Vivipary in *Cocos nucifera* L. var. Andaman Green Dwarf

Coconut (*Cocos nucifera* L.) is an important subsistence crop of the humid tropical zones and a life-supporting species in fragile island and coastal ecosystems. Coconut is believed to have originated in the Indo-Malayan region (Indonesia, Malaysia and the Philippines) from where it was dispersed, mainly via oceanic currents, to sandy and coralline tropical coasts where it got established[1]. The archipelago of the Andaman and Nicobar (A&N) Islands stretches over 800 km in the Bay of Bengal, approximately 1220 km southeast of the coast of West Bengal and 1190 km east of Chennai. It comprises 572 islands, reefs and rocks, of which 38 islands are inhabited. A deep Ten Degree Channel, a wide gap of 155 km with heavy tidal flows, separates the A&N group of islands. These islands have a luxuriant evergreen tropical rainforest canopy. About 2100 varieties of plants have been recorded from these islands, out of which 11% is endemic and 1300 do not occur in mainland India[2]. A major part of the island flora is either of the Indo-Myanmarese–Thailand order or the Malaysian–Indonesian order[2]. The A&N islands receive 3200–3500 mm of annual rainfall, have tropical equatorial climate with 80–85% relative humidity and less diurnal variations.

The Central Plantation Crops Research Institute, Kasaragod, maintains the world's largest repository of coconut germplasm with 398 accessions (consisting of 226 indigenous and 132 exotic genotypes) of which 87 accessions are from A&N Islands. The diversity of coconut in the A&N Islands is exceptional[3]. Coconut accessions having horned fruits, beaked fruits, palms with persistant petiole and inflorescence, fused leaflets (plicata) and unbranched inflorescence (spicata) are found in these islands. These rare types may be potential sources of resistance to pests and diseases, and may prove invaluable in future coconut breeding programmes[4]. Unexploited diversity in coconut reported earlier included plicata types, persistant petiole types and compact dwarf types[5].

The Division of Horticulture and Forestry, Central Agricultural Research Institute, is engaged in research on coconut genetic resources management and breeding for development of high-yielding varieties with biotic and abiotic stress tolerance since for the last three decades. The coconut palms are primarily classified based on the stature and breeding habit into two main categories, viz. talls and dwarfs. The tall types are primarily cross-pollinating whereas the dwarf types are mainly self-pollinating with a few exceptions. The tall cultivars are the most commonly cultivated for commercial production in all coconut-growing regions of the world, whereas the dwarf varieties are usually grown for ornamental and tender nut purpose. The dwarf palms are of short stature; attain 8–10 m height at 20–25 years of age and flower in 3–4 years after planting. They have short economic reproductive life cycle of 40–50 years.

Vivipary is an unusual phenomenon commonly observed in mangroves[3] and other plants such as phorminium[6], jatropha[7], wherein the seeds germinate and seedlings grow from a fruit while still attached to the mother plant before dropping down to establish themselves or be transported elsewhere. It is the germination of seeds while still attached to the parent plant; in some crops it is called pre-harvest sprouting or precocious germination. Generally, it is production of offspring from within the body of the parent. Morphological, ecological and physiological explanations have been put forward to explain the extent of vivipary in mangroves. However, vivipary is rarely reported in flowering plants accounting for less than 0.1% of the angiosperms[8].

In coconut, generally, the mature nuts are harvested when at least one nut in the oldest bunch starts becoming dry. In talls, it takes 11–12 months from the date of inflorescence opening to become a mature seed nut, whereas in dwarfs, nuts will mature in 10–11 months. The physiologically matured fruits should be harvested without much delay. Generally, coconut seed germination is slow and it takes about four months for the shoot to emerge. The cotyledon of the embryo begins to swell and elongate and extend backwards into the cavity of the endosperm where it enlarges into a haustorial organ, known as the 'apple'. Initially, it absorbs nutrients from the coconut water and then from the solid endosperm. The shoot and root grow through the eye of the nut. Nutrients are also absorbed by the root from the fibrous mesocarp[9].

Out of 36 accessions (comprising 24 collections from six Pacific Ocean territories, six collections from the Nicobar Islands and six collections from the Andaman group of islands) observed in South Andaman, seven accessions, viz., Niu Leka, Niu Oma, Nikkore, Hari Papua, Andaman Green Dwarf, Andaman Orange Dwarf and Andaman Yellow Dwarf were characterized as dwarfs based on their morphology[10]. Among the dwarfs, except Niu Leka, all other varieties exhibited traits of persistent nuts – even after drying they were attached to their respective bunches on the palm, whereas the mature nuts were observed to shed in Niu Leka Dwarf upon maturity like in other tall accessions. Among the dwarfs, Andaman Green Dwarf has exhibited vivipary to the extent of 40–50%. This rare phenomenon of vivipary was observed during late June to August in 2011 and 2012 (Figure 1).

It was observed that if harvesting is delayed by three weeks, at least 6–8 nuts in a bunch of Andaman Green Dwarf variety germinate under Andaman conditions, whereas viviparous germination is absent in other dwarf accessions and talls. The germinated seedlings are seen attached to the bunch on the crown and continue to grow on the crown. In coconut, according to the seedling selection index, traits such as early germination, faster growth, and early splitting of the unexpanded leaf into leaflets are positively correlated with high yield and vigour. A number of seedling traits are

Figure 1. Vivipary in *Cocos nucifera* L. var. Andaman Green Dwarf.

also used as marker traits for establishing varietal identity[9]. In commercial proportions, vivipary in coconut does not seem to be economical, as it will not allow seed storage, result in loss of kernel quality, and less copra quality, thus reducing the marketability of the nuts. However, it is useful in producing early seedlings which may be useful in the creation of new variability for earliness in coconut. The occurrence of vivipary in *C. nucifera* L. var. Andaman Green Dwarf can be interpreted as an adaptive reproductive strategy that enables seedlings to establish more rapidly and subsequent dispersal by water or other means. Coconut has been reported to be dispersed by sea-water currents around the world[1]. The viviparous germinated nuts would not have been suitable for this long-distance sea dispersal and hence a natural selection for non-viviparous types might have been predominant during the dispersal of coconut. Hence, vivipary in coconut can be considered as a rare trait exhibited after reselection and planting of Andaman Green Dwarf for earliness over generations. The present report on vivipary in coconut would therefore give ample scope for further studies on the ecological and evolutionary significance in coconut.

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M. SANKARAN*
V. DAMODARAN
D. R. SINGH
B. A. JERARD

Division of Horticulture and Forestry, Central Agricultural Research Institute, Port Blair 744 101, India
**e-mail: kmsankaran@gmail.com*

Barail Wildlife Sanctuary, Assam: an eco-climatic reservoir of diverse liverworts of North East India

The North East (NE) region of India contains a globally significant proportion of wild flora and fauna as it falls under the Indo-Burma biodiversity hotspot[1]. Barail Wildlife Sanctuary (BWS), a unique piece of vibrant NE Indian landscape, is situated amongst the lofty hills and undulating hillocks of southern Assam. The sanctuary is situated in the northern part of Cachar district, Assam and lies along the foothills of North Cachar and Barail Hills between 24°58′–25°5′N lat. and 92°46′–92°52′E long., covering an area of 326.24 sq. km. It enjoys tropical humid climate with average annual rainfall of 3,383.5 mm and average humidity of 78% (ref. 2). Unique geographical position, variable eco-climatic conditions with variation in elevation and high precipitation have blessed the area as one of the richest treasure-houses of floral and faunal wealth including rich bryofloral diversity. In an ongoing study on the group Marchantiophyta (liverworts), we surveyed four localities within the sanctuary, viz. Malidar (ca. 70 m), Damcherra (ca. 200 m), Marwacherra (ca. 50 m) and Kumba (ca. 70 m). A total of 11 families of liverworts have been identified, among which Jungermanniaceae, Lejeuneaceae, Pallaviciniaceae and Marchantiaceae are the most dominant. Diversity of taxa is richest in the family Lejeuneaceae with five genera, viz. *Archilejeunea* (Spruce) Schiffn., *Cololejeunea* (Spruce) Schiffn., *Lejeunea* Lib., *Leptolejeunea* (Spruce) Schiffn. and *Lopholejeunea* (Spruce) Schiffn. The sanctuary harbours a number of taxa which are endemic to India (*Chiloscyphus campanulatus* Steph.)[3] or new for Assam [*Heteroscyphus pandei* S.C. Srivast. & Abha Srivast., *Bazzania sumbavensis* (Gottsche ex Steph.) Steph.][4]. The species are both as terrestrials (on soil and rock) and epiphytes. Epiphytes are found to grow mainly on barks of angiospermic host plants like *Anthocephalus* sp., *Terminalia* sp., *Mangifera indica*, *Alstonia scholaris*, etc.[5]. We could not locate any truly epiphyllous taxa in the four localities surveyed, except one partially foliicolous species of genus *Jungermannia* L. During the survey, we noticed several hazardous effects on the liverworts growing in Marwachhera and Malidar due to construction of highways and bridges. At Marwacherra, the Silchar–Haflong Highway passing through the sanctuary is under construction. Cutting of roadside rock walls and destruction of forests are gradually wiping out the liverworts and other bryophytic flora inhabiting the region (Figure 1). We collected *Heteroscyphus pandei* from a single locality at Marwacherra during our first visit to the area. But, during our second visit to the same area, we could not relocate the species in its earlier habitat. At Malidar, the plants are facing the same kind of threat

Figure 1. Cutting of rock walls in Barail Wildlife Sanctuary for construction of roads at Marwacherra.