The Asian cycad scale *Aulocaspis yasumatsui*, a threat to native cycads in India

Plant species in the families Cycadaceae, Stangeriaceae and Zamiaceae are commonly known as cycads. *Cycas* is the only genus which occurs in the wild in India. Six species of *Cycas* are native to India, among which *Cycas annaikalii*, *C. beddomei*, *C. circinalis* and *C. spherica* occur only in India. The other two species, *C. pectinata* and *C. rumphii* are found in India and other adjacent Southeast Asian countries. *C. annaikalii* was identified recently from Kozhikode and Palaghat areas of the Western Ghats[1]. *C. beddomei* grows in Tirupati and Caddapah areas of the Eastern Ghats (Figure 1). *C. circinalis* occurs in Karnataka, Kerala and Tamil Nadu along the Western Ghats. *C. spherica* grows along the Eastern Ghats regions in Orissa. *C. pectinata* is abundant in northeastern India, Nepal, Bhutan, Thailand, Laos, Vietnam and southern China. *C. rumphii* is restricted to the Andaman and Nicobar Islands in India, but is widespread in Indonesia and Papua New Guinea[2–6]. Among these six species, *C. beddomei* is considered highly endangered, as it has become rare due to land clearing. Local people also harvest the male cones before pollen shedding for various medicinal purposes[7]. Conservation status of *C. circinalis* is not good and that of *C. spherica* is not known[6]. Only recently, *C. annaikalii* has been differentiated from *C. circinalis*[1]. It is reasonable to assume that the conservation status of *C. annaikalii* is the same as that of *C. circinalis*. Some of the exotic cycads such as *C. revoluta*, *C. siamensis*, *Zamia* sp., etc. have been introduced to India by the landscape industry under ornamental horticulture.

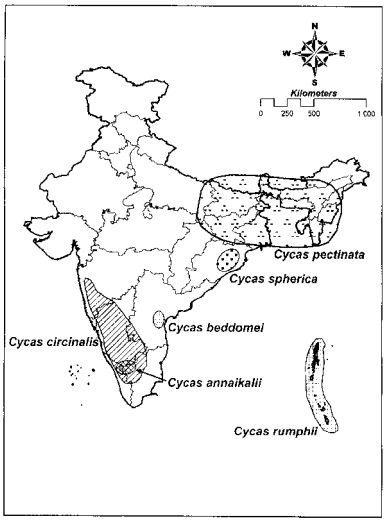

Figure 1. Species distribution of native *Cycas* in India.

The following key will help in the identification of species of *Cycas* in India.

[Note: *C. annaikalii* has not been included, as it is not yet formally described.]

1. Margins of leaflets revolute or recurved 2
– Margins of leaflets flat or very slightly recurved 3
2. Small palm-like tree, average height of trunk 2 m or more, diameter about 20–30 cm; leaves 0.6–1.5 m long, leaflets about 5–8 mm wide; megasporophyll blade lacinate bearing 2–6 ovules in middle part; apex of ovule emarginate, with a micropyle in an apical beak; mature ovule flattened, covered with hairs, bright reddish-orange about 3.5 cm long – *Cycas revoluta* Thunb.
– Small palm-like shrub, stem up to 1.5 m long often shorter, diameter up to 15 cm; leaves about 1 m long, leaflets narrow, about 2.0–3.5 mm wide; megasporophyll ferruginous–tomentose, blade ovate, lanceolate with deeply dentate margins; ovules usually 2 but often up to 4 and rarely 6–8 per megasporophyll, ovules about 5.5 cm long and 4 cm in diameter, ovoid, globose – *Cycas beddomei* Thiselton-Dyer
3. Blade of megasporophyll longer than broad, is sterile end dentate 4
– Blade of megasporophyll as broad as long, deeply pectinate, leaflet margins very slightly recurved 6
4. Leaves with leaflet 6–12 mm broad, blade of megasporophyll margin with pungent lateral spines 5–10 mm long, apical spine distinct from lateral spines, ovule 3–5, up to 2.5 cm long, subglobose, yellow – *Cycas spherica* Roxb.
– Leaves with leaflet 12–19 mm broad, blade of megasporophyll without an apical spine from lateral spines 5
5. Blade of megasporophyll rhombiform, margin with sharp narrow teeth, ovules 6–12, up to 4 mm long, ovoid, reddish-yellow – *Cycas circinalis* L.
– Blade of megasporophyll elongated ovate to ovate–lanceolate, margin of apical sterile end with small teeth, ovules generally 3–10 per megasporophyll, 7.5 cm long and 2.5 cm wide, orange – *Cycas rumphii* Miq.
6. Trunk glabrous, usually between 2 and 6 m tall, leaves about 1–2 m long, leaflets usually 4–14 mm wide, each megasporohyll with 4–6 ovules, about 4 cm long, ovoid, glabrous, yellowish-orange – *Cycas pectinata* Hamilton
– Trunk usually geophilous, but sometimes up to about 1–2 m long, above ground conspicuously swollen at base; leaflets not more than 8 mm broad, each megasporophyll usually with only two ovules, one on either side of the stalk, ovules 4–6 cm long, 3.0–4.5 cm in diameter, orange-red or yellow – *Cycas siamensis* Miq.

Little attention has been paid towards preservation and conservation of the endemic cycads. Detailed survey and documentation of geographical distribution of the native cycad taxa, their pests and diseases is urgently needed. *C. beddomei* has already been placed on the IUCN Red List of Threatened Plants. Efforts should be made to protect the natural habitats of all the four endemic species. Seeds should be collected and propagated for conservation and for commercial use in the landscape industry instead of sourcing them directly from nature. Botanical gardens should be encouraged to delineate areas solely for the cultivation of native cycads and educate the public. The Department of Environment and Forest and other agencies should provide grants for ecological and biological studies on endemic species of cycads.

The Asian cycad scale, *Aulacaspis yasumatsui* (Hemiptera: Diaspididae), a native of Southeast Asia, was accidentally introduced to Florida, USA prior to 1996, through imported cycads from Thailand. Since then, it has killed several trees of *C. revoluta*, *C. rumphii*, *C. taitungensis*, *Stangeria* sp., *Ceratozamia* sp., *Dioon* sp. and *Encephalartos* sp.[8]. It

Figure 2. *Cycas revoluta* infested with *Aulacaspis yasumatsui*. ***a***, Infested *C. revoluta* plant with all the leaves turning white. ***b***, Close-up of fronds showing infestation and yellowing of leaflets. ***c***, Close-up of the colony of *A. yasumatsui* on undersurface of leaflets of *C. revoluta*.

has spread to Puerto Rico, Virgin Islands, Hawaii and Guam from Florida in the past few years. It is threatening with the possible extinction of *C. taitungensis* in Taiwan, and *Cycas micronesica* in Micronesia. In Thailand it is not considered a serious pest as its natural enemies, a parasitoid, *Coccobius fulvus* (Hymenoptera: Aphilinidae) and a predaceous beetle, *Cybocephalus nipponicus* (Coleoptera: Cybocephalidae) have kept it under control. However, in the introduced countries, it has become one of the serious pests of cycads in the absence of its natural enemies.

The Asian cycad scale belongs to the group known as armoured scales. It is covered with white wax (Figure 2 *c*), the female is pear-shaped and the male is elongate. Females lay more than 100 eggs. Only the early first-instar stage (crawlers) and the adult males are mobile. Second and third instars and adult female are sedentary and covered with wax. In the early stages of infestation, scales are found mostly in the lower surface of the leaves and chlorotic spots appear on the upper surface (Figure 2 *b*). Heavily infested leaves are completely coated with a white crust of the scales and become brown (Figure 2 *a*) and wither[9]. Spread in and around an infested area is due to the dispersal of crawlers by wind; however, introduction to distant regions is by the transportation of infested plants.

Treatments with systemic insecticides such as dimethoate and dinotefuran and the growth regulator, pyriproxyfen have given satisfactory results in controlling this scale on the cycads that are planted as ornamentals[10]. This method is expensive and difficult to use in the natural habitats of the cycads as they grow mostly in the forests. The parasitoid, *C. fulvus* and the predaceous beetle, *C. nipponicus* have been identified and collected in Thailand and introduced[11] to Florida in 1998. In Taiwan, *C. nipponicus* from Thailand was released in 2005. A ladybird beetle, *Rhyzobius lophanthae* (Coleoptera: Coccinellidae) has been introduced from Hawaii to Guam in 2005. As these natural enemies have not proven effective, efforts are being made to explore additional natural enemies from southern China and Vietnam for possible biological control of the Asian cycad scale in USA.

Recent increase in cycad trade and transportation and the absence of adequate quarantine regulations and inspection facilities at the various ports of entry in India, enhance the chances of introduction of the Asian cycad scale as evidenced by the establishment of several new pests in the past few years. Once this scale gets introduced to India, the result will be catastrophic, as it will likely wipe out the endemic species of cycads before the problem is recognized. As few people are aware of the habitats of these plants, even if the problem is recognized early, it will take several years to implement any remedial measures.

We hope that the Plant Protection and Quarantine Division will prohibit importation of cycads from the Asian cycad scale-infested countries and also alert quarantine officials at the ports of entry to prevent the introduction of this scale. This is the only means of fully protecting the endemic cycads in India.

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Occurrence of *Phyllanthus scabrifolius* Hook. f. in Amingad, Bagalkot district, Karnataka – a new distributional record

During a botanical exploration in Bagalkot district, Karnataka, the authors collected an interesting species of *Phyllanthus* on a dry, gravelly hilly slope near Amingad village. The habitat of the species looked completely unlike most other herbaceous species of *Phyllanthus*. Critical examination and study of the specimens revealed that they belong to a species of *Phyllanthus scabrifolius* Hook. f. Further, the identity of the specimens was also confirmed at the Botanical Survey of India (BSI), Kolkata. Reference to the literature[1–3] revealed that the species is endemic to Maharashtra and Madhya Pradesh. Cooke[2] stated that there is only one sheet of this species in Kew, whereas Chaudhary and Rao[3] reported this species from Madhya Pradesh based on a solitary collection in LWG. Therefore, the present collection of the species from Amingad forms a new distributional record for Karnataka. Quite likely the species may occur in other similar habitats, but must have been confused with *Phyllanthus kozhikodianus* Siv. & Mani. with which it superficially resembles. However, the two species can be separated as follows.

P. scabrifolius: Branches angled, winged, scaberulous; stipules linear, lanceolate, irregularly serrate along margins; leaves hispidulous, minutely dentate; male calyx lobes lanceolate, disk segment six, saucer-shaped with tuberculate surface; female perianth lobes hispidulous, lanceolate, acuminate, dentate along margins; female disk rounded with irregularly lobed margin.

P. kozhikodianus: Branches terete, glabrous; stipules triangular–lanceolate, entire to dentate; leaves glabrous, entire; male calyx lobes biseriate, unequal, outer lanceolate acute, inner elliptic subobtuse; disk segment cupular with glandular margins; female perianth lobes glabrous, acute or subacute; female disk variable, discoid with distinctly dentate or dissected margins.

To facilitate easy identification, a description and illustration of *P. scabrifolius* is provided in Figure 1.

Phyllanthus scabrifolius Hook. f. in Fl. Brit. India. **5**: 299. 1887; Cooke, Fl. Pres. Bombay. **3**: 84, 1967 (repr. ed.); Chaudhary & Rao, *Phytotaxonomy*. **2**: 155, 2002.

Erect annual herbs, 20–35 cm high, main stem branched or unbranched, terete below, angular or grooved above, glabrous below, stem and branches winged, dentate or toothed, laciniate. Cataphylls ca. 1.5–2 mm long, narrowly triangular, lanceolate, acuminate, midrib greenish to pale brownish, margin minutely dentate or serrate. Stipules ca. 2 mm long, triangular–lanceolate, acuminate to cirrhose, margin dentate to serrate, or laciniate. Leaf blade 4–15 × 2–10 mm, thick, obovate, obovate–elliptic, broadly elliptic or rounded, cuneate at base, entire or serrate to dentate, acuminate to apiculate, obtuse or occasionally mucronate, densely scaberulous below, sparsely scaberulous above, midrib raised below, lateral veins 4–6 pairs; petioles 1–1.5 mm long, glabrous. Cymules unisexual with solitary female flowers in upper axils and 1–3 male flowers in lower axils. Male flowers minute, pedicel 1 mm long, filiform; calyx lobes six, membranous, biseriate, unequal, outer ca. 0.8–1 mm long, lanceolate, acute, inner ca. 0.5–0.8 mm long, ovate–obovate or obtuse, acute to rounded; stamens three, filaments connate below (two-thirds of the length), free and spreading above; disk segments six, saucer-shaped with tuberculate surface. Female flowers with ca. 1.5–2 mm long pedicel, angular; calyx lobes six, subequal, greenish, thickened along the midrib, margin membranous, minutely serrate to wavy, outer ones 2 × 1 mm, linear–obovate, lanceolate, acute, inner 2 × 1–1.2 mm, linear–obovate, subobtuse or apiculate; disk rounded with irregularly lobed margin; styles three, free, recurved from base, distinctly bilobed. Capsules 3–4 mm across, depressed–globose, three-lobed, smooth or minutely puberulous; seeds 1.5 mm long, trigonous, brownish, with 8–10 straight longitudinal lines and many fine transverse striae on the back.

Distribution: Maharashtra, Madhya Pradesh and Karnataka (India), endemic.