

Stem rust-resistant wheat

Stem rust race Ug99 of *Puccinia graminis* sp. *tritici* and its variants threaten global wheat production as about 90% of world cultivars have shown susceptibility to varied extent due to breakdown of the widely used *Sr31*-based resistance. It was first reported¹ in 1999 from Uganda and since then it has been detected from Kenya, Ethiopia, Eritrea, Sudan, Yemen, Iran, Tanzania, Mozambique, Zimbabwe and South Africa. Besides the original Ug99 race, seven other variants have been identified which knocked down *Sr24* and *Sr36* genes besides other minor genes and gene combinations.

Several studies have been carried out to identify resistant genes. In a recent issue of *Science*, two stem rust genes *Sr33* and *Sr35* have been reported that may help scientists to develop new wheat varieties and strategies that protect wheat crop against this deadly fungal disease. A team of scientists from USA reported a gene², *Sr35* that confers resistance to Ug99 stem rust race group. The *Sr35* gene was discovered in einkorn wheat grown in Turkey and later transferred to hexaploid wheat. During field tests in Kenya, this gene imparted resistant to moderately resistant infection responses with relatively low disease severity. Researchers used two complementary approaches to identify the location of the *Sr35* gene in the wheat genome. Initially, they chemically mutagenized the resistant accession of wheat to identify plants that become susceptible to the stem rust pathogen. Thereafter, the candidate gene

was isolated and biotechnological approaches were used to develop transgenic plants that carried the *Sr35* gene and showed resistance to the Ug99 race of stem rust. In the same issue of *Science*³, an Australian group reported the identification of another stem rust resistance gene, *Sr33*. This gene was introgressed from the wild relative *Aegilops tauschii* into bread wheat and confers resistance to diverse stem rust races, including the Ug99 race group. They also used a combination of high-resolution genetic and physical mapping to define the *Sr33* locus and confirmed this gene using barley stripe mosaic virus-induced gene silencing. These genes may be transferred together in a single resistance cassette, which will facilitate their simultaneous use in the breeding programmes.

Stem rust in India is a problem of the warmer areas in the central and southern regions, though it has also been identified from very high-altitude areas. Genes like *Sr2*, *Sr9*, *Sr11*, *Sr25* and *Sr31* were incorporated in Indian wheat cultivars to ensure durable resistance for stem rust races occurring in these cultivars⁴. This defence developed for managing stem rust in wheat has remained effective for commercial use over a large area till date. In India, stem rust race Ug99 has not yet been tracked. As it has now been reported to occur in Iran, it became imperative to look for resistance to this race in Indian wheat cultivars. Indian wheat lines have been screened regularly in

Kenya and popular varieties such as Lok1, C306 and VL404 were found resistant besides several other genetic stocks and wheat lines in advanced varietal trials. Indian wheat scientists have been working to incorporate genes (*Sr22*, *Sr35* and *Sr39*) imparting resistance to Ug99 and other races prevalent in India in the wheat varieties grown over large areas. These recently reported *Sr33* and *Sr35* genes could also be introgressed into high-yielding wheat varieties along with other minor genes released for the central and southern regions of India. The detailed account showing resistance to Ug99 in Indian wheat varieties has been reported^{5,6}.

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Cryptocoryne cognata Schott and *Rotala ritchiei* (C.B. Clarke) Koehne – the critically endangered aquatic herbs on verge of extinction

During assessment of endemic and threatened angiosperm taxa of Western Ghats in Goa, Karnataka and Maharashtra from 2007 to 2012, extensive surveys were made in the entire regions during which, we established the extant, but scanty populations of two critically endangered aquatic herbs *Cryptocoryne cognata* Schott and *Rotala ritchiei* (C.B. Clarke) Koehne, listed in Red Data Book¹⁻⁴, in Maharashtra.

Strictly endemic to Sindhudurg district, Konkan region of Maharashtra, the type locality and first described⁵ in 1857, the species *C. cognata* was re-collected after about one and half decade, in 1990 and 1997 from two other localities, Ajaon and Vaibhawadi in Sindhudurg district, although represented by only few individuals each^{4,6}. This anchored aquatic, annual herb inhabits the sides of lakes and running waters (with roots

anchored under water). Its habitat is extremely restricted and specifically confined to the widened ends of narrow flowing streams arising from the hills. The bulbous roots with dense vermiform fibres, leaves 12–25 × 3–6 cm, oblong-lanceolate with undulating margins and 12–18 cm long dark purplish spathes, sprawling in the direction of water current when submerged, or spreading on ground when on edges, are the diagnostic

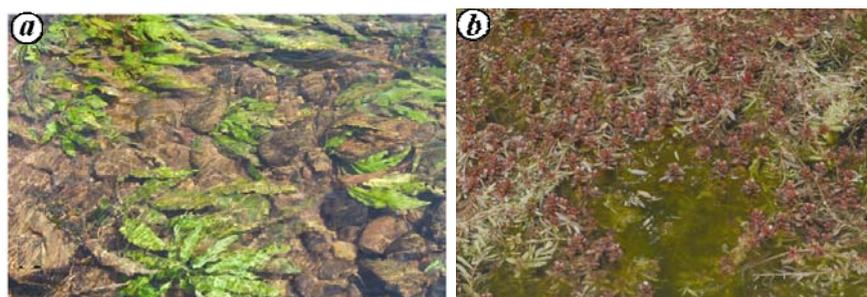


Figure 1. a, *Cryptocoryne cognata* Schott under water. b, Habit of *Rotala ritchiei* (C.B. Clarke) Koehne.

characters for species recognition in field (Figure 1a). Our surveys revealed that the Ajgaon population had vanished completely, while the species survived in the only shrunken, miniature, extant population in Vaibhawadi, Maharashtra, with few (c. 50) individuals in a small area (c. 500 sq. m.). Except for this single population, there were no traces of existence of any individual in the entire Konkan stretch covering Goa, Karnataka and Maharashtra. Due to the specific habitat and rarity, surveys were focussed on site of broadened ends of the downhill streams before they join the sea waters and the emanating nasty smell of flowers served as guiding factor and clue of its presence in the vicinity. Further, the probability of adaptation of *C. cognata* in specific edaphic conditions of water enriched with bauxite and iron traces perpetually, as it permeates and flows down the hills of iron and bauxite ores, cannot be ruled out. At present, the critically endangered, isolated, single, scanty population of *C. cognata* is exposed to various threats due to ever increasing developmental activities, mainly mining and road construction. The State Highway adjacent to its present site is of immediate concern as even slightest widening of this shall witness the species to perish forever.

Conservation of yet another critically endangered aquatic herb, *Rotala ritchiei* (C.B. Clarke) Koehne, is also of serious disquiet. First described⁷ in 1883 from the type locality Belgaum in Karnataka, the species soon vanished from the type locality. However, after a century⁸ in 1979 it was rediscovered from a pond (Kochala cha talao), adjacent to the Chakan–Alandi road, Pune in Maharashtra, but soon got eradicated during expansion of the adjacent, narrow road,

into a wide, 4-lane National Highway. In 1989 another site of the species Devarakerai in Coimbatore, Tamil Nadu, came to light on the basis of herbarium collection of 1907, which was misidentified as *Ammania pentandra* Roxb., but correctly determined as *Rotala ritchiei* by Mathew and Ahmedulla⁹. The angular, pale pinkish stem giving out 5–8 cm long purplish emergent flowering branches during September–October, bearing solitary rose coloured bracteolate flowers c. 3–4 mm long (Figure 1b) are the diagnostic characters of this c. 40 cm long, floating annual herb. This paved way to the possible endemic status of the species in the above three locations of the three states, Karnataka, Maharashtra and Tamil Nadu. However, the present surveys confirmed the alarming loss of all individuals from all above sites, but repeated searches resulted in locating one extant population in a small pond of c. 150 × 100 m area, in the centre of Kaas plateau, Satara district, Maharashtra. This habitat was already exposed to many anthropogenic pressure as the Kaas plateau, well known as the Valley of Flowers of Western Ghats, had become a famous picnic spot with all its grandeur of blooming flowers during flowering season from July to September and supplemented with the water pond. Hence the entire plateau got prone to immense human interferences with the pond serving as the only water resource, especially in dry season. Any damage caused to this pond is sure to result in adverse effect on the survival of *Rotala ritchiei*, if left unchecked.

The integrated stochastic perturbations operating on the extant, narrow, restricted populations of the two critically endangered species *C. cognata* and *Rotala ritchiei* are focused here to elucidate

threats to which these are currently exposed. Unless measures are not adopted immediately for conservation of their wild gene pool, the species would become extinct. The finding also opens vistas for studies on the reproductive biology and pollination ecology of these species to establish causes of rarity. But under the present scenario, the ever increasing anthropogenic pressures are extremely detrimental to survival of these populations and calls for immediate conservation in wild as our experiments have also revealed that *ex-situ* conservation of these species is not successful.

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