Germination of *Typhonodorum lindleyanum* at Brisbane, Australia

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The giant Madagascar swamp aroid, *Typhonodorum lindleyanum* Schott, has been successfully grown in an artificial lake at the Mt. Coot-tha Botanic Gardens near Brisbane. Plants have flowered and produced fruit and new plants have been established from the germinated seedlings. As early literature may not be readily available to some readers, a brief account of germination is given below.

Some Early Literature

This large aquatic aroid, up to 3-4 m high, with emergent stems and leaves, has been recorded in Madagascar and on the neighboring islands of Mauritius, the Comoro Islands, and Zanzibar in East Africa (Engler, 1915). A detailed description of the plants and floral parts (in Latin with German comments) and with illustrations was given by Engler. He described the berry or fruit as large (about 2.5 cm long), one-seeded and viviparous, that is, with the plumule or shoot developed within the seed while still attached to the parent plant, and with a large 'haustorial' process at the base. After flowering, the upright peduncle of the inflorescence gradually turns downwards, exhibiting positive geotropism, so that it becomes goose-necked. The fruit (already with curved shoot inside) falls into the water as the tip of the spathal chamber opens and releases them. The fruit remain floating on their sides for some time.

After the fruit has anchored into a substrate (swamp bank or whatever) the seedling produces some narrow awl-shaped leaves. Later lanceolate leaf blades gradually form until finally, likewise gradually, the sagittate or arrowhead-shaped adult leaves are produced. Engler included drawings of two germinating seedlings, one with four cataphylls (early leaf forms) and one with five cataphylls and one leaf with blade.

Ridley (1930) stated that the one-seeded and viviparous fruits of *T. lindleyanum* were eaten by the locals. He also stated that after floating, the young plant was eventually stranded in the mud. Tillich (1985) included a drawing of one germinated seed with three young and three older cataphylls, and some young roots in his short account in German.

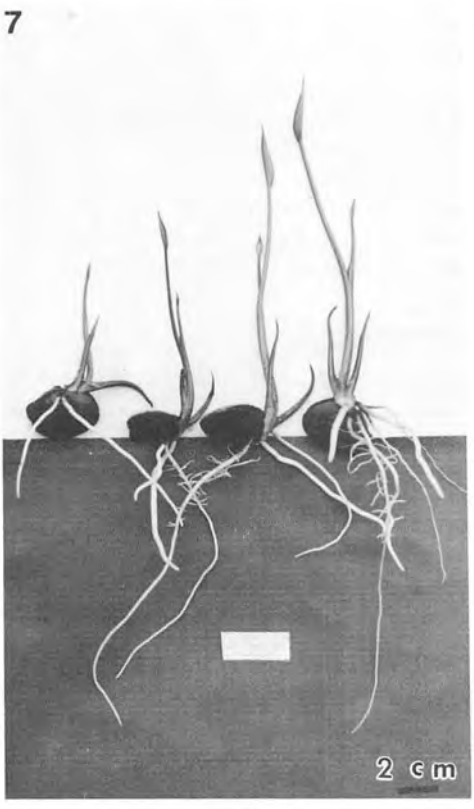
In his key of the aroids, Nicolson (1982) gave the ovules as 1 (rarely 2) orthotropous (the orientation of the ovule in the ovary in an upright position from the placenta where it is attached to the maternal tissue), the seeds as without endosperm and a very large embryo. French (1986) described ovules and their well-developed vascular system.

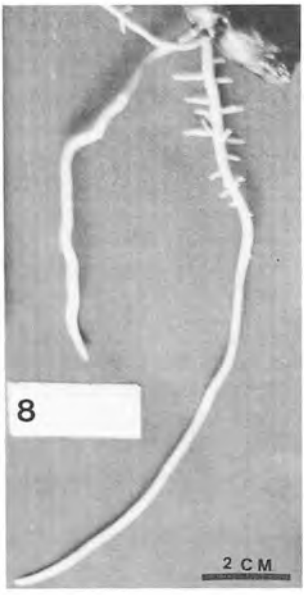
Present Germinations

As I needed to obtain seedlings of *T. lindleyanum* for a pathology study, the Curator of the Botanic Gardens gave permission for the collection of the fruit and also provided a small skiff and a staff member as rower to enable me to reach the *Typhonodorum* growing in the lake in May 1988. The group consisted of seven plants with 11 pseudostems and some infructescences (Fig. 1).

Fig. 1. *Typhonodorum lindleyanum* growing in a lake at Mt. Coot-tha Botanic Gardens in Brisbane.

Fig. 2. *T. lindleyanum* infructescence. Fig. 3. *T. lindleyanum* infructescence, cut open to show the position of the viviparous fruit which would later drop downwards into the water. Fig. 4. Yellowish fruit of *T. lindleyanum* with coats and dark brown fruit without coats floating on their sides in a deep beaker of water. Fig. 5. Four fruit of *T. lindleyanum*. Fig. 6. Four fruit showing the emerging, previously curved plumules.





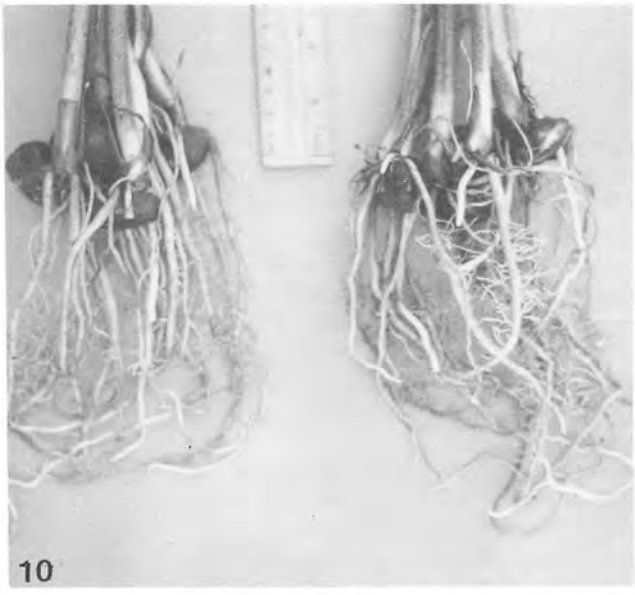


Fig. 7. Four seedlings of *T. lindleyanum* 39 days after sowing. Fig. 8. Roots of one seedling 39 days after sowing. Fig. 9. Two lots of seedlings of *T. lindleyanum*, one lot grown in damp soil and the other in water-logged soil, 9.5 weeks after sowing. Fig. 10. Roots of the seedlings shown in Fig. 9.

The oldest infructescences were already pointing downwards on curved peduncles. One detached infructescence is shown in Fig. 2 and one cut to reveal the enclosed whitish fruit in Fig. 3.

The fruit of some of the infructescences had already fallen into the water and were floating around the plants and between the water lily leaves. Some of the fruit with the outer coat still intact (now pale yellow) and some with the coat rotted off are both shown floating on their sides in a 19 cm deep beaker of water (Fig. 4). Four of the latter fruit are shown in Fig. 5 and four others with their plumules emerging from their former curved position in Fig. 6.

Eighteen of the fruit were sown on their sides in a shallow dish of potting mix (hereafter called 'soil') partially covered with water on 17 May 1988. The plumules were negatively geotropic, rising into the air. Four of the seedlings are shown in Fig. 7, taken 39 days after sowing in the tray. A close-up of the roots of one of them is shown in Fig. 8. The main roots had a reddish pigment near the base of the plant shading into white towards the tip. The lateral roots issued at right angles to the main roots and were white and translucent (Fig. 8). When examined microscopically, neither the main roots nor the laterals had root hairs.

The seedlings were grown on in food jars, nine of them in soil kept damp and nine maintained with water above the soil surface. Both lots were about 55 cm above soil level 9.5 weeks later (Fig. 9). The roots, washed free from soil, are shown in Fig. 10, and those from both damp and waterlogged soil were still without root hairs.

Some of the plants were grown on by a grower with suitable facilities and were nearly 2 m above soil level in July 1989, that is, 14 months after sowing (Fig. 11).

A further collection of infructescences was made by a Gardens staff member in September 1989 and the germination of this material followed the same pattern as previously. The main and lateral roots of the young seedlings again lacked root hairs. Microscopic examination of the roots of one of these plants after growing in an outside pond for 14 months also showed hairlessness. Roots from the plants shown in Fig. 11 were also examined microscopically 30 months after sowing when they were 2.5 m high and were also found to be without root hairs.

Comments

The roots of the seedlings and of plants up to 30 months old lacked root hairs. Although no root hairs are shown in the drawings of Engler (1915) or Tillich (1985), this fact is not mentioned by either author, even though Tillich, for example, mentioned the hairlessness of roots of other plants. Another aquatic aroid, *Pistia stratiotes* L., also lacks root hairs (Schwarz 1883; Tillich 1985; and Shaw, personal observation). Mature plants of *T. lindleyanum* in their natural habitat may also lack root hairs, and if this has not been investigated already, needs to be determined.

T. lindleyanum grows in great profusion in swamps and marshes near Tamatave (18° 10′ S latitude) and in the lower reaches of rivers on the east coast of Madagascar facing the Indian Ocean, as shown in illustrations such as those of Rüe, Boulière & Harroy (1957) and Graf (1981, 1982), although it is said to extend to 900 m altitude (Croat (1988)1990). It also grows on the Comoro Islands (about 12° S) and Zanzibar (6° 19′ S) which are much further north. It has been cultivated outdoors in the Botanic Gardens at Rio de Janeiro (22° 53′ S), as illustrated by Graf (1982) in color. The plant has also been growing outside at Brisbane (27° 30′ S) which is slightly colder than even Rio de Janeiro, as well as in the warmer geodesic dome at the Mt. Coot-tha Botanic Gardens (Shaw 1987).

Seedlings at Brisbane, however, grown in an outside pond were smaller (about 1 m high) at 14 months than those grown the previous year in the glasshouse (as shown in Fig. 11). Those

Fig. 11. Plants of *T. lindleyanum* (originally shown in Fig. 9) 14 months after growth in a glasshouse.

grown in the glasshouse had reached nearly 2 m high in the same time.

Bown (1988) described *T. lindleyanum* and mentioned that in many ways it resembles the American *Peltandra*; the latter, however, is only knee-high and its staminodes (sterile stamens) are joined together, whereas they are free in *T. lindleyanum*. Also, the three dimensional organization of vascular bundles in the ovules in *Typhonodorum* and *Peltandra* are different: in *Typhonodorum* about six bundles are symmetrically arranged around the circumference of the chalaza (the basal region of the ovule), whereas the bundles occur in the dorsal region of *Peltandra* (French 1986). Bown (1988) discussed Grayum's (1984) suggestion that *Typhonodorum* and *Peltandra* may have had the same ancestor in Africa before the continents drifted apart after populations of the plants had spread into what is now Asia and Europe and then across to North America. In this scenario those that remained on the mainland of Africa later became extinct during the ages of drought, leaving survivors in North America and on islands east of Africa. These separate populations continued to evolve: those in North America becoming *Peltandra* and the Madagascan dynasty forming the monotypic *Typhonodorum*.

Not many private gardens have growing areas large enough to contain a pond or lake suitable for the growth of this giant aquatic aroid. In large gardens, however, the plants are spectacular items in the landscape. It is also, of course, of great interest from a botanical and evolutionary point of view.

Acknowledgements

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