

THE TEA COMPLEX

I. Taxonomy of Tea Clones

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ABSTRACT

The taxonomy of the species of *Camellia* L. involved in the evolution of the tea plant is discussed at length; a key and descriptions of species are given for ready identification. It is inferred that the cultivated tea populations are complex species hybrids and in view of this, Art. 29 of the "Cultivated Code" is applied to name the tea clones.

THE tea plant is, indeed, a fascinating subject to the botanist as well as the horticulturist. It is commonly referred to the species *Camellia sinensis* (L.) O. Kuntze, while tea botanists distinguish three taxa, *C. sinensis* (L.) O. Kuntze ("China type"), *C. assamica* (Masters) Wight ("Assam type") and *C. assamica* ssp. *lasiocalyx* (Planch.) Wight ("Southern form" or "Cambod type") as responsible for the commercial tea. A careful observation, however, indicates an entirely different situation in the field, where one comes across a wide spectrum of tea populations, particularly in leaf form and other morphological characters of taxonomic significance. We have in our collection tea selections varying widely from the small-leaved "China type" to the large-leaved "Assam type", with innumerable intermediates between these two extreme forms. Apart from variations in leaf size and form, one often recognises in cultivated tea populations certain other features, namely, pigmentation of young shoots and leaves, presence or absence of punctations on the leaf, variation in the number of styles, their freedom or union, disposition of the stylar arms, and an ovary glabrous or pubescent to different degrees, which are not readily discernible in the typical forms of the three taxa mentioned above. The characters of *C. sinensis*, *C. assamica* and *C. assamica* ssp. *lasiocalyx* often overlap and also a few other characters unknown to these taxa appear in some populations of the cultivated tea. Several questions at once come to the mind, and they are: Is there a true or typical *C. sinensis*, *C. assamica* or *C. assa-*

Shrubs, 1–3 m tall, with virgate branches arising from ground. Leaves 4–8.2 × 1.5–3.2 cm, elliptic, erect, bluntly serrulate with incurved and black-tipped teeth along margins, thickly coriaceous, dark green, non-punctate, strongly matted and glabrous above, pale green and appressed villous but glabrescent with age below, obtuse or rarely subacute at apex, cuneate to acute at base, garnet-brown to purple when young. Flowers paired, solitary or very rarely fascicled in axils; bracteoles 2–3, inserted slightly below the middle of pedicel, subopposite, concave, broadly ovate, caducous; sepals 5–6, orbicular-deltoid, obtuse, somewhat membranous and ciliolate along margins, glabrous or sometimes sparsely hairy without, velutinous within; petals 7–8, adnate to androecium at base, suborbicular, outer smaller, concave; filaments of outer stamens united at base; ovary densely white hairy; styles 3, free up to base or to a great part, geniculate distally. Capsules 3-loculed or 2- or 1-loculed by abortion, each locule with 1 or 2 dull brown to reddish-brown seeds (Fig. 1 A).

Specimens examined.—Masters 1493 (CAL). Assam: Borbhetta area, 24 Jan. 1962, P. K. Barua 3535 (CAL). Tocklai, Dec. 1971, A. C. Dutta s.n. (*UPASI).

Camellia assamica (Masters) Wight in *Curr. Sci.* 31: 298, 1962; Barua in *Two and A Bud* 10: 3–11, 1963 and 12: 13–27, 1965. *Thea assamica* Masters in *J. agric. hort. Soc. India* 3: 63, 1844. *C. sinensis* var. *assamica* (Masters) Kitamura in *Acta Phytotax. and Geobot. Kyoto* 14: 59, 1950; Sealy l.c. 119, f. 55.

Much branched trees, 10–15 m tall. Leaves 8–15.5 × 3–5.7 cm, elliptic, elliptic-oblong to narrowly elliptic-oblong, or elliptic-obovate, usually spreading, not erect, thinly coriaceous, supple, light green, glossy, glabrous and nonpunctate above, puberulous chiefly along midrib below, denticulate to bluntly and distantly undulate-serrate or serrulate with incurved and black tipped teeth along margins, usually bluntly acuminate or sometimes bluntly and broadly acute with a mucro at apex, cuneate to acute or rarely rounded at base, light green to green when young. Bracteoles 3, inserted at middle of pedicel or above; styles 3, united for greater part and then spreading horizontally at distal end. In other floral characters this species resembles *C. sinensis* (Fig. 1 B).

Specimens examined.—October 1868, S. Kurz s.n., Accn. No. 50107 (CAL). Assam: Pashok estate, 1879, J. Monro s.n. Accn. No. 50119

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(CAL); Tocklai, December 1958, P. K. Barua 3536 (CAL); Tocklai, December 1972, A. C. Dutta s.n. (UPASI); Tocklai, December 1972, A. C. Dutta s.n. (UPASI).

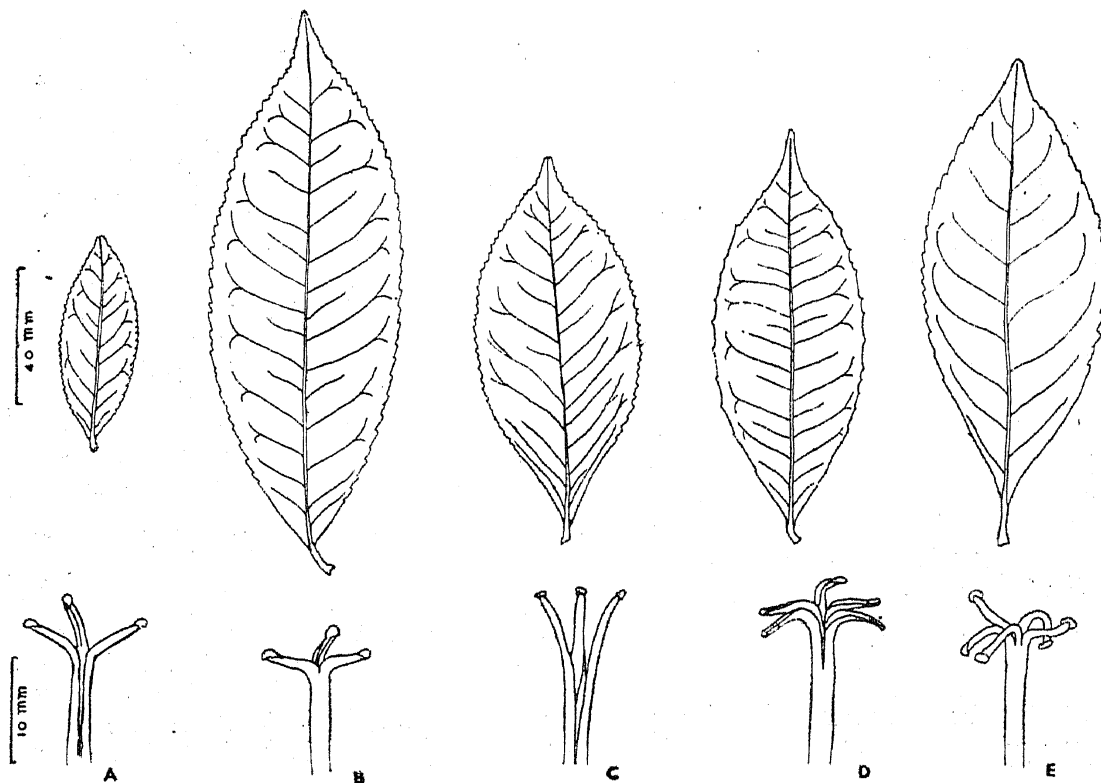


FIG. 1. Leaf and styles of (A) *Camellia sinensis*; (B) *C. assamica* ssp. *assamica*; (C) *C. assamica* ssp. *lasiocalyx*; (D) *C. irrawadiensis*; (E) *C. taliensis* (1 E after Sealy, 1958).

Masters (*l.c.*) himself felt that there was no necessity to separate *Thea assamica* from *T. sinensis* complex though he admitted that the former epithet was used by him, for a "better understanding" of the "Assam tea". Subsequent morphological and chemical studies of *Thea assamica* prove that it is distinct from *T. sinensis* and its retention as a species is justified. Since Masters (*l.c.*) expressed only a taxonomic doubt about the conspecificity of the species, the publication of the species *Thea assamica* does not become invalid (*vide* Note 1, Art. 34, *International Code of Botanical Nomenclature*, 1966).

The subspecies '*lasiocalyx*' recognised by Wight (*l.c.*) has been accepted and can be distinguished as follows:

Leaves spreading, green when young; styles united for a greater part and free only at the distal end, spreading horizontally
 *C. assamica* ssp. *assamica*

Leaves erect, ox-blood coloured when young; styles free up to about half their length, linear, ascending
 *C. assamica* ssp. *lasiocalyx*

Camellia assamica ssp. *lasiocalyx* (Planchon ex Watt) Wight in *Curr. Sci.* **31**: 298, 1962; Barua in *Two and A Bud* **10**: 3-11, 1963 and **12**: 13-27, 1965. *C. thea* Link var. *lasiocalyx* Planchon ex Watt in *J. roy. hort. Soc.* **32**: 79, 1907 and *Comm. Prod. India* 215, 1908. *C. sinensis* var. *sinensis* f. *parvifolia* (Miquel) Sealy *l.c.* 116, excl. f. 54-A. *Thea sinensis* var. *parvifolia* Miquel in *Ann. Mus. Bot. Lugd. Bat.* **3**: 17, 1867.

Shrubs or undertrees, about 6 m tall, with many erect branches. Leaves 5-11 × 2.5-5.2 cm, broadly elliptic, erect, coriaceous, glossy and non-punctate above, glabrous on both surfaces, denticulate with incurved and black-tipped teeth along margins, shortly and bluntly acuminate at apex, cuneate at base, usually ox-blood coloured when young. Flowers 2 or sometimes 1 on a very short axillary peduncle, sometimes several flowers on an axillary peduncle but not clustered; bracteoles 3, inserted above the middle of pedicel and at the base of sepals; sepals orbicular, closely imbricated; styles 3, free up to about half their length; linear, ascending (Fig. 1 C).

Specimens examined : Assam: Tocklai, December 1972, A. C. Dutta s.n. (UPASI).

Camellia irrawadiensis Barua in *Camellian* 18-20, c. tab., f. 1-3, Nov. 1956 and *Two and A Bud* **12**: 13-27, 1965; Sealy *l.c.* 125, f. 56.

Openly branched shrubs 6-7 m tall, with many virgate branches arising from base. Leaves 7.5-11.5 × 3-4.3 cm (up to 15.7 × 5.9 cm according to Barua, *l.c.*), elliptic, distantly denticulate to obscurely denticulate or nearly entire and slightly incurved along margins, thinly coriaceous, glossy, glabrous and pellucidly punctate above, finely puberulous along midrib but glabrescent with age beneath, bluntly acuminate at apex, cuneate to acute at base, brick-red when young. Flowers 1 or 2 in axils; bracteoles generally 4, inserted at and above middle of pedicel, caducous; sepals 5, suborbicular, coriaceous with narrow thin margins, glabrous without, velutinous within; corolla of 7-9 or 10 petals, ca 4.4 cm in diam, widespreading, adnate to stamens at base, usually white, sometimes tinted pink; stamens numerous, outer adnate to petals at base; ovary ca 3.5 mm in diam, densely tomentose, 4-5-loculed; styles as many as locules divided up to about half their length, erect and closely appressed and then suddenly spreading horizontally at

distal end. Capsules 3.1–4.3 cm in diam, globose, reddish at maturity, with 1 or rarely 2 seeds per locule (Sealy, *l.c.*) (Fig. 1 D).

Specimens examined.—Assam: Tocklai, 2 March 1955, *I.T.A.* 3110 (CAL); Tocklai, 23 May 1955, *A. C. Dutta* 3241 (UPASI); Tocklai, December 1971, *A. C. Dutta s.n.* (UPASI).

** *Camellia taliensis* (W. W. Smith) Melchior in *Nat. Pflanzenfam.* ed. 2, 21: 131, 1925; Sealy, *l.c.* 127–128, f. 57; Barua and Wight in *Phytomorphology* 8: 257–264, 1958. *Thea taliensis* W. W. Smith in *Notes Roy. Bot. Gard. Edinb.* 10: 73, 1917.

Shrubs or undertrees, 2–7 m tall; young branches brown, glabrous. Leaves 8.5–15.3 × 3–7.2 cm, elliptic to broadly elliptic, coriaceous, glabrous, bluntly serrulate along margins, bluntly acute or shortly bluntly acuminate at apex, cuneate at base. Flowers 1–3, axillary or terminal; bracteoles 2 or 3, caducous; sepals 5, unequal, suborbicular, pubescent or glabrous without and velutinous within, ciliolate along margins; corolla 5–6 cm in diam, of 11 spreading white petals, adnate to androecium at base; filaments of outer stamens united at base, rest more or less free; ovary 3–4 mm in diam, densely white tomentose, 5-loculed; style glabrous or tomentose at base, divided distally into 5 widespreading arms with conspicuous, terminal stigmas (Fig. 1 E).

Sealy (1948 and 1958) treated the plants raised from the seed collected by Forrest (Barua and Wight, 1958) under *C. taliensis* distinguishing it from *C. assamica* by “its larger flowers with more numerous widespreading (not concave) petals, longer stamens, and longer 5-carpellary gynoecium” (Sealy, *l.c.*, 128, 1958). Barua and Wight (1958) and later Visser (1969) questioned the taxonomic significance of the size of floral parts and considered Forrest’s *Camellia* as a hybrid between *C. assamica* and *C. irrawadiensis* on the basis of sclereid morphology and chemical composition. Besides the size of the floral parts, Sealy (1958) characterised Forrest’s *Camellia* with a greater number of petals, pentacarpellary gynoecium with a columnar style, distally divided into 5 horizontally spreading arms with terminal stigmas (*cf.* Sealy, *l.c.*, 128, f. 57-E). The number of carpels and styles and the morphology of the latter are very important characters of the various species of the section *Thea* and were indeed accepted as of considerable taxonomic significance by Wight (1962) and Barua (1963). Forrest’s

** Description adopted from Sealy (*l.c.*).

Camellia as described by Sealy (1958) undoubtedly belongs to and is assignable only to *C. taliensis*. The morphology of sclereids and the chemical composition can at best be interpreted as an indication of its close relationship with *C. assamica* and *C. irrawadiensis* but not of hybridization.

C. taliensis is closely allied to *C. sinensis* in chemical composition though not identical with it and is likely to make an acceptable tea, though of a poor quality (Roberts *et al.*, 1958).

C. sinensis is characterised by its leaf size, shape, matted upper surface and the splitting and morphology of the styles and, in these characters it differs from *C. assamica* and *C. assamica* ssp. *lasiocalyx*. In general, *C. assamica* and *C. assamica* ssp. *lasiocalyx* show a close resemblance but the latter can be readily distinguished from both the other two taxa by its closely imbricated orbicular sepals, flowers on a common stalk and the three linear ascending styles split up to about half their length; the glossy, erect leaves of *C. assamica* ssp. *lasiocalyx* at once distinguish it from either of the other two taxa.

Anatomically also, the three taxa show marked differences. The leaves of *C. sinensis* are almost devoid of sclereids and when present, they are long and slender with a narrow lumen and more or less smooth walls (Barua, *l.c.*, f. 3 A-D and Barua and Dutta, f. 1-10, 1959). The sclereids of *C. assamica* are short, thick, with lumen constricted at several points, acuminate at apex and covered with a few spicules (Barua, *l.c.*, f. 3 E-H and Barua and Dutta, *l.c.*, f. 11-25); sclereids of *C. assamica* ssp. *lasiocalyx* resemble those of *C. assamica* but are distinguishable by their unconstricted broad lumen and dense covering of large spicules (Barua, *l.c.*, f. 3 I-L and Barua and Dutta *l.c.*, f. 26-40).

C. irrawadiensis is characterised by brick-red young shoots, pellucid punctations on the leaf which are associated with the presence of sclereids, and 4 or 5 erect styles spreading horizontally at distal end. The sclereids of this species differ from those of the other taxa in their thick, elongated, slightly branched body, with claw-like extensions at base and usually with a disc at apex and a wide unconstricted lumen extending from one end to the other (Barua, f. 4, 1965 and Barua and Wight, f. 1-10, 1958). In its leaf form it closely resembles *C. assamica* and differs markedly from *C. sinensis* and *C. taliensis*. Though morphologically it appears to be closely related to *C. assamica* and *C. taliensis*, chemically it is distinct from both, especially in the absence of caffeine (Roberts *et al.*, 1958). The chemical composition

of this species indicates a close relationship with *C. sinensis* and *C. taliensis* but is more distant to the former than *C. taliensis* is (Roberts *et al.*, *l.c.*). *C. irrawadiensis* yields a product which looks like tea but commercially not acceptable as tea.

C. irrawadiensis crosses readily with *C. assamica*. Wight and Barua (1957) reported that the experimental F₁ hybrids of the above two species resemble *C. assamica*. A product which was accepted as tea, though not of best quality, was prepared from the shoots of these hybrids (Wood and Barua, 1957).

The leaves of the typical forms of *C. sinensis* and *C. assamica* are non-punctate, while the non-tea-producing *C. irrawadiensis* is characterised by punctations on leaf which are associated with the sclereid forms. The pellucid dots are less in the hybrids between *C. irrawadiensis* and *C. assamica* and could be further reduced by back-crossing the hybrid with *C. assamica*. Based on these results, Wight and Barua (1957) conclude that the presence of such punctate leaf forms among cultivated tea plants is indicative of natural hybridization of *C. sinensis* and *C. assamica* in earlier generations with *C. irrawadiensis* or with some other species of *Camellia* with similar punctations. Barua (1965) further contends that the tea in cultivation could be regarded as complex hybrids derived at least from four taxa, namely, *C. sinensis*, *C. assamica*, *C. assamica* ssp. *lasiocalyx* and *C. irrawadiensis*. He concludes that the tea populations originally introduced into India from China were species hybrids.

It is also pertinent to add here that in an estate on the Nilgiris (S. India), plants of the species *C. lutescens* Dyer, of doubtful taxonomic position, form part of a field, freely mixed with tea plants. This species is characterised by highly pigmented young shoots, very irregularly united stamens, hairy ovary with three very short, free styles. A product visually resembling tea could be made from the tender shoots of this species, although it may not be accepted as such by the trade. Caffeine is absent in the flush of this species and it also differs from the species of the *Thea* section in chemical composition (Kanthamani, MS.). We have observed a few plants bearing some resemblance to this species in a population of small-leaved tea, leading one to suspect whether this species is also involved in natural hybridisation and evolution of some of the cultivated tea plants. Chromatographic screening of this taxon might throw some light on its relationship with tea.

According to Wight (1962) species like *C. flava* (Pitard) Sealy and *C. petelotii* (Merrill) Sealy, have contributed to hybrid tea populations.

The possible involvement of species of sections other than *Thea* in hybridisation gains strength by Bezbaruah and Gogi's (1972) report of a triploid hybrid ($2n = 45$) between a tetraploid *C. sinensis* ($2n = 60$) and a diploid *C. japonica* L. ($2n = 30$). The hybrid bears close resemblance to some of the pigmented "Cambod type" of tea plants.

Leaf form, pose, patina and pigmentation, number and nature of styles and the sclereid types characteristic of the different species discussed in this article overlap in widely varying tea clones indicating possible hybridisation amongst them. Having arrived at this conclusion, it is but meet to suggest that the word "tea" should cover the progeny of *C. sinensis*, *C. assamica* ssp. *assamica* and *C. assamica* ssp. *lasiocalyx* or hybrids thereof, or between them and other species of *Camellia*, including those that fall outside the purview of the *Thea* section of the genus.

The *International Code of Nomenclature of Cultivated Plants* (1969) provides guidelines for naming cultivars derived from species hybrids (Arts. 14-19), but of known parentage. In tea clones, which apparently are derivatives of complex species hybrids, it is difficult to fix the parentage with any certainty. The "Code" does not provide information in such cases where the parentage cannot be determined. It is, therefore, appropriate to apply Art. 29 of the "Code" and form clonal names by suffixing cultivar epithets to the common term tea, for example: Tea 'Sundaram'.

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* Not seen in original.