Tiger Reserve.

Figure 6. Namdapha National Park is the third largest national park in India in terms of area, located in the Eastern Himalayan subregion and is recognized as one of the richest biodiversity hotspots in India (Photo: Dipankar Borah).

also found in these populations.

In all the occasions, the host plant is a wiry and glabrous climber of the genus *Tetrastigma* that belongs to the grape family Vitaceae. Two species, such as *Tetrastigma bracteolatum* (Wallich) Planchon and *T. serrulatum* (Roxb.) Planchon are reported as the host plants of *Sapria* in Namdapha [7]. Moreover, three different species, such as *T. cruciatum* Craib & Gagnepain., *T. laoticum*

Gagnepain, and *T. obovatum* (Laws.) Gagnepain. are reported as the host plants of *Sapria* in Thailand [3]. All the species of *Tetrastigma* are woody lianas with tendrils and are found to be very common in those possible habitats of *Sapria* growing as a member of understory layer.

Threat Factors

Sapria has been confined to a few small patches in its natural habitat. But how long the species will survive in Namdapha is a matter of speculation. The main threat to survival is habitat destruction. For a long time, Namdapha has human encroachments in and around the park, including the core area (*Figure* 7). Anthropogenic activities like settled as well as shifting cultivation in the park is bringing more and more land under agricultural use. During the preparation of the land, forest is cleared indiscriminately by lopping off the undergrowth and branches of trees followed by burning, which severely damage the host plants of *Sapria*. In addition, camping is another problem in Namdapha National Park. The park is a large hilly terrain close to international boundaries with Myanmar, and its weather condition also fluctuates at times. People enroute border areas like Gandhigram and Vijaynagar are required to trek for 3–4 days and camp inside the park. Also, as the canopy cover reduces flowers are directly exposed to sunlight, which could suddenly wipe off the habitat range of the species. Landslides and landslips are common on the slopes in the park which may be another cause of habitat loss.

Anthropogenic activities like settled as well as shifting cultivation in the park is bringing more and more land under agricultural use. During the preparation of the land, forest is cleared indiscriminately by lopping off the undergrowth and branches of trees followed by burning, which severely damage the host plants of *Sapria*.

Unlike *Rafflesia*, its Indian relative *Sapria* has no known commodity value in terms of food, drug or other natural products to the local inhabitants, except for the beautiful flowers that bloom in winter. As a result, people lack interest in *Sapria* and its conservation. In addition, the host-specificity of *Sapria* is a natural constraint to its existence. We have little knowledge about its host range and the host-parasite interaction.

Figure 7. Namdapha has human settlements in and around the park; most of the dwellers are immigrants from neighbouring countries (Photo: Dipankar Borah).

Conservation Need

Sapria himalayana is a very rare and endemic species of the Eastern Himalayas whose population has drastically shrunk in the last 2–3 decades [8]. Probably due to its limited distribution around the world, it is not on the priority list of IUCN to monitor the population dynamics, genetic diversity, and gene flow across the plant life for a time being for its further conservation. *Sapria* has immense aesthetic value and this species also enriches the species diversity of Indian angiosperms, though it is not clear how the elimination of *Sapria* will impact the overall stability of the ecosystem [7].

Sapria has immense aesthetic value and this species also enriches the species diversity of Indian angiosperms, though it is not clear how the elimination of *Sapria* will impact the overall stability of the ecosystem.

Necessary actions like more surveys throughout the whole National Park, as well as its possible habitats nearby, should be done, for the status and threat assessment. However, *Sapria* can only be conserved in its natural habitats. For such *in situ* conservation measures, plantation of host plant in nearby areas to the present population and in areas already recorded (but no surviving population is present now) should be done. Other methods of conservation, like germplasm collection, cultivation, micropropagation, etc., is not possible due to its parasitic nature.

Conclusion

Sapria himalayana is an extremely rare species. The authors feel highly pleased and lucky to have had the opportunity to spot such a marvelous parasitic angiosperm in its natural habitat. The species is facing high risk of extinction as the only observed population falls into the foot trail through the park. Even unauthorized and unproductive collection of specimens for research activities from the only possible habitat could lower the chances of its survival. Rigorous studies on population dynamics of *S. himalayana*, the associated species of *S. himalayana* and its host should be undertaken as conservation measures. Continuous monitoring of *S. himalayana*'s natural habitat with proper protection and management could possibly ensure its conservation.

Suggested Reading

[1] **W Griffith, *Journals of Travels in Assam, Burma, Bhootan, Afghanistan and the Neighbouring Countries*, Calcutta, India, 1847 (Reprinted in 1857, Mittal Publications, Delhi).**

[2] **N L Bor, A Sketch of the Vegetation of the Aka Hills, Assam: A Synecological Study, *Indian Forest Record (N.S.) Bot*., Vol.1, No.i–ix, pp.103–221, 1938.**

[3] **S Elliott, Status, Ecology and Conservation of *Sapria himalayana* Griff. (Rafflesiaceae) in Thailand, *Journal of Wildlife in Thailand*, Vol.2, No.1, pp.44–52, 1992.**

[4] **T J Barkman, S H Lim, K M Salleh and J Nais, Mitochondrial DNA Sequences Reveal the Photosynthetic Relatives of *Rafflesia*, the World's Largest Flower, *Proceedings of the National Academy of Sciences of the United States of America*, Vol.101, No.3, pp. 787–792, 2004.**

[5] **L A Nikolov, Y M Staedler, S Manickam, J Schonenberger, P K Endress, E M Kramer and C C Davis, Floral Structure and Development in Rafflesiaceae with Emphasis on Their Exceptional Gynoecia, *American Journal of Botany*, Vol.101, No.2, pp.225–243, 2014.**

[6] **A S Chauhan, K P Singh, D K Singh and P K Hazra (Ed), *A Contribution to the Flora of Namdapha, Arunachal Pradesh*, Botanical Survey of India, Kolkata, India, p.257, 1996.**

[7] **A Arunachalam, D Adhikari, R Sarmah, M Majumder and M L Khan, Population and Conservation of *Sapria himalayana* Griffith. in Namdapha National Park, Arunachal Pradesh, India, *Biodiversity and Conservation*, Vol.13, pp.2391–2397, 2004.**

[8] **H J Chowdhery, Arunachal Pradesh – The Cradle of Flowering Plants, In G S Rawat (Ed): *Envis Bulletin Special Habitats and Threatened Plants of India*, Vol.11, No.1, pp.77–82, 2008.**

Address for Correspondence
Dipankar Borah
Department of Botany
Rajiv Gandhi University
Rono Hills, Doimukh
Arunachal Pradesh 791 112,
India.
Email:
dipankarborah085@gmail.com
Dipanjan Ghosh
Chotonilpur Pirtala
PO Sripally Dist. Purba
Bardhaman 713 103
West Bengal, India.
Email:
dpanjanghosh@gmail.com