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An unusual case of epigeal cryptocotylar germination in *Rollinia salicifolia* (Annonaceae)

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An unusual case of epigeal cryptocotylar germination found in *Rollinia salicifolia* Schltdl. (Annonaceae) is described and is discussed in relation to the terminology used for germination studies. The terms cryptocotylar and phanerocotylar are used to describe the permanence of cotyledons within the seed coat or endocarp; the terms epigeal and hypogeal are used to refer the position of cotyledons in relation to ground level. The terms to describe position about ground level and permanence of cotyledons within the seed coat or endocarp are not used simultaneously in many papers, and some authors consider the terms cryptocotylar and hypogeal to be synonyms. Cases of epigeal cryptocotylar germination seem to be scarce in the literature. The morphological characters shown by *R. salicifolia* seeds and seedlings – a non-chlorophyllous embryo, abundant endosperm, thick woody seed coat, thickened hypocotyl and non-photosynthetic haustorial cotyledons – are closely related to its epigeal cryptocotylar germination. This is the first record of this type of germination in Argentina. *Botanical Journal of the Linnean Society*, 2004, **146**, 53–56.

ADDITIONAL KEYWORDS: endocarp – germination terms – sclerenchymatous seed coat – seedling.

INTRODUCTION

Rollinia (Annonaceae) is a neotropical genus comprising 44 tree and shrub species, three of which occur in Argentina: *Rollinia emarginata* Schltdl., *R. rugulosa* Schltdl. and *R. salicifolia* Schltdl.

Examples of epigeal cryptocotylar germination seem to be scarce. Ricardi (1999a, b) found only three of the 90 forest species of Venezuela with this type of germination: *Guatteria saffordiana* Pittier, *R. fendleri* R. E. Fr. and *Xylopia aromatica* (Lam.) Mart. (Annonaceae). Of the 20 humid forest species of Mexico, Ibarra-Manríquez, Martínez Ramos & Oyama (2001) described five species with epigeal cryptocotylar germination. These authors, following the terminology suggested by Garwood (1996), proposed five functional types of seedling. Besides considering the position of the cotyledons with respect to the ground surface and their permanence within the seed coat or endocarp, they also considered their function in the seedling, namely photosynthesis or storage cotyledons.

Among the scarce germination reports from Argentina (Bravo, 1978; Gartland *et al.*, 1990, 1991; Orfila, 1995; Franceschini, 2000), there are no cases of epigeal cryptocotylar germination.

Duke (1969) recorded phanerocotylar germination as a general characteristic for the family Annonaceae, and also pointed out that cryptocotyly probably takes place in species with large seeds.

The purpose of this paper is to report cryptocotylar germination in *R. salicifolia* Schltdl. (Annonaceae) and morphological characters closely related with this unusual type of germination and to discuss the terminology used by different authors for germination studies.

MATERIAL AND METHODS

Voucher specimens have been deposited in the Instituto de Botánica del Nordeste Herbarium (CTES). The material was collected in: Argentina, Prov. Misiones,

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Fruits were collected and seeds were separated manually from the pulp, washed and air dried. Seeds were mechanically scarified by piercing each seed's hilum. The seeds were then placed on filter paper and cotton in transparent plastic boxes and, after germination, seedlings were transplanted to pots containing a mixture of humus and perlite. Water with fungicide was added to the boxes to prevent desiccation. The material was cultivated at ambient daytime temperature. The different stages of germination and seedling development were described and drawn using the camera lucida of a Wild M5 stereomicroscope.

RESULTS

The seeds of *R. salicifolia* are obovate, elliptical or ovate, 15–17 mm long × 10–11 mm wide × 7 mm (Fig. 1A). The seed coat is sclerenchymatous. The embryo is basal, nonchlorophyllous, 3 mm long × 1 mm wide, and is found inside a fleshy ruminate endosperm. According to Martin's (1946) terminology, the embryo belongs to the 'axile division, linear subdivision, linear type' (Fig. 1B, C).

Germination starts the eighth week after planting (Fig. 1D). On attaining a length of 25 mm, the seedling's axis becomes considerably thicker at the hypocotyl's lower part, and at the root's neck. The thickening is gradually more prominent at the hypocotyl, which acquires a green-olive colour with short parallel longitudinal reddish lines (Fig. 1E–G).

The haustorial cotyledons remain enclosed within the seed coat; the petioles start growing a little after the third week revealing the epicotyl. The apical bud remains partially hidden inside the seed coat.

Towards the 11th week, the epicotyl develops between the cotyledon petioles. Cotyledon abscission then takes place, and the first nomophyll appears showing the seed coat at the apical extreme (Fig. 1F). The scars of the cotyledons are evident because they are surrounded by hairs.

The seedling has a glabrous hypocotyl and a thin puberulent epicotyl; nomophylls are simple and alternate; the petiole is 2–4 mm long, puberulent and channelled; the limb about 15–44 mm long × 9–18 mm wide, elliptic, herbaceous, puberulent on the abaxial face, light green, with acute base and apex, and with entire margin (Fig. 1G).

DISCUSSION

The occurrence of cryptocotyly for Annonaceae species with large seeds (Duke, 1969) is confirmed here. Epigeal cryptocotylar germination in the genus *Rollinia* has already been described by Ricardi (1999a) for the seedlings of *R. fendleri*.

In the seedling of *R. salicifolia* the hypocotyl is considerably thickened, providing sufficient mechanical strength to elevate the cotyledons and the seed coat. The cotyledons are haustorial and remain enclosed within the hard sclerenchymatous seed coat.

The morphological characters found in the seed of *R. salicifolia*, as well as the nonchlorophyllous embryo, abundant endosperm and woody hard seed coat, are related to epigeal cryptocotylar germination and with the relatively long time that the sporophyte takes to initiate its development. The hard seed coat protects the embryo against temperature and humidity fluctuations and microorganismal infection. However, this character is considered unfavourable, as it slows germination and reduces palatability for animal dispersal of the seeds (Mohamed-Yasseen *et al.*, 1994).

Cryptocotylar epigeal species are related to the zoochore dispersal syndrome (Ibarra-Manríquez *et al.*, 2001).

Seedling morphological characters, e.g. thickened hypocotyl and non-photosynthetic haustorial cotyledons are related to the type of germination in *R. salicifolia*. In this species the hypocotyl is hooked at the beginning, gradually acquiring a vertical position. Although in other epigeal cryptocotylar species, the developed hypocotyl does not have sufficient strength to raise the seed, it is hooked and the seed coat gets to the ground surface (Flores, 1994).

Many authors use the word cryptocotylar when the cotyledons remain enclosed by the seed coat or endocarp, and phanerocotylar when the cotyledons emerge from these structures (Duke, 1965; Duke, 1969; Ricardi, 1999a, b). The expressions epigeal and hypogeal germination are used to describe conditions where the cotyledons are carried above or stay below ground surface, respectively, depending on the hypocotyl's development (Toledo Rizzini, 1965; Kozlowski, 1972; Montégut & Jauzein, 1979a, b; Gartland *et al.*, 1990, 1991; Díaz Lifante, 1994; Macías Rodríguez & Pérez Jiménez, 1994). These terms are not used interchangeably in the mentioned papers. Some authors consider the terms cryptocotylar and hypogeal to be synonyms (Duke, 1969; Nozzolillo, 1985; Burrows, Boag & Stockley, 1992; Ibarra-Manríquez, 1992). Flores & Rivera (1989) define these terms and describe the epigeal cryptocotylar germination in *Virola sebifera* Aubl. as a variant, because in this species, cotyledons do not emerge from the seed coat and the growth hypocotyl rises above the ground surface. In this paper, the use of both terms is suggested following Flores & Rivera (1989).

The results presented here represent the first record of this type of germination for Argentina.

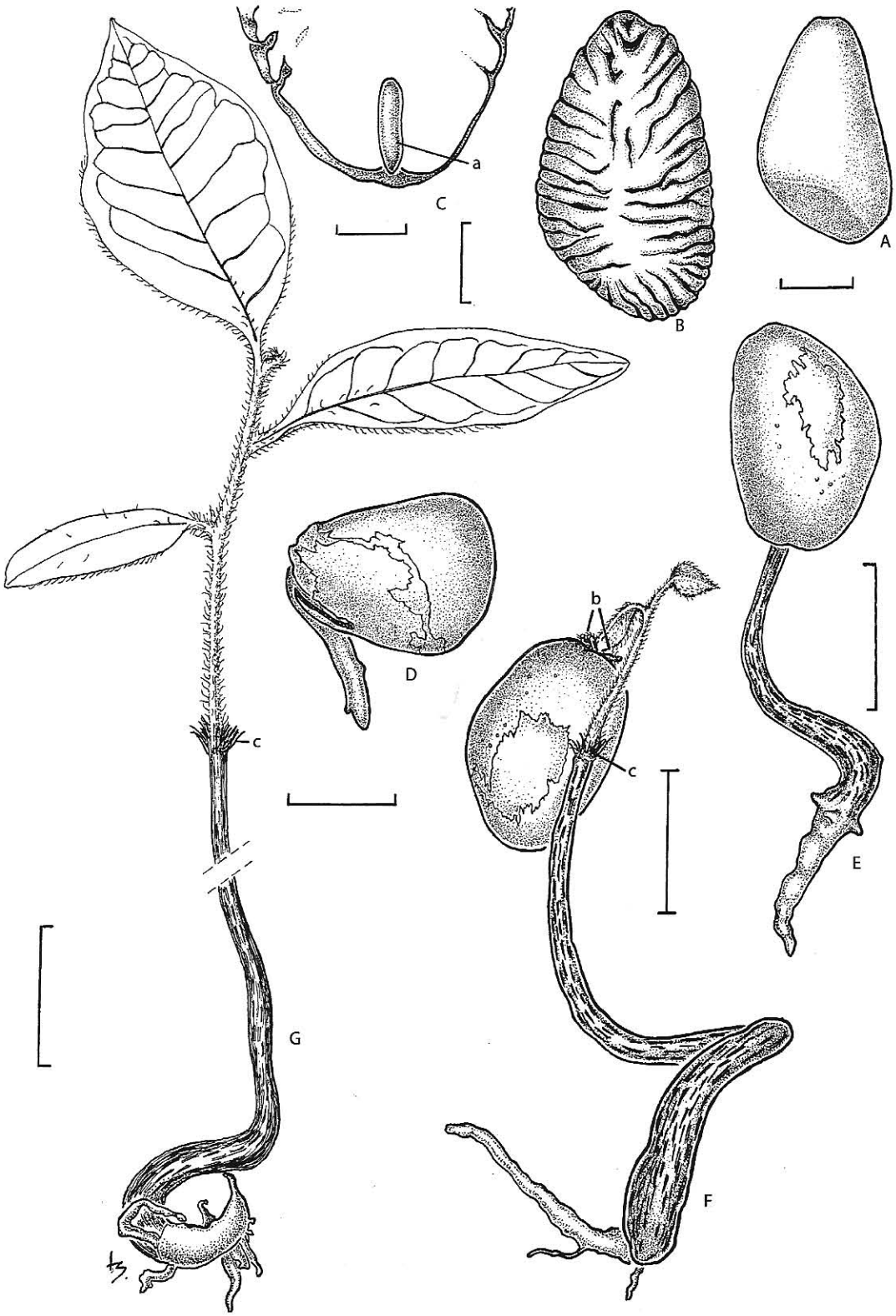

Figure 1. *Rollinia salicifolia* (Annonaceae). A, seed (scale bar = 5 mm); B, ruminate endosperm (scale bar = 4 mm); C, endosperm details showing the basal embryo (scale bar = 2 mm); D, germinating seeds (scale bar = 5 mm); E, 3rd week after germination (scale bar = 10 mm); F, seedling after 11th week of germination (scale bar = 1 mm); G, 5-month-old seedling (scale bar = 10 mm). a, embryo; b, cotyledon petioles; c, scars of cotyledons.

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