

Seedling Morphology of Some Woody Species in a Subtropical Rain Forest of Southern Taiwan

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ABSTRACT : The seedling morphology was studied in the Nanjenshan forest of southern Taiwan. A total of eighty-one species of woody plants was described and illustrated. Based on initial germination pattern, four types were recognized. The epigeal type of germination is exhibited by the majority of species (64.2%), followed by hypogeal type (18.52%), semi-hypogeal type (14.81%), and durian type (2.47%). Compared to the Malayan forest, the percentage of the epigeal type seems to be no difference, but that of the durian type is considerably lower. For the present study, all species within the same genus show only one seedling type. At family level, however, the types of seedlings are not so uniform.

KEY WORDS : Seedling, Morphology, Nanjenshan, Taiwan.

INTRODUCTION

Juvenile forms of plants, particularly of trees, are often different from those of the adult stages. Even with good field knowledge of plants it is often hard to distinguish the seedling from an adult plant of the same species. Knowledge about seedlings is of vital importance, because it provides information useful for the study of silviculture, taxonomy and ecology. Considerable works have been done on the seedling morphology in tropical and temperate regions (Lubbock, 1892; Pammel and King, 1918; Duke, 1965; Burger, 1972; Muller, 1978; Ng, 1978; de Vogel, 1980; Ye, 1983a,b). However, only few studies have been conducted on seedlings of wild species in Taiwan (e.g., Huang, 1965). Since 1994, we have studied seedling regeneration in Nanjenshan forest of southern Taiwan. Forced by the need to identify seedling species in the field, we tried to collect, raise, and figure out the seedlings. This paper presents some of the results on a number of woody seedlings which are commonly encountered in the forest of Taiwan.

MATERIALS AND METHODS

This study was conducted in a broad-leaved evergreen forest in the Nanjenshan Reserve

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(centered at 22°03'N, 120°51'E, 240-340 m asl.) of Kenting National Park of southernmost Taiwan. The forest has been classified as "Paratropical Rain forest" by Wolfe (1979). This forest is closely related to the tropical rain forest, having many families in common with it. However, it includes also members of some genera typically thought of as temperate. More extensive descriptions of forest vegetation, climate, topography, and soils can be found in the paper of Sun *et al.* (1996).

In this study, 81 species, representing 63 genera and 38 families, have been treated. In terms of major growth forms, there are 62 trees, 15 shrubs, and 4 lianas. The seedlings studied covered most dominant species in Nanjenshan forest and together accounted for 68% of the total dominance in the plot studied by Sun *et al.* (1996). During 1994 – 1996, most seedlings were observed on forest floors. Others were raised from seeds in winter season in the greenhouse of the Department of Botany, National Taiwan University. The seed samples were collected from Nanjenshan forest, except for those of the species *Ilex asprella*, *Calophyllum inophyllum*, *Engelhardtia roxburghiana*, *Micholia compressa* which were collected from Taipei and *Liodendron formosanum* from Hsinchu. After collecting, the seeds were grown immediately in pots of soil. Under normal conditions, germination occurred generally within one month. The term seedling is used here for juvenile plant about one month after germination. During this stage, the cotyledons still play important role in food supply.

Nomenclature follows the 1st and 2nd editions of the Flora of Taiwan (Li *et al.*, 1978; Huang *et al.*, 1993, 1994, 1996).

RESULTS

Four types of initial seedling morphology (Fig. 1) were recognized for the 81 species. The division of these types was based on whether the hypocotyl is developed or not and the cotyledons become exposed or hidden (Ng, 1978): (1) epigeal germination, in which the hypocotyl is developed and the cotyledons are exposed; (2) hypogeal germination, in which the hypocotyl is undeveloped and the cotyledons are hidden within the testa; (3) semi-hypogeal germination, in which the hypocotyl is undeveloped and the cotyledons are exposed; and (4) durian germination, in which the hypocotyl is developed and the cotyledons are hidden. Four more words will be used for the following descriptions of seedlings: (1) cryptocotylar: the cotyledons remain enveloped in the testa (Duke, 1965); (2) phanerocotylar: the cotyledons become entirely exposed and free from the testa (Duke, 1965); (3) eophylls: the first few leaves with green expanded lamina in a seedling above the cotyledons (Tomlinson, 1960); and (4) cataphylls: reduced or scale-like leaves succeeding the cotyledons (Duke, 1965).

For the present study, most seedlings (64.20%) belong to the epigeal type of germination. The semi-hypogeal condition is exhibited by 18.52% of our sample and the hypogeal condition by 14.81%. Only 2.47% of species show the durian condition. The descriptions and illustrations are as follows. The species are arranged in the same sequence as the Flora of Taiwan (Li *et al.*, 1978; Huang *et al.*, 1993, 1994, 1996).

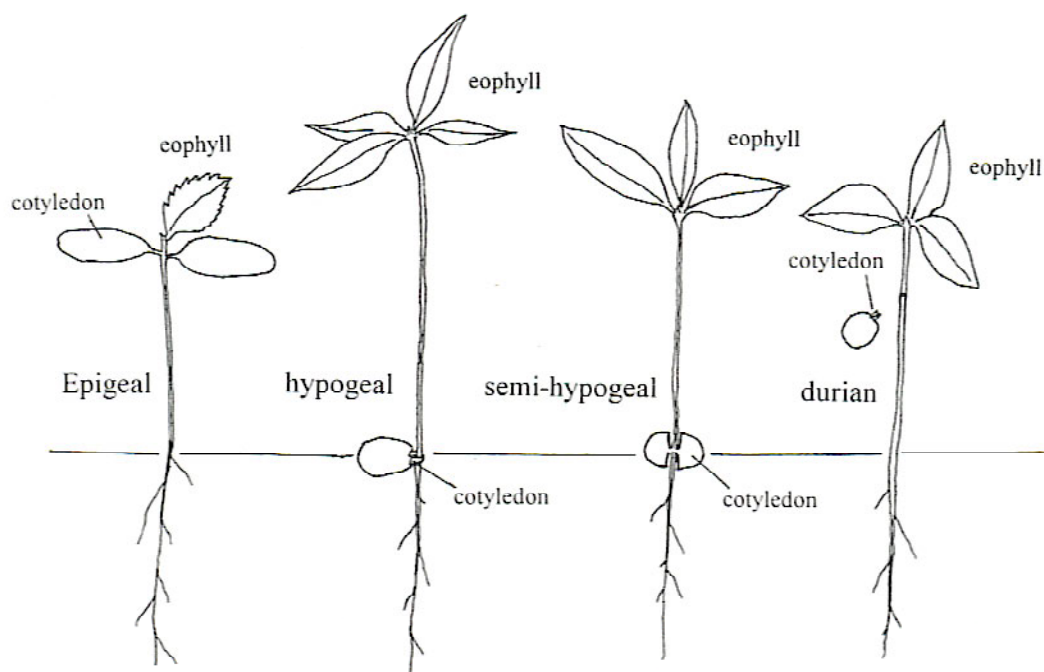


Fig. 1. Four types of initial seedling morphology.

Podocarpaceae

1. *Nageia nagi* (Thunb.) O. Ktze.

竹柏 Fig. 2

Epigeal, phanerocotylar. Hypocotyl fusiform, 4–6 cm long, glabrous, green. Cotyledons 2, opposite, linear, about 2 cm long, 0.2 cm wide, entire, sessile. Testa persistent on the cotyledon apex and drops with it. First eophylls 3–4, alternate, opposite or fasciculate, elliptic-lanceolate, entire; apex attenuate; base cuneate; veins parallel.

2. *Podocarpus macrophyllus* (Thunb.) Sweet

羅漢松 Fig. 3

Epigeal, phanerocotylar. Hypocotyl round, about 6 cm long, glabrous, green. Cotyledons 2, opposite, sessile, linear, entire, about 1.6 cm long, 0.1 cm wide; apex obtuse. First eophylls 4–7, spirally arranged, oblong, about 1.9–2.2 cm long, 0.6–0.8 cm wide, entire; apex shortly acuminate or mucronulate; base acute to cuneate; midribs raised on both surfaces.

Note: The seedlings of this species usually grow on the ground in Nanjenshan forest. But recently we found many seeds germinating already on the parent plants that have been cultivated in the garden in Taipei City. This phenomenon is vivipary.

Apocynaceae

1. *Anodendron affine* (Hook. & Arn.) Druce

錦蘭 Fig. 4

Epigeal, phanerocotylar. Hypocotyl round, about 5 cm long, glabrous. Cotyledons 2, opposite, elliptic, about 2.8 cm long, 1.5 cm wide, coriaceous, glabrous, entire; apex and base obtuse; lateral veins inconspicuous; petioles 0.25 cm long. Eophylls opposite. First eophylls 2, petiolate, elliptic, coriaceous, glabrous, entire; veins pinnate.



Fig. 2. *Nageia nagi* (x0.63); a. seedling with cotyledons; b. seedling showing first eophylls. Fig. 3. *Podocarpus macrophyllus* (x0.8). Fig. 4. *Anodendron affine* (x0.63). Fig. 5. *Ilex asprell* (x0.9). Fig. 6. *Ilex cochinchinensis* (x0.9). Fig. 7. *Ilex maximowicziana* (x0.9). Fig. 8. *Ilex rotunda* (x0.9).

Aquifoliaceae

1. *Ilex asprella* (Hook. & Arn.) Champ.

燈稱花 Fig. 5

Epigeal, phanerocotylar. Hypocotyl 4-angled, 2–3 cm long, glabrous, green. Cotyledons 2, opposite, long ovate, about 1.1 cm long, 0.4–0.5 cm wide, chartaceous, entire; apex retuse; base acute; veins inconspicuous; petioles about 0.1–0.2 cm long. Epicotyl green, glabrous. Bud green, glabrous. Eophylls alternate. First eophyll simple, broadly ovate, about 1–1.2 cm long, 0.6–0.8 cm wide, chartaceous, serrate; apex acute to attenuate; base obtuse; midrib conspicuous; petiole 0.2 cm long.

2. *Ilex cochinchinensis* (Lour.) Loes. 革葉冬青 Fig. 6
 Epigeal, phanerocotylar. Hypocotyl 4-angled, red-brownish, glabrous, 2–3 cm long. Cotyledons 2, opposite, broadly ovate, about 1.2–1.4 cm long, 0.8–1 cm wide, coriaceous, entire; apex retuse; base round to truncate; veins inconspicuous; petioles about 0.1–0.2 cm long. Epicotyl glabrous. Bud red. Eophylls alternate. First eophyll simple, ovate, about 1.3 cm long, 0.6–0.8 cm wide, coriaceous, sparsely serrate; apex and base acute; lateral veins inconspicuous; petiole 0.1–0.2 cm long.
3. *Ilex maximowicziana* Loes. 金平氏冬青 Fig. 7
 Epigeal, phanerocotylar. Hypocotyl green, 4-angled, glabrous, 2.5–4 cm long. Cotyledons 2, opposite, elliptic, about 1–1.3 cm long, 0.5 cm wide, coriaceous, entire; apex retuse; base obtuse; veins inconspicuous, shortly petiolate. Stem above the cotyledons 4-angled, glabrous, green. Eophylls alternate. First eophyll simple, petiolate, elliptic, coriaceous, serrate, about 1.2–1.5 cm long, 0.6–0.7 cm wide; apex mucronate; base cuneate; midrib sunken above and raised beneath.
4. *Ilex rotunda* Thunb. 鐵冬青 Fig. 8
 Epigeal, phanerocotylar. Hypocotyl green, 4-angled, 2–2.5 cm long, glabrous. Cotyledons 2, opposite, ovate, about 0.7–0.9 cm long, 0.5 cm wide, coriaceous, entire; apex retuse; base obtuse; midrib conspicuous; petioles about 0.1 cm long. Epicotyl and bud green, glabrous. Eophylls alternate. First eophyll simple, ovate, about 0.8–1 cm long, 0.5–0.6 cm wide, coriaceous, serrate; apex and base acute; midrib conspicuous; petiole 0.1–0.2 cm long.
5. *Ilex uraiensis* Mori & Yamamoto 烏來冬青 Fig. 9
 Epigeal, phanerocotylar. Hypocotyl red-brownish, 4-angled, glabrous, 2–3 cm long. Cotyledons 2, opposite, ovate to elliptic, about 1.5 cm long, 0.7–0.9 cm wide, coriaceous, entire; apex retuse; base round; veins inconspicuous; petioles about 0.2 cm long. Eophylls alternate. First eophyll simple, petiolate, ovate to elliptic, about 1.1–1.6 cm long, 0.6–1.1 cm wide, coriaceous, serrate; apex and base acute; veins conspicuous beneath.

Araliaceae

1. *Schefflera octophylla* (Lour.) Harms 江某 Fig. 10
 Epigeal, phanerocotylar. Hypocotyl green, glabrous, 2–3 cm long. Cotyledons 2, opposite, broadly ovate, about 1.2 cm long, 1.1 cm wide, chartaceous, entire; apex retuse; base round to truncate; veins ternate; petioles about 0.2 cm long. Eophylls alternate. First eophyll simple, orbicular-ovate, about 1.1–1.4 cm long, 1–1.2 cm wide, chartaceous, serrate; apex and base obtuse; veins conspicuous; petiole 0.6–0.7 cm long.

Boraginaceae

1. *Ehretia longiflora* Champ. ex Benth. 長葉厚殼樹 Fig. 11
 Epigeal, phanerocotylar. Hypocotyl green, pubescent, 1.5–2 cm long. Cotyledons 2, opposite, ovate, about 1–1.2 cm long, 0.8 cm wide, chartaceous, entire; apex acute; base obtuse, pubescent; veins inconspicuous; petioles 0.15 cm long. Eophylls alternate. First eophyll simple, elliptic, pubescent; margin entire or coarsely serrate toward the apex; veins pinnate; petiole 0.3–0.5 cm long.

Caparifoliaceae

1. *Viburnum odoratissimum* Ker

著生珊瑚樹 Fig. 12

Epigeal, phanerocotylar. Hypocotyl round, green, glabrous, 1.5–4.5 cm long. Cotyledons 2, opposite, narrowly ovate, coriaceous, entire; apex obtuse; base acute; veins pinnate; petioles 0.2–0.4 cm long. Epicotyl and bud covered with stellate hairs. Eophylls opposite. First eophylls 2, opposite, obovate, coriaceous, serrate; apex and base acute; veins pinnate and covered with stellate hairs; petioles 0.2–0.3 cm long.

Celastraceae

1. *Microtropis japonica* (Fr. & Sav.) Hall. f.

日本賽衛矛 Fig. 13

Epigeal, phanerocotylar. Hypocotyl round green, glabrous, with 2 vertical grooves, 3.5–4 cm long. Cotyledons 2, opposite, shortly petiolate, elliptic to broadly elliptic, about 2.5 cm long, 1.5–1.7 cm wide, coriaceous, entire; apex and base round; midrib raised above. Epicotyl alternate, with 2 pairs cataphylls. Eophylls alternate. First eophyll simple, shortly petiolate, oblanceolate, 2.7–3.4 cm long, 0.7–1.1 cm wide, coriaceous, entire; apex obtuse; base cuneate; midrib raised above; stipule triangular.

Chloranthaceae

1. *Sarcandra glabra* (Thunb.) Nakai

草珊瑚(紅果金粟蘭) Fig. 14

Epigeal, phanerocotylar. Hypocotyl round, green, glabrous, about 1–3 cm long. Cotyledons 2, opposite, round, about 1.9 cm long, 1.9 cm wide, coriaceous, entire; apex retuse or round; base obtuse; lateral veins inconspicuous; petioles 0.4–0.5 cm long. Epicotyl and bud green, glabrous. Eophylls opposite. First eophylls 2, opposite, elliptic, about 1.4–2 cm long, 1–1.3 cm wide, coriaceous, serrate; apex and base acute; midribs raised above, lateral veins inconspicuous; stipules forked; petioles 0.2–0.3 cm long.

Daphniphyllaceae

1. *Daphniphyllum glaucescens* Blume ssp. *oldhamii* (Hemsl.) Huang 奧氏虎皮楠 Fig. 15

Epigeal, phanerocotylar. Hypocotyl green, round, glabrous, 3.6–6 cm long. Cotyledons 2, opposite, linear, about 1.2 cm long, 0.2–0.3 cm wide, chartaceous, entire; apex obtuse; veins inconspicuous, sessile. First eophylls 2, opposite, elliptic, 2.2–3 cm long, 1.5 cm wide, chartaceous, upper portion lobed, green above, whitish beneath; apex acuminate to attenuate; base acute; midribs conspicuous; petioles 0.3–0.7 cm long. Second eophyll simple.

Ebenaceae

1. *Diospyros discolor* Willd.

毛柿 Fig. 16

Epigeal, phanerocotylar. Hypocotyl dark, round, sturdy, about 9.5 cm long. Cotyledons 2, sessile, opposite, fleshy, oblong, about 2.2–2.6 cm long, 1.5 cm wide, lacteus, entire, caducous. First eophylls 2, opposite, ovate-elliptic, 5.5–6 cm long, 3.3 cm wide, coriaceous, green above, with white sericeous hairs beneath; apex acuminate; base obtuse. Second eophyll, simple, oblong-lanceolate, about 8 cm long, 1.8 cm wide.

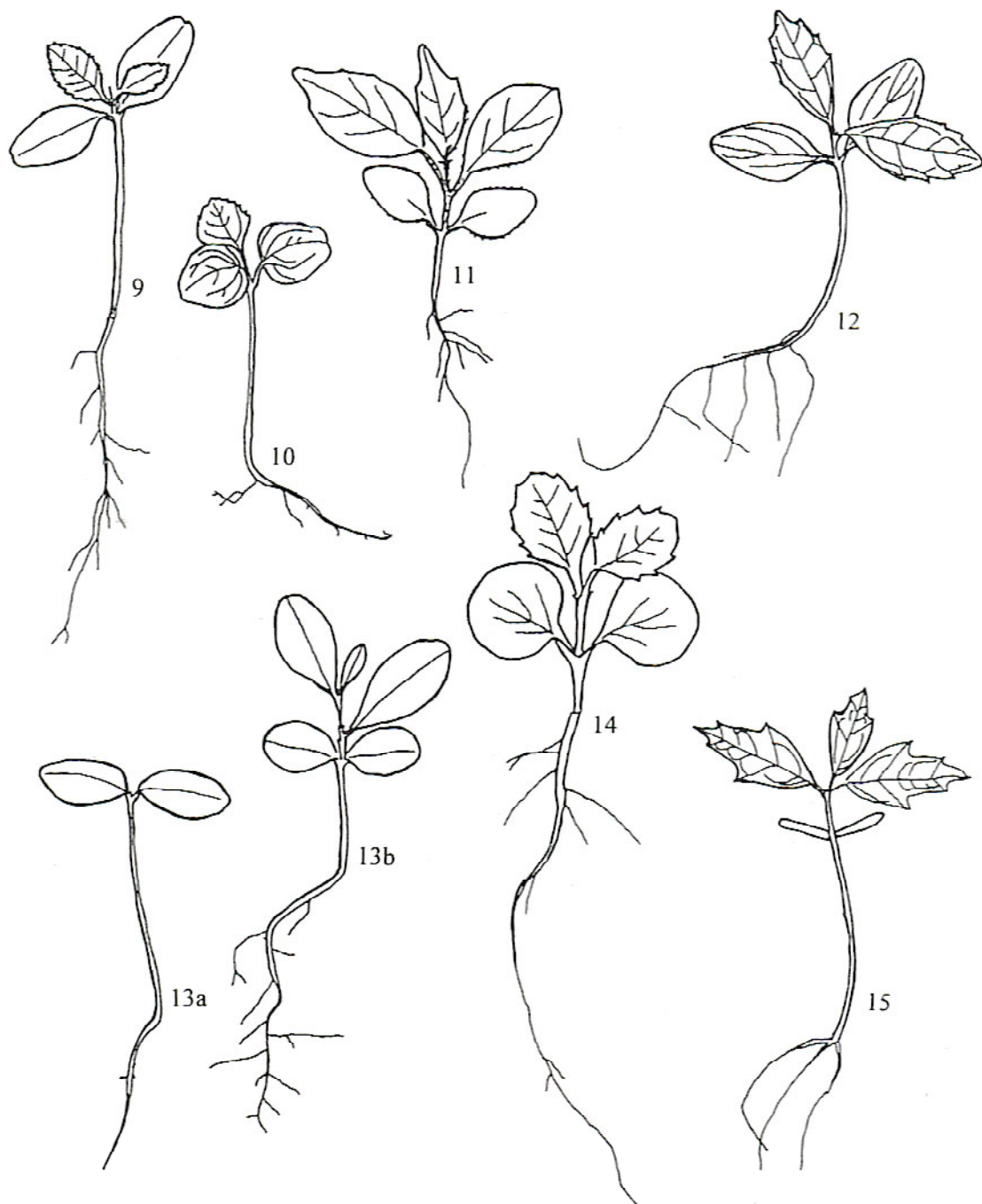


Fig. 9. *Ilex uraiensis* (x1). Fig. 10. *Schefflera octophylla* (x1). Fig. 11. *Ehretia longiflora* (x1). Fig. 12. *Viburnum odoratissimum* (x0.6). Fig. 13. *Microtropis japonica* (x0.6); a: cotyledon stage; b: eophylls developed and the cotyledons still attached on the stem. Fig. 14. *Sarcandra glabra* (x1). Fig. 15. *Daphniphyllum glaucescens* ssp. *oldhamii* (x0.6).

2. *Diospyros eriantha* Champ. ex Benth.

軟毛柿 Fig. 17

Epigeal, phanerocotylar. Hypocotyl red-brownish, glabrous, 3.5–6 cm long. Cotyledons 2, opposite, sessile, oblong, about 1 cm long, 0.4–0.5 cm wide, lacteus, entire, caducous; apex obtuse. Epicotyl and bud pubescent. First eophylls 2, opposite, broadly ovate, about 2.4 cm long, 1.7–1.9 cm wide, coriaceous, green above, whitish beneath; apex obtuse; base

rounded; margin entire and ciliated; veins pubescent beneath; petioles 0.2 cm long. Second eophyll, narrow elliptic, simple.

Elaeocarpaceae

1. *Elaeocarpus sylvestris* (Lour.) Poir.

杜英 Fig. 18

Epigeal, phanerocotylar. Hypocotyl green, glabrous, 4 – 4.5 cm long. Cotyledons 2, opposite, ovate-elliptic, about 2.5 cm long, 1 – 1.1 cm wide, chartaceous, entire; apex obtuse; veins ternate, shortly petiolate. Epicotyl pubescent, reddish. Bud pubescent. Eophylls alternate. First eophyll simple, elliptic, 3.8 – 4.1 cm long, 1 – 1.5 cm wide, chartaceous, sparsely serrate; apex acute to attenuate; base cuneate; midrib raised beneath, reddish; petiole 0.2 cm long.

Euphorbiaceae

1. *Acalypha suirenbiensis* Yamamoto

花蓮鐵莧 Fig. 19

Epigeal, phanerocotylar. Hypocotyl round, green, pubescent, about 2-3 cm long. Cotyledons 2, opposite, elliptic, about 0.6 cm long, 0.4-0.5 cm wide, chartaceous, entire, covered with white velutinous hairs; apex round; base acute. Epicotyl and bud green, pubescent. Eophylls alternate. First eophyll simple, ovate-elliptic, about 1.3 cm long, 0.6 cm wide, chartaceous; serrate, covered with white velutinous hairs; apex acute to acuminate; base cuneate; veins pinnate; petioles about 0.2 cm long.

2. *Bischofia javanica* Blume

茄苳 Fig. 20

Epigeal, phanerocotylar. Hypocotyl round, green, glabrous, about 3 cm long. Cotyledons 2, opposite, nearly round, about 1.5 cm long, 1.1 cm wide, coriaceous, entire, glabrous; apex round; base obtuse; veins pinnate; petioles about 0.3 cm long. Eophylls alternate. First eophyll simple, ovate, about 1.7 cm long, 1 cm wide, chartaceous, serrate; apex acute; base obtuse; veins pinnate; stipule triangular, 0.2 cm long; petiole 0.2 – 0.4 cm long.

3. *Bridelia halansae* Tutch.

刺杜蜜 Fig. 21

Epigeal, phanerocotylar. Hypocotyl green, pubescent, 3-3.5 cm long. Cotyledons 2, opposite, obcordate, about 0.6 – 0.7 cm long, 0.8 cm wide, green, slightly fleshy, caducous, entire; apex emarginate; shortly petiolate, pubescent. Epicotyl pubescent. Eophylls green above, whitish beneath. First eophylls 2, opposite, elliptic to ovate, 2 – 2.6 cm long, 1 – 1.4 cm wide, chartaceous, entire; apex acute; base acuminate; veins pinnate; stipules triangular, pubescent; petioles 0.1 – 0.2 cm long, pubescent. Second eophyll simple, elliptic; apex and base acute.

4. *Croton cascarilloides* Raeush.

裏白巴豆 Fig. 22

Epigeal, phanerocotylar. Hypocotyl round, green, covered with white stellate hairs, about 3.5 cm long. Cotyledons 2, opposite, nearly round, about 1.3 cm long, 1 cm wide, chartaceous, entire, covered with sparsely white hairs; apex and base round; vein ternate; petioles 0.15 cm long. Epicotyl covered with white stellate hairs. First eophyll simple, elliptic, chartaceous, green above and covered with white stellate hairs, the under surface covered with silvery peltate scales, the scales are stellated-hairiness; veins inconspicuous; petiole about 0.25 cm long.

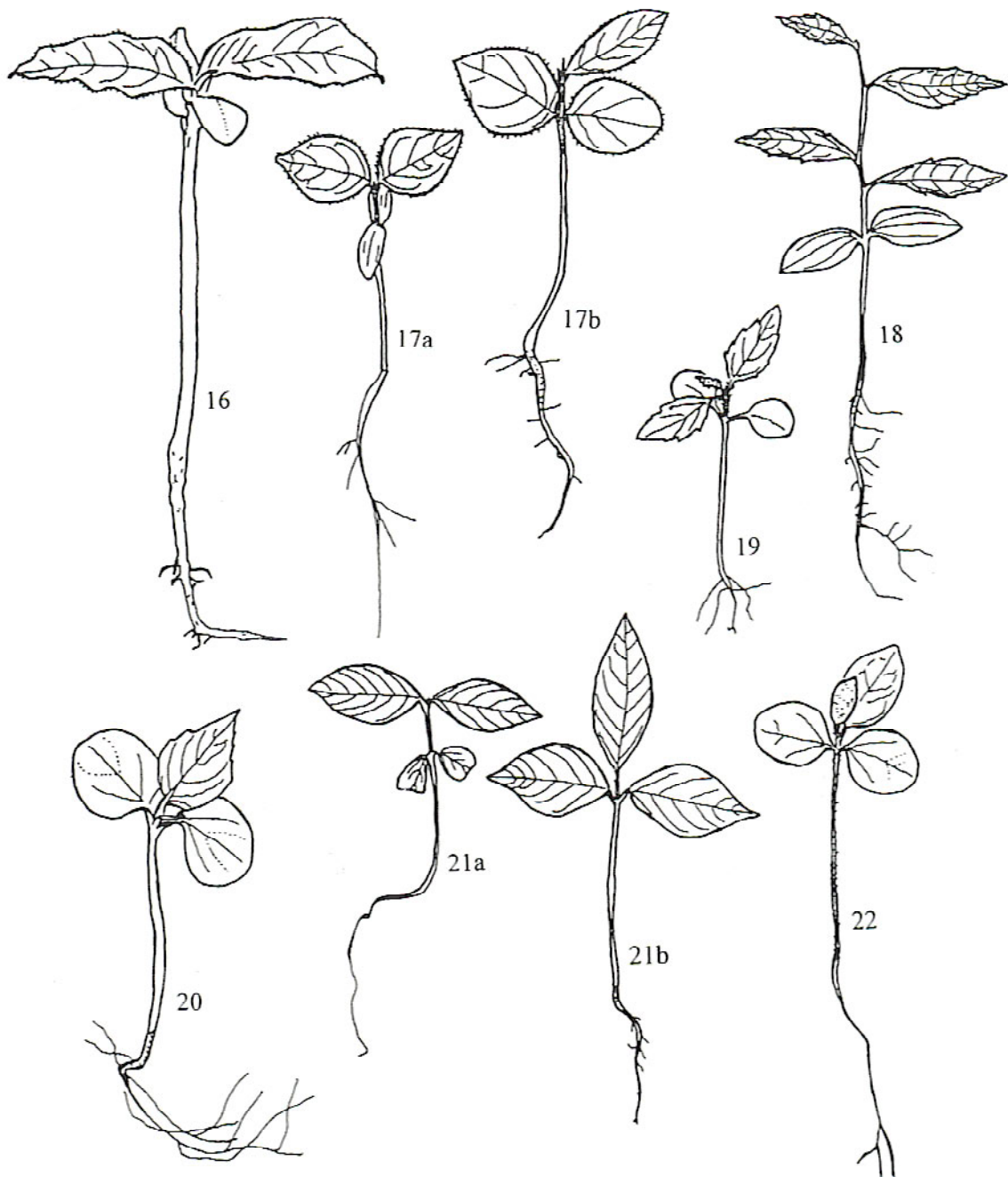


Fig. 16. *Diospyros discolor* (x0.5). Fig. 17. *Diospyros eriantha* (x0.7); a: seedling with first ephylls and cotyledons; b: seedling at three-ephyll stage. Fig. 18. *Elaeocarpus sylvestris* (x0.5). Fig. 19. *Acalypha suirensiensis* (x1). Fig. 20. *Bischofia javanica* (x0.9). Fig. 21. *Bridelia balansae* (x0.75); a: seedling showing first ephylls and cotyledons; b: seedling at three-ephyll stage. Fig. 22. *Croton cascarilloides* (x0.8).

5. *Drypetes karapinensis* (Hayata) Pax

交力坪鐵色 Fig. 23

Epigeal, phanerocotylar. Hypocotyl round, green, pubescent, about 7-8 cm long. Cotyledons 2, opposite, broadly ovate, about 4 cm long, 3.2 - 3.8 cm wide, chartaceous, entire; apex acuminate; base cordate; veins ternate; petioles ca. 0.5 cm long, pubescent. Ephylls alternate. First ephyll simple, narrowly elliptic, about 7 cm long, 2 cm wide, chartaceous, entire; apex acuminate to caudate; base acute; veins pinnate; petiole 0.3 cm long.

6. *Drypetes littoralis* (C. B. Rob.) Merr. 鐵色 Fig. 24
Epigeal, phanerocotylar. Hypocotyl round, covered with brown hairs, green, 6–7 cm long. Cotyledons 2, opposite, elliptic, about 3–3.5 cm long, 1.7–2 cm wide, coriaceous, entire, glabrous; apex round; base obtuse; veins ternate, raised and with groove above; petioles 0.15–0.2 cm long, pubescent. Epicotyl covered with brown hairs. Eophylls alternate. First eophyll simple, elliptic, about 4.8 cm long, 1.6 cm wide, coriaceous, serrate; apex and base acute; midrib raised and with groove above.
7. *Glochidion rubrum* Blume 細葉餛飩果 Fig. 25
Epigeal, phanerocotylar. Hypocotyl glabella, 1.5–2.5 cm long. Cotyledons 2, opposite, shortly petiolate, oblate, about 1–1.2 cm long, 0.7 cm wide, chartaceous, entire; apex and base rounded; veins pinnate. Epicotyl pubescent. Eophylls alternate. First eophyll simple, shortly petiolate; stipulate, obovate-lanceolate, 1.2–1.5 cm long, 0.9 cm wide, chartaceous, entire, pubescent; apex mucronate; base cuneate.
8. *Liodendron formosanum* (Kanehira & Sasaki) Keng 臺灣假黃楊 Fig. 26
Durian, cryptocotylar. Hypocotyl fusiform, green, pubescent, 2–3 cm long. Cotyledons 2, hidden in testa. The hypocotyl carrying the enclosed cotyledons on top. When the epicotyl is developed, cotyledons drop with testa. Epicotyl pubescent. Cataphylls alternate. First eophylls several, alternate, ovate-elliptic, about 2–2.5 cm long, 0.6–0.8 cm wide, chartaceous, glabrous, serrate; apex acuminate; base acute; midribs raised above; petioles 0.2 cm long.
9. *Mallotus paniculatus* (Lam.) Muell.-Arg. 白飽子 Fig. 27
Epigeal, phanerocotylar. Hypocotyl green, pubescent, about 5.5 cm long. Cotyledons 2, opposite, oblate, 1.1–1.3 cm long, 0.8–1 cm wide, chartaceous, pubescent, entire; apex and base round; veins ternate; petioles 0.4–0.5 cm long. First eophyll simple, stipulate, ovate, chartaceous, pubescent, serrate; apex acuminate; petiole about 0.2 cm long.
10. *Sapium discolor* Muell.-Arg. 白白 Fig. 28
Epigeal, phanerocotylar. Hypocotyl round, glabrous, about 1 cm long. Cotyledons 2, opposite, oblong, ca. 1 cm long, 0.5 cm wide, chartaceous, entire; apex round; base obtuse; veins ternate; petioles about 0.3 cm long. Epicotyl glabrous. First eophylls 2, opposite, ovate-lanceolate to ovate, 1.7–2 cm long, 0.7–1 cm wide, chartaceous, entire; apex acute; veins pinnate; petioles about 1 cm long. Second eophyll simple.

Fagaceae

1. *Castanopsis formosana* (Skan) Hayata 臺灣栲 Fig. 29
Hypogean, cryptocotylar. Cotyledons 2, together at side of stem, enclosed within testa. Stem above the cotyledons covered with brown hairs. First eophylls alternate, obovate, coriaceous, glabrous, serrate, green above, silvery beneath; apex acuminate to caudate; base cuneate; veins pinnate, raised beneath; stipules covered with brown hairs; petioles swelling at base.

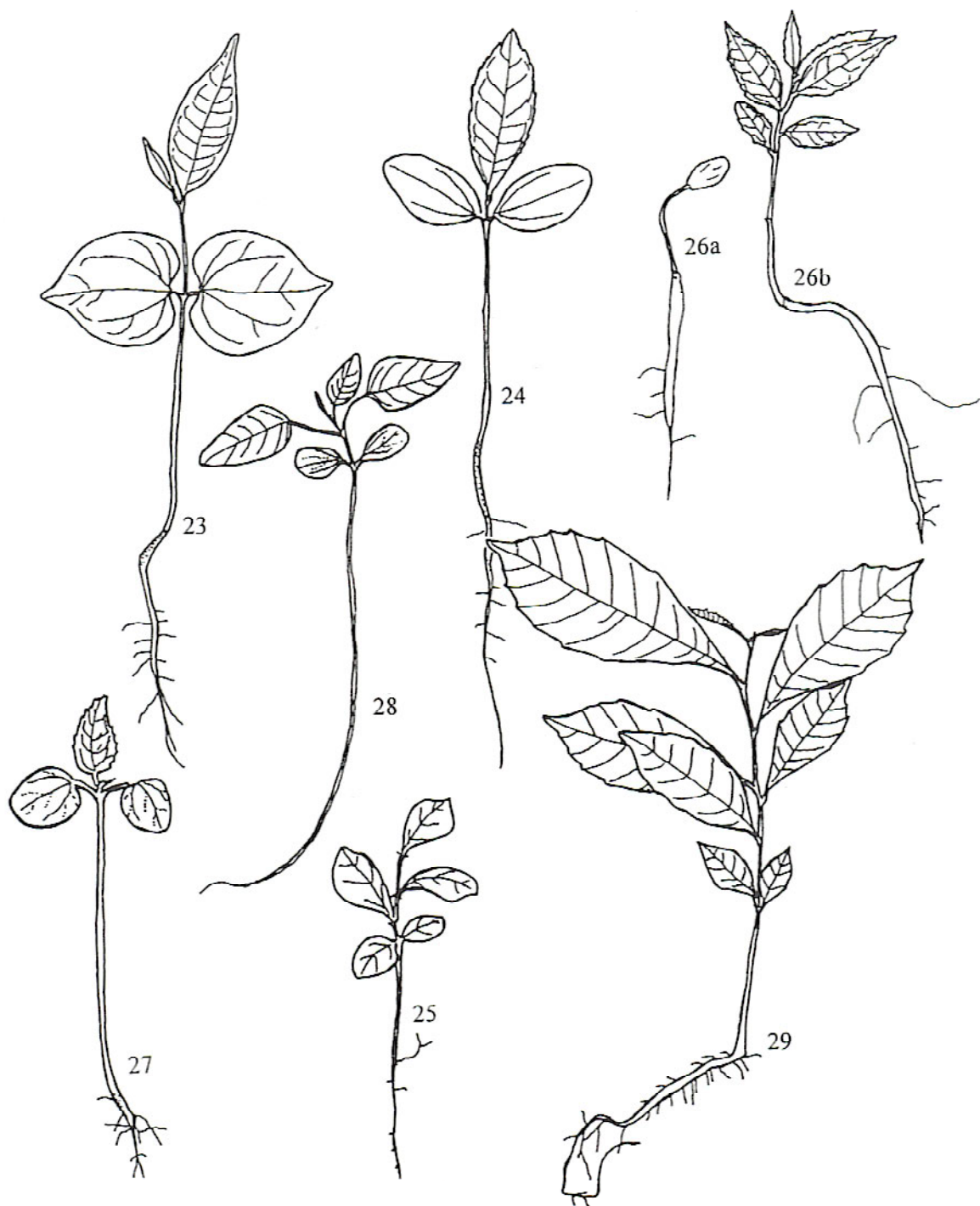


Fig. 23. *Drypetes karapinensis* (x0.5). Fig. 24. *Drypetes littoralis* (x0.5). Fig. 25. *Glochidion rubrum* (x0.6).
 Fig. 26. *Liodendron formosanum* (x0.6). Fig. 27. *Mallotus paniculatus* (x0.8). Fig. 28. *Sapium discolor* (x0.5).
 Fig. 29. *Castanopsis formosana* (x0.35).

2. *Cyclobalanopsis championii* (Benth.) Oerst.

嶺南桐 Fig. 30

Hypogeal, cryptocotylar. Cotyledons 2, together at side of stem, enclosed within testa. Plant covered with stellate hairs. Epicotyl about 5.5 cm long. Cataphylls alternate. First eophylls 2, opposite, petiolate, elliptic, about 4.5 cm long, 1.5 cm wide, coriaceous, entire; apex acuminate; base acute; stipules triangular, about 0.15 cm long.

3. *Cyclobalanopsis longinix* (Hayata) Schott.

錐果櫟 Fig. 31

Hypogeal, cryptocotylar. Cotyledons 2, together at side of stem, enclosed within testa. Epicotyl glabrous, about 9 cm long. First eophylls 4, whorled, ovate-lanceolate, 3–4 cm long, 0.8–1.2 cm wide, serrate; apex attenuate; base acute; veins pinnate; stipules triangular, about 0.2 cm long; petioles 0.2–0.4 cm long, pubescent.

4. *Cyclobalanopsis pachyloma* (O. Seem.) Schott.

金斗桐 Fig. 32

Hypogeal, cryptocotylar. In early stage of germination, plant covered with brown hairs. In later stage, leaves glabrous, bud and nodes pubescent. Cotyledons 2, together at side of stem, enclosed within testa. Eophylls opposite. First eophylls opposite, lanceolate, about 10 cm long, 2.5–2.8 cm wide, coriaceous, entire; apex and base acute; veins pinnate; stipules triangular, about 0.3 cm long; petioles about 0.7 cm long.

Guttiferae

1. *Calophyllum inophyllum* L.

瓊崖海棠 Fig. 33

Hypogeal, cryptocotylar. Cotyledons 2, fleshy, together at side of stem, enclosed within testa. Stem above the cotyledons terete, glabrous. Cataphylls alternate, elliptic, about 0.5 cm long, 0.2 cm wide; petioles about 0.3 cm long. First eophylls opposite, elliptic, coriaceous, entire; apex rounded; veins numerous, pinnate; petioles about 0.5 cm long.

2. *Garcinia multiflora* Champ.

恆春福木 Fig. 34

Hypogeal, cryptocotylar. Cotyledons are rudimentary or absent. During germination the testa remains persistent around the hypocotyl. The taproot emerges from apex of the seed. The shoot emerges opposite to the root, from the base of the seed. Epicotyl green, round, 5–9 cm long, glabrous. Cataphylls opposite, 1–3-paired. First eophylls 2, opposite, elliptic to narrowly elliptic, 6–6.5 cm long, 2–2.4 cm wide, coriaceous, entire; apex acute; veins inconspicuous; petioles about 0.5 cm long.

Illiciaceae

1. *Illicium arborescens* Hayata

紅花八角 Fig. 35

Epigeal, phanerocotylar. Hypocotyl green, round, 3.5–6 cm long, glabrous. Cotyledons 2, opposite, petiolate, elliptic to round, about 2.1–3.3 cm long, 1.9–2.1 cm wide, fleshy, entire; apex round; veins inconspicuous. Bud red. Eophylls alternate. First eophyll simple, obovate to elliptic, about 3.5–4.5 cm long, 1.5–2 cm wide, green, coriaceous, entire; apex and base acute; veins inconspicuous; petiole 0.2–0.3 cm long.

Juglandaceae

1. *Engelhardtia roxburghiana* Wall.

黃杞 Fig. 36

Epigeal, phanerocotylar. Hypocotyl terete, green, pubescent, about 3–4 cm long. Cotyledons 2, opposite, about 1 cm long, 1.6 cm wide, 4-lobed, the lobes divided nearly to the base, chartaceous; petioles about 0.2 cm long; apex round; base acute. Stem above the cotyledons pubescent. Eophylls alternate. First eophyll simple, elliptic, about 1.7 cm long, 0.7 cm wide, chartaceous, serrate; apex and base acute.

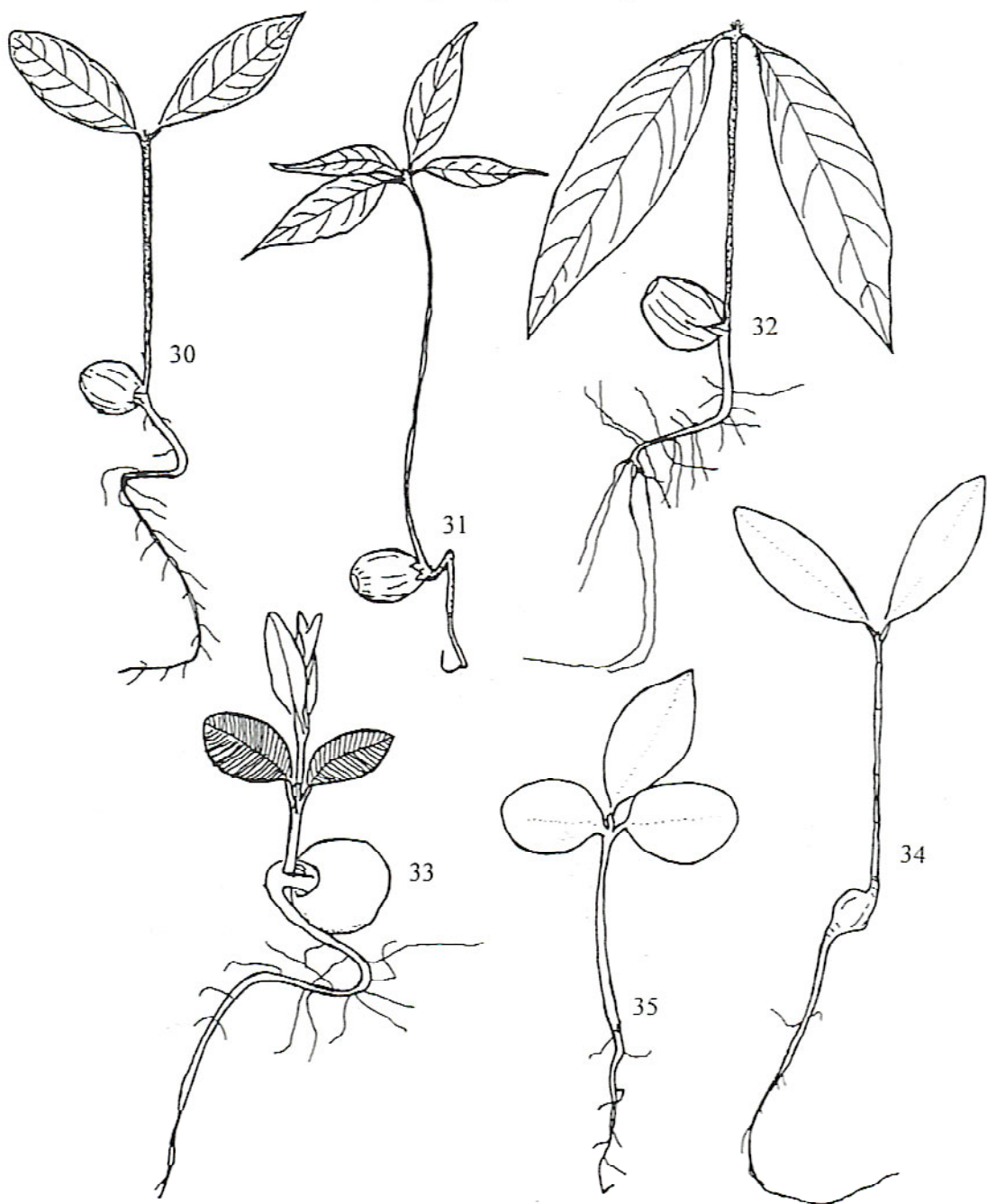


Fig. 30. *Cyclobalanopsis championii* (x0.6). Fig. 31. *Cyclobalanopsis longinux* (x0.6). Fig. 32. *Cyclobalanopsis pachyloma* (x0.5). Fig. 33. *Calophyllum inophyllum* (x0.6). Fig. 34. *Garcinia multiflora* (x0.5). Fig. 35. *Illicium arborescens* (x0.7).

Lauraceae

1. *Beilschmiedia tsangii* Merr.

廣東瓊楠 Fig. 37

Hypogeal, cryptocotylar. Cotyledons 2, together at side of stem, enclosed within testa. Epicotyl pubescent, about 7 cm long. Bud pubescent. Cataphylls alternate. Eophylls alternate. First eophyll simple, elliptic, about 4.9 cm long, 2.1 cm wide, coriaceous, entire; apex shortly caudate; base obtuse; petiole about 0.25 cm long.

2. *Cryptocarya concinna* Hance

海南厚殼桂 Fig. 38

Hypogeal, cryptocotylar. Cotyledons 2, together at side of stem, enclosed within testa. Epicotyl and bud covered with brown hairs, about 6 cm long. First eophylls 2, opposite, elliptic, about 3.5 cm long, 1.4–1.7 cm wide, entire; apex acute; base obtuse; veins pinnate, pubescent; petioles 0.35 cm long.

3. *Litsea acutivena* Hayata

銳脈木薑子 Fig. 39

Semi-hypogeal, semi-cryptocotylar. Cotyledons 2, borne opposite on either side of the stem and covered with testa, hard succulent. Epicotyl pubescent, covered with brown hairs, 5.5–6.5 cm long. Cataphylls alternate, about 0.4 cm long. First eophylls 3, alternate, spirally arranged, elliptic, 2–3.6 cm long, 0.8–1.7 cm wide, coriaceous, entire, green above, whitish beneath; apex and base acute; veins pinnate, raised beneath, pubescent; petioles pubescent. Second eophyll simple, narrowly elliptic, with several bracts covering the stem under the second eophyll.

4. *Machilus japonica* Sieb. & Zucc. var. *kusanoi* (Hayata) Liao

大葉楠 Fig. 40

Semi-hypogeal, semi-cryptocotylar. Cotyledons 2, borne opposite on either side of the stem and covered with testa, hard succulent. Epicotyl glabella, about 8 cm long. Bud covered with brown hairs. Cataphylls alternate. First eophylls 3, alternate, elliptic to narrow elliptic, 4–5 cm long, 1.2–1.8 cm wide, entire; apex and base acute; veins pinnate; petioles 0.3–0.4 cm long, pubescent.

5. *Machilus obovatifolia* (Hayata) Kanehira & Sasaki

倒卵葉楠 Fig. 41

Semi-hypogeal, semi-cryptocotylar. Cotyledons 2, borne opposite on either side of the stem and covered with testa, hard succulent. Epicotyl green, pubescent, about 4–5 cm long. Bud pubescent, red. Cataphylls alternate. First eophylls 3, alternate, obovate to elliptic, 2–4.4 cm long, 1–1.7 cm wide, coriaceous, entire, green above and whitish beneath; apex obtuse; base acute; midrib conspicuous, reticulate veins conspicuous beneath; petioles red, 0.3–0.4 cm long.

6. *Machilus thunbergii* Sieb. & Zucc.

紅楠 Fig. 42

Semi-hypogeal, semi-cryptocotylar. Cotyledons 2, borne opposite on either side of stem and covered with testa, hard succulent. Epicotyl glabella, about 8–16 cm long. Bud covered with brown hairs. Cataphylls alternate. First eophylls 3, alternate, petiolate, narrowly ovate, 4.2–6.2 cm long, 1.2–2.1 cm wide, chartaceous, entire, green above, green-whitish beneath with very shortly white hairs; apex and base acute.

7. *Machilus zuihoensis* Hayata

香楠 Fig. 43

Semi-hypogeal, semi-cryptocotylar. Cotyledons 2, borne opposite on either side of the stem and covered with testa, hard succulent. Epicotyl covered with brown hairs, about 7 cm long. Bud covered with brown hairs. Cataphylls alternate. First eophylls 2, alternate, lanceolate, 2.5–3.3 cm long, 0.8–1 cm wide, chartaceous, entire, green above and whitish beneath; apex and base acute; petioles about 0.3 cm long.

8. *Neolitsea buisanensis* Yamamoto & Kamikoti

武威山新木薑子 Fig. 44



Fig. 36. *Engelhardtia roxburghiana* (x1). Fig. 37. *Beilschmiedia tsangii* (x0.6). Fig. 38. *Cryptocarya concinna* (x0.7). Fig. 39. *Litsea acutivena* (x0.5). Fig. 40. *Machilus japonica* var. *kusanoi* (x0.5). Fig. 41. *Machilus obovatifolia* (x0.5). Fig. 42. *Machilus thunbergii* (x0.5).

Semi-hypogeal, semi-cryptocotylar. Cotyledons 2, borne opposite on either side of the stem and covered with testa, hard succulent. Epicotyl covered with brown villous, about 4 cm long. Bud covered with brown hairs. Cataphylls alternate, about 0.2 – 0.4 cm long, covered with brown villous. First eophylls 2, opposite, elliptic, about 3 cm long, 1.5 cm wide, coriaceous, entire, pubescent; apex and base acute, whitish beneath; vein ternate; petioles about 0.2 cm long, pubescent.

9. *Neolitsea hiiranensis* Liu & Liao

南仁山新木薑子 Fig. 45

Semi-hypogeal, semi-cryptocotylar. Cotyledons 2, borne opposite on either side of the stem and covered with testa, hard succulent. Epicotyl pubescent, about 7 cm long. Cataphylls alternate, about 0.3 cm long. First eophylls 3, spirally arranged, ovate-elliptic, about 3.3–3.5 cm long, 1.7–2 cm wide, coriaceous, glabrous, entire, white beneath; apex acute; base obtuse; veins ternate; petioles 0.3–0.4 cm long, pubescent.

Leeaceae**1. *Leca guineensis* G. Don**

火筒樹 Fig. 46

Epigeal, phanerocotylar. Hypocotyl 4-angled, green, glabrous, about 2.5–5 cm long. Cotyledons 2, opposite, ovate to broadly ovate, about 1.5 cm long, 1.1 cm wide, chartaceous, entire; apex obtuse; base obtuse to round; veins ternate; petioles 0.3–0.4 cm long. Eophylls alternate. First eophyll simple, ovate, about 2–2.5 cm long, 1.5–1.8 cm wide, chartaceous, serrate; apex acute; base round; veins pinnate; petioles with wing, about 1 cm long. Second eophyll simple, ovate. Third eophyll pinnate.

Leguminosae**1. *Archidendron lucidum* (Benth.) I. Nielsen**

領垂豆 Fig. 47

Semi-hypogeal, semi-cryptocotylar. Cotyledons 2, borne opposite on either side of the stem, and covered with testa, succulent. Epicotyl pubescent, about 5 cm long. Eophylls alternate. First eophyll pinnate, leaflets 2, opposite, obliquely ovate, about 2.2–3 cm long, 0.8–1.6 cm wide, chartaceous, entire; apex caudate; base obtuse; petioles 0.8–1.2 cm long.

2. *Derris laxiflora* Benth.

疏花魚藤 Fig. 48

Hypogeal, cryptocotylar. Cotyledons 2, together at side of stem, enclosed with testa. Epicotyl pubescent, about 3.5–7.5 cm long. Eophylls alternate. First eophyll simple, ovate, about 3–5 cm long, 1.5–2.3 cm wide, coriaceous, glabrous, entire; apex acuminate; base round; veins pinnate; petioles 1.5 cm long.

Lythraceae**1. *Lagerstroemia subcostata* Koehne**

九芎 Fig. 49

Epigeal, phanerocotylar. Hypocotyl terete, pubescent, about 5 cm long. Cotyledons 2, opposite, cordate, about 0.6 cm long, 0.9 cm wide, chartaceous, entire, glabrous; apex lobed; base cuneate; petioles pubescent, about 0.1 cm long. Epicotyl pubescent. First eophylls 2, opposite, ovate-elliptic, 2 cm long, 1.4 cm wide, chartaceous, glabrous, entire; apex and base obtuse; veins pinnate, pubescent; petioles pubescent, about 0.2–0.3 cm long.

Magnoliaceae**1. *Michelia compressa* (Maxim.) Sargent**

烏心石 Fig. 50

Epigeal, phanerocotylar. Hypocotyl round, green, glabrous, about 3.5–5 cm long. Cotyledons 2, opposite, ovate, about 2.4 cm long, 1.3–1.8 cm wide, glabrous, coriaceous,



Fig. 43. *Machilus zuihoensis* (x0.6). Fig. 44. *Neolitsea buisanensis* (x0.6). 45. *Neolitsea hirranensis* (x0.6)
 Fig. 46. *Leea guineensis* (x0.6). Fig. 47. *Archidendron lucidum* (x0.6). Fig. 48. *Derris laxiflora* (x0.6). Fig. 49
Lagerstroemia subcostata (x0.6). Fig. 50. *Michelia compressa* (x0.6).

entire; apex and base obtuse; veins inconspicuous; petioles about 0.15 cm long. Epicotyl and scale buds covered with brown hairs. When the scale buds drop, leaving ring bud scars on stem. Eophylls alternate. First eophyll simple, elliptic, about 3.5 cm long, 1–2 cm wide glabrous, coriaceous, entire; apex acuminate; base acute, lateral veins inconspicuous petioles 0.4–0.5 cm long.

Malpighiaceae

1. *Hiptage benghalensis* (L.) Kurz

猿尾藤 Fig. 51

Hypogeal, cryptocotylar. Cotyledons 2, together at side of stem, enclosed within testa. Hypocotyl covered with dense hairs, about 2.5 cm long. First eophylls 2, opposite, ovate, about 3.5 cm long, 2 cm wide, subcoriaceous, glabrous, entire; apex acute; base rounded; midrib covered with hairs beneath, veins pinnate; petioles 0.2–0.3 cm long, pubescent.

Meliaceae

1. *Aglaia elliptifolia* Merr.

大葉樹蘭 Fig. 52

Semi-hypogeal, semi-cryptocotylar. Cotyledons 2, borne opposite on either side of the stem and covered with testa, hard succulent. Plant covered with brown peltate scales. Epicotyl brown, about 8.5 cm long. First eophylls 2, opposite, elliptic, about 4.5–5.5 cm long, 2.2–2.7 cm wide, coriaceous, entire; apex and base acute; veins pinnate; petioles about 0.6 cm long.

2. *Dysoxylum hongkongense* (Tutch.) Merr.

紅果控木 Fig. 53

Semi-hypogeal, semi-cryptocotylar. Cotyledons 2, green, borne opposite on either side of the stem and covered with testa, hard succulent. Epicotyl green, glabrous, about 9 cm long. First eophylls 2, opposite, elliptic, about 11 cm long, 4.5 cm wide, chartaceous, entire; apex acuminate to caudate, little inequilateral at base; veins pinnate; petioles 1.2–1.5 cm long. Second eophyll simple.

Myrsinaceae

1. *Ardisia sieboldii* Miq.

樹杞 Fig. 54

Epigeal, phanerocotylar. Hypocotyl terete, glabrous, about 3–4 cm long. Cotyledons 2, opposite, sessile, oblong, 0.6–0.7 cm long, 0.2–0.3 cm wide, coriaceous, entire, glabrous; apex round; base acute; midrib white above, raised beneath. Eophylls alternate. First eophylls 3–4, alternate, ovate to elliptic, about 2 cm long, 1 cm wide, coriaceous, nearly entire, glabrous above, covered with brown scales beneath; apex and base acute; veins conspicuous above, white, pinnate, closed nearby margin; petioles about 0.15 cm long.

2. *Ardisia virens* Kurz

黑星紫金牛 Fig. 55

Epigeal, phanerocotylar. Hypocotyle terete, reddish, pubescent, about 2.5 cm long. Cotyledons 2, opposite, sessile, cuneiform, about 0.6 cm long, 0.4 cm wide, entire; apex truncate; base acute. Plant black glanduloso-punctatus. Eophylls alternate, entire. First eophyll minor, ovate, about 0.5–1 cm long. Second eophylls lanceolate to narrowly ovate, about 3 cm long, 1.2 cm wide; lateral veins inconspicuous.

Myrtaceae

1. *Decaspermum gracilentum* (Hance) Merr. & Perry

十子木 Fig. 56

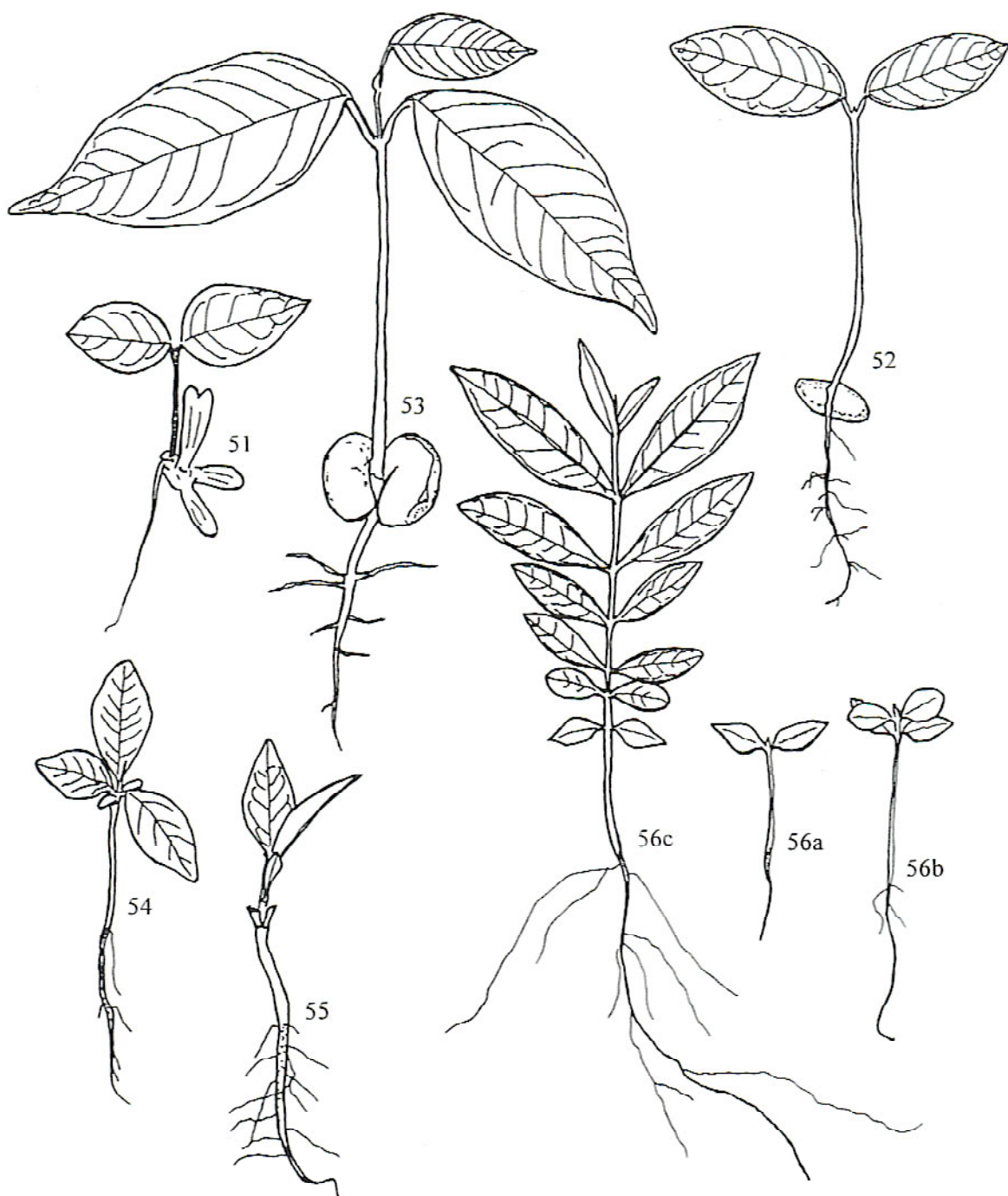


Fig. 51. *Hiptage benghalensis* (x0.6). Fig. 52. *Aglaia elliptifolia* (x0.5). Fig. 53. *Dysoxylum hongkongense* (x0.5). Fig. 54. *Ardisia sieboldii* (x0.6). Fig. 55. *Ardisia virens* (x0.6). Fig. 56. *Decaspermum gracilentum* (x1).

Epigeal, phanerocotylar. Hypocotyl terete, green, glabrous, about 2 cm long. Cotyledons 2, opposite, ovate, 0.7-0.8 cm long, 0.4 cm wide, coriaceous, glabrous, entire; apex mucronate; base obtuse; veins inconspicuous; petioles about 0.1 cm long. Epicotyl 4-angled. Eophylls opposite. First eophylls 2, opposite, shortly petiolate, elliptic, about 0.7 - 0.9 cm long, 0.4 - 0.5 cm wide, coriaceous, entire; apex and base obtuse, lateral veins inconspicuous. Second eophylls narrowly elliptic; apex acute.

2. *Syzygium buxifolium* Hook. & Arn.

小葉赤楠 Fig. 57

Semi-hypogeal, semi-cryptocotylar. Cotyledons 2, borne opposite on either side of the stem and covered with testa, hard succulent. Epicotyl 4-angled, about 3.5 cm long. Cataphylls opposite or approximate. Eophylls opposite. First eophylls 2, opposite, shortly petiolate, elliptic, about 1.2 cm long, 0.5 cm wide, coriaceous, glabrous, entire; apex round; base acute; midrib conspicuous.

3. *Syzygium euphlebioides* (Hayata) Mori

細脈赤楠 Fig. 58

Semi-hypogeal, semi-cryptocotylar. Cotyledons 2, borne opposite on either side of the stem and covered with testa, hard succulent. Epicotyl 4-angled, red, about 4 cm long. Cataphylls nearly opposite. First eophylls opposite, obovate-elliptic, coriaceous, glabrous, entire, about 1.4–2.7 cm long, 0.6–1 cm wide; apex acuminate; base cuneate; veins pinnate, lateral veins inconspicuous.

4. *Syzygium kusukusense* (Hayata) Mori

高士佛赤楠 Fig. 59

Semi-hypogeal, semi-cryptocotylar. Cotyledons 2, borne opposite on either side of the stem and covered with testa, hard succulent. Epicotyl 4-angled, red, about 4.5 cm long. Cataphylls alternate. First eophylls 2, opposite, narrowly elliptic, about 6.5 cm long, 1.5 cm wide, coriaceous, entire; lateral veins inconspicuous. Sometimes the first eophylls shrink, linear.

Oleaceae

1. *Osmanthus marginatus* (Champ. ex Benth.) Hemsl.

小葉木犀 Fig. 60

Hypogeal, cryptocotylar. Cotyledons 2, borne on the same side of the stem, enclosed within testa. Epicotyl angled, about 3.5–5.5 cm long. Cataphylls opposite, 1–3-paired. Eophylls opposite. First eophylls 2, opposite, elliptic, coriaceous, serrate, apex and base acute; midrib sunken above; petioles about 0.5 cm long. Taproot sturdy.

Proteaceae

1. *Helicia formosana* Hemsl.

山龍眼 Fig. 61

Semi-hypogeal, semi-cryptocotylar. Cotyledons 2, borne opposite on either side of the stem and covered with testa, hard succulent. Plant covered with brown hairs. Epicotyl about 4.5 cm long. Cataphylls alternate, leaf-like, serrate, petiolate. First eophylls alternate, elliptic, 2.4–3 cm long, 1–1.5 cm wide, serrate; apex acuminate; base acute; veins pinnate; petioles 0.5–0.8 cm long.

Rosaceae

1. *Prunus phaeosticta* (Hance) Maxim.

黑星櫻 Fig. 62

Semi-hypogeal, semi-cryptocotylar. Cotyledons 2, borne opposite on either side of the stem and covered with testa, hard succulent. Epicotyl pubescent, about 6–7 cm long. First eophylls 2–3, opposite or whorled, elliptic-lanceolate, 4.5–5.2 cm long, 1.5–2 cm wide, nearly coriaceous, entire, densely glanduloso-punctatus beneath, less densely so above; apex caudate-acuminate; base obtuse; midrib sunken above, stipules triangular; petioles about 0.15 cm long. Second eophylls 2, opposite, glabrous above, glanduloso-punctatus beneath. Stem with alternate cataphylls on the upper part of the first eophylls.



Fig. 57. *Syzygium buxifolium* (x0.7). Fig. 58. *Syzygium euphlebioides* (x0.6). Fig. 59. *Syzygium kusukusense* (x0.5). Fig. 60. *Osmanthus marginatus* (x0.6). Fig. 61. *Helicia formosana* (x0.6). Fig. 62. *Prunus phaeosticta* (x0.5). Fig. 63. *Rhaphiolepis indica* var. *hiiranensis* (x0.6). Fig. 64. *Lasianthus plagiophyllus* (x1). Fig. 65. *Psychotria rubra* (x0.6).

2. *Rhaphiolepis indica* (L.) Lindl. ex Ker var. *hiiranensis* (Kanehira) Li

恆春石斑木 Fig. 63

Hypogeal, cryptocotylar. Cotyledons 2, borne on the same side of the stem, enclosed within testa. Stem covered with brown hairs. Epicotyl about 3.5–6.5 cm long. Cataphylls

alternate. First eophylls 2, opposite, ovate, about 2.5 – 3 cm long, 1.2 – 1.5 cm wide, coriaceous, coarsely serrate; apex and base acute; veins conspicuous, reticulate; petioles about 0.2 cm long. Second eophyll simple, elliptic.

Rubiaceae

1. *Lasianthus plagiophyllus* Hance

圓葉雞屎樹 Fig. 64

Epigeal, phanerocotylar. Hypocotyl terete, green, glabrous, about 0.9 cm long. Cotyledons 2, opposite, petiolate, broadly ovate, about 0.6 cm long, 0.6 – 0.7 cm wide, thin-chartaceous, entire; apex retuse; base round; veins pinnate; midrib pubescent. Epicotyl velutinous. First eophylls 2, opposite, elliptic, about 0.8 cm long, 0.4 cm wide, chartaceous, entire, pubescent; margin with ciliated hairs; apex shortly acuminate; base obtuse.

2. *Psychotria rubra* (Lour.) Poir.

九節木 Fig. 65

Epigeal, phanerocotylar. Hypocotyl glabrous, about 3 – 4.5 cm long. Cotyledons 2, opposite, stipulate, very broadly ovate or nearly round, about 1.8 cm long, 1.6 cm wide, coriaceous, glabrous, entire, green above, pale green beneath; apex and base obtuse; veins pinnate; petioles 0.2 cm long. First eophylls 2, opposite, stipulate, petiolate, oblanceolate, about 3.5 cm long, 1 cm wide, glabrous, entire; veins inconspicuous.

3. *Tricalysia dubia* (Lindl.) Ohwi

狗骨仔 Fig. 66

Epigeal, phanerocotylar. Hypocotyl glabrous, 1.5 – 2.5 cm long. Cotyledons 2, opposite, stipulate, petiolate, nearly rounded, about 1 cm long, 1 cm wide, thin-chartaceous, pale-green, glabrous, entire; apex and base obtuse; veins inconspicuous. Epicotyl covered with light-brown hairs. First eophylls 2, opposite, stipulate, ovate, about 1 cm long, 0.7 cm wide, pale-green, entire, pubescent; margin with ciliated hairs; petioles 0.15 cm long.

Rutaceae

1. *Glycosmis citrifolia* (Willd.) Lindl.

石苓舅 Fig. 67

Epigeal, phanerocotylar. In early stage of germination, plant pubescent. Hypocotyl terete, pubescent, about 2 cm long. Cotyledons 2, opposite or approximate, fleshy, thick, green. Epicotyl pubescent. Eophylls with numerous glands. First eophylls 2, opposite, petiolate, ovate to elliptic, about 3 cm long, 2 cm wide, coriaceous, entire; apex obtuse; midrib pubescent; veins pinnate. Second eophylls alternate, elliptic; apex acute.

2. *Melicope semecarpifolia* (Merr.) T. Martley

山刈葉 Fig. 68

Epigeal, phanerocotylar. Hypocotyl terete, green, glabrous, about 1 – 2 cm long. Cotyledons 2, opposite, oblong, about 0.7 cm long, 0.3 – 0.4 cm wide, chartaceous, toothed, glabrous; apex round; base obtuse; veins inconspicuous; petioles 0.1 cm long. First eophylls 2, opposite, 3-foliolate, serrate; petioles 0.2 – 0.3 cm long.

3. *Zanthoxylum nitidum* (Roxb.) DC.

崖椒 Fig. 69

Epigeal, phanerocotylar. Hypocotyl terete, green, glabrous, about 4 cm long. Cotyledons 2, opposite, suborbiculate, about 1.1 cm long, 0.8 cm wide, coriaceous, toothed, both surfaces glanduloso-punctatus; veins inconspicuous; petioles 0.15 cm long. First eophyll

simple, elliptic, 2 cm long, 0.9 cm wide, coriaceous, serrate, glanduloso-punctatus; apex acute; base obtuse; midrib with spines, lateral veins inconspicuous.

Santalaceae

1. *Champereia manillana* (Blume) Merr. 山柚 Fig. 70

Durian, cryptocotylar. Hypocotyl terete or little fusiform, glabrous, green. Cotyledons 2, hidden in testa. The hypocotyl carrying the enclosed cotyledons on top. When the epicotyl is developed, cotyledons drop with testa. First eophylls 2 or 3, opposite or whorled, ovate-lanceolate, green, coriaceous, entire; apex acute to acuminate; base obtuse, shortly petiolate; midrib raised above, lateral veins inconspicuous. Second eophylls 3, spirally arranged.

Sterculiaceae

1. *Reevesia formosana* Sprague 臺灣梭羅木 Fig. 71

Epigeal, phanerocotylar. Hypocotyl green, terete, pubescent, 3–3.5 cm long. Cotyledons 2, opposite, broadly ovate, about 1.6 cm long, 1.5 cm wide, chartaceous, entire; apex round; base cordate; veins pinnate; petioles 0.3 cm long. Epicotyl pubescent. Bud red, pubescent. Eophylls alternate, entire, coriaceous, glabrous above, pubescent beneath; veins raised beneath. First eophyll simple, elliptic, 2.6 cm long, 1.6 cm wide; apex and base obtuse; petioles 0.5 cm long. Second eophyll oblanceolate.

Schisandraceae

1. *Kadsura japonica* (L.) Dunal 南五味子 Fig. 72

Epigeal, phanerocotylar. Hypocotyl terete, red, glabrous, about 6 cm long. Cotyledons 2, opposite, elliptic, about 2.1 cm long, 1.1 cm wide, coriaceous, entire; apex round; base obtuse and oblique; veins inconspicuous; petioles about 0.5 cm long. Epicotyl red, glabrous. First eophyll simple, ovate-elliptic, coriaceous, serrate; apex acuminate; base acute, lateral veins inconspicuous; petioles about 0.5 cm long.

Staphyleaceae

1. *Turpinia ternata* Nakai 三葉山香圓 Fig. 73

Epigeal, phanerocotylar. Hypocotyl terete, glabrous, 2.5–3.5 cm long. Cotyledons 2, opposite, broadly obovate, about 1.1–1.3 cm long, 1.1 cm wide, chartaceous, entire, glabrous; apex emarginate; base acute; vein ternate; petioles 0.2 cm long. Eophylls opposite, long petiolate, elliptic to oblanceolate or narrow oblanceolate, chartaceous to coriaceous, glabrous; veins pinnate; stipules opposite, interpetiolar, triangular. First eophylls 2, elliptic, chartaceous, coarsely serrate; apex and base acute; petioles about 0.4 cm long.

Symplocaceae

1. *Symplocos modesta* Brand 小葉白筆 Fig. 74

Epigeal, phanerocotylar. Hypocotyl round, green, glabrous, about 3 cm long. Cotyledons 2, opposite, sessile, linear, about 1.2 cm long, 0.1–0.2 cm wide, chartaceous, glabrous, entire; apex obtuse. Epicotyl villous. First eophyll simple, elliptic-ovate, about 1 cm long, 0.6 cm wide, serrate, chartaceous; apex acute; base obtuse; petioles 0.1 cm long.

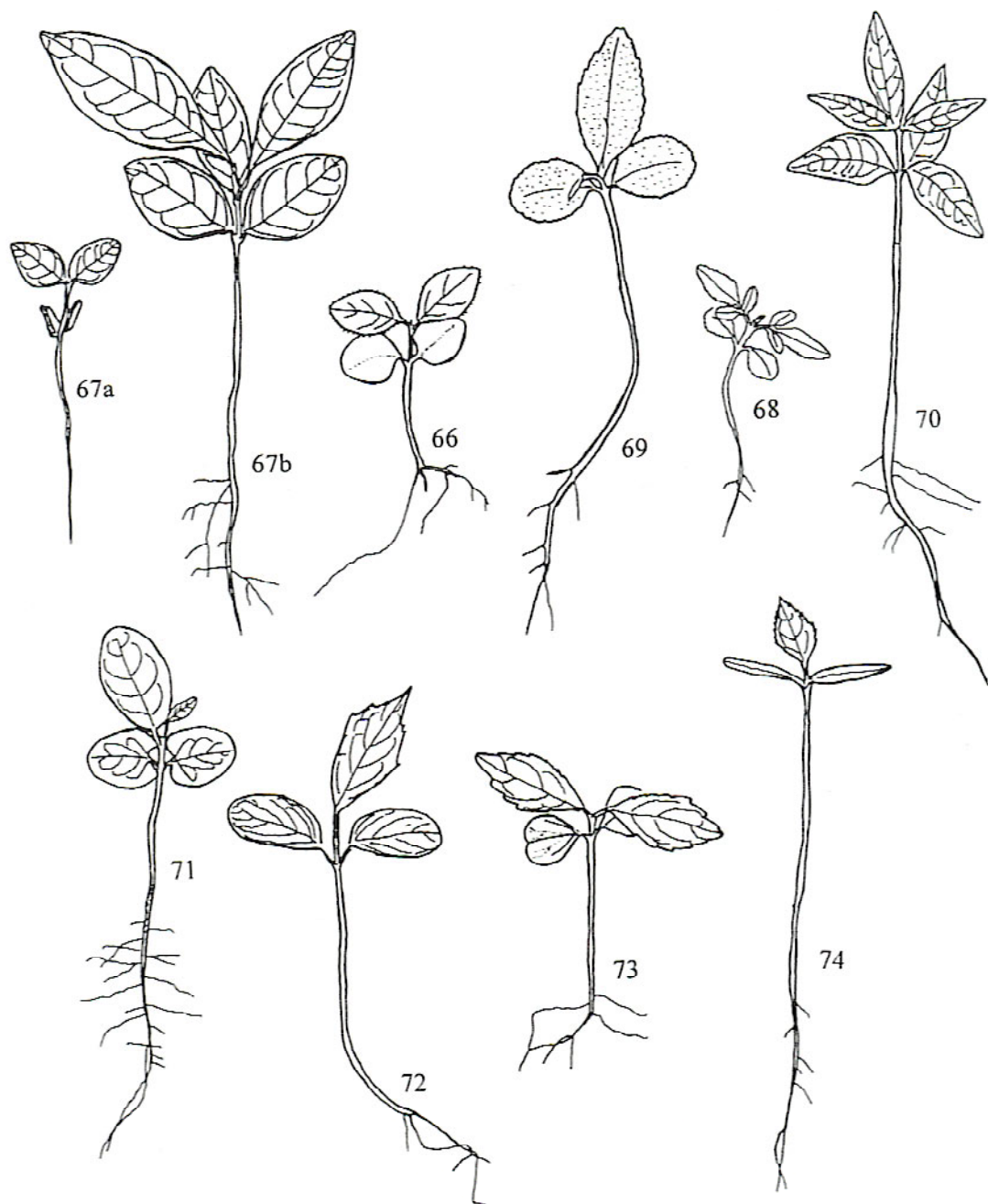


Fig. 66. *Tricalysia dubia* (x1). Fig. 67. *Glycosmis citrifolia* (x0.5). Fig. 68. *Melicope semecarpifolia* (x1). Fig. 69. *Zanthoxylum nitidum* (x1). Fig. 70. *Champereaia manillana* (x0.6). Fig. 71. *Reevesia formosana* (x0.6). Fig. 72. *Kadsura japonica* (x0.6). Fig. 73. *Turpinia ternata* (x0.6). Fig. 74. *Symplocos modesta* (x1).

2. *Symplocos shilanensis* Liu & Lu

南仁灰木 Fig. 75

Epigeal, phanerocotylar. Hypocotyl terete, glabella, about 4 cm long. Cotyledons 2, opposite, sessile, linear, about 2 cm long, 0.2 cm wide, chartaceous, glabrous, entire; apex obtuse. Epicotyl triangular, covered with villous. Eophylls alternate. First eophyll simple, ovate-elliptic, about 1.5 cm long, 0.7 cm wide, chartaceous, glabrous, serrate; apex and base acute; midrib raised above; petioles about 0.2 cm long.

3. *Symplocos theophrastaefolia* Sieb. & Zucc. 山豬肝 Fig. 76

Epigeal, phanerocotylar. Hypocotyl terete, glabrous, 3.5 – 5 cm long. Cotyledons 2, opposite, linear, about 2 cm long, 0.2 cm wide, chartaceous, glabrous, entire; apex obtuse, sessile. Epicotyl glabrous. Eophylls alternate. First eophyll simple, elliptic to broadly elliptic, about 1.9 cm long, 0.6 – 1 cm wide, coriaceous, glabrous, serrate; midrib conspicuous; petioles 0.2 cm long.

Theaceae

1. *Eurya nitida* Korthals var. *nanjenshanensis* Hsieh, Ling & Yang

南仁山柃木 Fig. 77

Epigeal, phanerocotylar. Hypocotyl terete, green, sometimes reddish, about 1 cm long. Cotyledons 2, opposite, oblong, about 0.4 – 0.6 cm long, 0.3 – 0.4 cm wide, chartaceous, entire, glabrous; apex slightly emarginate; veins inconspicuous; petioles 0.1 cm long. Epicotyl pubescent. Eophylls alternate. First eophyll simple, petiolate, obovate-elliptic, 0.4 – 0.5 cm long, 0.3 cm wide, serrate; apex round; base acute; veins inconspicuous.

2. *Gordonia axillaris* (Roxb.) Dietr. 大頭茶 Fig. 78

Epigeal, phanerocotylar. Hypocotyl glabella, about 3.5 cm long. Cotyledons 2, opposite, oblong, entire, about 1.5 cm long, 0.6 – 0.7 cm wide; apex and base round; vein ternate; midrib conspicuous, the others inconspicuous; shortly petiolate. Epicotyl and bud pubescent. First eophyll simple, elliptic, serrate, about 2 – 2.5 cm long, 1 cm wide; apex round or obtuse; base acute; midrib conspicuous, lateral veins inconspicuous, pubescent; shortly petiolate.

3. *Schima superba* Gardn. & Champ. var. *kankaensis* (Hayata) Keng

港口木荷 Fig. 79

Epigeal, phanerocotylar. Hypocotyl pubescent, about 2.5 – 3.5 cm long. Cotyledons 2, opposite, broadly ovate, about 1.2 cm long, 1 cm wide, thin-chartaceous, glabrous, entire; apex and base obtuse; veins ternate; petioles 0.2 cm long. Epicotyl covered with light-brown hairs. First eophyll simple, obovate-elliptic, thin-chartaceous, green above, whitish beneath, coarsely few-serrate toward the apex; margin and veins with hairs; petioles 0.3 – 0.4 cm long.

4. *Ternstroemia gymnanthera* (Wight & Arn.) Sprague 厚皮香 Fig. 80

Epigeal, phanerocotylar. Hypocotyl terete, reddish, 4 – 4.5 cm long. Cotyledons 2, opposite, lanceolate, about 2.1 – 2.7 cm long, 0.5 – 0.8 cm wide, coriaceous, glabrous, entire; apex and base obtuse; veins ternate, sometimes inconspicuous. First eophylls 2 or simple, shortly petiolate, elliptic, 1.8 cm long, 0.8 cm wide, coriaceous, glabrous, sparsely serrate; veins inconspicuous.

Thymelaeaceae

1. *Wikstroemia taiwanensis* C. E. Chang 臺灣堯花 Fig. 81

Epigeal, phanerocotylar. Hypocotyl green, round, glabrous, 2 – 2.5 cm long. Cotyledons 2, opposite, fleshy, thick, shortly petiolate, obovate-elliptic, about 0.6–0.8 cm long, 0.3 – 0.4 cm wide, green, glabrous; apex round; base obtuse; veins inconspicuous. Epicotyl pubescent. Eophylls opposite. First eophylls 2, opposite, shortly petiolate, elliptic to narrow elliptic, about 2 cm long, 0.6 cm wide; apex and base acute; lateral veins inconspicuous.

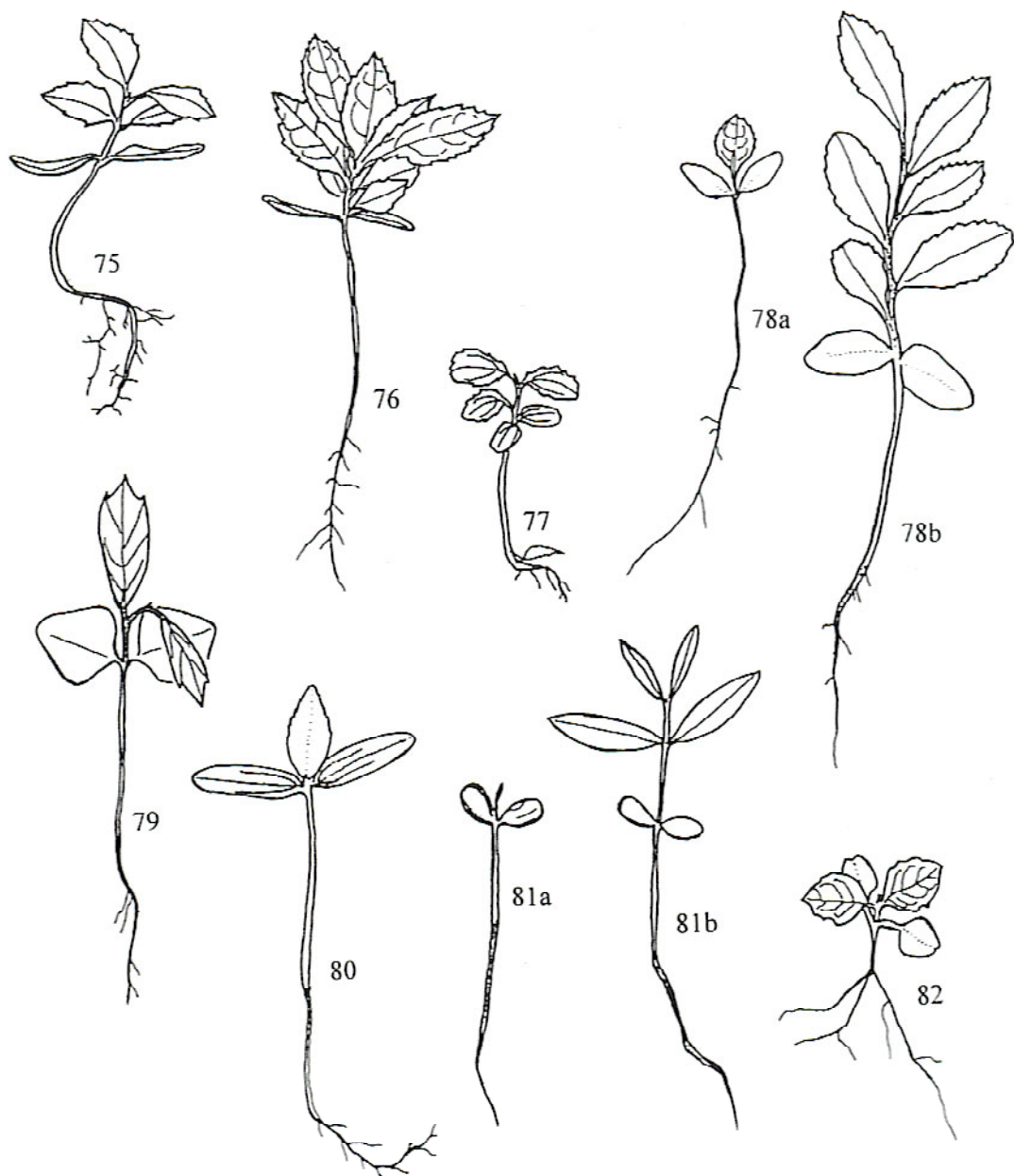


Fig. 75. *Symplocos shilanensis* (x0.6). Fig. 76. *Symplocos theophrastaefolia* (x0.6). Fig. 77. *Eurya nitida* var. *nanjenshanensis* (x2). Fig. 78. *Gordonia axillaris* (x0.7). 79. *Schima superba* var. *kankaoensis* (x0.9). Fig. 80. *Ternstroemia gymnanthera* (x0.7). 81. *Wikstroemia taiwanensis* (x0.7). Fig. 82. *Callicarpa remotiflora* (x1).

Verbenaceae

1. *Callicarpa remotiflora* Lin & Wang

疏花紫珠 Fig. 82

Epigeal, phanerocotylar. Hypocotyl terete, pubescent, about 0.5 cm long. Cotyledons 2, opposite, very broadly ovate, about 0.4 cm long, 0.4 cm wide, entire, glabrous; apex emarginate; base nearly truncate; veins inconspicuous; petioles 0.3 cm long. Epicotyl pubescent. First eophylls 2, opposite, ovate-elliptic, chartaceous, pubescent, serrate; veins pinnate; petioles 0.15 cm long.

DISCUSSION

The present study shows that the ratio of the four types of initial seedling morphology in Nanjenshan forest is closed to that studied by Ng (1978) in Malayan forests. Appendix 1 shows that about 64% of the samples in both regions exhibit the epigeal type of germination. But the ratio of the durian condition is higher in Malaya (8%) than the Nanjenshan forest (2.47%). Ng (1978) mentioned that the durian condition was absent from nontropical regions and merely tolerated in tropical rain forests. Floristically, the Nanjenshan forest, located in the Hengchun Peninsula of southernmost Taiwan, is much more closely allied to the tropical rain forests of the Malesian floristic region (Wolfe, 1979; Hsieh *et al.*, 1994). It does not seem surprising that the durian condition of germination could be found for some species in Nanjenshan, although the proportion is considerably low. On the other hand, the semi-hypogeal and hypogeal conditions, together comprising to 33% of the seedling species in Nanjenshan forest, are higher than those of the Malayan forests (28%) (Ng, 1978). This indicates the existence of a number of shade-tolerant species, especially those of the dominant families such as Fagaceae and Lauraceae, in the Nanjenshan forest. Species of these two seedling types are able to establish in low light condition under the mature forests (Martinez-Ramos and Soto-Castro, 1993).

The phyllotaxy in seedlings of the 81 species is more variable. In 34 species the first eophylls are two and opposite, while in other 32 species they are simple. Only a few species show other kinds of arrangements.

As mentioned by de Vogel (1980), the seedlings usually have similar features in the same genus. For the present study, all species within the same genus show only one seedling type (Appendix 1). For examples, species of the *Ilex*, *Symplocos*, *Cyclobalanopsis*, *Machilus* and *Syzygium* have the same germination type. At family level, however, the seedlings are not so uniform. Although seedling are not known from all species in the families studied, it is clear that in some families (e.g., Lauraceae, Euphorbiaceae) only one seedling type is predominant.

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Appendix 1. Comparison of seedling morphology for the 81 species found in Nanjenshan forest.

Species	Germination type	Cotyledon			First eophyll
		Phanerocotylar	Cryptocotylar	Form	
Podocarpaceae					
<i>Nageia nagi</i>	Epigeal	+	-	Linear	3-4, fasciculate
<i>Podocarpus macrophyllus</i>	Epigeal	+	-	Linear	4-7, fasciculate
Apocynaceae					
<i>Anodendron affine</i>	Epigeal	+	-	Elliptic	2, opposite
Aquifoliaceae					
<i>Ilex asprella</i>	Epigeal	+	-	Long ovate	Simple
<i>Ilex cochinchinensis</i>	Epigeal	+	-	Broadly ovate	Simple
<i>Ilex maximowicziana</i>	Epigeal	+	-	Elliptic	Simple
<i>Ilex rotunda</i>	Epigeal	+	-	Ovate	Simple
<i>Ilex uraiensis</i>	Epigeal	+	-	Ovate to elliptic	Simple
Araliaceae					
<i>Schefflera octophylla</i>	Epigeal	+	-	Broadly ovate	Simple
Boraginaceae					
<i>Ehretia longiflora</i>	Epigeal	+	-	Ovate	Simple
Capparidaceae					
<i>Viburnum odoratissimum</i>	Epigeal	+	-	Narrowly ovate	2, opposite
Celastraceae					
<i>Microtropis japonica</i>	Epigeal	+	-	Elliptic	Simple
Chloranthaceae					
<i>Sarcandra glabra</i>	Epigeal	+	-	Round	2, opposite
Daphniphyllaceae					
<i>Daphniphyllum glaucescens</i> ssp. <i>oldhamii</i>	Epigeal	+	-	Linear	2, opposite
Ebenaceae					
<i>Diospyros discolor</i>	Epigeal	+	-	Oblong	2, opposite
<i>Diospyros eriantha</i>	Epigeal	+	-	Oblong	2, opposite
Elaeocarpaceae					
<i>Elaeocarpus sylvestris</i>	Epigeal	+	-	Ovate-elliptic	Simple
Euphorbiaceae					
<i>Acalypha suirensiensis</i>	Epigeal	+	-	Elliptic	Simple
<i>Bischofia javanica</i>	Epigeal	+	-	Round	Simple
<i>Bridelia balansae</i>	Epigeal	+	-	Obcordate	2, opposite
<i>Croton cascarilloides</i>	Epigeal	+	-	Round	Simple
<i>Drypetes karapinensis</i>	Epigeal	+	-	Broadly ovate	Simple
<i>Drypetes littoralis</i>	Epigeal	+	-	Elliptic	Simple
<i>Glochidion rubrum</i>	Epigeal	+	-	Oblate	Simple
<i>Liodendron formosanum</i>	Durian	-	+		Several
<i>Mallotus paniculatus</i>	Epigeal	+	-	Oblate	Simple
<i>Sapium discolor</i>	Epigeal	+	-	Oblong	2, opposite
Fagaceae					
<i>Castanopsis formosana</i>	Hypogeal	-	+		Several, Alternate
<i>Cyclobalanopsis championii</i>	Hypogeal	-	+		2, opposite
<i>Cyclobalanopsis longinux</i>	Hypogeal	-	+		4, whorled
<i>Cyclobalanopsis pachyloma</i>	Hypogeal	-	+		2, opposite
Guttiferae					
<i>Calophyllum inophyllum</i>	Hypogeal	-	+		2, opposite
<i>Garcinia multiflora</i>	Hypogeal	-	+		2, opposite
Illiciaceae					
<i>Illicium arborescens</i>	Epigeal	+	-	Elliptic to round	Simple

Juglandaceae					
<i>Engelhardtia roxburghiana</i>	Epigeal	+	-	4-lobed	Simple
Lauraceae					
<i>Beilschmiedia tsangii</i>	Hypogeal	-	+		Simple
<i>Cryptocarya concinna</i>	Hypogeal	-	+		2, opposite
<i>Litsea acutivena</i>	Semi-hypogeal	-	+		3, fasciculate
<i>Machilus japonica</i> var. <i>kusanoi</i>	Semi-hypogeal	-	+		3, fasciculate
<i>Machilus obovatifolia</i>	Semi-hypogeal	-	+		3, alternate
<i>Machilus thunbergii</i>	Semi-hypogeal	-	+		3, fasciculate
<i>Machilus zuihoensis</i>	Semi-hypogeal	-	+		2, alternate
<i>Neolitsea buisanensis</i>	Semi-hypogeal	-	+		2, opposite
<i>Neolitsea hiiranensis</i>	Semi-hypogeal	-	+		3, fasciculate
Lecaceae					
<i>Leea guineensis</i>	Epigeal	+	-	Broadly ovate	Simple
Leguminosae					
<i>Archidendron lucidum</i>	Semi-hypogeal	-	+		Pinnate
<i>Derris laxiflora</i>	Hypogeal	-	+		Simple
Lythraceae					
<i>Lagerstroemia subcostata</i>	Epigeal	+	-	Cordate	2, opposite
Magnoliaceae					
<i>Michelia compressa</i>	Epigeal	+	-	Ovate	Simple
Malpighiaceae					
<i>Hiptage benghalensis</i>	Hypogeal	-	+		2, opposite
Meliaceae					
<i>Aglaia elliptifolia</i>	Semi-hypogeal	-	+		2, opposite
<i>Dysoxylum hongkongense</i>	Semi-hypogeal	-	+		2, opposite
Myrsinaceae					
<i>Ardisia sieboldii</i>	Epigeal	+	-	Oblong	3-4, fasciculate
<i>Ardisia virens</i>	Epigeal	+	-	Cuneiform	Simple
Myrtaceae					
<i>Decaspermum gracilentum</i>	Epigeal	+	-	Ovate	2, opposite
<i>Syzygium buxifolium</i>	Semi-hypogeal	-	+		2, opposite
<i>Syzygium euphlebiun</i>	Semi-hypogeal	-	+		Several, opposite
<i>Syzygium kusukusense</i>	Semi-hypogeal	-	+		2, opposite
Oleaceae					
<i>Osmanthus marginatus</i>	Hypogeal	-	+		2, opposite
Proteaceae					
<i>Helicia formosana</i>	Semi-hypogeal	-	+		Several, alternate
Rosaceae					
<i>Prunus phaeosticta</i>	Semi-hypogeal	-	+		2-3, opposite or whorled
<i>Rhaphiolepis indica</i> var. <i>hiiranensis</i>	Hypogeal	-	+		2, opposite
Rubiaceae					
<i>Lasianthus plagiophyllus</i>	Epigeal	+	-	Broadly ovate	2, opposite
<i>Psychotria rubra</i>	Epigeal	+	-	Round	2, opposite
<i>Tricalysia dubia</i>	Epigeal	+	-	Round	2, opposite
Rutaceae					
<i>Glycosmis citrifolia</i>	Epigeal	+	-	Elliptic	2, opposite
<i>Melicope semecarpifolia</i>	Epigeal	+	-	Oblong	2, opposite
<i>Zanthoxylum nitidum</i>	Epigeal	+	-	Suborbiculate	Simple

Santalaceae						
<i>Champereia manillana</i>	Durian	-	+			2 or 3, opposite or whorled
Sterculiaceae						
<i>Reevesia formosana</i>	Epigeal	+	-	Broadly ovate		Simple
Schisandraceae						
<i>Kadsura japonica</i>	Epigeal	+	-	Elliptic		Simple
Staphyleaceae						
<i>Turpinia ternata</i>	Epigeal	+	-	Broadly obovate		2, opposite
Symplocaceae						
<i>Symplocos modesta</i>	Epigeal	+	-	Linear		Simple
<i>Symplocos shilanensis</i>	Epigeal	+	-	Linear		Simple
<i>Symplocos theophrastaefolia</i>	Epigeal	+	-	Linear		Simple
Theaceae						
<i>Eury nitida</i> var.	Epigeal	+	-	Oblong		Simple
<i>nanjenshanensis</i>						
<i>Gordonia axillaris</i>	Epigeal	+	-	Oblong		Simple
<i>Schima superba</i> var.						
<i>kankaoensis</i>	Epigeal	+	-	Broadly ovate		Simple
<i>Ternstroemia gymnanthera</i>	Epigeal	+	-	Lanceolate		2, opposite or simple
Thymelaeaceae						
<i>Wikstroemia taiwanensis</i>	Epigeal	+	-	Obovate-elliptic		2, opposite
Verbenaceae						
<i>Callicarpa remotiflora</i>	Epigeal	+	-	Very broadly ovate		2, opposite

臺灣南部南仁山森林之小苗形態

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摘 要

本文描述臺灣南部南仁山森林 81 種木本植物的小苗形態，其中有 64.20% 為地上萌發、14.81% 為地下萌發、18.52% 為半地下萌發、2.47% 為榴槿型萌發。與馬來西亞的熱帶雨林相較，地上萌發種類的比例相當，但是榴槿型萌發的比例甚低。在所研究的植物中，同一屬的種類均顯示同一萌發類型，對同一科而言，各屬間如非一致時，仍以某一萌發類型佔優勢。

關鍵詞：小苗，形態，南仁山，臺灣。

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