

ILLICIACEAE

(Richard M. K. Saunders, University of Hong Kong)¹

Illiciaceae A. C. Sm., *Sargentina* 7 (1947) 8, nom. cons.

One genus only.

ILLICIUM

Illicium L., *Syst. Nat.*, ed. 10 (1759) 1050; *Gen. Pl.*, ed. 6 (1764) 244; Ridl., *Fl. Malay Penins.* 1 (1922) 18; A. C. Sm., *Sargentina* 7 (1947) 10; Ng in *Tree Fl. Malaya* 2 (1973) 253; R. M. K. Saunders, *Bot. J. Linn. Soc.* 117 (1995) 341–342; in *Tree Fl. Sabah & Sarawak* 1 (1995) 227. — Type species: *Illicium anisatum* L.

Cymbostemon Spach, *Hist. Vég. Phan.* 7 (1839) 444. — Type species: *Cymbostemon parviflorus* Spach (syn. *Illicium parviflorum* Michx. ex Vent.).

Badianifera L. ex Kuntze, *Rev. Gen. Pl.* 1 (1891) 6. — Type species: *Badianifera anisata* Kuntze (syn. *Illicium anisatum* L.).

Shrubs or small to medium sized *trees*, evergreen, glabrous, aromatic with scattered ethereal oil cells. *Leaves* simple, entire, alternately arranged although often clustered to give appearance of whorls of 3–6 at distal nodes, exstipulate; lamina ovate to elliptic, papyraceous or coriaceous, pinnate venation, apex generally acuminate, base generally attenuate, decurrent; stomata on abaxial surface only, mesogenous, generally paracytic; petioles with groove on adaxial surface. *Flowers* solitary or in clusters of 2 or 3, mostly axillary, sometimes cauliflorous, bisexual, regular, hypogynous, 1–1.5 cm diam.; pedicels 0.5–7(–10) cm long. *Perianth* not differentiated into sepals and petals, segments numerous (7–33), free, overlapping at anthesis, spirally arranged, white, cream, pink, red or purplish. *Androecium* of (4–)numerous (up to c. 50) stamens, spirally arranged in one to several series; filaments short, thick; anthers basifixed, introrse to introrse-lateral, dehiscent by longitudinal slits; pollen grains binucleate, semitectate, tricolporate. *Gynoecium* of (5–)7–15(–21) free, conduplicate carpels, arranged in a single whorl, obliquely attached to receptacle; stigma dry, nonpapillate, decurrent; ovary unilocular, with single, near-basal, anatropous, bitegmic, crassinucellar ovule. *Fruit* a follicetum of single-seeded follicles, star-shaped, 2–3 cm across, green (ripening red), splitting along ventral edge of each segment when ripe. *Seeds* solitary in each segment, glossy, brown, with copious oily endosperm. — **Fig. 1.**

DISTRIBUTION

A medium sized genus, with a disjunct distribution in south-eastern North America, Mexico and the West Indies (5 species) and eastern Asia (centre of diversity, with about 35 species). The Asian distribution extends from southern Japan to the Malay Peninsula,

1) With contributions by R.W.J.M. van der Ham, Leiden (pollen morphology) and R. Hegnauer, Leiden (phytochemistry and chemotaxonomy). The drawing is by H.L. Wilks.

and from Assam to the Philippines. In *Malesia* 7 species: northern and central Sumatra, Malay Peninsula, Borneo (Sabah and Sarawak, with two records from Kalimantan), and the Philippines (Mindoro and Luzon).

HABITAT

The genus primarily occurs in subtropical evergreen forests, although some species extend into north temperate deciduous forests, and others (in Malesia) extend into tropical montane forests (c. 450 to 2000 m altitude).

ECOLOGY

Vegetative growth is markedly discontinuous, with periods of dormancy of vegetative buds alternating with active growth (Ng 1973). The resumption of growth involves the rapid elongation of buds to produce stems several centimetres long, which bear small caducous leaves; apical 'pseudowhorls' of leaves are then produced, consisting of alternately arranged normal leaves that are tightly clustered together.

Studies of the reproductive biology of the North American species *I. floridanum* Ellis and *I. parviflorum* Michx. ex Vent. have shown that they are pollinated by a wide variety of small insects, but primarily Diptera, with unspecialised feeding habits (Thien et al. 1983; White & Thien 1985). The plants typically grow in very dense populations and produce large numbers of flowers over a short period of time; the inefficiency of the insects in dispersing pollen, however, is suggested as one of the reasons for the typically low seed set. It has also been shown that a gametophytic self-incompatibility mechanism operates, and that the species frequently reproduce asexually by root suckers and runners (Thien et al. 1983; White & Thien 1985).

A system of ballistic seed dispersal (autochory) is apparent in *I. floridanum* (Roberts & Haynes 1983), although its efficacy in Malesian species has not been demonstrated. Seeds are expelled from the follicle as a result of hygroscopic tensions that develop in the succulent mesocarp walls and possibly also the sclerenchymatous endocarp. The role of water in the dispersal of seeds is unclear: whilst Thien et al. (1983) claim that the seeds can remain afloat for up to 10 days as a result of surface tension and the entrapment of air in an indentation of the testa at the point of attachment of the seed, Roberts & Haynes (1983) comment that mature seeds sink within 24 hours due to the absorption of water.

References: Ng, F.S.P. in *Tree Flora of Malaya* 2 (1973) 253–256. — Roberts, M.L. & R.R. Haynes, *Pl. Syst. Evol.* 143 (1983) 227–232. — Thien, L.B., et al., *Amer. J. Bot.* 70 (1983) 719–727. — White, D.A. & L.B. Thien, *J. Elisha Mitchell Sci. Soc.* 101 (1985) 15–18.

FOSSILS

The geographical occurrence of fossils of *Illicium* indicate that the genus previously had a comparatively wide distribution, occurring in Eocene to Pliocene boreotropical forests of Europe (e.g., Mai 1970a, b; Jähnichen 1976) and North America (e.g., Tiffney &

Barghoorn 1979), and in the Pliocene to Pleistocene of Japan (e.g., Miki & Kokawa 1962). Fossil evidence of the genus is comparatively rare, however, due in part to the susceptibility of the pollen to degradation, and most fossil remains are consequently of the distinctive coriaceous leaves (e.g., Jähnichen 1976). Other reports, however, describe the characteristic star-shaped fruits (e.g., Miki & Kokawa 1962; Mai 1970a, b; Tiffney & Barghoorn 1979). A progressive reduction in the number of floral parts can be inferred, despite the limited fossil material available (Tiffney & Barghoorn 1979).

Fossil pollen resembling *Illicium* pollen except that it is 6-colpate, was reported from the Cretaceous (Maastrichtian) of California (Chmura 1973). According to Thanikaimoni (1984) the fossil pollen genera *Terseissus* and *Trisectorius* from the Upper Cretaceous to Palaeocene of America (Tschudy 1970) cannot be attributed to the *Illiciaceae* because they lack the median ridges on the aperture membranes.

Gottwald (1992) described the fossil wood *Illicioxylon* from the Eocene of Germany as putatively affiliated to the *Illiciaceae*.

References: Chmura, C.A., *Palaeontographica* 141 (1973) 89–171. — Gottwald, H., *Palaeontographica* 225 (1992) 27–103. — Jähnichen, H., *Alttertiär. Abh. Zentr. Geol. Inst., Paläontol. Abh.* 26 (1976) 151–197. — Mai, D.H., *Paläontol. Abh., B, Paläobot.* 3 (1970a) 441–498; *Feddes Repert.* 81 (1970b) 347–370. — Miki, S. & S. Kokawa, *J. Biol., Osaka City Univ.* 13 (1962) 65–86. — Thanikaimoni, G., *Trav. Sect. Sci. Tech. Inst. Fr. Pondichéry* 18 (1984) 1–135. — Tiffney, B.H. & E.S. Barghoorn, *Amer. J. Bot.* 66 (1979) 321–329. — Tschudy, R.H., *U.S. Geol. Surv. Prof. Pap.* 643F (1970) 1–13.

ANATOMY

Leaf anatomy — The most comprehensive discussions of the leaf anatomy of *Illicium* are by Bailey & Nast (1948) and Metcalfe (1987). Characteristic features of the leaves include: conspicuously pitted abaxial epidermal cells, with undulating anticlinal walls and ridged cuticular thickenings; idioblastic sclereids in the mesophyll; and resin, ethereal oil and mucilage secretory cells in the mesophyll and occasionally also in the epidermis. The stomata are restricted to the abaxial leaf surface, and are paracytic (occasionally laterocytic), showing mesogenous development. The guard cells are dumb-bell-shaped, and often have large T-shaped cuticular thickenings at the stomatal poles (Baranova 1972). The leaf nodes are unilacunar, with a single vascular bundle.

Wood anatomy — The wood anatomy of the genus *Illicium* has been described in detail by Bailey & Nast (1948) and Carlquist (1982), including the Malesian species *I. ridleyanum* A.C. Sm. and *I. tenuifolium* (Ridl.) A.C. Sm. The genus has comparatively unspecialised wood, with a relatively uniform and stable secondary xylem. The vessel elements are almost exclusively solitary, and are long, thin-walled and polygonal, with scalariform perforation plates with numerous anastomosing bars; lateral pitting is scalariform to opposite. The fibre-tracheids bear conspicuous bordered pits. Axial parenchyma is sparse, abaxial to vessels with some diffuse cells also present. The rays are both uniseriate and narrowly multiseriate; the uniseriate rays consist of predominantly erect cells, although procumbent cells are found in some species.

References: Bailey, I.W. & C.G. Nast, *J. Arnold Arbor.* 29 (1948) 77–89. — Baranova, M., *Taxon* 21 (1972) 447–469. — Carlquist, S., *Amer. J. Bot.* 69 (1982) 1587–1598. — Metcalfe, C.R., *Anatomy of the Dicotyledons*, ed. 2, 3 (1987) 75–82.

FLORAL MORPHOLOGY

The floral structure in *Illicium* is primitive, with numerous spirally arranged organs around an elongated receptacle, and a regular perianth of unfused segments that do not form distinct sepals and petals [see discussions by Smith (1947) and Keng (1965, 1993)]. Although *Illicium* flowers tend to be comparatively uniform in structure, taxonomically significant variation is evident in several perianth characters, including tepal number, shape and colour. Keng (1965) has suggested that differences in tepal shape are correlated with the number of vascular bundles at the point of attachment to the receptacle: those with narrowly oblong, ligulate or lanceolate tepals possess a single main bundle at the base, whereas those with ovate to suborbicular tepals possess five or more basal bundles. Saunders (1995), however, has shown that all tepals in *Illicium* possess only a single basal vascular bundle, irrespective of their shape. The apparent distinction between the vascular patterns of the two tepal shapes is due to differences in the location of the dichotomous divisions of the vascular system: the bundle divides closer to the point of attachment in ovate to suborbicular tepals.

The number of stamens is also variable within the genus, and taxonomically valuable at the specific level. The filaments are short and thick, with a single broad vascular bundle, sometimes appearing as two separate bundles. The anthers have two lobes with two locules each, joined by a truncate connective, and show introrse or introrse-lateral dehiscence. The gynoecium consists of a whorl of free carpels that are attached laterally to the elongated receptacle; the number of carpels is also variable in the genus and taxonomically useful at the specific level.

Each carpel is differentiated into an enlarged ovary, short style and curved stigmatic crest with numerous papillae, and initially develops as a conduplicate structure (Robertson & Tucker 1979). Studies of mature floral structure, particularly with respect to the vasculature of filaments and carpels, indicate a putative reductive evolutionary trend in the genus (Keng 1965).

The floral ontogeny of several species has been described by Robertson & Tucker (1979), Erbar & Leins (1983), and Ronse Decraene & Smets (1993); the floral organs have been shown to develop in helical succession, with the carpels later appearing whorled.

References: Erbar, C. & P. Leins, *Bot. Jahrb. Syst.* 103 (1983) 433–449. — Keng, H., *Bot. Bull. Acad. Sin.* 6 (1965) 61–73; in: K. Kubitzki (ed.), *The families and genera of vascular plants*. Vol. 2: K. Kubitzki, J.G. Rohwer & V. Bittrich (eds.), *Flowering plants. Dicotyledons*. Berlin (1993) 344–347. — Robertson, R.E. & S.C. Tucker, *Amer. J. Bot.* 66 (1979) 605–617. — Ronse Decraene, L.P. & E.F. Smets, *Bot. J. Linn. Soc.* 113 (1993) 285–350. — Saunders, R.M.K., *Bot. J. Linn. Soc.* 117 (1995) 333–352. — Smith, A.C., *Sargentia* 7 (1947) 1–224.

POLLEN MORPHOLOGY

(R.W.J.M. van der Ham)

Pollen of *Illicium* has been more or less extensively described and illustrated by Wodehouse (1935), Erdtman (1952), Pokrovskaja (1958), Agababian (1966), Mitroiu (1970), Lieux (1980), and Saunders (1995). The most comprehensive studies, with many scanning electron micrographs, are by Lin (1989) and Liu & Yang (1989), but these do not include any of the Malesian taxa. The only Malesian species treated are *I. philippinense* (Huang 1967, 1972; Saunders 1995) and *I. tenuifolium* (Saunders 1995). A detailed ultrastructural study, with scanning and transmission electron micrographs of both early and mature stages, is by Takahashi (1994).

Illicium pollen grains are usually isopolar (2–)3(–4)-aperturate monads. Grain size is 21–48 μm . Grain shape is oblate to spheroidal ($P/E = 0.69\text{--}1.00$). The aperture system is colpate or syncolpate, occasionally heteropolar colpate/syncolpate (see below) or deviating (Liu & Yang 1989). The aperture membranes do not show any endoapertures, but are always provided with a distinctive ridge along their entire length (confluent at syncolpate poles), which may be inconspicuous due to invagination of the membranes. The exine is (1–)2–3 μm thick and clearly stratified, showing a (semi)tectate-columellate sexine and a usually thinner nexine, the inner sublayer of which is endexinous. The tectum is reticulate, with relatively high narrow inperforate muri or low broad perforate muri (see below). The columellae typically taper towards the nexine. Takahashi (1994) observed rings of continuous columellae around the lumina and isolated columellae under the central parts of the muri. Combined with the somewhat less superficial position of the perforations around the lumina, such a condition may have led to observations such as “with an undulating tegillum?” (Erdtman 1952) and “reticulum rests directly upon the nexine and is not held up by distinct columellae” (Walker 1976).

Two pollen types can be distinguished in *Illicium* (Lin 1989; Liu & Yang 1989; Saunders 1995). Type 1 is syncolpate with narrow carinate inperforate muri. Type 2 is colpate with broad perforate muri with a smooth arched top. This distinction correlates fairly well with the subdivision into the sections *Cymbostemon* and *Illicium* respectively. A notable exception is *I. floridanum* (sect. *Illicium*) which has syncolpate pollen. *I. anisatum* (synonym *I. religiosum*; sect. *Illicium*) seems to take an intermediate position, since both colpate pollen (Agababian 1966; Erdtman 1952; Lin 1989; Liu & Yang 1989; Takahashi 1994) and syncolpate pollen (Pokrovskaja 1958; Wodehouse 1935) were found. *Illicium anisatum* is the only species in which heteropolar colpate/syncolpate pollen grains were reported (Ikuse 1956; Mitroiu 1970).

The (syn)colpate apertures of *Illicium* pollen are homologous to the heteropolar colpate/syncolpate apertures of *Schisandraceae* pollen, in which the syncolpate pole has the distal position. In both groups the colpi are arranged according to Garside's law during the tetrad stage (Huynh 1976; Praglowski 1976), which is an exceptional configuration among 3-colpate angiosperm pollen. Necessarily, the three alternating, nonfused colpi of 6-aperturate pollen of *Schisandraceae* (*Kadsura*, *Schisandra* p.p.) are arranged

according to Fischer's law. Wodehouse (1935) already suggested that the colpi in *Illicium* and possibly the *Schisandraceae* may not be homologous with those of all other 3-colpate angiosperms. In a cladistic analysis of the *Magnoliidae* (Donoghue & Doyle 1989) the *Illiciaceae* proved to be the sister group of the *Schisandraceae*, and the *Winteraceae* the sister group of both families together. Doyle et al. (1990), using only pollen characters and adding several fossil pollen genera, and Loconte & Stevenson (1991), using pollen as well as macromorphological characters, found the same relationships and all three families appeared to be nested in a group possessing pollen with a single distal aperture. This implies that the colpi of *Illiciaceae* and *Schisandraceae* pollen are indeed not homologous with those of other 3-colpate angiosperms, but are independently derived from a single distal aperture such as present in modern *Winteraceae* (see also Liu & Yang 1989). In this view the heteropolar 3-colpate/syncolpate pollen of *Schisandra* p.p. and some collections of *I. anisatum* would be intermediate between the *Winteraceae* condition and the isopolar 3-(syn)colpate *Illicium* pollen. The presence of the three supplementary colpi that occur in the 6-aperturate *Schisandraceae* must be considered as a derived character. The above results would explain the exceptional orientation of colpi according to Garside's law in the *Illiciales*, because this is characteristic for the three arms of the distal aperture of trichotomosulcate angiosperm pollen (see also under *Schisandraceae*, page 187–189 in this issue).

References: Agababian, V.S., Biol. Zh. Armenii 19 (1966) 77–89. — Donoghue, M.J. & J.A. Doyle, Syst. Ass. Spec. Vol. 40A (1989) 17–45. — Doyle, J.A., C.L. Hutton & J.V. Ward, Amer. J. Bot. 77 (1990) 1558–1568. — Erdtman, G., Pollen morphology and plant taxonomy (1952). — Huang, T.C., Taiwania 13 (1967) 15–110; Pollen flora of Taiwan (1972). — Huynh, K.L., Beitr. Biol. Pflanzen 52 (1976) 227–253. — Ikuse, M., Pollen grains of Japan (1956). — Lieux, M.H., Pollen et Spores 22 (1980) 17–57. — Lin, Q., Bull. Bot. Res. 9 (1989) 115–124. — Liu, H. & C.S. Yang, Chin. J. Bot. 1 (1989) 104–115. — Loconte H. & D.W. Stevenson, Cladistics 7 (1991) 267–296. — Mitroiu, N., Acta Bot. Hort. Bucurest. 1969 (1970) 3–243. — Pokrovskaja, I.M., Ann. Serv. Inform. Géol. B.R.-G.G.M. 24 (1958) 1–435. — Praglowski, J., World Pollen Spore Flora 5 (1976) 1–32. — Saunders, R.M.K., Bot. J. Linn. Soc. 117 (1995) 333–352. — Takahashi, M., Grana 33 (1994) 309–312. — Walker, J.W., Linn. Soc. Symp. Ser. 1 (1976) 251–308. — Wodehouse, R.P., Pollen grains (1935).

SPOROGENESIS AND EMBRYOLOGY

Microsporogenesis (Hayashi 1960) and megasporogenesis and embryology (Hayashi 1963) have been described in detail for *Illicium anisatum*. The development of the embryo sac appears to conform to the *Polygonum* type, and the development of the embryo is of the Asterad type.

References: Hayashi, Y., Sci. Rep. Tôhoku Univ., ser. IV (Biol.), 26 (1960) 45–52; *ibid.* 29 (1963) 27–33.

CYTOLOGY

There is only one published chromosome count for a Malesian species of the genus *Illicium*: *I. stapfii* Merr. (syn. *I. cauliflorum* Merr.) is reported to have $n = 14$ and $2n = 28$ (Ratter & Milne 1973). The same number has been reported for four extra-Malesian species (Morinaga et al. 1929; Whitaker 1933; Stone & Freeman 1968; Ehrendorfer et al.

1968; Okada 1975; Ratter & Milne 1976; Nagl et al. 1977), although the North American species *I. floridanum* has also been reported as $n = 13$ and $2n = 26$ (Stone 1965; Stone & Freeman 1968). The base number for the genus is therefore regarded as $x = 13, 14$. As this base number is also shared by the closely related family *Schisandraceae*, Ehrendorfer et al. (1968) have suggested that these two families (collectively forming the order *Illiciales*) diverged from the basic Magnolialean stock and extinct precursors with $x = 7$ by dysploid reduction from the palaeotetraploid level of $2x = 14$ to $2x = 13$.

References: Ehrendorfer, F., et al., *Taxon* 17 (1968) 337–353. — Morinaga, T., et al., *Bot. Mag. (Tokyo)* 43 (1929) 589. — Nagl, W., et al., *Pl. Syst. Evol.* 127 (1977) 103–105. — Okada, H., *J. Sci. Hiroshima Univ. ser. B (Bot.)*, 15 (1975) 115–200. — Ratter, J.A. & C. Milne, *Notes Roy. Bot. Gard., Edinb.* 32 (1973) 423–428; *ibid.* 35 (1976) 143–145. — Stone, D.E., *Madroño* 18 (1965) 122–126. — Stone, D.E. & J.L. Freeman, *J. Arnold Arbor.* 49 (1968) 41–51. — Whitaker, T.W., *J. Arnold Arbor.* 14 (1933) 376–385.

PHYTOCHEMISTRY AND CHEMOTAXONOMY

(R. Hegnauer)

Formerly *Kadsura*, *Illicium* and *Schisandra* were incorporated in *Magnoliaceae*. Later these three genera were united in a separate family called *Schisandraceae* s.l. (e.g. Gundersen 1950) or in two families, *Illiciaceae* (*Illicium* only) and *Schisandraceae* s.str. (*Kadsura* and *Schisandra*). Hegnauer (1973, 1990) treated chemical characters of all three genera sub *Schisandraceae* s.l.; many references and structural formulae are available in these two reviews.

Summarizing, the following statements seem to be adequate today.

The three fore-mentioned genera are well known in oriental medicine, especially in China, Korea, Taiwan and Japan. They have yielded a considerable number of crude drugs. A lot of chemical work has been performed in recent times with several of these medicinal plants. Nevertheless our knowledge of their chemical characters is still rather fragmentary. As far as chemical constituents are known they allow some preliminary taxonomic conclusions.

The production of essential oils and their deposition in idioblastic oil cells is shared by all three genera. This is a character of woody polycarps. There are marked differences, however, in secondary metabolism of *Kadsura* and *Schisandra* on the one side and *Illicium* on the other. The following special features of natural product chemistry are known from several taxa of the first mentioned two genera. 1) Production and accumulation of biologically active lignans belonging mainly to three types. The most peculiar lignans of *Kadsura* and *Schisandra* are bibenzocyclo-octadienoid compounds, such as the gomisin, the schizandrins and many others; they seem to be biogenetically related with bibenzylbutanoid-type lignans, e.g. anwulignan, pregomisin and others. 2) Moreover, both genera produce characteristic lanostane-type tetracyclic triterpenic acids. Striking structural features of some of these triterpenoids are a *seco*-A-ring and/or a rearranged C/D-ring-junction. However, very recently, similar triterpenoids were isolated from fresh twigs and leaves of *Illicium dunnianum* (Sy et al. 1997).

Illicium contains several toxic species in Indochina, China, Korea, Taiwan, Japan, and the USA (*I. floridanum* ?; toxic constituents still unknown).

The toxins of *I. anisatum* L. (syn. *I. religiosum* Siebold & Zucc.) were investigated thoroughly and shown to be rearranged, dilactonic, picrotoxin-like sesquiterpenoids. Anisatin, neoanisatin and the non-toxic pseudoanisatin became first known from fruits (pericarps and seeds) of *I. anisatum* (Japanese Star Anise or Shikimi). Anisatin and pseudoanisatin are convulsants. Fruits of *I. anisatum* later yielded two other, but biogenetically related, types of C₁₅-dilactones, i.e. the majucin-type 6-deoxymajucin (Kouono et al. 1988) and the anislactone-type anislactones A and B (Kouono et al. 1990). Recently (Okuyama et al. 1993) trace amounts of anisatin-derivatives, i.e. veranisatin A and B, have been isolated from the spice Chinese Star Anise, which is derived from a cultigen of southern China and northern Vietnam that is known as *I. verum* Hook. f. The negligible amounts of these two new convulsants present in the fruits of *I. verum* are however without risk for their medicinal and culinary uses by man. Still another type of C₁₅-dilactones was detected in wood of *I. tashiroi*; two compounds were isolated and called illicinolide A and B (Fukuyama et al. 1992a). The same wood also yielded tashironin, C₂₂H₂₆O₆, which was shown to be the monobenzoate of a tricyclic rearranged sesquiterpenetriol; tashironin may be related to the C₁₅-progenitor of the *Illicium*-dilactones (Fukuyama et al. 1995). Toxic C₁₅-dilactones are presently known also from *I. dunnianum* Tutcher (Yang et al. 1988) and *I. majus* Hook. f. & Thomson.

The essential oils of fruits, leaves, barks, woods and other parts of *Illicium* taxa contain mainly phenylpropanoids, e.g. chavicol, eugenol, safrol and related propenyl- and allylbenzenoids, and mono- and sesquiterpenes. Their composition depends on taxa and plant parts. Anethol (= O-methylanol = *p*-methoxypropenyl-benzene) is the predominant oil constituent of Chinese Star Anise. Bark of *I. difengpi* B.N. Chang, a non-toxic Chinese taxon, also produces the rutinoside of 2-hydroxy-safrol and several derivatives of a dihydroconiferylalcohol 4-glycerinether (Kouono et al. 1992).

A tendency to prenylate phenylpropanoids in various ways is a special feature of *Illicium* taxa. O-Prenylation yields natural products like O-prenyleugenol and illicinol (= 2-prenyloxysafrol). C-Prenylation combined with reductions, rearrangements and cyclizations generates the so-called phytoquinoids, the illicinones and illifunones (Yakushijin et al. 1980, 1984). Wood of *I. tashiroi* Maxim. yielded many illicinones and illifunones. Illicinone E is one of its main constituents; it is accompanied by a whole array of derivatives, some of which are chlorinated (Fukuyama et al. 1992b, 1994).

In a number of *Illicium* taxa illicinones and illifunones seem to be replaced by lignane-like C₆-C₃-dimers and -trimers. Biphenyl-type neolignans (magnolol, honokiol) and triphenyl-type sesqueneolignans (dunnianol, macranthol, simonsinol) were isolated from Chinese material of *I. dunnianum*, *I. macranthum* A.C. Sm., *I. majus* and *I. simonsii* Maxim. (Kouono et al. 1994). Otherwise, *I. difengpi* and *I. majus* seem to produce predominantly neolignans of the aryldihydrobenzofuranpropanol-type. One of the neolignans of the bark of *I. difengpi* was shown to be identical with sakuraresinol, a glycerin ether already known from the bark of *Prunus jamasakura* Koidz. (Kouono et al. 1993).

Shikimic acid is one of the precursors of aromatic plant constituents. It was first isolated from fruits of *I. anisatum* (Shikimi) where it is present in large amounts and is accompanied by protocatechuic acid. Common plant phenolics such as hydroxybenzoic and hydroxycinnamic acids, flavonoids and proanthocyanidins seem to be ubiquitous in *Illicium*; however, their chemical investigation was rather neglected hitherto. Glycosides of the flavonols kaempferol and quercetin (isoquercitrin isolated from *Illicium* material) were detected in every investigated species including the American *I. floridanum* Ellis. The only recent investigations of common phenolics concern herbarium leaves of *I. manipurensis* Watt ex King (Williams & Harvey 1982) and fresh bark of *I. anisatum* (Morimoto et al. 1988). The latter contains catechin, 6- and 8-prenylcatechin and much procyanidins of which several dimeric and trimeric compounds were isolated.

The foregoing summary is based predominantly on investigations of Chinese, Taiwanese and Japanese (including the Ryukyus) plant material. Southern China, Taiwan and the Ryukyu Islands seem to be together the present centre of diversification of *Illicium* and the precise systematic status of many described taxa is still questionable. The following taxa are mentioned in recent phytochemical literature: *I. arborescens*, *I. difengpi*, *I. dunnianum*, *I. macranthum*, *I. majus*, *I. manipurensis*, *I. religiosum*, *I. simonsii*, *I. tashiroi*, and *I. verum*.

The toxic dilactonic sesquiterpenes (anisatin, majucin, anislactones etc.), modified isoprenylated phenylpropanoids (illicinones, illifunones), prenylated catechins and biphenyl-type neolignans represent outstanding chemical features of *Illicium*. Such compounds have not yet been detected in *Kadsura* and *Schisandra*. Secondary metabolism, therefore, seems to agree with the treatment of *Illicium* as a separate family.

Johnson (1954) and Johnson & Fairbrothers (1965) have used serological techniques to verify the assertion by Smith (1947) that the genus does not have a close relationship with the *Magnoliales*.

References: Fukuyama, Y., et al., *Tetrahedron* 48 (1992a) 5847–5854; *Phytochemistry* 31 (1992b) 3975–3979; 36 (1994) 1497–1503; 37 (1994) 1653–1657; *Tetrahedron Letters* 36 (1995) 583–586. — Gundersen, A., *Families of dicotyledons* (1950). *Chronica Botanica*, Waltham, Mass. — Hegnauer, R., *Chemotaxonomie der Pflanzen* 6 (1973) 336–343, 745; 9 (1990) 520–527. — Johnson, M. A., *Serol. Mus. Bull.* 13 (1954) 1–5. — Johnson, M. A. & D. E. Fairbrothers, *Bot. Gaz.* 126 (1965) 260–269. — Kouono, I., et al., *Chem. Pharm. Bull.* 36 (1988) 2990–2992 (from seeds); 38 (1990) 3060–3063 (from pericarps); 40 (1992) 2461–2464; 42 (1994) 112–114. — Kouono, I., et al., *Phytochemistry* 32 (1993) 1573–1577. — Morimoto, S., et al., *Phytochemistry* 27 (1988) 907–910. — Okuyama, E., et al., *Chem. Pharm. Bull.* 41 (1993) 1670–1671. — Smith, A. C., *Sargentia* 7 (1947) 1–224. — Sy, L.-K., et al., *Phytochemistry* 44 (1997) 1099–1108. — Williams, C. & W. J. Harvey, *Phytochemistry* 21 (1982) 329–337; treats mainly *Winteraceae*; the flavonols kaempferol and quercetin and the flavanol dihydroquercetin, but no flavones detected in hydrolysed leaf extracts of *Illicium manipurensis*; procyanidins present. — Yakushijin, K., et al., *Chem. Pharm. Bull.* 28 (1980) 1951–1954; 32 (1984) 11–22. — Yang, C.-S., et al., *Tetrahedron Letters* 29 (1988) 1165–1168.

USES

The fruit of *Illicium verum* Hook. f. is the source of the spice Chinese Star Anise, used for flavouring food and liqueurs. Although this species does not occur in Malesia, the

spice has been imported extensively from China and is traded in Malaysia as 'bunga lawang' or 'adas china' (Burkill 1966). The fruits of the Japanese species *I. anisatum* (syn. *I. religiosum* Siebold & Zucc.) are poisonous, although small quantities can be used for flavouring, and are sometimes retailed in Southeast Asia; confusion with the Chinese Star Anise resulted in unsuccessful attempts to grow it in Singapore (Burkill 1966). There has been considerable confusion regarding the application of common names to *I. verum* and *I. anisatum* (Small 1996). Although the name 'star anise' is rather ambiguous, it is widely used commercially; its use for the poisonous species *I. anisatum* should therefore be avoided. Other *Illicium* species have various reported medicinal properties, often as a stomachics, carminatives, stimulants or vermifuges (Perry 1980). The timber is of very limited value due to the small size of the trees.

None of the Malesian species is of any reported ethnobotanical value.

References: Burkill, I.H., A dictionary of the economic products of the Malay Peninsula 2 (1966) 1244–1246. — Perry, L.M., Medicinal plants of East and Southeast Asia (1980) 180–181. — Small, E., Econ. Bot. 50 (1996) 337–339.

TAXONOMY

The taxonomic position of *Illicium* has been the source of considerable discussion, although its affinities with the *Magnoliales* have long been recognised; this is reflected historically by its classification in both the families *Magnoliaceae* (e.g., Bentham & Hooker 1862) and *Winteraceae* (e.g., Ridley 1922). The treatment that is most widely accepted today (proposed by Smith 1947), involves the isolation of *Illicium* in the monotypic family *Illiciaceae* on the basis of various morphological and anatomical criteria (discussed in detail by Bailey & Nast 1945, 1948). The *Illiciaceae* bear the closest relationship to the *Schisandraceae*, a small family of scrambling and twining woody vines. The isolated evolutionary position of these families has been recognised more recently by their classification as the sole members of the order *Illiciales* (e.g., Takhtajan 1980; Cronquist 1981); it is generally agreed, however, that the *Illiciales* were derived from a common ancestry with such orders as *Magnoliales* and *Winterales*, although the *Illiciales* are without very close modern relatives.

The last comprehensive revision of *Illicium* was the monograph by Smith (1947), who recognised 42 species. He divided the genus into two sections, viz. section *Badiana* Spach (which includes the type species and should therefore bear the autonym sect. *Illicium*), and section *Cymbostemon* (Spach) A.C. Sm. Section *Illicium* is characterised by narrowly oblong, ligulate or lanceolate inner perianth segments, and is represented in the Malesian flora by the distinctive species, *I. philippinense* Merr. The remaining six Malesian species belong to section *Cymbostemon*, which is characterised by generally ovate to suborbicular inner perianth segments. The two basic types of pollen in the genus (discussed above) are broadly correlated with the sectional distinctions, with trizonocolpate pollen occurring in sect. *Illicium* and trisyncolpate pollen in sect. *Cymbostemon*; although many of the Malesian species had not previously been studied palynologically, they are all shown by Saunders (1995) to conform to this taxonomic distinction.

The North American species *I. floridanum* (sect. *Illicium*) is atypical, however, since it possesses trisyncolpate grains (Wodehouse 1959; Lieux 1980).

References: Bailey, I.W. & C.G. Nast, *J. Arnold Arbor.* 26 (1945) 37–47; *ibid.* 29 (1948) 77–89. — Bentham, G. & J.D. Hooker, *Genera Plantarum* 1 (1862). — Cronquist, A., *An integrated system of classification of flowering plants* (1981). — Lieux, M.H., *Pollen et Spores* 22 (1980) 17–57. — Ridley, H.N., *Flora of the Malay Peninsula* 1 (1922). — Saunders, R.M.K., *Bot. J. Linn. Soc.* 117 (1995) 333–352. — Smith, A.C., *Sargentia* 7 (1947) 1–224. — Takhtajan, A., *Bot. Rev.* 46 (1980) 225–359. — Wodehouse, R.P., *Pollen grains* (1935, repr. 1959) 335–337.

KEY TO THE SPECIES

- 1a. Largest perianth parts narrowly elliptic (length: width ratio c. 2–4) **3. *I. philippinense***
 b. Largest perianth parts ± ovate (length: width ratio c. 0.5–2) 2
 2a. Leaves thin, papyraceous, becoming contorted along lateral veins after drying ... **7. *I. tenuifolium***
 b. Leaves thick, coriaceous, ± flat after drying 3
 3a. Leaves large, 5.5–14.5(–19) by 2–6.5(–8.5) cm; carpels 8–14; fruit of up to 14 follicles 4
 b. Leaves small, 3–9(–11.5) by 1.5–4(–5) cm; carpels 5–10; fruit of up to 10 follicles 6
 4a. Stamens 9–19(–20); carpels 8–14 5
 b. Stamens 20–33(–39); carpels 12–13 **2. *I. peninsulare***
 5a. Outermost perianth parts large, 4–8.5 by 4–6.5 mm; stamens 9–14(–20) **5. *I. stapfii***
 b. Outermost perianth parts small, 1.1–2.2 by 1.3–3 mm; stamens 15–19 **6. *I. sumatranum***
 6a. Perianth parts 8–10(–13); stamens 7 or 8; carpels invariably 8; fruit of up to 8 follicles **1. *I. kinabaluense***
 b. Perianth parts 10–17; stamens (5–)9–19; carpels 5–10; fruit of up to 10 follicles **4. *I. ridleyanum***

1. *Illicium kinabaluense* A.C. Sm.

Illicium kinabaluense A.C. Sm., *Sargentia* 7 (1947) 61; R.M.K. Saunders, *Bot. J. Linn. Soc.* 117 (1995) 342; in *Tree Fl. Sabah & Sarawak* 1 (1995) 230. — Type: *Clemens 50154* (A holo; L), Mt Kinabalu, Sabah.

Small *tree*, to 14 m height, 90 cm girth. *Leaves* ± coriaceous, elliptic, (4.5–)7(–11) by 1.5–3 cm, midrib ± impressed above and prominent below, apex (short-)acuminate, base attenuate, margins slightly revolute; petioles c. 9–16 mm long, grooved on adaxial surface. *Flowers* axillary on young growth, generally solitary; pedicels 12–20 mm long at anthesis. *Perianth parts* 8–10(–13), pink, red or purplish, outermost perianth parts ovate, not reduced, 3.5–4.7–6 by 3–3.1–3.5 mm, largest perianth parts ovate, 4–5.4–7 by 2.5–3.4–5 mm, innermost perianth parts ovate, 2–3.6–5 by 1–1.8–2 mm. *An-*

androecium of 7 or 8 stamens, uniseriate; stamens 1.8–2.1–2.5 mm long; pollen grains trisyncolpate. *Gynoecium* of 8 carpels; carpels 1.6–1.8–2 mm long. *Fruit* of up to 8 follicles.

Distribution — *Malesia*: restricted to Mt Kinabalu, Sabah.

Habitat — Montane forests between 1200 and 2000 m altitude.

2. *Illicium peninsulare* A.C. Sm.

Illicium peninsulare A.C. Sm., *Sargentia* 7 (1947) 56; Keng in *Fl. Thailand* 2 (1972) 115; Ng in *Tree Fl. Malaya* 2 (1973) 254; R.M.K. Saunders, *Bot. J. Linn. Soc.* 117 (1995) 343. — Type: *Nur 11247* (A holo; UC), Fraser Hill, Pahang.

Illicium cambodianum auct. non Hance: King, *J. As. Soc. Beng.* 58, ii (1889) 374, pro parte.

Illicium cambodianum Hance var. *crassifolia* Ridl., *Fl. Malay Penins.* 1 (1922) 18, pro parte, nom. illeg.

Small tree, to 10 m height, 60 cm girth. *Leaves* coriaceous, elliptic, (9.5–)10–14.5 (–15) by 4–6.5(–7) cm, midrib impressed above and very prominent below, apex acute to short acuminate, base attenuate, margins ± revolute; petioles 11–20 mm long, grooved on adaxial surface. *Flowers* axillary on young growth, generally solitary; pedicels 1–7 (–10) mm long at anthesis. *Perianth parts* 15–25, yellowish white, outermost perianth parts broadly ovate, reduced, 2–2.9–3.5 by 2.8–3.5–4.8 mm, largest perianth parts ovate, 6.5–7.9–9.6 by 5–6.2–7 mm, innermost perianth parts ovate, c. 3.5 by 1.6 mm. *Androecium* of 20–33(–39) stamens, biseriate; stamens 2.6–2.8–3 mm long; pollen grains trisyncolpate. *Gynoecium* of 12 or 13 carpels; carpels 3.2–3.7–4 mm long. *Fruit* of up to 13 follicles.

Distribution — Peninsular Thailand; *Malesia*: Malay Peninsula (Perak, Pahang, Selangor, Malacca, and Johore).

Habitat — Montane forests between 450 and 1520 m altitude.

Note — The *Illicium* species from the Malay Peninsula have been the source of considerable confusion due to their initial identification as *I. cambodianum*; this is discussed by Saunders (l.c.).

3. *Illicium philippinense* Merr.

Illicium philippinense Merr., *Philipp. J. Sc., Bot.* 4 (1909) 254; A.C. Sm., *Sargentia* 7 (1947) 33, f. 6H; H.L. Li in *Fl. Taiwan* 2 (1976) 405; R.M.K. Saunders, *Bot. J. Linn. Soc.* 117 (1995) 344. — Type: *Curran & Merritt 9515* (holo destroyed; US lecto; K), Luzon.

Illicium montanum Merr., *Philipp. J. Sc., Bot.* 7 (1912) 106. — Type: *Vanoverbergh 1048* (holo destroyed; K lecto), Luzon.

Shrub or small tree, to 8 m height. *Leaves* ± coriaceous, elliptic, 5–7(–9) by 2–4 cm, midrib ± raised above and ± prominent below, apex acute to acuminate, base attenuate, margins ± revolute; petioles 8–10 mm long, groove ± absent on adaxial surface. *Flowers* axillary on young growth, generally solitary or few in clusters; pedicels 5–15 mm long at anthesis. *Perianth parts* 15–27, white, outermost perianth parts ovate, c. 4.5 by 2.5–3 mm, largest perianth parts narrowly elliptic, 9–14 by 3.3–4.5 mm, innermost perianth parts ovate, c. 4.5 by 3 mm. *Androecium* of (11–)16–25 stamens, biseriate;

stamens 2.2–2.5–2.9 mm long; pollen grains trizonocolpate. *Gynoecium* of 9–11 carpels; carpels 3.3–3.7–4.5 mm long. *Fruit* of up to 11 follicles.

Distribution — Taiwan (Li, l.c.); *Malesia*: Philippines (Luzon, Mindoro).

Habitat — Montane forests between 800 and 3000 m altitude.

Note — The pollen has been illustrated by T.-C. Huang in *Pollen Flora of Taiwan* (1972) 125 and Saunders (l.c.).

4. *Illicium ridleyanum* A.C. Sm.

Illicium ridleyanum A.C. Sm., *Sargentia* 7 (1947) 66; Ng in *Tree Fl. Malaya* 2 (1973) 254; R.M.K. Saunders, *Bot. J. Linn. Soc.* 117 (1995) 344. — Type: *Robinson s.n.*, 18 Jan. 1913 (K holo), Selangor, Malay Peninsula.

Illicium cambodianum Hance var. *crassifolia* Ridl., *Fl. Malay Penins.* 1 (1922) 18, pro parte, nom. illeg.

Small *tree*, to 20 m height, 80(–120) cm girth. *Leaves* ± coriaceous, elliptic to ovate-elliptic, 3–9(–11.5) by (1.5–)2–4(–5) cm, midrib ± impressed above and very prominent below, apex acute or (short-)acuminate, base attenuate, margins ± revolute; petioles (5–)8–13 mm long, grooved on adaxial surface. *Flowers* axillary on young growth, generally solitary or few clustered; pedicels to c. 15 mm long at anthesis. *Perianth parts* 10–17, (pinkish-)red, outermost perianth parts broadly ovate, not reduced, 2–4.3–8 by 2.5–4–5.3 mm, largest perianth parts ovate, 4.1–6–8.4 by 4–5.7–8 mm, innermost perianth parts ovate, 1.3–2.9–5 by 0.6–1.5–2.5 mm. *Androecium* of (5–)9–19 stamens, uniseriate; stamens 0.8–2.2–3 mm long; pollen grains trisyncolpate. *Gynoecium* of 5–10 carpels; carpels 1.6–2.6–3.8 mm long. *Fruit* of up to 10 follicles.

Distribution — *Malesia*: Malay Peninsula (Perak, Kelantan, Trengganu, Pahang, Selangor, Malacca and Johore).

Habitat — Montane forests between 600 and 2040 m altitude.

Note — The *Illicium* species from the Malay Peninsula have been the source of considerable confusion due to their initial identification as *I. cambodianum*; this is discussed by Saunders (l.c.).

5. *Illicium stapfii* Merr.

Illicium stapfii Merr., *Philipp. J. Sc., Bot.* 13 (1918) 67; A.C. Sm., *Sargentia* 7 (1947) 65; R.M.K. Saunders, *Bot. J. Linn. Soc.* 117 (1995) 347; in *Tree Fl. Sabah & Sarawak* 1 (1995) 230. — Types: *Clemens 10995* (PNH lecto), *10949* (PNH para), *11081* (syn, destroyed), Mt Kinabalu, Sabah.

Illicium cauliflorum Merr., *Sarawak Mus. J.* 3 (1928) 522. — Type: *Mjöberg 114* (UC holo), Mt Murud, Sarawak.

Medium sized *tree*, to 25 m height, 80 cm girth. *Leaves* coriaceous, elliptic, (6–)10–14(–19) by 2–6(–8.5) cm, midrib markedly impressed above and prominent below, apex (short-)acuminate, acute or obtuse, base obtuse to attenuate, margins markedly revolute; petioles 10–35 mm long, groove on adaxial surface. *Flowers* axillary on young growth or occasionally ramiflorous/cauliflorous, generally solitary; pedicels up to 50 mm long at anthesis. *Perianth parts* 9–19, pink, red or purplish, outermost perianth

parts ovate, not reduced, 4–6.3–8.5 by 4–4.5–6.5 mm, largest perianth parts ovate, 5–7.4–9.5 by 3.4–5.1–7.6 mm, innermost perianth parts ovate 3.5–5.5–7.5 by 1–2.9–4.5 mm. *Androecium* of 9–14(–20) stamens, uniseriate; stamens 2–2.6–3.2 mm long; pollen grains trisyncolpate. *Gynoecium* of 8–14 carpels; carpels 2.1–3.1–5 mm long. *Fruit* of up to 14 follicles. $n = 14$, $2n = 28$ [Ratter & Milne, Notes Roy. Bot. Gard. Edinb. 32 (1973) 423–428].

Distribution — *Malesia*: Borneo, from Mt Kinabalu (Sabah) in the north to the Linau-Balui Plateau (Sarawak) in the south; also reported from northern Kalimantan.

Habitat — Montane forests between 800 and 2000 m altitude.

Note — The reduction of *I. cauliflorum* to a synonym of *I. stapfii* is discussed by Saunders (l.c.).

6. *Illicium sumatranum* A.C. Sm.

Illicium sumatranum A.C. Sm., Sargentia 7 (1947) 70; R. M. K. Saunders, Bot. J. Linn. Soc. 117 (1995) 347. — Type: *van Steenis 6317* (A holotype; K), Aceh, Sumatra.

Small tree, to 15 m height. *Leaves* coriaceous, (narrow-)elliptic to slightly obovate, 5.5–13(–15) by 2–4.5(–5) cm, midrib very impressed above and very prominent below, apex acute to acuminate, base attenuate, margins highly revolute; petioles 5–13 mm long, grooved on adaxial surface. *Flowers* axillary on young growth, generally solitary; pedicels to c. 32 mm long at anthesis. *Perianth parts* 15–21, white to deep red (outer perianth parts often greenish), outermost perianth parts broadly ovate, reduced, 1.1–1.7–2.2 by 1.3–2.1–3 mm, largest perianth parts ovate, 4.7–5.7–7 by 3.5–4.9–6 mm, innermost perianth parts narrowly ovate, 2.4–3.3–4 by 1.6–1.8–2 mm. *Androecium* of 15–19 stamens, uni- or biseriate; stamens 1.6–2.3–2.9 mm long; pollen grains trisyncolpate. *Gynoecium* of 8–12 carpels; carpels 2.2–2.6–2.8 mm long. *Fruit* of up to 12 follicles.

Distribution — *Malesia*: Sumatra (Aceh, Sumatera Barat and Sumatera Utara).

Habitat — Montane forests between 1000 and 1800 m altitude.

7. *Illicium tenuifolium* (Ridl.) A.C. Sm.

Illicium tenuifolium (Ridl.) A.C. Sm., Sargentia 7 (1947) 68; Keng in Fl. Thailand 2 (1972) 116; Ng in Tree Fl. Malaya 2 (1973) 254, f. 1; R. M. K. Saunders, Bot. J. Linn. Soc. 117 (1995) 349. — *Illicium cambodianum* Hance var. *tenuifolia* Ridl., Fl. Malay Penins. 1 (1922) 18. — Type: *Ridley 13534* (K lecto), Pahang, Malay Peninsula.

Illicium cambodianum auct. non Hance: King, J. As. Soc. Beng. 58, ii (1889) 374, pro parte.

Illicium tenuifolium (Ridl.) A.C. Sm. var. *angustifolium* A.C. Sm., Sargentia 7 (1947) 70. — Type: *Robinson & Kloss 6089* (K holotype), Kedah, Malay Peninsula.

Illicium tenuifolium (Ridl.) A.C. Sm. var. *obovatum* A.C. Sm., Sargentia 7 (1947) 70. — Type: *Sy- mington 24243* (K holotype; SING), Selangor, Malay Peninsula.

Small tree, to 15 m height, 30 cm girth. *Leaves* papyraceous, becoming contorted after drying along secondary (and occasionally tertiary) veins, elliptic to obovate, (6.5–) 8–13(–19) by (2–)2.5–6 cm, midrib ± impressed above and ± prominent below, apex

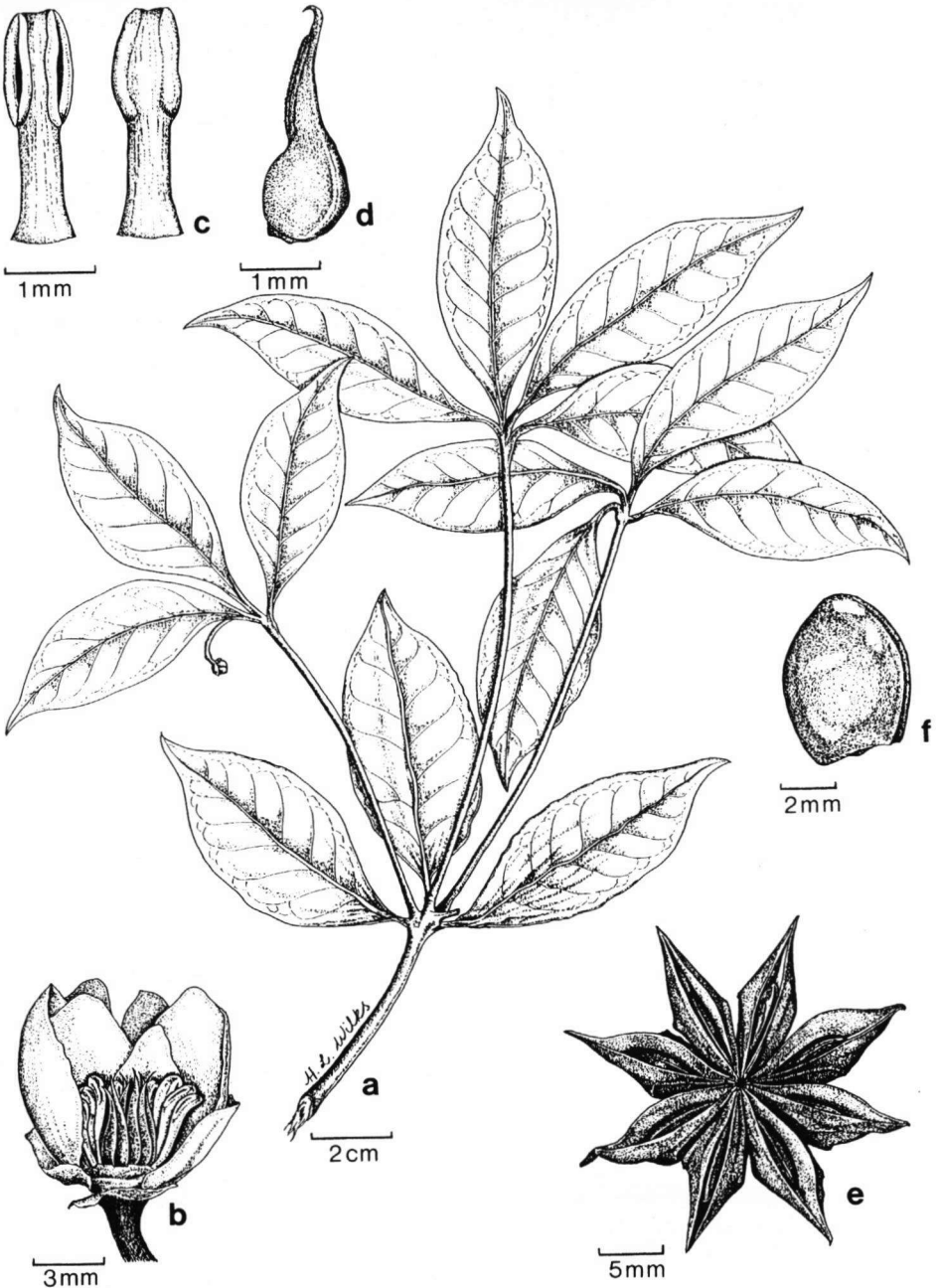


Fig. 1. *Illicium tenuifolium* (Ridl.) A.C. Sm. a. Flowering branch; b. flower, with proximal perianth parts and stamens removed; c. isolated stamens (abaxial and adaxial views); d. isolated carpel (lateral view); e. fruit (follicetum of eight follicles); f. seed (a: H. & R. S. Keng 4329; b: de Wilde & de Wilde-Duyffes 19036; c, d: de Wilde & de Wilde-Duyffes 13222; e: Ding Hou 810; f: Ridley s. n. Drawing by H. L. Wilks, reproduced with permission from Bot. J. Linn. Soc. 117 (1995).

(long-)acuminate, base attenuate, margins \pm revolute or not revolute; petioles 6–18 mm long, grooved on adaxial surface. *Flowers* axillary on young growth or ramiflorous/cauliflorous, generally solitary or few clustered; pedicels 10–50 mm long at anthesis. *Perianth parts* 10–18, white to red, outermost perianth parts broadly ovate, reduced, 0.9–1.9–3.3 by 1–2–3.4 mm, largest perianth parts broadly ovate, 2.4–5.6–8.9 by 1.6–5.2–8.3 mm, innermost perianth parts ovate, 2.1–4.4–6.3 by 1.2–2.6–6.4 mm. *Androecium* of (8–)12–16(–20) stamens, uniseriate; stamens 1.7–2.7–3.8 mm long; pollen grains trisyncolpate. *Gynoecium* of (6–)8(–13) carpels; carpels 2.6–3.5–5.5 mm long. *Fruit* of up to 13 follicles. — **Fig. 1.**

Distribution — Peninsular Thailand; *Malesia*: Malay Peninsula (Kedah, Perak, Trengganu, Pahang, Selangor, Negri Sembilan and Johore).

Habitat — Montane forests between 420 and 1680 m altitude.

Notes — 1. The *Illicium* species from the Malay Peninsula have been the source of considerable confusion due to their initial identification as *I. cambodianum*. This is discussed by Saunders (l.c.), as is the validity of the infraspecific classification proposed by Smith (l.c.).

2. The pollen of the present species is illustrated by Saunders (l.c.).

EXCLUDED

Illicium evenium King, J. As. Soc. Beng. 58, ii (1889) 374–375 = *Ternstroemia evenia* (King) A. C. Sm., Sargentia 7 (1947) 78 (*Theaceae*) [syn. *Ternstroemia scortechinii* King, J. As. Soc. Beng. 59, ii (1890) 193].