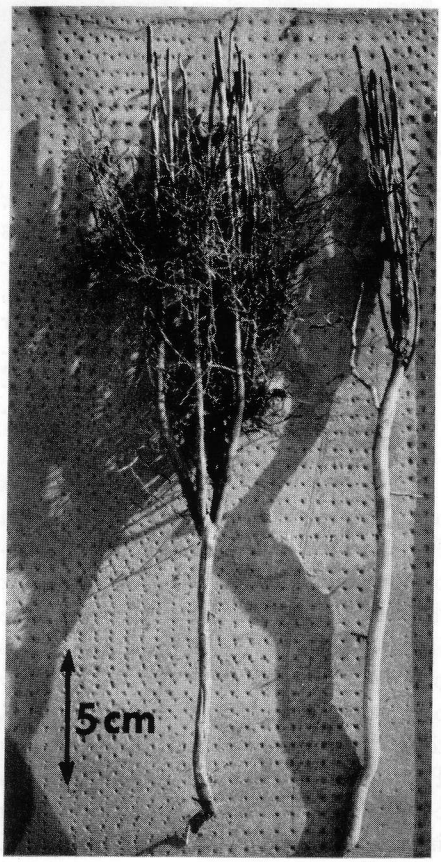
Principes, 22(4), 1978, pp. 136–141

Aerial Roots in Raphia

JEAN PIERRE CARDON*
Laboratoire de Cytogénétique et d'Ecologie,
Université des Sciences et Techniques de Lille,
59650 Villeneuve d'Ascq, France

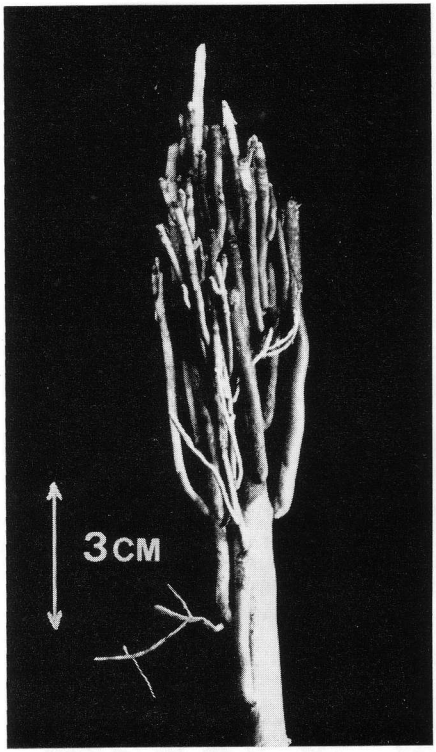
Among plants that produce aerial negatively geotropic roots, the best known are the mangrove genera, especially *Avicennia* and *Sonneratia*. Aerial roots of this kind occur in palms, especially *Raphia*, an essentially African genus (but with one species in South America) noted for the length of its leaves and inflorescences. These skirting roots were noted by Jumelle and Perrier de la Bathie (1913) in *Raphia farinifera* (*R. ruffia*) in Madagascar and by Chevalier (1932) in most of the West African species. Authors who studied the anatomy of aerial roots in several palms (Jost, 1887; Gage, 1901; Gatin, 1907) noted on the surface of these organs plates of mealy tissue, called pneumathodes by Jost, which played a respiratory role in the manner of lenticels. Here the usual external protective

1. *Raphia vinifera* in South Cameroon, to a height of 15 m.



2. *Raphia* cf. *monbuttorum*. Aspect of aerial roots.

* Translated from French by P. B. Tomlinson.



3. *Raphia farinifera.* Apical part of an aerial root forming a mass of secondary branches, each with a root cap.

4. *Raphia farinifera.* Detail of attachment and origin of root branches, to show their basal constriction.

tissues were absent and the underlying layers formed a loose tissue of rounded cells produced by a diffuse meristematic zone. These cells were sometimes covered with minute warty thickenings.

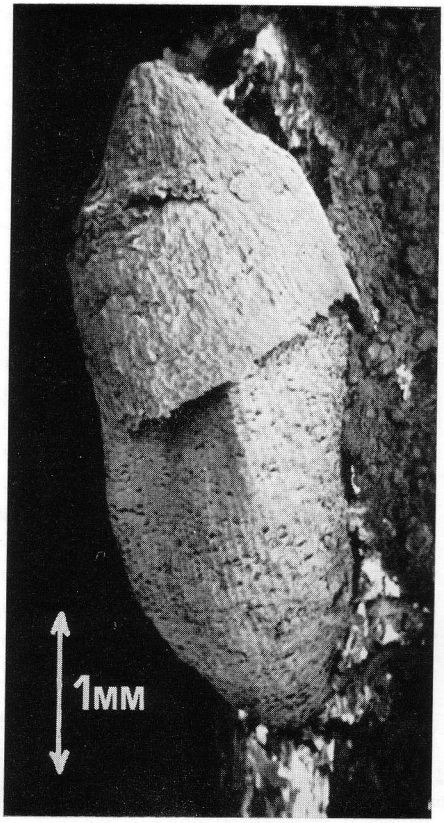
The following detailed account of the aerial roots of *Raphia* uses not only classical methods of microscopy, but the scanning electron microscope, applied to this subject for the first time.

Morphology

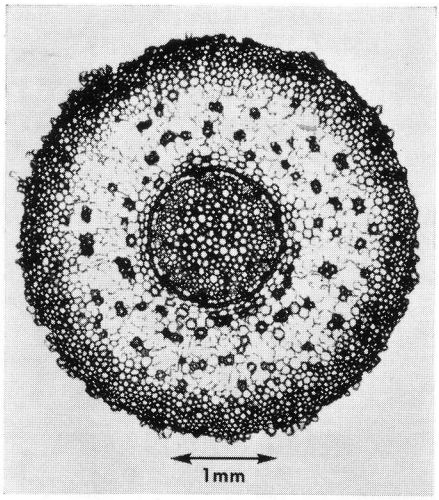
On penetrating a population of *Raphia* (Fig. 1), one discovers the surface of the swampy soil covered with a veritable carpet of aerial roots. These are produced by horizontal roots forming a subterranean network in the mud, and extend to a height of 20–30 cm above their insertion. The upper half more or less emerges above the surface of the soil or water and is branched (Fig. 2). Branches are quite numerous and form a dense mass of small secondary roots (Fig. 3). The apical root cap is clear on each of them (Figs. 4, 5).

The distribution of these secondary branches seems without order. Each new root has a pronounced negative geotropism evident from its inception. At the level of insertion of the secondary root on its parent there is a constriction where the cortex is somewhat narrower (Fig. 4).

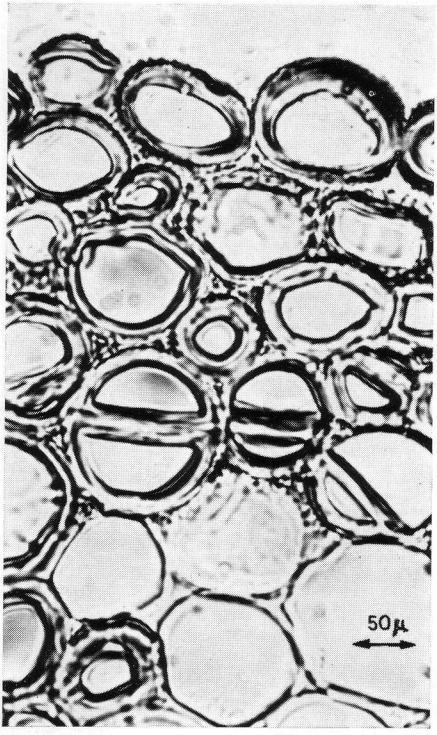
Surface observation of aerial roots



5. *Raphia farinifera.* Origin of a new lateral root (SEM photo), with prominent root cap. Exodermis still continuous.



6. *Raphia farinifera.* Transverse section of aerial root. Cortical parenchyma includes numerous fibers, mainly in groups; outer cortex without a protective layer.

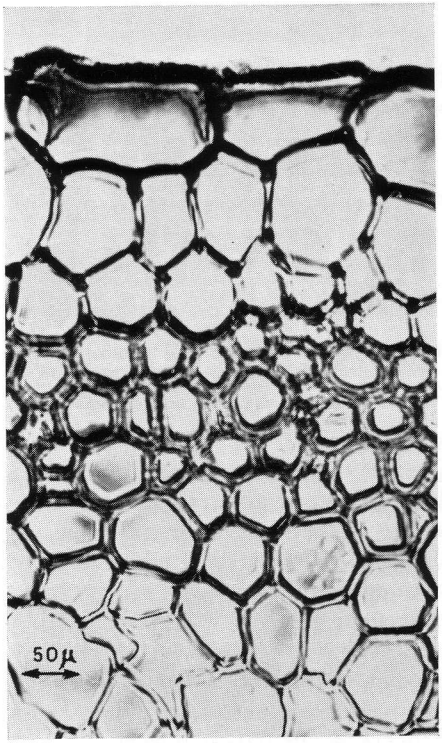


7. *Raphia farinifera.* Detail of the outer cortex of the aerial root.

with both a binocular microscope and the scanning electron microscope demonstrates the strips of exodermis between which masses of elongated, rounded cells appear. Anatomical study provides details of internal structure.

Anatomy

A transverse section of a root stained with methyl green shows the typical monocotyledonous anatomy, the central cylinder including numerous vascular strands (Figs. 6, 9). The cortical parenchyma includes an internal region composed of two or three layers of small

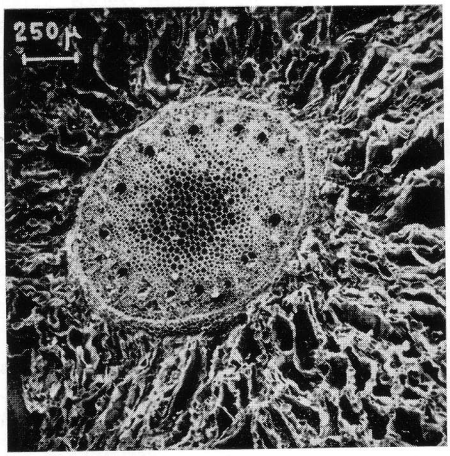


8. *Raphia farinifera.* Detail of the outer cortex of a subterranean root, for comparison with Fig. 7.

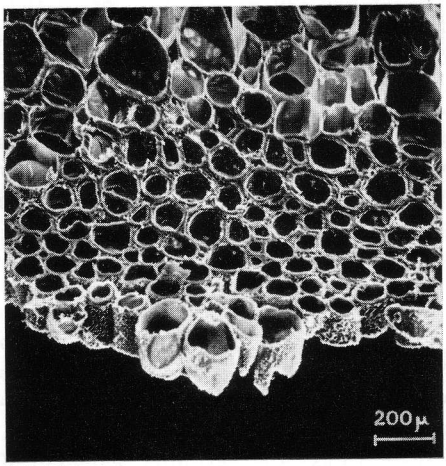
10. *Raphia farinifera.* SEM photo of cortical parenchyma to show cortical fibers which maintain some rigidity in the lacunose system.

regular cells and a middle lacunose region with radially elongated air spaces together with numerous cortical fibers, either isolated or in narrow bundles (Fig. 10).

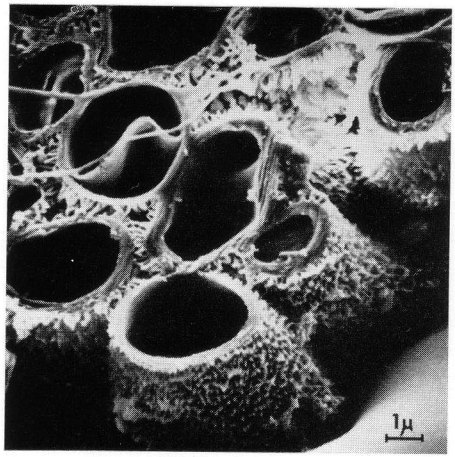
The aerial root (Fig. 7) differs from the subterranean root (Fig. 8) mainly in the outer cortex. The exodermis is developed only in the form of strips, or is completely absent. The two or three



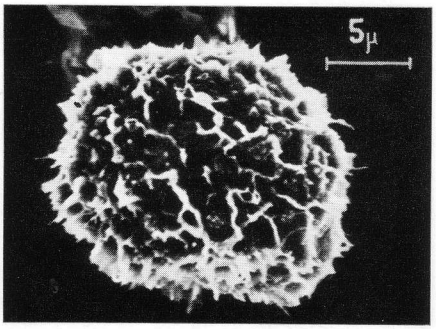
9. *Raphia farinifera.* SEM photo of central cylinder of an aerial root. Metaxylem vessels of central cylinder evident. Cortex with lacunae separated by radial files of cells.



11. *Raphia farinifera.* SEM photo of outer cortex of aerial root, the outer layers forming a loose tissue.



12. *Raphia farinifera.* SEM photo of peripheral cells showing their dissociation.



13. *Raphia farinifera.* SEM photo of peripheral cells with irregular warted sculpturing.

adjacent layers develop as a zone of rounded cells that form a loose exfoliating tissue (Fig. 11). Microscopy shows that these cells are covered with numerous minute spines (Figs. 12, 13). Towards the center of the root there is a more or less lignified zone and an adjoining zone of parenchyma 2–3 cells wide with the walls of recent divisions, forming a diffuse meristematic zone. Scanning electron microscopy shows that the peripheral cells (10 μ long, 5 μ wide) are covered by a banded network of irregular protuberances (Fig. 13). The functional interpretation of this structure is difficult, but it seems certain that the loose tissue formed by these cells facilitates gaseous exchange with the atmosphere.

Conclusions

The presence of aerial roots is tied up with the ecology of *Raphia*. Populations of *Raphia* are localized in swampy depressions and backwaters of rivers. These roots are certainly capable of aerating subterranean roots, which are found in an anaerobic substrate. This interpretation is supported by three facts. First, at all levels there is an increase in the surface for gas exchange; the surface of the mud is entirely covered by roots; each root is much branched; there is a surface proliferation of cells provided with warty bands. Second, all species of *Raphia* that occur in the Cameroons (*R. farinifera*, *R. hookeri*, *R.* cf. *monbuttorum*, *R. vinifera*) show the same root development. The only exception is *R. regalis*, which does not grow in swamps but on slopes and summits of hills in Nigeria and Gabon. Third, other plants that grow in mud develop aerial roots, such as *Avicennia*, *Sonneratia*, and other mangroves adapted to anaerobic soils.

One can conclude that the aerial roots of *Raphia* function as aerating organs or *pneumatophores*. This term is used to describe roots with *pneumathodes*, which refers to the lenticel-like structures that occur on different organs.

LITERATURE CITED

CHEVALIER, A. 1932. Nouvelles recherches sur les palmiers du genre *Raphia*. Rev. Int. Bot. Appl. Agric. Trop. 12: 93–104, 198–213.

GAGE, A. T. 1901. On the anatomy of the roots of *Phoenix paludosa* Roxb. Sci. Mem. Off. Med. Dept. Gov. India 12: 103–112.

GATIN, C. L. 1907. Observations sur l'appareil respiratoire des organes souterrains des palmiers. Rev. Gén. Bot. 19: 193–207.

JOST, L. 1887. Ein Beitrag zur Kenntniss der Athmunsorgane der Pflanzen. Bot. Zeitung (Berlin). 45: 600–606, 617–628, 633–642.

JUMELLE, H. AND H. PERRIER DE LA BATHIE. 1913. Palmiers de Madagascar. Ann. Inst. Bot.-Géol. Colon. Marseille sér. 3, 1: 83–87.

Principes, 22(4), 1978, p. 141

NOTES ON CULTURE

Proper Watering the Key to Keeping Palm Green*

In recent months, I have counted seven dead palms along my block in New York. It's not that we've taken to planting palms as street trees, of course, but a lot of people seem to have trouble keeping them alive indoors—especially the areca.

The irony in this is that while the areca (uh-REEK-uh) is the cheapest and most widely distributed palm, it is also one of the most difficult to grow as a house plant.

The chief killer of the areca is lack of water. As nearly as I can tell, this stems not so much from neglect, but from widely published and spoken advice to let it dry out between waterings.

I learned about the areca's need for soil that is always evenly moist when a super gardener friend from Florida visited me a few years ago. We had hardly exchanged proper greetings when he walked over to my sickly areca and said, "Why don't you ever give it a decent drink of water?"

It was then that I discovered what an amazing difference proper watering can make in the life of a plant. My areca is about five feet tall and grows in a 14-inch standard clay pot. I had been giving it about one quart of water a week, which meant that the soil sometimes became quite dry between waterings. In order to keep the soil always evenly moist, I have found it necessary to apply from four to six quarts of water every week.

Within six months after I switched to watering more, the new growth was shooting up vigorously—without so much as a single dead leaf tip.

In a nutshell, here is the care I recommend for areca palms: Light, some direct sun, especially in the winter, or bright light all day. Temperature, an average house during the winter heating season; avoid drafts of hot or cold air. Humidity, medium (30 per cent or more). Mist the fronds frequently with water to help keep them rain-fresh. Water generously, often enough to keep the soil moist at all times, but do not leave the pot standing in a saucer of water for more than an hour or two. Feed with a foliage plant fertilizer in the spring and summer; fish emulsion in particular is excellent for palms.

My areca has been growing in the same pot for five years without a change of soil.

ELVIN MCDONALD

* Reprinted with permission from the Miami News, February 15, 1977, copyright King Features Syndicate Inc. 1977. The technical name for the palm in question is *Chrysalidocarpus lutescens*.