

## VIVIPARY IN *GLUTA TRAVANCORICA*: ITS PHYTOGEOGRAPHIC AND EVOLUTIONARY SIGNIFICANCE

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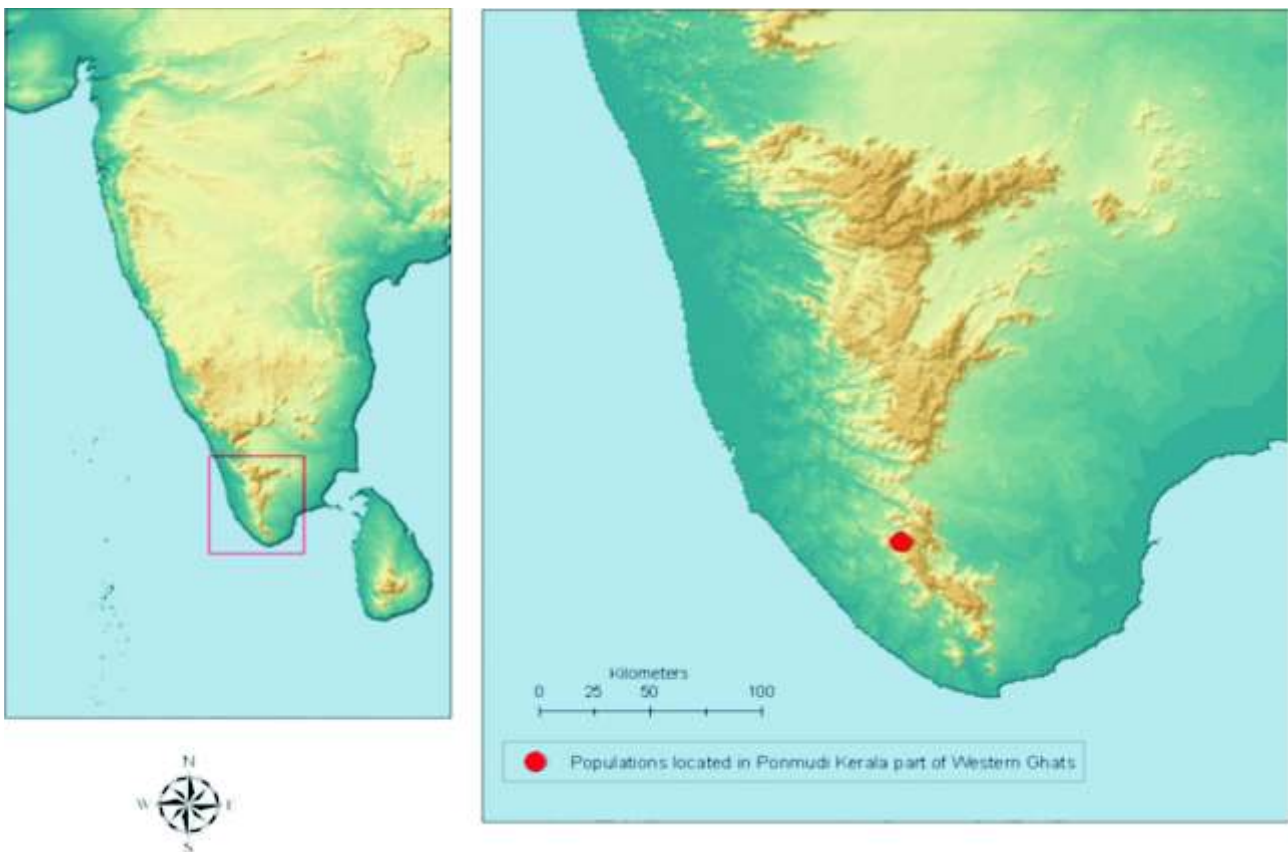
### ABSTRACT

The occurrence of vivipary in *Gluta travancorica* has been treated as a genetic linked adaptive strategy through an evolutionary process to sustain the minimum viable individuals in its habitats. The vicariance of *Gluta* spp. viz., Southern Western Ghats, Madagascar and New Guinea from the main stock of the Malayan peninsula implies the phytogeographic history of the peninsular India on the basis of continental drift and biotic ferry model of transoceanic movement in plants. Malayan peninsula accommodates about 10 species of the *Gluta*, which usually inhabit peat swamps or marshy places. The ever-ending physical vagaries experiences in the presently degraded shola/montane ecosystems of the southern Western Ghats has compelled the species to produce viviparous seed germination as an adaptation to make sure its progenies. Further, the vivipary in *G. travancorica* recalls its possible original habitats in the peat swamps since its allied species are growing as mangrove associates in the Malayan peninsula.

**Keywords:** Vicariance, Phytogeography, Endemism, Evolution, Adaptation

### INTRODUCTION

The tropical forests of the Western Ghats (India) are characterized by rich plant diversity and high concentration of endemism. However, most of the endemic species experience rapid habitat loss and shrinking niches. As a result, many of the species are on the way of extinction or endangered. There are various programmes under progress at state and national level to rescue these species from untimely extirpation and ensuring their conservation. *Gluta travancorica* Bedd. (Malayalam: Chenkurinji; Fam. Anacardiaceae) is an endemic tree of the Southern Western Ghats of India. Chenkurinji is a large evergreen tree reaching 35 - 40m in height and a girth up to 5m. The species is found in dense moist forests of Travancore in Kerala and the adjacent areas of Tamil Nadu (Tirunelveli), between 400 and 1,200m above msl. The wood is hard and durable with a pleasant reddish heartwood and therefore very much in demand for ship building, furniture, turnery and carving (Anonymous, 1956). Considering its economic value and the endemic nature, the species has been recommended for conservation on a priority basis (Anonymous, 1991). As part of a study on rare and endemic trees of the Western Ghats, various aspects of *G. travancorica* such as ecology and reproductive biology had been studied by the authors of this communication. The studies were conducted in the patchy shola forests of Ponmudi, Thiruvananthapuram District (Fig.1). The populations lie between 8°44' N latitude and 77° 04' E longitudes at an altitude of 900m. The populations were monitored at monthly intervals in order to understand the reproductive phenology and population dynamics. The flowering behavior showed a peak during February-March with random individuals flowering during September-October. Maximum ripe fruits were observed during December-January and sometimes a less intense second episode of fruiting during July-August. In accordance with the occasional two fruiting episodes, corresponding episodes of regeneration were also met with during February-March (summer) and July-August (monsoon). However, the degree of varied disturbances experienced in the habitats was too high to the survival of the seedlings (Jose, 2001). Evident to these observations, the incidence of vivipary was noted rarely among the individuals of the population during the month of August (Fig.2) where the process of fruit senescence and natural regeneration of the species are taking place *in situ*. The viviparous germination was recorded along with climatic / edaphic conditions which prevailed in the shola niches covered; the atmospheric temperature (21-22°C), atmospheric humidity (85-90%) canopy temperature (22-23°C), soil temperature (20-21°C) and soil moisture (17%). The *G. travancorica*, a non-



**Fig.1 :** Western Ghats of Peninsular India and showing study site



**Fig.2 :** Incidence of vivipary on *G. travancorica* Bedd.



- 1 - Southern Western Ghats (India) 2- Madagascar (South Africa)  
 3- Papua New Guinea (North Australia)  
 4- Malaysia, Thailand, Sumatra, Borneo, Myanmar (SE Asian countries)

**Fig. 3 :** World distribution of *Gluta* spp.

viviparous and non-mangrove species of the Western Ghats, vivipary is reported for the first time and this communication is a result of the interpretations of the findings from the above study.

### **Vicariance in *Gluta* and its phytogeographical significance**

The genus *Gluta*, known by about 30 species, is mostly Asiatic in distribution with most of the species restricted to the Malayan Peninsula in Borneo, Sumatra, Burma, Thailand and Malaysia. One species each has also been reported from North Australia (New Guinea), India (Western Ghats) and South Africa (Madagascar) (Van Steenis, 1978). (Fig.3). *G. travancorica* is the only species reported from India, known from the southern part of Western Ghats. The tree is an exclusive endemic to areas south of Ariyankavu pass. Apparently, vicariance in the genus *Gluta* with different species in different continents is a result of geological separation of continents and their subsequent drifting apart. The isolated occurrence of *G. travancorica* in Western Ghats therefore supports the concept of Gondwana land and the continental drift hypothesis. Changing geography of the continents usually causes geographic isolation from the nearest groups for very long periods of time and the species to remain restricted in distribution. This in turn causes the gene pool to become narrow and driven by the changed geography and the environment further the species loses many adaptations it originally possessed. This in turn would not leave the species with opportunities to evolve for newer pathways of adaptive radiation (Nayar, 1980). According to Wegener's theory of continental drift, Peninsular India was part of the Gondwana super-continent c. 200 million years before present. During the Jurassic period, the Indo-Madagascar plate drifted away from East Africa, followed by the separation of Peninsular India from Madagascar. Ali and Aitchison, 2008 have discussed the plant morphological, geological and geophysical observations supporting these events. After separation from Madagascar, the Indian plate underwent a period of isolation for about 30 - 40 million years. This long period of isolation has caused the fauna and flora of Peninsular India to become unique and highly endemic (Keast, 1971). Apparently the Indian plate collided with Eurasian plate enabling the Gondwanian elements to migrate to India and Asia, and many Asian and African elements to migrate to India. Thus, the Indian continent was drifting very much like a raft for many million years. This event has been conceptualized into a geological phenomenon, the ferry concept (Roy and Karanth, 2009). According to this, the rafting Indian plate carried ancient Gondwanian flora and fauna to Asia. Zoogeographic evidences on frog genus *Nasikabatrachus* (Biju and Bossuyt, 2003) and phytogeographic evidences from studies on Asian Dipterocarps (Dayanandan & al., 1999) are in support of this hypothesis. Vicariance in the genus *Gluta*, with isolated species distributed in the Western

Ghats, Madagascar and New Guinea and differing from the main stock represented in the Malayan Peninsula (SE Asia) (Fig.3) is in agreement with the ferry concept. Apparently, the species in India, Madagascar and the New Guinea originated as a result of isolation of the stocks through continental drift and subsequent inability to evolve further, thus resulting in endemism. Peninsular India does not hold any endemic or primitive families of its own. On the other hand, it represents the Indian plate of the Gondwana land containing a rich stock of relictual tropical SE Asian plants (c. 35%). *G. travancorica* in Western Ghats is a representative of this ancient flora which got separated from the main stock of the Gondwana land due to continental drift and became endemic in the shola/evergreen forests. Similarly, the occurrence of the representatives of the species in Madagascar and New Guinea supports in line with the above and subsequent restricted distribution in the region.

### **Vivipary in *Gluta travancorica* and its meanings**

Vivipary denotes germination of seeds while attached to the mother plant and is rare in the plant kingdom except in the case of mangroves. Thus vivipary is an adaptation for ensuring enhanced survival and establishment in the saline/aquatic environment (Baskin and Baskin, 2001). Vivipary is also prevalent in a number of tropical trees with large seeds and inhabiting non-saline mesic habitats. Jack (*Artocarpus heterophyllus*; Fam. Moraceae) and in members of the family Dipterocarpaceae are typical examples and presumably a few other trees also share this germination trait (Kunju, 2003). Apparently because of the recalcitrant nature, in such species, longevity of the seed is too short, often just for a few days. In these species, germination while on the tree has a minimizing effect on the time required for establishment of the seedlings on the soil, and is again of adaptive significance. Vivipary in *Gluta travancorica* differs from both the types of vivipary described above. Here the trees do not inhabit hydric or swampy habitats and the seeds are not at dismay, as the longevity of the normal seeds extends up to one month in ambient conditions days (in press). Added to this, the normal non-viviparous seeds have an inherent (apparently physiological) dormancy period of 30 - 35 days. So, the causes for vivipary here can neither be attributed to saline water nor to short lifespan of seeds. There are two plausible explanations. The major stock of the genus *Gluta* in South East Asia (10 species) is confined to peat swamps, marshy places, tidal rivers, brackish to riverain forests, where viviparous seed germination is of definite adaptive significance in the saline or aquatic environment. *G. travancorica* having derived from the very same stock rarely shows vivipary, indicating its ancient relationship to the Malaysian species. It may also be possible that the species displays vivipary due to atavism, i.e. reappearance of a lost character, and hence genetically controlled. Nevertheless, in order to express atavism, there should be some kind of a selective advantage for the atavistic expression. Unlike in Malaysian species which inhabit hydric or saline biotopes, in India, *G. travancorica* inhabits mesic habitats. Apparently, there is no reason why a germination trait suitable for hydric or saline biotopes has to be adopted by a tree inhabiting mesic biotopes. The scientific reasoning for the co-occurrence of vivipary and mesic biotope are to be explored further. Vivipary, irrespective of the causal driving forces, basically involves preponing the temporal amplitude of germination. In other words, it is a situation of 'precautious germination'. It is a known fact that moisture status of the seeds and the tree floor play key role in determining the germination and the regeneration episodes. Viewed from this angle, there is a possibility that the atavistic vivipary observed in *G. travancorica* is triggered by certain uncertainties or larger changes in the soil moisture regime, which in turn is controlled by the pattern of precipitation. In order to understand the meanings of the vivipary under discussion, it has to be analyzed in conjunction with the changes experienced along the Western Ghats during the last 100 years.

During the last century (1900-2000), the forested biomes of the Western Ghats have experienced heavy disturbances in terms of human interventions as encroachments, denudation of vegetation, or their thinning out to sparse covers. The extent of forest cover of the region got reduced to less than 10% of its original extent (Khoshoo, 1994). Consequently, mutilation of the natural habitats becomes the major cause for the decline of endemic species. The shola forests, the natural home of *G. travancorica*, have also been subject to the kind of disturbance mentioned above. There is a possibility that the microclimatic change experienced due to depletion of forests in the region has contributed to the precarious germination in *G. travancorica*. This may also be interpreted as a gene-linked adaptive strategy to ensure a sound population of the species. Multiple emergences of albino seedlings observed in *ex situ* seed propagation trials in *G. travancorica* (Jose and Pandurangan, 2011) also is an indication of the genetic drift contributing to the rarity of the species.

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## REFERENCES

- ALI, J.R. AND J.C. AITCHISON 2008. Gondwana to Asia: plate tectonics, paleogeography and the biological connectivity of the Indian subcontinent from the middle Jurassic through latest Eocene (166-35 Ma). *Earth-Science Reviews* 88(3-4): 145-166.
- ANONYMOUS, 1956. The Wealth of India (Raw materials). Vol.4 CSIR, New Delhi.
- ANONYMOUS, 1991. Recommendations. The Proceedings of the Symposium on Rare, Endangered and Endemic plants of the Western Ghats, In: C.K. Karunakaran (ed.), Kerala Forest Department (Wildlife Wing) 16-19. Thiruvananthapuram, Kerala.
- BIJU, S.D. AND F. BOSSUYT 2003. New frog family from India reveals an ancient biogeographical link with the Seychelles, *Nature* 425: 711-714.
- BASKIN, C.C. AND J.M. BASKIN 2001. Seeds - Ecology, Biogeography and Evolution of Dormancy and Germination, Academic Press, New York.
- DATTA-ROY, A. AND K. PRAVEEN KARANTH 2009. The out-of-India hypothesis: what do molecules suggest? *J. Biosci.* 34: 687-697.
- DAYANANDAN, S., P.S. ASTON, S.M. WILLIAMS, S.M. AND R.B. PRIMACK 1999. Phylogeny of the tropical tree family Dipterocarpaceae based on nucleotide sequences of the chloroplast *rbcl* gene. *Amer. J. Bot.* 86: 1182-1190.
- JOSE, P.A. 2001. A study on the Population structure, Dynamics and Conservation of Two Rare and Endemic Trees of Western Ghats of Kerala. Ph.D. Thesis, Kerala University, Thiruvananthapuram.
- JOSE, P.A. AND A.G. PANDURANGAN 2011. Occurrence of albino seedlings and its genetic significance in *Gluta travancorica*. *Indian J. For.* 34(3): 377-378.
- KAMARUDEENKUNJU, M. 2003. Physiological and biochemical studies on seeds of *Hopea parviflora* Bedd. and *Vateria indica* Linn.: two economically important endemic trees of Western Ghats. Ph.D Thesis, University of Kerala, Thiruvananthapuram.
- KEAST, A. 1971. Continental drift and the evolution of the biota on southern continents, *Quarterly Review on Biology* 46(4): 335-378.
- KHOSHOO, T.N. 1994. India's Biodiversity: Tasks Ahead. *Curr. Sci.* 67: 577-582.
- NAYAR, M.P. 1980. Endemic Flora of Peninsular India and its Significance. *Bull. Bot. Surv. India* 22 (1-4): 12-23.
- VAN STEENIS, C.G.G.J. 1978. (ed.), *Flora Malesiana*. ser. I, vol. 8. part 3. Anacardiaceae (Ding Hou, pages 395 - 548). Nationaal Herbarium Nederland. Sijthoff & Noordhoff International Publishers, Alphen van der Rijn.

## दक्षिणी पश्चिमी घाट के ग्लुटा ट्रेवेंकोरिका में विविपेरी तथा इसका पादप भौगोलिक एवं विवर्तनीय (Evolutionary) महत्व

पी ए जोस एवं ए जी पाण्डुरंगन

सारांश

ग्लुटा ट्रेवेंकोरिका में उद्भिद बीजधारिता इसके प्राकृतवास में न्यूनतम जीवनक्षम व्यष्टि संपोषण हेतु एक विवर्तनीय प्रक्रिया के माध्यम से उत्पत्तिमूलक अनुकूलन कौशल से जुड़ा हुआ माना गया है। दक्षिणी पश्चिमी घाट, मडागास्कर तथा मलय प्रायद्वीप के मुख्य भण्डार से ग्लुटा जातियों के विस्तार में पौधों के पास महासागर संचरण का महादेशीय विलगन तथा जैव संतरण के आधार पर प्रायद्वीपीय भारत का पादप भौगोलिक इतिहास समाविष्ट है। मलय प्रायद्वीप में व्याप्त ग्लुटा की 90 जातियों का प्राकृतवास सामान्यतः पीटदलदल जगहों में है। दक्षिणी पश्चिमी घाट के वर्तमान अवक्रमित पर्वतीय पारितंत्र में अनुभूत अनन्त तरंगों ने अनुकूलन के रूप में इन जातियों को उद्भिद बीजधारी अंकुरण के लिए विवश किया है। इससे इनकी सन्तति सुनिश्चित होती है। ग्लुटा ट्रेवेंकोरिका में उद्भिदबीजधारिता इसके पीट दलदलों में सम्भावित मूल प्राकृतवास स्मरण दिलाता है। मलय प्रायद्वीप में मैंग्रोव सहचर के रूप में इनकी समवर्गी जातियां उगती हैं।