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CORIARIACEAE

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CORIARIA

Coriaria L., Sp. Pl. ed. 1 (1753) 1037. — Lectotype species: *Coriaria myrtifolia* L.

Shrubs (rarely perennial herbs with herbaceous stems) or small *trees*. *Roots* with nodules with nitrogen fixing bacteria. Innovations in flushes from perulate apical buds. Branches 4-angular, ridges alternating; xylem with broad medullary rays. *Leaves* generally small, sessile or subsessile, with a narrow joint at base, simple, entire, cordate-ovate to lanceolate, acute, decussate, or (not in Malesia) in whorls, phyllotaxis of the lateral branches mostly showing as pseudo-distichous; blades palmately 3–9-curvi-nerved, net-veined, those sustaining side-branches often of somewhat different shape. Stipules absent (but see note). *Racemes* terminal or axillary. Flowers in the axils of small bracts, greenish or reddish, actinomorphic, hypogynous, polygamous, i.e., bisexual or functionally unisexual (both male and female flowers with rudiments of the other sex). Pedicel slender, bracteoles absent. Perianth 5-merous; sepals 5, imbricate, persistent, ovate; petals 5, alternate, shorter than the sepals, keeled inside, accrescent, becoming more or less fleshy, each enveloping a carpel in fruit. *Stamens* 10, in two whorls, free, or those opposite the petals adnate to the keel of the petal; filaments filiform; anthers exserted, ellipsoid or sagittate, papillose or smooth, 2-celled, opening lengthwise. Carpels 5–10(–12), free, one-celled, the basal part adnate to a central conical receptacle, each with a slender distinct papillose style. Ovules one per carpel, pendulous, anatropous, with the micropyle directed upwards. *Pseudo-fruit* consisting of hard-walled, laterally compressed achenes, more or less enclosed by the fleshy-accrescent petals, each achene subtended on each side by half of the adjoining petal. *Seed* compressed, without an aril, testa thin, endosperm scanty or none; embryo straight. — **Fig. 1.**

Distribution — About 20 species, depending on the taxonomic treatment (see infrageneric variation), with a much broken distribution: the West-Mediterranean, the Himalayan Region from Pakistan to SE Asia, and E Asia (Japan, China, incl. Hainan), through Malesia (rare) to New Zealand (and the Subantarctic Islands), Chile, Peru as far North as Mexico; in *Malesia:* the Philippines (Luzon) and Papua New Guinea.

Habitat & Ecology — In Malesia and SE Asia in the submontane and montane zone, often pioneering in exposed situations. Apparently a genus of temperate and subtropical climatic conditions. There are remarkable disjunctions in the distribution. The flowers, with exerted slender stamens and styles, are adapted to wind pollination. The fleshy pericarp suggests dispersal by animals, presumably birds. The racemes and fruits have a superficial resemblance with the *Phytolaccaceae*.

Systematic position of the family — This monogeneric family has been the subject of various studies in an attempt to settle its phylogenetic and systematic position. It has no close relationship to any suggested family. Its distribution and the numerous proposed putative alliances give the impression of an old genus; it is also found as a fossil (see the chapter on palynology). Possibly the status of a separate order *Coriariales* for this single isolated genus is a good solution.

References: Bohm, B.A. & R. Ornduff, Syst. Bot. 6 (1981) 15–26. — Carlquist, S., Syst. Bot. 10 (1985) 174–183. — Cronquist, A., An integrated system of classification of flowering plants (1981) 136–139; The evolution and classification of flowering plants (1988) 289, 504. — Engler, A., in Engler & Prantl, Nat. Pflanzenfam. III, 5 (1896) 128–129. — Garg, M., Phytomorphology 30 (1980) 15–26. — Hutchinson, J., Families of flowering plants (1926) 156; ibid., ed. 3 (1973) 136, 183–184. — Oginuma, K., M. Nakata, M. Suzuki, & H. Tobe, Bot. Mag. Tokyo 104 (1991) 297–308. — Takhtajan, A., Evolution und Ausbreitung der Blütenpflanzen (1973) 173; Bot. Rev. 46 (1980) 225–259; Floristic regions of the world (1988) 334.

Infrageneric variation — Because of the great variation within populations of *Coriaria*, the generally weak demarcation of species described and the occurrence of natural hybridization, especially apparent in New Zealand, Skog (1972) distinguished only five species in total for the whole genus. One of these is the aggregate species *C. ruscifolia* L., comprising all species from South and Central America, the South Pacific islands, New Zealand and New Guinea. *Coriaria ruscifolia* has two subspecies, subsp. *ruscifolia* and subsp. *microphylla*, the latter including *C. papuana* from New Guinea. Following Skog, our present *C. intermedia* would be included in *C. japonica*. To the contrary, a recent karyomorphological study (Oginuma et al. 1991) provides evidence for distinguishing at least four species in *C. ruscifolia* sensu Skog. For convenience sake, two locally well-characterized species are accepted here for Malesia, *C. intermedia* and *C. papuana*.

References: Oginuma, K., M. Nakata., M. Suzuki & H. Tobe, Bot. Mag. Tokyo 104 (1991) 297–308. — Skog, L.E., Rhodora 74 (1972) 242–253.

Vegetative Anatomy — *Leaf anatomy*. Cuticle striated; stomata paracytic; lamina dorsiventral; midrib with single collateral vascular strand supported by weakly developed sclerenchyma caps.

Wood anatomy. Wood weakly semi-ring-porous or diffuse-porous. Vessels angular, thin-walled, in multiples and small clusters, rarely solitary, with simple perforations and alternate intervessel pits with slit-like, occasionally coalescent apertures. Vascular tracheids, resembling narrow vessel elements, present in association with vessel groups. Ground tissue composed of libriform fibres. Parenchyma vasicentric to confluent, fusiform or in 2(–4)-celled strands. Rays multiseriate, broad and tall, composed predominantly of erect and square cells, integrading with procumbent cells. Crystals present in some ray cells. Vessel elements, axial parenchyma, and sometimes also the fibres storied.

Carlquist (1985) concluded that the affinities of *Coriaria* remain elusive, despite some wood anatomical similarities with *Corynocarpus*, woody *Ranunculaceae*, and several *Simaroubaceae*.

References: Carlquist, S., Syst. Bot. 10 (1985) 174–183 (wood anatomy of *Coriaria arborea, C. japonica, C. ruscifolia* and *C. thymifolia*) — Metcalfe, C.R. & L. Chalk, Anatomy of the Dicotyledons (1950) — Santos, J.K., Philipp. J. Sc. 46 (1931) 257–266 (leaf anatomy of *Coriaria intermedia*). — Suzuki, M. & K. Yoda, J. Jap. Bot. 61 (1986) 289–296, 333–341 (wood anatomy of *Coriaria terminalis, C. japonica, C. nepalensis* and *C. intermedia*). — Yoda, K. & M. Suzuki, Bot. Mag. Tokyo 105 (1992) 235–245 (wood anatomy of 14 species, including also *Coriaria intermedia*).

P. Baas

Chromosomes — The basic chromosome number is x = 20; the somatic chromosome number is for the majority of species, including the Malesian representatives, 2n = 40, but outside Malesia tetraploidy (2n = 80) also occurs.

Reference: Oginuma, K., M. Nakata, M. Suzuki, & H. Tobe, Bot. Mag. Tokyo 104 (1991) 297–308.

Palynology — *Coriaria* pollen is small to medium-sized (polar axis 14–35 µm, equatorial diameter 20–34 µm), isopolar, usually suboblate (P/E 0.75–0.88) and 3-aperturate, either colporate or pororate. The equatorial outline is (sub)circular, the meridional outline elliptic. The colpori have an ectocolpus of 4–10 by 0.5–2 µm and a lalongate endoporus of 2–5 by 3–8 µm. Pororate grains have isodiametric ectopori of 2–4 µm, often with thickened protruding margins, and lalongate to isodiametric endopori of 3–5 by 4–6 µm. The exine is 0.75–1.5 µm thick and distinctly stratified, showing a nexine columellate infratectal layer and a tectum, which are about equally thick. The tectum has a scabrate ornamentation consisting of c. 0.2 µm high conical elements and shows many small funnel-shaped perforations. Individual columellae, scabrae and perforations are usually not distinguishable with light microscopy.

Praglowski (1970) studied the pollen of 16 species. He recognised a group with colporate pollen (12 species from America, the Mediterranean region, China, New Guinea and New Zealand) and a group with pororate pollen (4 species from India, China, Japan, Taiwan and Luzon). The colporate *C. terminalis* from China is intermediate, having rather short ectocolpi (3–5 µm).

Skog (1972) distinguished only 5 species in *Coriaria: C. ruscifolia* (including all material from America, New Guinea, New Zealand and other Pacific islands) has colporate pollen; *C. terminalis* (Tibet, China) and *C. myrtifolia* (Mediterranean region) are two other colporate species; *C. nepalensis* (including *C. sinica*; India, Nepal, China) and *C. japonica* (including *C. intermedia*; Japan, Taiwan, Luzon) have pororate pollen.

Pollen morphology does not elucidate the phylogenetic position of *Coriaria*. *Coriaria* pollen has been tentatively compared with that of *Sapindaceae* (Meenakshi Garg 1980), but obviously the available data of the latter did not represent adequate reference material. *Coriaria* pollen is relatively 'simple', and does not show special features that allow affiliation with other taxa. It resembles pollen of *Corylus* (*Betulaceae*) and *Myrica* (*Myricaceae*). However, this resemblance may be explained from the anemophilous pollination system shared by these plants.

Fossil *Coriaria* pollen has been reported from the upper Miocene of Spain, the Pliocene of New Zealand (see Muller 1981) and the Pleistocene of the Netherlands (see Praglowski, l.c.).

References: Meenakshi Garg, Phytomorphology 30 (1980) 5–10. — Muller, J., Bot. Review 47 (1981) 1–142. — Praglowski, J., World Pollen Flora 1 (1970) 15–22, 25–31. — Skog, L.E., Rhodora 74 (1972) 242–253.

R.W.J.M. Van Der Ham

Phytochemistry — The monogeneric family has its name from the Latin *corium* (= leather) because leaves and twigs of the Mediterranean *Coriaria myrtifolia* were formerly used in tannery. Chemical characters of *Coriariaceae* were summarized by Hegnauer (1964, 1989), where many references to phytochemical and toxicological literature are available. The phytochemistry of this small family is surprisingly well known. All species seem to contain bitter, toxic lactones and to produce large amounts of ellagitannins accompanied by lesser amounts of precursor gallotannins.

The toxic, lactonic principles are picrotaxan-type sesquiterpenes. Coriamyrtin, corianin, tutin (from the Maori name 'Tutu' of the genus), and pseudotutin are the toxic picrotoxin-like compounds of *Coriaria*. All *Coriaria* species are known to be toxic. The picrotaxans are a group of convulsive, insecticidal and ichthyotoxic natural products which occur erratically in angiosperms (also known from a few genera of *Menispermaceae, Euphorbiaceae, Orchidaceae*).

The ellagitannins of *Coriaria japonica* were studied thoroughly by Okuda's group (Okuda et al. 1990, 1993). Monomeric ellagitannins like tellimagrandin-I and -II, coriariin-B and -F and geraniin and dimeric ellagitannins like coriariin-A and -C to -E, and rugosin-D and -E are produced by this taxon which also contains trigalloylglucose.

Glycosides of the flavonols kaempferol and quercetin are present in leaves of all species which have been investigated. They are accompanied in most species by the 7-glucoside of the flavanone naringenin.

Fruits, leaves and twigs of the South American species *C. ruscifolia* yielded the triterpenic acid ursolic acid and phytosterins and coriamyrtin.

The carbohydrate metabolism of the family shows special features. A new heptulose, coriose, was isolated from roots, stems, leaves, fruits and seeds of *C. japonica*; it is accompanied by sedoheptulose in leaves and by a corresponding heptitol, volemitol, in seeds. Coriose and another heptulose are also present in *C. intermedia, nepalensis, ruscifolia* and *thymifolia*. *Myo*-inositol is also present in easily detectable amounts in all parts of *C. japonica*.

Seeds contain much fatty oil (up to 70% of kernels) with an unusual fatty acid, coriolic acid, as the main fatty acid. Coriolic acid is 9-*cis*,11-*trans*-13-hydroxyoctadecadienoic acid; this acid can be interpreted as a monohydrated α-elaeostearic acid. Seed oils of all investigated species, *C. myrtifolia, nepalensis, papuana, ruscifolia, sarmentosa* and *terminalis*, contained this new fatty acid.

On account of its chemistry the family must belong to the core of dicotyledons which produce and accumulate ellagitannins.

Phytochemistry suggests *Euphorbiaceae* on the one side and *Crassulaceae-Saxifragaceae* s. str. on the other side as good candidates for remote relatives. Thorne (1992) classifies *Coriariaceae* in *Rutanae* in the most recent version of his phylogenetic system of angiosperms and Huber (1991) suggests close relationship with *Anacardiaceae*.

References: Huber, H., Angiospermen. Leitfaden durch die Ordnungen und Familien der Bedecktsamer (1991), G. Fischer, Stuttgart. — Okuda, T., et al., Heterocycles 30 (1990) 1195 (review of oligomeric hydrolisable tannins; a new class of plant polyphenols). — Okuda, T., et al., Phytochemistry 32 (1993) 507 (classification and distribution in dicotyledons of oligomeric hydrolisable tannins). — Thorne, R.F., Classification and geography of the flowering plants, Bot. Rev. 58 (1992) 225–348.

R. Hegnauer

Uses — Rich in tannin, used locally for tanning and black-dye. The flowers and fruits contain a narcotic, poisonous substance, coriariin. Some *Coriaria* species (e.g. the Mediterranean *C. myrtifolia* L., some New Zealand species, and also *C. papuana*) possess root nodules with nitrogen-fixing properties. As these species often grow in pioneering situations, such as lava fields and roadsides, they may have a place in planting programmes for erosion control in wet scree country (Daly et al. 1972). *Coriaria nepalensis* (India) is one of the food plants of the silk moth.

References: Ambasta (ed.), Useful plants of India (1986) 142. — Daly, G.T., B.E. Smith & S. Chua, Proc. New Zeal. Ecol. Soc. 19 (1972) 65–74. — Watt, G., The commercial products of India (1908) 1012.

Note — In and beside the leaf-axils numerous minute, fleshy, finger-shaped, and gland-like emergentia are usually present. These have been called stipules by various authors.

KEY TO THE SPECIES

1a. Racemes 4–10 cm long, axillary, aggregated in groups of (1 or) 2 or 3, subtended by small cataphylls. Flowers c. 5 mm across. Leaves oblong, 5–7 cm long, 3-nerved. Fruits c. 5 mm across ..... **1. C. intermedia**

b. Racemes (7–)20 cm long, axillary, solitary. Flowers c. 2.5 mm across. Leaves ovate-oblong, 1.5–4 cm long, 5–7(–11)-nerved. Fruits 2–3 mm across **2. C. papuana**

1. Coriaria intermedia Matsumura, Bot. Mag. Tokyo, Bot. Soc. 12 (1898) 62 ; Hui-Lin Li, Woody Fl. Taiwan (1963) 443; in Fl. Taiwan 3 (1977) 563, pl. 729; Kanehira, Formos. Trees, rev. ed. (1936) 361, f. 317; Keng, Orders and families of seedplants of Taiwan (1987) 62, f. 20.1; Merr., Enum. Philipp. Flow. Pl. 4 (1926) 88. — Types: *Tashiro s.n.* (not seen), *Owatari s.n.* (not seen), both from Taiwan.

Shrubs or small trees, 1–3 m high. Roots forming nodules. *Leaves* decussate; petioles c. 2 mm long; blades oblong (or ovate), glabrous, 3-nerved, midrib pinkish, (3–)5–7 by 1.5–2.5 cm, base cuneate, apex acute. *Inflorescences* consisting of subaxillary fascicles of 1–3 racemes, 4–10 cm long, glabrous; bracts ovate, glabrous, 4.5–5 by 2.5–4 mm, acute or blunt, the margins irregularly serrate. *Flowers* bisexual or unisexual, yellowish green; pedicels 2–7 mm long. *Male flowers:* sepals broadly ovate, c. 3.2 by 2.4 mm, obtuse; petals ovate, c. 1.2 by 0.5 mm, acute; stamens c. 8 mm long, filaments c. 6 mm long, anthers 1.5–2 by c. 0.8 mm, papillose. *Female flowers:* sepals broadly ovate, c. 3 by 2 mm, obtuse, or acute; petals ovate, c. 2.8 by 1.8 mm, acute; styles c. 3.5 mm long; carpels 5, c. 1.5 by 1 mm. *Pseudo-fruit* 3–5 mm across; achenes 2.8–3 by 1.5–1.8 mm, glabrous, with a few longitudinal ribs.

Distribution – Taiwan; in *Malesia:* Philippines (N Luzon).

Habitat & Ecology – Thickets, open forests, sunny and stony slopes, dry riverbeds and watercourses, from low altitudes up to c. 2400 m.

Notes – Closely allied to *C. japonica.*

Due to its occurrence in riverbeds and watercourses, *C. intermedia* is possibly a facultative rheophyte, but it was not recognized as such by Van Steenis (1981); see also under *C. papuana.*

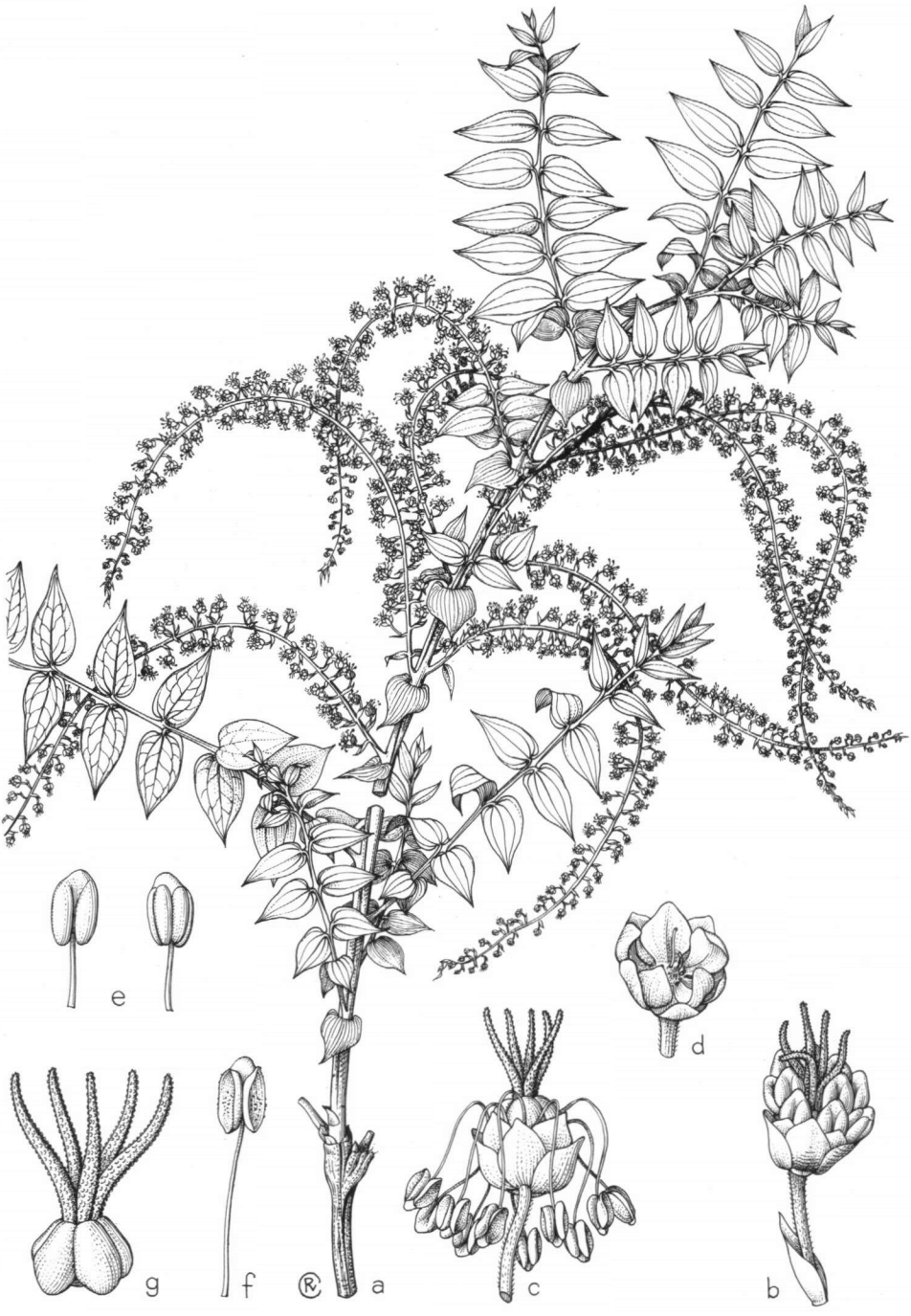

Fig. 1. *Coriaria papuana* Warburg. a. Portion of branch and apical part of branch with inflorescences, × 0.6; b, c. flowers, young and in anthesis, × 6; d. perianth, stamens and pistil removed, × 6; e, f. immature and mature stamens, × 10; g. pistil, × 10 (drawn by R. van Crevel after a specimen collected by Gyldenstolpe in herb. S).

According to Hui-Lin Li (1963, 1977) the roots and seeds are very poisonous. Keng (1987) mentioned that the species is used in local medicine.

Bisexual and unisexual flowers: in the studied material, besides bisexual flowers with normal looking stamens and pistils, only unisexual male flowers were present, i.e. flowers with well-developed stamens, destitute of pistillodes; unisexual female flowers have never been seen. Most flowers had already developed pseudo-fruits with persisting withered stamens.

2. Coriaria papuana Warb., Bot. Jahrb. 16 (1893) 22, f. 741; P. van Royen, Alpine Flora New Guinea 4 (1983) 2547; Steenis, Rheophytes of the World (1981) 219. — Type: *Hellwig 364* (B, lost); neotype: *van Royen 16242* (L).

Spreading and much branched bushy shrubs or small trees 0.5–4 m high; young flushes tinged reddish. Root system extensive and forming nodules. *Leaves* decussate, subsessile, ovate-oblong, base rounded to cordate, apex acute; (1–)1.5–4 by 0.8–1.7 cm, glabrous, except nerves on both surfaces with short white hairs; nerves 3–5; leaves at the base of lateral twigs and inflorescences smaller, cordate, up to 11-nerved. *Inflorescences* consisting of solitary axillary racemes 7–20 cm long, rhachis and pedicels densely beset with short white hairs; bracts ovate to lanceolate, 2–3 mm long, shortly acuminate, glabrous or scabrous on the lower surface, margin irregularly serrate. *Flowers* bisexual, dark red, pink or yellow-green; pedicels 3–7 mm long; sepals broadly ovate, 1.5–2 by 1–1.2 mm, acute; petals broadly ovate, 1–1.8 by 1–1.5 mm, acute. *Stamens* 2–3 mm long; filaments filiform, 0.5–1 mm long; anthers ellipsoid, 1–1.2 mm long, papillose. Carpels 5, c. 0.8 by 0.4–0.8 mm; styles c. 3 mm long. *Pseudo-fruits* 2–3 mm across, red, dark purple or blackish, soft when ripe; achenes c. 1.5 by 1.2 mm, glabrous, with a few longitudinal vein-like ribs. – **Fig. 1.**

Distribution – *Malesia:* endemic to Papua New Guinea: Western Highlands (Chimbu), Eastern Highlands, Morobe Prov. (Finisterre Mts, Mt Dickson area).

Habitat & Ecology – Alongside and in stony and rocky riverbeds, on foothills and in upper montane forest; altitude 600–3500 m. Frequently growing gregariously as a pioneer in exposed places like ridges and landslides.

Note – Because of the enormous root-system and the preference for growing in riverbeds, the species was listed as a facultative rheophyte by Van Steenis (1981).