



The spectacular inflorescence of *Amorphophallus titanum*

Amorphoballus

in the wild and in cultivation

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HETTERSCHIED
discuss the natural
history, diversity
of species and
cultivation
requirements of
a legendary genus
of aroids

SPECIES OF THE GENUS *Amorphoballus* are among the most striking and enigmatic of all plants. Famed for including some of the largest flower structures of all the world's flora, many members of this beautiful and diverse genus remain poorly understood and seldom cultivated, despite their spectacular blooms.

The genus was named after the Greek for 'misshapen (or deformed) penis', in reference to the shape of the prominent, saggy, spire-like spadix of the first described species.

The 200 or so known species of this tropical and subtropical herbaceous genus of the *Araceae* are distributed mainly in lowland areas across West Africa, southern Asia (south of the Himalayas, to China and the Philippines), to the Pacific islands. No *Amorphoballus* are native to the Americas, although *Dracontium*, which are similar but smaller in size and not closely related, are endemic there.

Habitats and life cycle

Most *Amorphoballus* species can be found growing in semi-shady areas in disturbed ground, such as secondary forests, but also in grassy savannas.

Many species are found in relatively localized geographic areas, and several dozen species remain poorly understood. These have been observed only on one or a few occasions in the wild, and have never been introduced into cultivation.

All species of *Amorphoballus* share the same basic life history. They are perennial plants that in their first year of growth produce a swollen, underground tuber that may be globose (as in *A. konjac*) or elongated (as in *A. macrorrhizus* and *A. longituberosus*), or a horizontal rootstock formed from a cluster of consecutive tubers (*A. coaetaneus*), or a true horizontal rootstock (*A. rhizomatosus*). The different species vary in the number of years that they require to mature, but in

most cases, growth is seasonal and they undergo cyclical periods of activity and dormancy throughout the year. The age that individual plants can reach in the wild is not known, but likely to be many decades, or in some cases, possibly even centuries.

Tubers and foliage

The tubers of *Amorphoballus* vary in size, but in the larger species (such as *A. titanum*), they are the largest in the plant kingdom (Gandawijaja *et al.* 1983) and may weigh as much as 117kg, with a diameter of 1m or more.

The tuber, as a storage organ, is fundamental to the geophyte life cycle of *Amorphoballus*, particularly in the larger species which may produce no leaves during years when an inflorescence is produced. In these cases, the colossal floral structure develops entirely from the supply of starch and nutrients stored in the tuber from the previous season. Plants tend to flower every one to two years, rarely longer apart as in *A. titanum*.

The foliage of *Amorphoballus* is often overlooked in favour of its exuberant flowers. Each plant usually produces a single leaf during a ➤

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growing season which emerges from the top of the subterranean tuber. It consists of a trunk-like petiole, that is often variably mottled, which branches and supports an expansive, horizontally-held leaf which is divided into numerous leaflets. In the largest *Amorphophallus* species the leaf may resemble a sapling tree, being up to 6m or more in height and 7m across. The tree sapling effect is strengthened by the mottling which consists of raised patches, suggesting lichen on a woody trunk. The foliage is usually short-lived and collapses within nine months of developing, often less.

Inflorescence

Not all *Amorphophallus* species produce large inflorescences. Indeed, most produce inflorescences that are shorter than 1m, and some are a mere 4cm high. As is typical of the *Araceae*, *Amorphophallus* develop a compound inflorescence consisting of an elongate or ovate spathe (a sheathing bract) which usually envelops the spadix (a flower spike with a fleshy axis).

The spathe shape varies between species but in the more dramatic species it is bell-shaped with ribbed sides and a frilled margin. It is generally brownish-purple to red or whitish-green. The spadix may be yellow, cream, whitish, dark red, purple or black, and often hollow. It is completely enveloped in the spathe and bracts when it first



The foliage of *Amorphophallus paeoniifolius*. The leaves of some of the larger species resemble a young tree, an effect enhanced by the mottled appearance of the leaf stalk

emerges. The base of the spadix bears numerous male and female florets, more-or-less tightly enclosed in a chamber created by the spathe. The female florets are at the base of the spadix and consist of a pistil. The male florets sit above them and consist of stamens. In many species a specialised zone is found between the male and female florets; this either provides food for visiting insects or carries barrier structures

to temporarily enclose pollinating insects. Above the male florets is the terminal part, called the appendix, which actually consists of fused sterile male flowers (staminodes). These may form a smooth surface, or parts of the staminodes may be visible or transformed to other structures such as warts or hairs.

In many *Amorphophallus* species the life of the inflorescence is fleeting. Once the spathe opens, pollination must happen the same day. Some *Amorphophallus* species have a pleasant odour, but many do smell strongly of carrion or rotting fish, distributed by way of the tall spadix. In the giant species, horticulturists report that the odour is produced in waves, but is strongest on the first two days that the bloom opens.

The life cycle stages of *Amorphophallus titanum*



Lesley Hammett



Amorphophallus abyssinicus showing the typical arrangement found in the genus of male flowers (here shedding pollen) above the female flowers

Although bulbils are usually produced underground, some species, such as *Amorphophallus muelleri*, bear them on the leaves

The interior surface of the spathe may bear ridges or warts that attract mostly smaller beetles. Through a number of ingenious traps, pollinating insects are retained inside the spathe to deposit pollen on the female flowers, which stay receptive for a single day, while the male flowers are still closed. The male flowers open the next day and shower the trapped insects with pollen, but by this time, the female flowers are no longer receptive. Finally, the imprisoned, pollen-laden insects can escape, and they transport pollen to another flower, bringing about cross-pollination. Unfortunately, this elaborate flowering process may not result in seed set because different flowers must bloom almost simultaneously, and within relatively close proximity. If pollination is successful the inflorescence develops

berry-like fruits which may be red, orange, white, yellow or blue.

Some Victorian naturalists thought that the inflorescences of the largest *Amorphophallus* were pollinated by wild elephants. However, ongoing observations have revealed that in most species, pollination of the flowers is actually performed only by small insects, usually carrion beetles.

The genus is famous for including *A. titanum* with a record inflorescence height of 3.06m, and *A. gigas* which can produce an inflorescence 4m high, albeit on a tall peduncle; these are commonly regarded as the largest unbranched flower structures on earth. The largest single flower is borne by *Rafflesia arnoldii*, and the largest branched inflorescence in the plant kingdom belongs to the talipot palm, *Corypha umbraculifera*. The

gigantic inflorescence of *A. titanum* is borne at ground level on a very short scape, whereas that of *A. gigas* is less massive, but borne on a much taller scape up to 3m high. Both species produce a strong, nauseating scent giving rise to their local name of *bunga bangkai*, or corpse flowers, in Sumatra, Indonesia.

Amorphophallus enthusiast Jeremy Holden (pers. comm.) describes how he sometimes found flowers by scenting the waves of odour at night: 'My guides and I would suddenly get a potent bout of that indescribable odour while in camp. *'Bunga bangkai'* would be the spontaneous chorus, followed by arguments about where the plant was located, often hundreds of metres away. Conversely, we might stumble on a scentless plant while out walking. On one occasion a guide and myself noted the lack ➤

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of scent. We both moved in and took a deep sniff – this must have coincided with a release because the effect was literally nauseating. Neither of us could eat for the rest of the day.’

Cultivation

Amorphophallus titanum was discovered in the forests of Sumatra by the Italian botanist and explorer Odoardo Beccari in 1878. Captivated by the startling size of the plant, Beccari dug up a tuber and recorded that it ‘measured nearly 5 feet in circumference, and was so heavy that two men could scarcely carry it’ (Anon. 1889).

Beccari’s initial report was met with disbelief by some. It was not until the first specimen flowered in cultivation at the Royal Botanic Gardens, Kew, in 1889 that the colossal size of the plant was truly appreciated. This first flowering attracted thousands of observers from across Europe, and it was reported that governesses were required to protect young women from so ‘indecent’ a sight (Hettterscheid & Ittenbach 1996). Kew’s achievement in flowering the first *A. titanum* is all the more astounding, since the plant had been brought to maturity from seed over a period of only 10 years or so.

One of the more widely known and commonly cultivated members of the genus is the smaller *A. konjac*. It is cultivated across India, China, Japan and Korea for its large, starchy tubers. These are used to make an edible flour or jelly that is commonly incorporated in a wide range of Asian cuisines. *Amorphophallus abyssinicus*, *A. albus* and *A. paeoniifolius* are also cultivated as crop vegetables; their tubers need to be cooked for a long time before they are edible.

The cultivation requirements of many *Amorphophallus* remain poorly



The distinctive flower of the commonly cultivated crop plant, *Amorphophallus paeoniifolius*

The tuber of *Amorphophallus paeoniifolius* is edible; this one is about 30cm in diameter





An *Amorphophallus* species encountered on Mount Halcon in the Philippines - the fused staminodes making up the appendix give it a warty appearance

A potentially new species from Vietnam



Amorphophallus beccarii, a Sumatran species



documented, but some species can be cultivated with relative ease, and encouraged to flower with little effort. Hettterschied & Ittenbach (1996) provide the most complete published overview of the specific cultivation needs of a wide range of *Amorphophallus* species, on which the following paragraphs are based.

The widely distributed *A. bulbifer*, *A. konjac* (usually grown under the name *A. rivieri*) and *A. paeoniifolius* are the easiest to grow. They are readily available through tropical markets and specialist tropical bulb suppliers. These species require rich, well-drained soil or compost, occasional fertilizing, shade from direct sunlight, a minimum temperature of 22°C in the day and 19°C at night, and a well-defined resting period. ➤

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Depending upon the species, during dormancy the tuber should either be dug up and stored in a cool, dry position, or left in the substrate.

It is likely that most other *Amorphophallus* species can be cultivated successfully in similar conditions, although a few from more arid habitats will require a drier regime.

Unfortunately, the giant species, *A. gigas* and *A. titanum*, are more difficult to cultivate because their huge tubers are prone to rotting. They also require enormous growing spaces, and are less likely to produce seeds or offshoots. However, if grown in well-drained conditions with considerable care given to dormancy, both may be cultivated to maturity in 10–15 years. They will flower every 2–3 years if suitable conditions are maintained.

Propagation

Most of the smaller *Amorphophallus* species readily produce offsets every year. These should be severed and planted separately when the mother tuber is replanted for a new season. The percentage that establish successfully as separate plants varies considerably; some may remain inactive for years without sprouting before finally dying. Conversely, a latent offset may start growing spontaneously after years, so tubers should not be discarded until dead.

Certain species produce bulbils on the leaves. In some, a bulbil develops on the surface of leaflet branching points (*A. bulbifer* and *A. muelleri*), whereas in others the entire branching point of the leaf develops into a bulbil and is released when the leaf rots away (*A. angulatus*, *A. manta*, and *A. sparsiflorus*). Once detached, the bulbils may be planted separately and treated as an adult plant. Cuttings can also be made from the leaves and parts of the tuber, although with variable success.

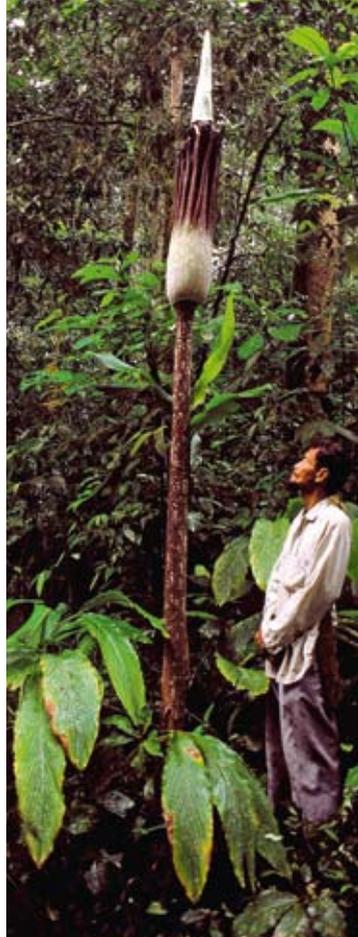


Amorphophallus napiger, a species from Thailand

Some *Amorphophallus* species produce seed without artificial pollination (*A. bulbifer*, *A. kiusianus* and *A. muelleri*), although most do not. If pollination is attempted in cultivation it must be done on the first day of flowering to fit with the plant's flowering physiology. Self-pollination does succeed in a few taxa, though this usually leads to a very poor seed-set.

Artificial hybrids have been created in cultivation, for example *A. albispatus* × *A. longituberosus* and *A. odoratus* × *A. yunnanensis*, although these are not widespread.

When harvesting, the seeds may be removed from the berry flesh but must not be allowed to dry, as this can cause fatal desiccation of the embryo. Fresh seed of *Amorphophallus* usually germinates quickly, within 1–3 weeks, when



The tall inflorescence of *Amorphophallus gigas*

sown on moist, nutrient-poor, slightly acidic compost. Notable exceptions include *A. henryi* and *A. kiusianus*, which may take a year or more to germinate. The first seedling leaf is often not very divided, becoming more so in successive leaves. Seedlings may produce many leaves over their first season before their first dormancy period starts. Dormant young tubers are best left in the soil until they are larger and more resistant to drought.

Where to see *Amorphophallus*

Some botanic gardens have amassed extensive collections of *Amorphophallus* for research or display. Those with the best collections accessible to the public are at the Leiden Botanical Garden in the Netherlands, Hamburg Botanic Gardens (the largest of its

kind and the former research collection of Wilbert Hetterscheid), Bonn Botanic Garden in Germany, Rooyal Botanic Gardens, Kew, in the UK, Bogor Botanic Garden in Indonesia, and the Fairchild Tropical Botanic Garden in the USA.

Seeing *A. titanum* flower in the wild requires patience. Although they usually flower after four years at the 'petiole stage' there is no advance warning (unlike with *Rafflesia* where buds can be located). The flower may only exist for 24 hours, usually opening at night, before closing up. This means most flowers that locals find are already closed before news gets out. One of the best places is Batang Palupuh reserve, 20km from the town of Bukittinggi, West Sumatra. It was set up to protect *Rafflesia arnoldii*, and *Amorphoballus titanum* can sometimes be seen there. If flowering specimens are not found within the reserve, the helpful guides can usually lead visitors to view plants in surrounding forests within a few days. The reserve does not have a website but it is easily accessible from Bukittinggi without an appointment.

Further information

The International Aroid Society (www.aroid.org) offers excellent information for those interested in *Amorphoballus*. The society's



Finding the flowers of *A. titanum* can be a challenge, but they can often be tracked down by scent

members and listed aroid nurseries are the best sources to acquire infrequently cultivated *Amorphoballus* species (one good source is www.wistuba.com).

All who are new to *Amorphoballus* cultivation are strongly recommended to read Hetterscheid & Ittenbach (1996), the most complete horticultural overview of the genus.

Conclusion

At the start of the 21st century we are only beginning to understand the diversity and taxonomy of this extraordinary genus. Many species are

infrequently observed, and the basic aspects of their biology and ecology are still unknown. Also, new species continue to be discovered as remote parts of tropical Africa and southern Asia open for exploration.

However, their extraordinary flower shapes, colours, scents, and sometimes gigantic sizes, make them fascinating plants to cultivate at home, often in conditions that are relatively easy to provide.

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