Climbing the Tree of Caffeine

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Eurosids II, Malvales, Malvaceae *s.l.*

Cola Schott et Endl. [N° of species = 125/whereof PuA-containing $\geq$ 6], tropical Africa [1]. *C. nitida* and *C. acuminata*, cola nut = seed without seed coat (storage cotyledons), chewed daily, caffeine ca. 2 %, tree. Used in socio-cultural ceremonies in the area of origin [2], in our latitudes component of pharmaceutical tonics [3]. Despite great efforts to breed high-yielding varieties, the worldwide production of cola remains on a very modest level, this in disaccord with that of cola drinks!

Herrania Goudot [17/17], tropical South America incl. the isthmus [4], seeds, theacrine, 0.2 – 2 % of the defatted cocoa mass [5]. Very striking are the linear or filiform ligules of the petal up to xy cm long. In the area of origin, the sweet-sour seed pulp is eaten or the seeds serve for the preparation of a cocoa drink (e.g. *H. purpurea*, Bribri-Indios in Costa Rica; [6]). The gene pool of *Herrania* may be crucial for cocoa breeding, however, like the "wild cocoa trees" (see Xref) these species attract little attention by the chocolate community and are altogether endangered.

Theobroma L. [20/20], tropical America [7], seeds (and pulp), PuA 2 –3(4.5) % of the defatted cocoa mass of *T. cacao* with theobromine as main alkaloid. The ratio out of theobromine to caffeine characterises the noblesse of the cocoa and is low ($\leq$ 3) in the noble subspecies *cacao* and high (up to 20) in the profane *sphaerocarpum* [8] [9]. Generally, the packaging is nobler than the wrapped chocolate, because the worldwide cultivation of fine cocoa is below 5 %. Equally to *Herrania*, the seeds of the "wild cacaos" accumulate, as far as known, theacrine, however, mostly $\leq$ 0.5 % [5]. Worth mentioning is here *T. grandiflorum*, cupuaçu, which in Brazil is cultivated by reason of its copious and very aromatic pulp.The cupuaçu beans are used for the manufacture of the theacrine-containing "cupulate".

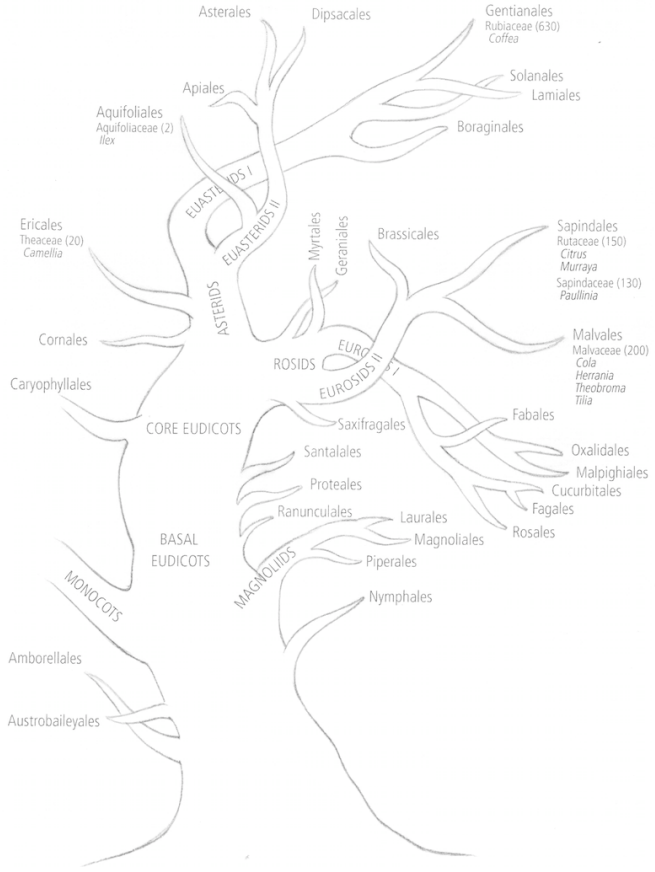

Figure 0.1 – Fig xy. Phylogenetic Tree of Angiosperms with orders, caffeine-containing families and genera. In brackets the number of genera. Illustration Beatrice Häsler, ©Verlag villacoffea

Tilia L. [23/$\geq$ 1], northern hemisphere, temperate, subtropical and tropical climate [10], nectar, honey, caffeine and theophylline [11] as well as theobromine [12]. The flower parts have not yet been investigated as to PuA.

Eurosids II, Sapindales, Rutaceae

Citrus L. [20/20], presumably all "true citrus fruit trees" [13] [14] including *Poncirus, Fortunella, Microcitrus* a.s.o., anthers, pollen, and honey [15] [16], caffeine as well as theophylline, little theobromine and paraxanthine, PuA totally 0.9 % (anther), thereof *ca.* one third theophylline, in citrus this PuA the precursor of caffeine signifying an alternative biosynthesis route for caffeine [17]. Based upon additional (and independent) discovery of caffeine in the flower of *Murraya paniculata* (L.) Jack (orange jasmine), we may assume even a larger occurrence of this alkaloid (*i.e.* Citreae).

Eurosids II, Sapindales, Sapindaceae

Paullinia L. [194/2], lianas, tropical America [18], *P. cupana*, seeds, caffeine 3–5 %, traditionally cultivated and processed by the Indians of the Central Amazon. For stock sourcing the slightly roasted seeds are pestled and with water (and manioc) mixed to a mash, which is formed into a rod, called "bastão" or small pieces of art [19]. Toucans digest the starchy aril in the crop [20]. *P. yoco*, the rasped bark squeezed into water, caffeine 0.5–2.5%, ethnies of southern Colombia of northeast of Ecuador [20] [20].

Asterids, Ericales, Theaceae

Camellia L. [120-290/4], Southeast Asia [21] [22], *C. sinensis* with the var. *sinensis* and *assamica*, China and Assam tea of a wide range of processing. Leaves, 2–7 % caffeine, *ca.* 10x less theobromine, gradually decreasing from the top tp the base of the plant. The variety *kucha* accumulates predominantly theacrine [23], and *C. ptilophylla* only theobromine, $\leq$ 5 % [24]. Camellias, *i.e. C. japonica*, are PuA free.

Asterids, Euasterids I, Gentianales, Rubiaceae

Coffea L. [103/14], Africa, *C. arabica* and *C. canephora*, arabica and robusta coffee of different provenance and varieties. Seeds, caffeine *ca.* 1.2 % (arabica), 2.4 % (robusta) or 0.6 % (laurina = arabica mutant). The "wild" caffeine-free species contain *inter alias* very bitter and distasteful diterpene glycosides [25]. Recently selected caffeine-free arabica plants [26] accumulate theobromine and serve for breeding of *decaffito*, that is naturally caffeine-free coffee [27]. Mature coffee fruits are consumed by several mammals and birds, which digest only the sweet "pulp" (exo- and mesocarp) and therefore excrete "pergamino" coffee in the feces. The resulting coffee is praised as the best of all, and the one produced by the Asian palm civet, *Paradoxurus hermaphroditus* is commercialised.

Asterids, Euasterids II, Aquifoliales, Aquifoliaceae

Ilex L. [400-500/6], cosmopol. but pref. in trop. and temp. Asia and America [28] [29], *I. paraguariensis*, maté tea. Leaves, caffeine around 1 %. Extremely high variability as to PuA: Caffeine- or theobromine-containing, or both, or totally alkaloid-free [30] [31]. The tea is sucked from vessels, partly very elaborate, with a tube called *bombilla*. A few wild *Ilex* species are used in ceremonies and rituals, *e.g.* the strongly caffeinated (more than 3%) *I. guayusa* in Peru and Ecuador, or the *I. vomitora* with an alkaloid spectrum similar to maté in the southeast of the USA. A clustering of caffeine-containing species is recognised in the "American clade" [32] of the genus *Ilex*.

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