

## A TAXONOMIC REVISION OF ACTINIDIACEAE OF VIETNAM

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### SUMMARY

Taxonomic study of morphological variability using multivariate analysis, together with field studies and literature review clarified the status of a number of paired species of *Saurauia* and *Actinidia* of Vietnam and resolved their correct nomenclature: *Saurauia tristyla* is different from *S. roxburghii*; *Saurauia petelotii* is not a synonym of *S. fasciculata* but is a separate species; *Actinidia tonkinensis* is a synonym of *A. latifolia*; *Actinidia indochinensis* is a distinct species, not a variety of *A. callosa*; *Saurauia dillenioides* is a synonym of *S. armata*; and *Saurauia griffithii* var. *annamica* is a synonym of *S. napaulensis*. Four taxa of *Actinidia* are newly recorded for Vietnam. The results of this study will allow us to better understand the conservation status of species of Actinidiaceae in Vietnam.

**Key words:** Actinidiaceae, *Actinidia*, *Saurauia*, Vietnam, multivariate analysis, taxonomy.

### INTRODUCTION

The definition of the family Actinidiaceae was established in 1899 by Van Tieghem to include the genera *Actinidia* Lindl. and *Saurauia* Willd. (Van Tieghem, 1899). However, the correct authority citation for the family is Gilg & Werdermann (1925), who used the family name correctly in its Latinized form. Van Tieghem used the French name Actinidiacées, which is not a validly published name (Article 18.4, Vienna Code; McNeill et al., 2006). The circumscription of Actinidiaceae has been much debated (Soejarto, 1980). Some taxonomists have recognized Actinidiaceae in a narrow sense to include only the genus *Actinidia*, and placed *Saurauia* in a distinct family, Sauraiaceae (Hutchinson, 1926: 177). In 1925, Gilg & Werdermann accepted Actinidiaceae in a broader concept to include four genera: *Actinidia*, *Saurauia*, *Clematoclethra* (Franch.) Maxim., and *Sladenia* Kurz. Contemporary taxonomists recognize Actinidiaceae as comprising three genera, *Actinidia*, *Saurauia*, and *Clematoclethra* (Soejarto, 1980, 2004; Cronquist, 1981; Woodland, 2000; Dressler & Bayer, 2004; Li et al., 2006), distributed in tropical Asia and America (Dressler & Bayer, 2004; Soejarto, 2004). Estimates on the number of species within the family range from 325–360, of which more than 300 species of *Actinidia* and *Saurauia* occur in tropical and temperate East

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Asia, while *Clematoclethra* is found only in China (Dressler & Bayer, 2004; Soejarto, 2004). Phylogenetically, Actinidiaceae is now firmly placed in Ericales (Soltis et al., 2000; Anderberg et al., 2002), and is closely related to Roridulaceae, Sarraceniaceae, Clethraceae, Cyrillaceae, and Ericaceae; the six families form a monophyletic group (Soltis et al., 2000; Anderberg et al., 2002).

Both *Actinidia* and *Saurauia* occur in Vietnam and are recognized to belong to Actinidiaceae (Hô, 1999; Bân, 2003), but in older Indo-Chinese literature, both genera were placed under Dilleniaceae (Finet & Gagnepain, 1907). Hô (1999) recognized six species of *Actinidia* from Vietnam – *A. callosa* var. *indochinensis*, *A. chinensis* (cultivated), *A. coriacea*, *A. latifolia*, *A. petelotii*, and *A. tonkinensis*, and five species of *Saurauia* – *S. armata*, *S. fasciculata*, *S. macrotricha*, *S. napaulensis*, and *S. roxburghii*. In a more recent checklist of the Flora of Vietnam, Nguyễn Tiên Bân (2003) recognized five species of *Actinidia* – *A. callosa* var. *indochinensis*, *A. coriacea*, *A. latifolia*, *A. petelotii*, and *A. tonkinensis* (he excluded the cultivated species *A. chinensis*), and seven species of *Saurauia* – *S. dillenioides*, *S. fasciculata*, *S. griffithii* var. *annamica*, *S. macrotricha*, *S. napaulensis*, *S. roxburghii*, and *S. tristyla*.

A number of questions in the taxonomic delimitation of these Vietnamese taxa needed to be resolved: 1) Is *S. roxburghii* different from *S. tristyla*?; 2) Are *S. fasciculata* and *S. petelotii* separate species?; 3) Are *A. latifolia* and *A. tonkinensis* the same species?; 4) Is *A. indochinensis* a separate species or is it a synonym of *A. callosa* var. *indochinensis*?; 5) Is *S. dillenioides* different from *S. armata*?; 6) Is *S. griffithii* var. *annamica* a synonym of *S. napaulensis*? To answer these questions, an effort was made to revise the taxonomic treatment of members of Actinidiaceae of Vietnam, using a combination of fieldwork, examination of existing collections of Vietnamese Actinidiaceae, and laboratory and literature studies. The present paper is the result of that effort.

#### MATERIAL AND METHODS

For the present study, 382 Actinidiaceae collections in repository at the Missouri Botanical Garden (MO), Arnold Arboretum of Harvard University (A), Field Museum of Natural History (F), National Herbarium of the Netherlands in Leiden (L), New York Botanical Garden (NY), National Museum of Natural History (P), and National Herbarium of the Smithsonian Institution (US) were examined. This herbarium examination was supplemented by fieldwork in Vietnam during the summer of 2006, in which 51 additional collections of Actinidiaceae were gathered from various localities, including the following national parks: Cuc Phuong, Bach Ma, Tam Dao, and Hoang Lien Son National Parks. Duplicates of the field collections were deposited at the herbarium of the Institute of Ecology and Biological Resources (IEBR) of the Vietnamese Academy of Science and Technology in Hanoi, and at Missouri Botanical Garden. Fruits and flowers were preserved in 70% alcohol, while leaves were dried in silica gel for future molecular studies. The literature, particularly of Indo-Chinese holding, was searched.

Initially, specimens were sorted and grouped into provisional taxa based on variation in the shape of foliar blade, inflorescence size and type, flower colour, sepals, petals, stamens, ovary and the styles, and the indumentum type. Twenty-three selected characters that appeared to help distinguish between species were then measured for

Multivariate analysis, but indumentum type and pseudo-qualitative characters were excluded. Only fruits of *Actinidia indochinensis* and *A. callosa* were included for the analysis. For three other species pairs, too few fruiting specimens were available for analysis: *Saurauia tristyla* and *S. roxburghii*; *S. petelotii* and *S. fasciculata*; *Actinidia latifolia* and *A. tonkinensis*. The data were entered into an Excel file and transferred to SPSS 12.0, in order to perform data analysis using Bivariate Analyses, Principal Component Analyses (PCA), Cluster Analyses, and ANOVA test, and in order to understand the variation patterns of these species pairs. The following morphological characters were submitted to these analyses:

- |                                     |                   |
|-------------------------------------|-------------------|
| 1. Petiole length                   | 13. Flower width  |
| 2. Leaf lamina length               | 14. Sepal length  |
| 3. Leaf lamina width                | 15. Sepal width   |
| 4. Leaf apex length                 | 16. Petal length  |
| 5. Number of pairs of lateral veins | 17. Petal width   |
| 6. Inflorescence length             | 18. Anther length |
| 7. Inflorescence width              | 19. Style length  |
| 8. Flower bud length                | 20. Ovary length  |
| 9. Flower bud width                 | 21. Ovary width   |
| 10. Peduncle length                 | 22. Fruit length  |
| 11. Pedicel length                  | 23. Fruit width   |
| 12. Flower length                   |                   |

To determine dioecy within *Actinidia latifolia*, pollen grains from flowers in specimens collected in Vietnam in the summer of 2006, and from a single flower of *Tsang 29907*, the type of *A. tonkinensis*, were examined using a microscope connected to a digital camera to record the images.

## RESULTS OF MULTIVARIATE ANALYSES

### 1. Is *Saurauia roxburghii* Wall. different from *S. tristyla* DC.?

Hô (1999) recognized *S. roxburghii* as occurring in Vietnam, and placed the names of *S. oldhamii* Hemsl., *S. poilanei* Gagnep., and *S. thorellii* Gagnep. in synonymy. Nowhere in the book is the Latin binomial *S. tristyla* found. The illustration (Fig. 1649) on p. 410 depicts *S. tristyla*. Thus, the reference to *S. roxburghii* by Hô is a case of misidentification. *Saurauia tristyla* has 3 styles, free for most of their length, while *S. roxburghii* has 4 or 5 styles (see also Dyer, 1874: 287), which are connate at base 0.6–0.7 of their length. Bân (2003), however, listed both species as occurring in Vietnam.

Analyses of variation — Bivariate analyses showed that many characters do not closely overlap between the two species. In the PCA (Fig. 1), the first axis accounted for 57.4% of the total variance, with sepal length and number of pairs of lateral veins (a negative value) being the major contributors to the variation, while the second axis accounted for 16.9% of the total variance, with apex length (a negative value) and inflorescence length being particularly important. The third axis accounted for 8% of the total variation, with major contributions coming from lamina length and ovary

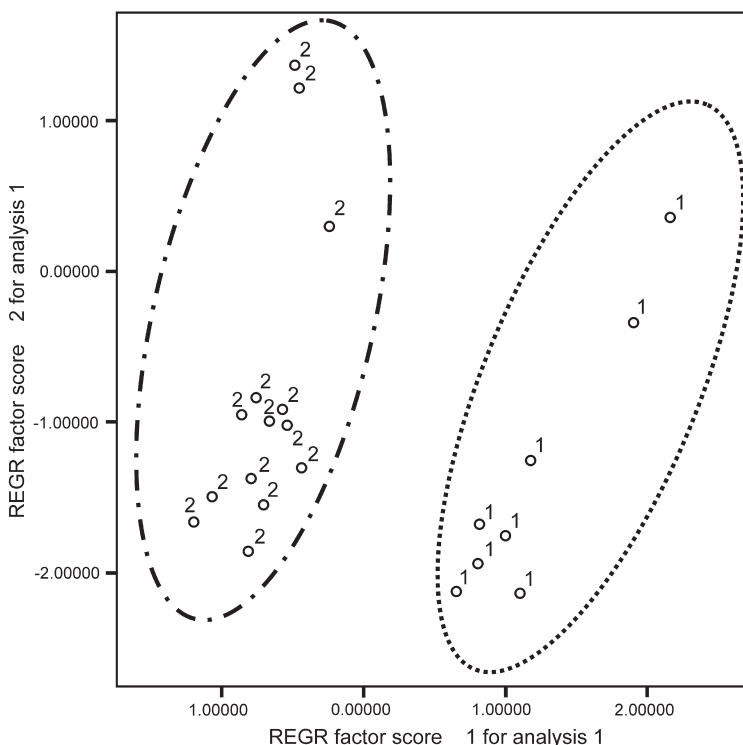


Fig. 1. PCA – two-dimensional scatter plots of variation in (1) *Saurauia tristyla* DC. and (2) *S. roxburghii* Wall.

length. The scatter plots (PCA) (Fig. 1) showed two distinct groups of specimens, suggesting that *S. tristyla* is distinct from *S. roxburghii*. In the Cluster Analysis (Fig. 2), however, specimens of *S. roxburghii* and *S. tristyla* form three or four clusters (see below). One-way ANOVA test compared mean values of two putative character groups and proved that many characters differed significantly at the level  $0.001 < P < 0.05$ .

Discussion — The results of the bivariate analyses show that most characters do not overlap. PCA scatter plot results suggest that *S. tristyla* is clearly distinct from

Table 1. Differences between *Saurauia tristyla* DC. and *S. roxburghii* Wall.

Characters	<i>S. tristyla</i>	<i>S. roxburghii</i>
Inflorescence	1.2–3 cm long	1.5–8 cm long
Peduncle	0.1–0.2 cm long	0.6–6 cm long
Flower size	5.5–10 by 6–8.5 mm	5–7.5 by 4–6 mm
Sepal size	5–7.5 by 4–5.5 mm	4–5 by 3–4.5 mm
Petal size	7–9 by 4–5 mm	5–7 by 3–4 mm
Styles	Separate from base, 4.5–7 mm long	Connate basally 1/2 to 3/4 their length, 1.5–3.2 mm long

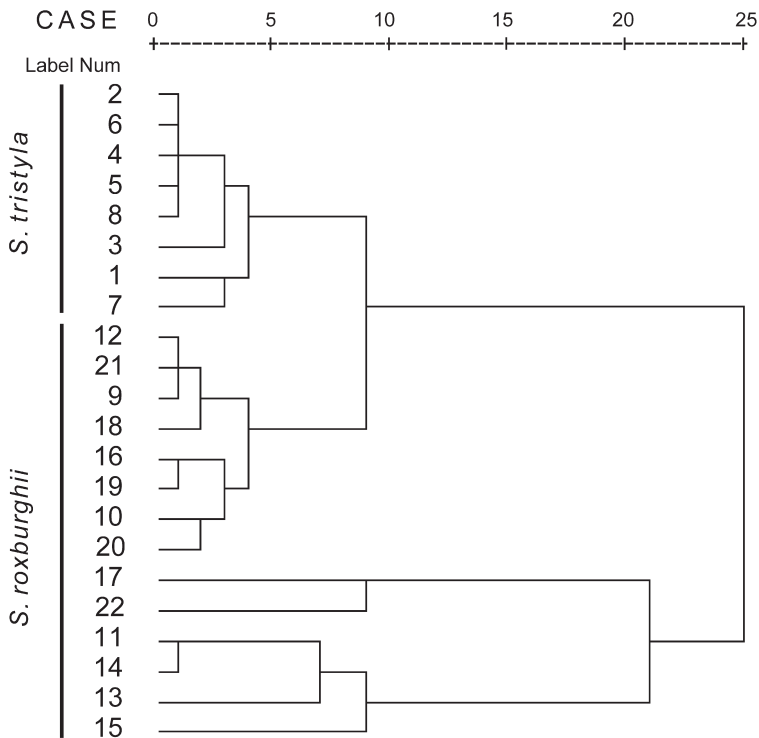


Fig. 2. Dendrogram of *Saurauia tristyla* DC. and *S. roxburghii* Wall.

*S. roxburghii* (Fig. 1). On the other hand, the dendrogram (Fig. 2) suggests that either there are a number of taxa, or *S. tristyla* is to be included in *S. roxburghii*. The pattern in the dendrogram can perhaps be explained by the fact that some specimens of *S. roxburghii* have inflorescences about the same length as those of *S. tristyla* (Table 1). Perusal of the literature and specimens showed that *S. tristyla* differs from *S. roxburghii* in the length of its peduncles, flower buds, flowers, anthers, and styles; the connation of the styles is an important distinguishing feature. All told, the evidence suggests that *S. tristyla* should be kept separate from *S. roxburghii*.

## 2. Are *Saurauia fasciculata* Wall. and *S. petelotii* Merr. separate species?

Both Hô (1999) and Bân (2003) included *Saurauia petelotii* as a synonym of *S. fasciculata*. In resolving the question of this synonym, 15 collections of the two species were assembled for analysis: 5 of *S. fasciculata* and 10 of *S. petelotii*.

Analyses of variation — Bivariate analyses showed that many characters did not overlap between the two species. In the PCA, 73% of the total variation was accounted for by the first axis, with major contributions coming from flower bud width and lamina width (a negative value) being particularly important, while 10.5% of the total variation was accounted for by the second axis, with pedicel length and ovary length

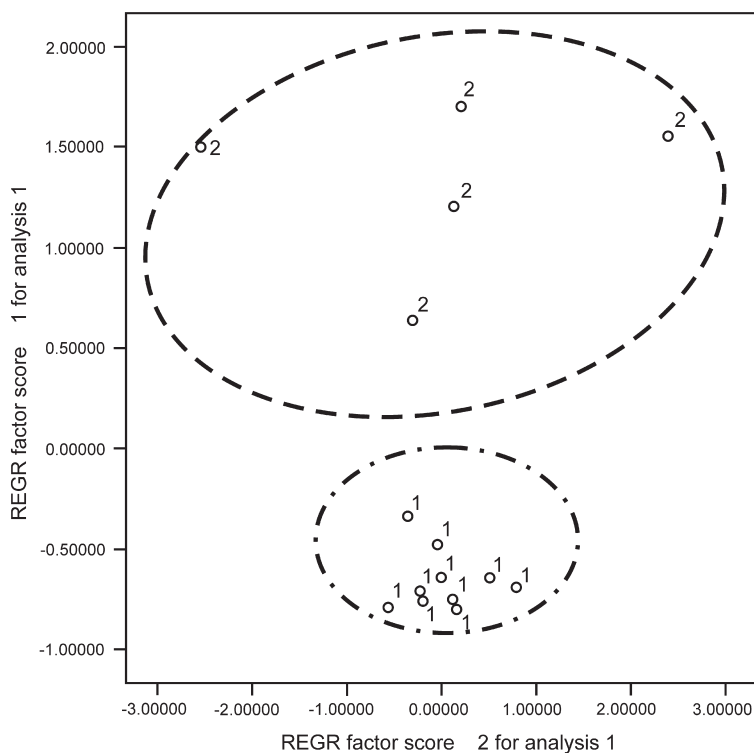


Fig. 3. PCA – two-dimensional scatter plots of (1) *Saurauia petelotii* Merr. and (2) *S. fasciculata* Wall.

(a negative value) being particularly important. The third axis accounted for 7.3% of the total variation, with lamina length and flower length (a negative value) being the contributors. The scatter plots (Fig. 3) show two separate groups of specimens, suggesting that *S. petelotii* is distinct from *S. fasciculata*, although one group is rather diffuse. The dendrogram (Fig. 4) showed two clearly distinct groups, and in a one-way ANOVA test, most characters showed significant differences.

Table 2. Differences between *Saurauia petelotii* Merr. and *S. fasciculata* Wall.

Characters	<i>S. petelotii</i>	<i>S. fasciculata</i>
Leaf	Obovate to rounded-ovate, 12–29 by 6.5–12.5 cm	Elliptic-oblong to elliptic-lanceolate, 10–25 by 3–8 cm
Inflorescence size, position	Spread from tip to lower down the branchlets, 2–4 cm long	Crowded behind tip of branchlets, 5–9 cm long
Peduncle size	Subsessile to 0.5–1 cm	1.5–4.2 cm
Flower size	5–6 by 4–5 mm	6.5–9 by 5–5.5 mm
Sepal size	3–4 by 2–3.5 mm	4–5 by 3.5–4.5 mm
Petal size	4.5–5.3 by 2–4 mm	6–8 by 4.5–5 mm

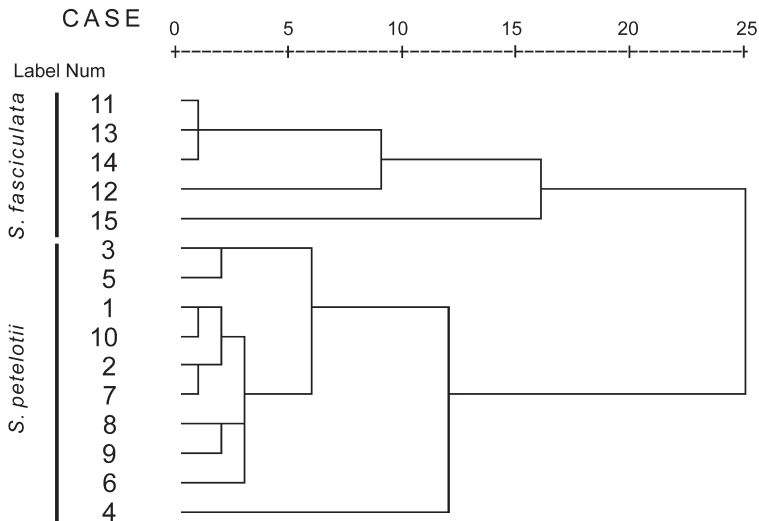


Fig. 4. Dendrogram of *Saurauia petelotii* Merr. and *S. fasciculata* Wall.

Discussion — The results of the bivariate analyses show that many characters do not overlap. The result of the PCA scatter plot and the cluster analysis show that *S. petelotii* is clearly different from *S. fasciculata* (Fig. 3, 4). Leaf length and width, and inflorescence, peduncle, flower, and style length are particularly important characters separating the species (Table 2). Merrill (1924) and Paul (1993) have also suggested that the two species are distinct. Geographically, *S. petelotii* grows in southwest China, Vietnam, and northwest Thailand, while *S. fasciculata* is known from Bhutan and Assam.

### 3. Is *Saurauia dillenioides* Gagnep. different from *S. armata* Kurz?

Gagnepain (1938) contrasted his *S. dillenioides* (based on type specimens collected in North Vietnam) with *S. cerea* Griff. ex Dyer (1874) (based on type specimens collected in the Himalayas), pointing out that sepals of the former were sparsely hairy dorsally, while those of the latter were covered by dense, scaly indumentum. Hô (1999) placed *S. dillenioides* as a synonym under *S. armata*, which Kurz (1877) described based on type specimens collected in Myanmar. Bân (2003), however, listed *S. dillenioides* as a distinct species, giving '*S. armata* apud Hô' as a synonym, and did not recognize *S. armata* Kurz as occurring in Vietnam. In his account of Actinidiaceae from India, Paul (1993) recognized *S. armata* Kurz, and listed *S. cerea* and *S. dillenioides* as synonyms. Liang (1984), on the other hand, recognized *S. dillenioides* and *S. armata* as two distinct species.

Examination of the available material collected in Vietnam and identified as *S. armata* Kurz – but also annotated as *S. dillenioides* Gagnep. –, and material from China identified as *S. cerea* Gagnep., indicates that *S. dillenioides* and *S. armata* Kurz are one and the same (Table 3), with the correct name being *S. armata* Kurz (an earlier name), while the Indian *S. cerea* appear to represent a separate species.

Table 3. Similarities between *Saurauia dillenioides* Gagnep. and *S. armata* Kurz.

Characters	<i>S. dillenioides</i>	<i>S. armata</i>
Indumentum	Strigose and puberulent	Appressed scales and tomentose
Leaf	Obovate to broadly obovate, 20–32 by 17–20 cm, (main and lateral) veins with strigose indumentum, lateral veins 17–21 pairs	Broadly ovate to obovate-oblong, 15–35 by 8–17 cm, main and lateral veins with scattered stiff scales, lateral veins 18–21 pairs
Inflorescence	Solitary or clusters	Solitary or clusters
Flower size	1.5–2 cm diameter	C. 1.5 cm diameter
Sepal size	7–10 by 5–8 mm, abaxially tomentose to scattered strigose, adaxially puberulent	C. 10 by 8 mm, abaxially tomentose and with pointed scales, adaxially tomentose
Petal size	Obovate; white, reddish at base, 10–15 by 8–9 mm, glabrous	Obovate; white, reddish at base, c. 12 by 8 mm, glabrous
Stamens	Numerous	Numerous
Styles	5	5
Ovary	Globose, densely tomentose	Globose, densely tomentose
Fruit	Ovoid, pubescent	Ovoid, pubescent

#### 4. Is *Saurauia griffithii* Dyer var. *annamica* Gagnep. a synonym of *S. napaulensis* DC.?

Gagnepain (1938) described *S. griffithii* var. *annamica* based on type specimens collected from Vietnam. Hô (1999) did not list this taxon as occurring in Vietnam, but Bân (2003) recognized *S. griffithii* var. *annamica* and listed it in his Checklist.

Discussion — Gagnepain (1938) described *S. griffithii* var. *annamica*, listing the presence of pubescence on the lower leaf surface, on the inflorescences, and on the adaxial sepal surfaces as a distinguishing character. However, examination of the syntypes of *S. griffithii* var. *annamica* showed that pubescence, and other characters, fall within the range of variation of *S. napaulensis*, namely, abundant tomentose pubescence on the lower surface of the leaf lamina, scattered strigose and tomentose indumentum on the inflorescences, and scattered puberulence on the adaxial surface of the sepals. Hence, *S. griffithii* var. *annamica* is placed as a synonym of *S. napaulensis* in the present treatment.

#### 5. Are *Actinidia latifolia* (Gardner & Champ.) Merr. and *A. tonkinensis* H.L. Li the same species?

Li (1943) described *A. tonkinensis* based on a type specimen (*Tsang 29907*) collected in Tonkin (North Vietnam). He recognized that *A. tonkinensis* is closely related to *A. latifolia*, but differing from it in having an acute or broadly acute lamina base (not cordate or broadly rounded), the lower surface has fewer stellate hairs, and the inflorescences longer, with more numerous and smaller flowers. In his 1952 revision of *Actinidia*, Li made an erroneous combination, *A. latifolia* (Gardner & Champ.) Merr. var. *indochinensis* H.L. Li; incorrectly citing his 1943 species (*A. tonkinensis*) based on



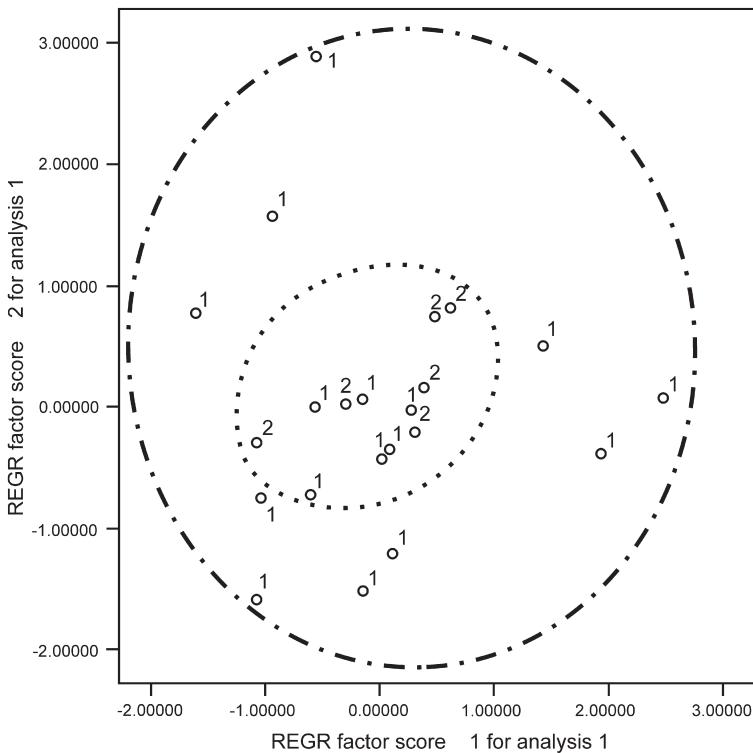


Fig. 5. PCA – two-dimensional scatter plots of (1) *Actinidia latifolia* (Gardner & Champ.) Merr. and (2) *A. tonkinensis* H.L. Li.

*Tsang 29907* as *A. indochinensis* (see further below). Both Hô (1999) and Bân (2003) accepted *A. tonkinensis* H.L. Li as a distinct species, while Liang (1984) included it as a synonym of *A. latifolia*.

**Analyses of variation** — Only the type of *A. tonkinensis* was initially identified as belonging to this species; however, five other collections were later also determined to belong to *A. tonkinensis*. In total, 22 collections were included in this study.

**Bivariate Analyses** showed that all characters (lamina length vs width, inflorescence length vs width), and others overlap between the two species. In the PCA analysis only 35.9% of the total variation is located along the first axis; sepal length and the number of lateral veins being particularly important. Of the total variance, 19.4% is accounted for by the second axis; inflorescence length and flower bud width (a negative value) being particularly important. The third axis accounted for 9.3% of the total variation, with major contributions from pedicel length and ovary width (a negative value). The scatter plot (Fig. 5) showed no distinct groupings, suggesting that only a single species is involved. When grouping using Cluster Analysis, specimens of *A. tonkinensis* were interposed with those of *A. latifolia* in the dendrogram (Fig. 6). In a one-way ANOVA test, variation of most characters lacked significance at level  $0.05 < P < 0.988$ .

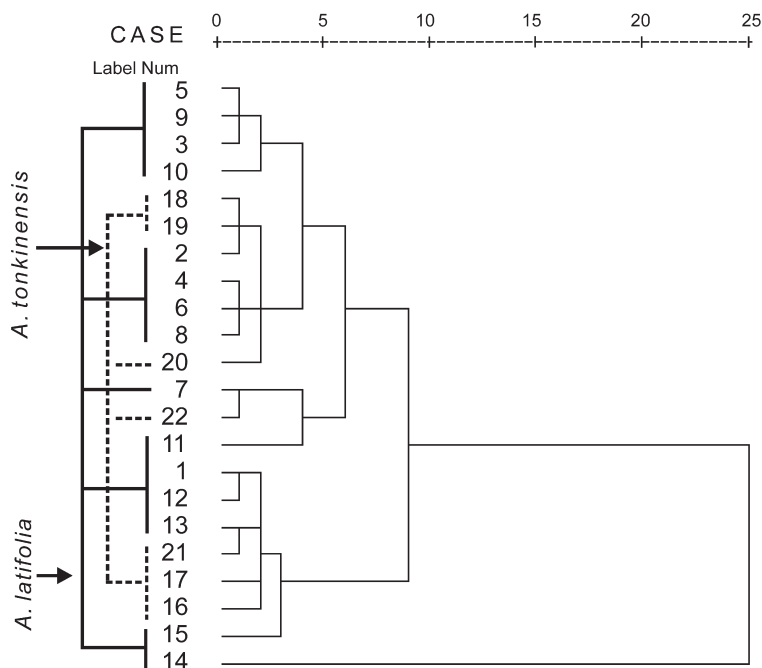


Fig. 6. Dendrogram of *Actinidia latifolia* (Gardner & Champ.) Merr. and *A. tonkinensis* H.L. Li.

Examination of pollen grains from two individual specimens initially identified as *A. latifolia* and *A. tonkinensis* suggested that differences between the species appeared to be connected with dioecy. Flowers of *Cuong 2050* (*A. latifolia*) produce sterile grains, which did not absorb cotton blue stain in lacto-phenol test (Fig. 7c, e). On the other hand, *Cuong 2048*, collected in the same locality as *Cuong 2050* and initially identified as *A. tonkinensis*, demonstrated to have functional (fertile) pollen, absorbing cotton blue in lacto-phenol test (Fig. 7f). Pollen from *Tsang 29907*, an isotype of *A. tonkinensis*, also has functional pollen (Fig. 7d). The gynoecia of *Cuong 2050* (Fig. 7a) are well developed with long styles (3–4 mm long), while those of *Cuong 2048* (Fig. 7b) lack styles or have only very short styles. The ovaries of *Cuong 2050* are 3–4 times larger than those of *Cuong 2048*.

These data suggest that *A. latifolia* and *A. tonkinensis* represent only a single species, the differences between the flowers of the two being linked to their breeding system; *Actinidia* is a dioecious taxon. The differences between these two presumed species that Li (1943) observed, smaller flowers and longer inflorescences in *A. tonkinensis* (staminate individuals) compared with those of *A. latifolia* (pistillate individuals), are also due to dioecy.

Discussion — The results of the bivariate analyses show clearly that most characters overlap. PCA scatter plot result suggest that *A. latifolia* and *A. tonkinensis* belong to a single species; all the specimens included in the analysis form only a single group (Fig. 5). The result of the cluster analysis show that specimens of *A. tonkinensis* are

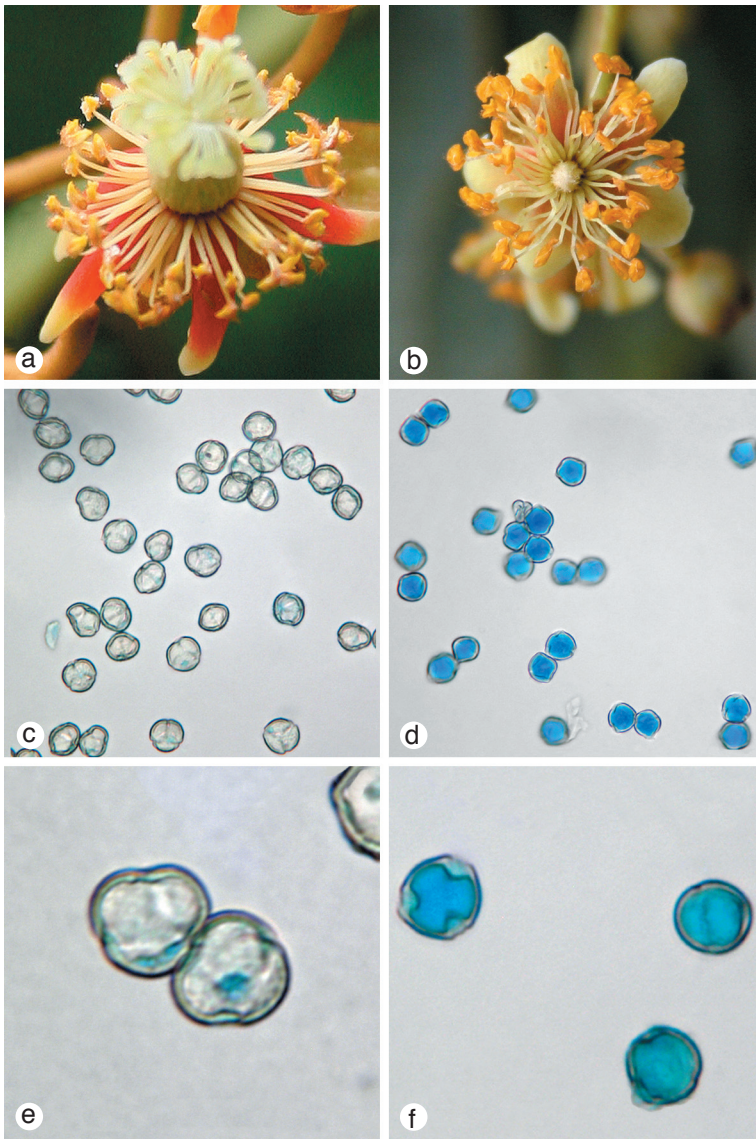


Fig. 7. Pollen analysis of *Actinidia latifolia* (Gardner & Champ.) Merr. 7a, c (87 $\times$ ) and e (330 $\times$ ) from female flower (Cuong 2050); 7b, f (220 $\times$ ) from staminate flower (Cuong 2048); 7d (65 $\times$ ) from flower of *A. tonkinensis* Li (Tsang 29907), and also Cuong 2048.

intermingled with *A. latifolia* (Fig. 6). Comparison of the flowers of *A. latifolia* and *A. tonkinensis* show that the latter has been described based on a staminate plant, which has a small ovary without or with only very short styles, but with functional pollen (Fig. 7d, f). Female flowers have a larger ovary, but with non-functional pollen (Fig. 7c, e). This study demonstrates that *A. tonkinensis* and *A. latifolia* represent only a single species.

## 6. Is *Actinidia indochinensis* Merr. a distinct species or is it a variety of *A. callosa* Lindl.?

Merrill (1938) described *A. indochinensis* as having granular indumentum on its younger parts and the abaxial leaf surfaces, and related it to *A. callosa*, which was completely glabrous. Li (1952), however, considered *A. indochinensis* to be a variety of *A. callosa*, citing the same characters that Merrill had used to justify the rank of species for this taxon (see also Hô, 1999; Bân, 2003). Liang (1984), on the other hand, concluded that *A. indochinensis* was completely different from *A. callosa* and its varieties. In this study, only 4 collections of *A. indochinensis* with flowers and 5 with fruits were available for inclusion.

Analyses of variation — In bivariate analyses, all the pairwise combinations of characters from flowering and fruiting specimens showed substantial overlap among the two taxa. In the PCA of specimens with fruit (Fig. 8), 42.4% of the total variation is accounted for by the first axis, with lamina length and fruit width (a negative value) being particularly important. The second axis accounted for 19.4% of the total variance, with major contributions coming from fruit length and apex length (a negative

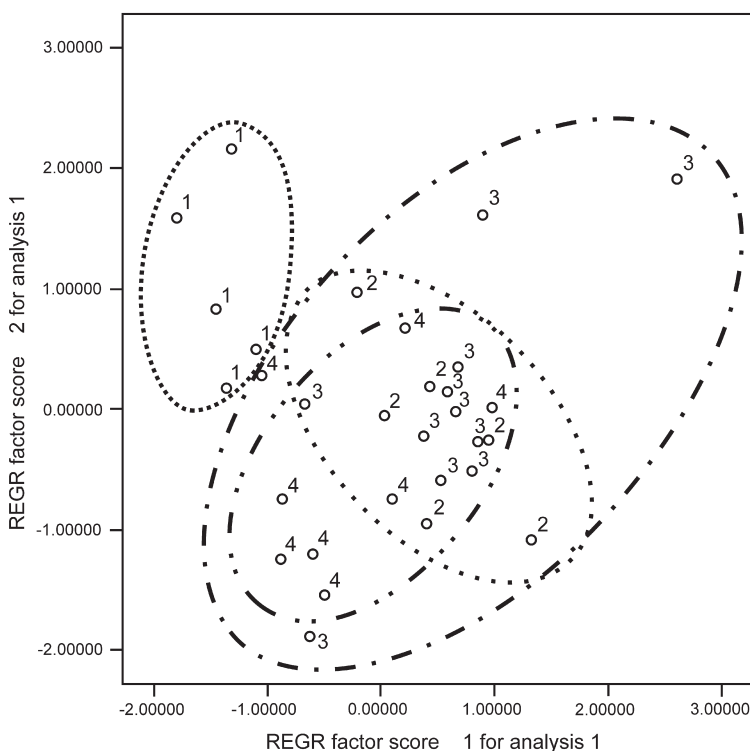


Fig. 8. PCA – two-dimensional scatter plots of *Actinidia indochinensis* Merr. and *A. callosa* Lindl. complex. Fruiting specimens: (1) *A. indochinensis* Merr.; (2) *A. callosa* Lindl. var. *callosa*; (3) *A. callosa* Lindl. var. *henryi* Maxim.; and (4) *A. callosa* Lindl. var. *discolor* C.F. Liang.

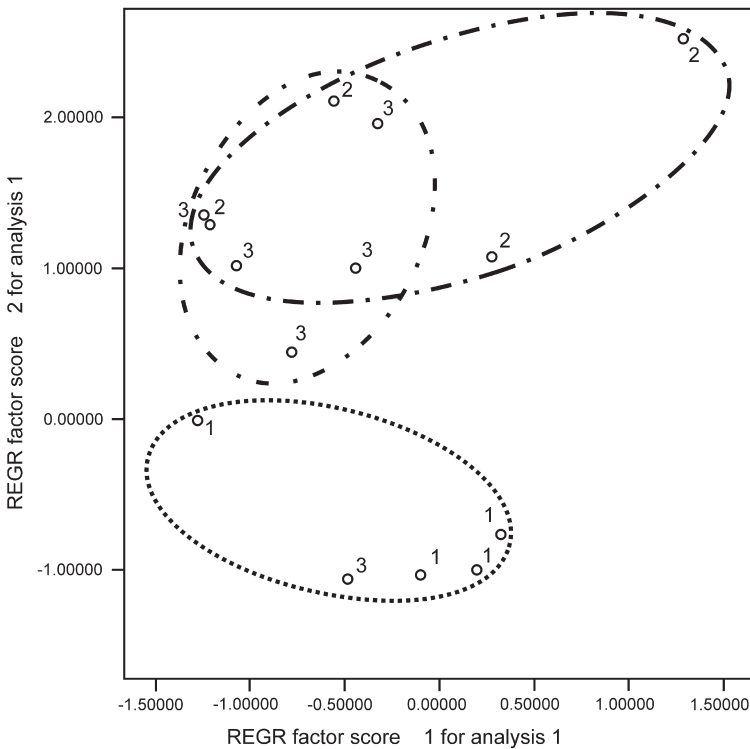


Fig. 9. PCA – two-dimensional scatter plots of *Actinidia indochinensis* Merr. and *A. callosa* Lindl. complex. Flowering specimens: (1) *A. indochinensis* Merr.; (2) *A. callosa* Lindl. var. *callosa*; and (3) *A. callosa* Lindl. var. *discolor* C.F. Liang.

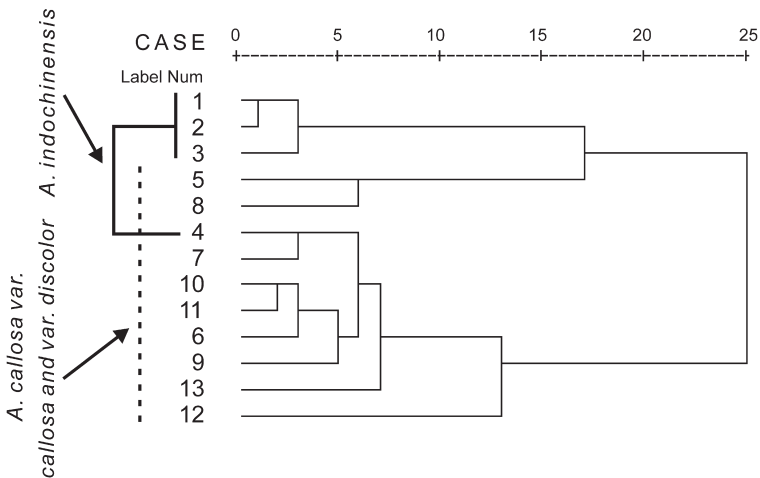


Fig. 10. Dendrogram of *Actinidia indochinensis* Merr., *A. callosa* Lindl. and its varieties. Flowering specimens: (1–4) *A. indochinensis* Merr.; (5–8) *A. callosa* Lindl. var. *callosa*; and (9–13) *A. callosa* Lindl. var. *discolor* C.F. Liang.

value). Specimens of *A. indochinensis* formed a coherent group adjacent to the group of specimens identified as *A. callosa*, the latter formed a single, composite group. In the PCA of specimens with flower (Fig. 9), the first axis accounted for 57% of the total variation, with major contributions coming from petal length and anther length (a negative value). The second axis accounted for 24.7% of the total variation, with major contributions from anther length and style length (a negative value). The overall pattern was similar to that of the preceding analysis, although there were perhaps too few specimens to draw too much in the way of the conclusion. Cluster dendrograms (Fig. 10, 11) showed that specimens of *A. indochinensis* were mixed up with those of *A. callosa* and its varieties.

Discussion — The results of the bivariate analyses show that many characters are correlated statistically but show a variable amount of overlap. The result of the PCA of both flowering and fruiting material show that specimens of *A. indochinensis* are barely

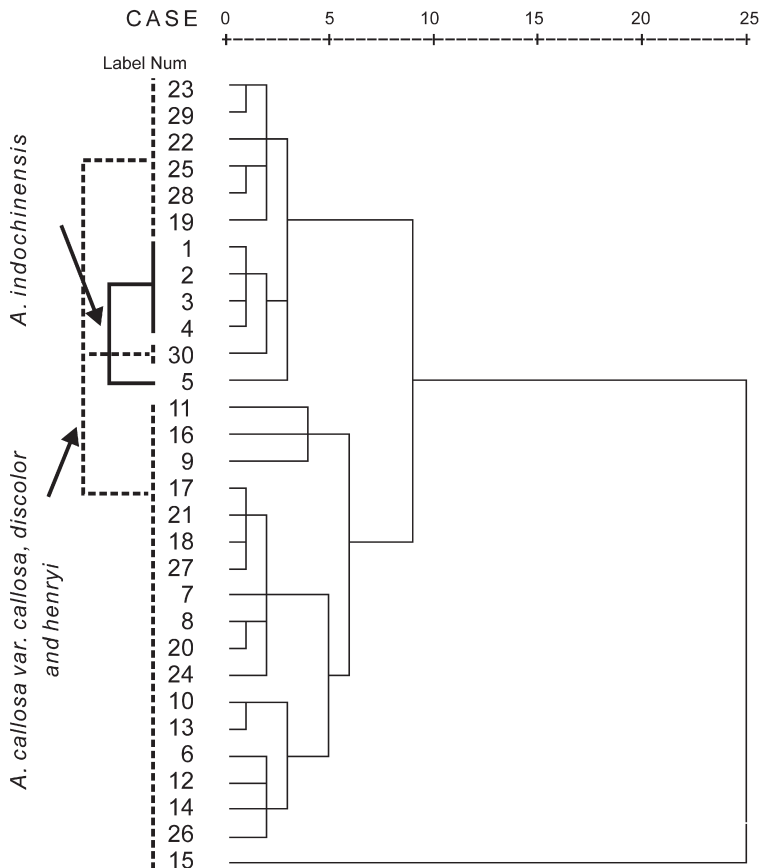


Fig. 11. Dendrogram of *Actinidia indochinensis* Merr., *A. callosa* Lindl. and its varieties. Fruiting specimens: (1–5) *A. indochinensis* Merr.; (6–11) *A. callosa* Lindl. var. *callosa*; (12–22) *A. callosa* Lindl. var. *henryi* Maxim.; and (23–30) *A. callosa* Lindl. var. *discolor* C.F. Liang.

separable from those of *A. callosa* and its varieties (Fig. 8, 9). In the cluster analysis of flowering specimens, only a single specimen of *A. indochinensis* fall within the range of specimens of *A. callosa* and its varieties (Fig. 10), but in the larger analysis of fruiting specimens, a cluster of *A. indochinensis* specimens fall very close to those of *A. callosa* var. *henryi* Maxim. (Fig. 11). On the other hand, young branches and lamina of *A. indochinensis* are slightly puberulent and have granular reddish spots, quite unlike the glabrous branches and lamina of *A. callosa* and its varieties; these characters are not included in the quantitative morphological analyses. This result suggests that *A. indochinensis* is distinct from *A. callosa* and its varieties.

In a molecular analysis (Li et al., 2002), *A. indochinensis* and specimens of two varieties of *A. callosa* appear together as a monophyletic group, or as a paraphyletic group in which other varieties of *A. callosa* and other species of *Actinidia* are embedded. This and our results clearly point to the fact that problems still need to be resolved in the taxonomic delimitation among these taxa.

## 7. Implications for future work

This study is a first step in an attempt to resolve taxonomic problems among species of Actinidiaceae in Vietnam. The multivariate analyses we employed greatly help to visualize the variation patterns in Vietnamese species of *Saurauia* and *Actinidia*. Such approaches are essential and are an integral component in critical morphological taxonomic studies, although, in the present study, the small number of specimens available for the measurements and analyses of the variation patterns, for a number of species, may have some influence on the results of our study. Such limitations, however, need to be resolved in future work, in which approaches such as molecular analysis need to be employed. Actinidiaceae are poorly known worldwide, and future studies will have to address problems at a broader geographical scale.

## TAXONOMIC TREATMENT

### ACTINIDIACEAE

*Actinidiaceae* Gilg & Werderm. (1925) 36. — Type: *Actindia* Lindl. — Fam. cons., ICBN 2006.

Trees, shrubs or woody vines, indumentum varies, often of multicellular branched and unbranched trichomes. *Leaves* simple, petiolate, spirally arranged, exstipulate; lamina usually pubescent, margins serrate or serrulate, lateral veins in pairs and ascending, tertiary veins scalariform. *Inflorescences* cymose or thyrsopaniculate, axillary or flowers solitary. *Plant* dioecious or functionally dioecious with perfect flowers or rarely monoecious (flowers bisexual in *Clematoclethra*). *Flowers* actinomorphic, bracteate, sepals normally 5, shorter than petals, persistent; petals normally 5, usually white; stamens numerous with filiform filaments, anthers dorsifixed, extrorse; gynoecium syncarpous, ovary superior, normally of 5 or numerous locules; styles distinct or basally connate. *Fruits* berries or, in *Clematoclethra* and some *Saurauia*, loculicidal capsules, globose to ovoid to oblong-ellipsoid; seeds numerous, reticulo-areolate, embedded in a mucilaginous pulp; embryo large, with copious endosperm.

## KEY TO GENERA OCCURRING IN VIETNAM

- 1a. Woody vine; flowers with free stamens and longitudinally dehiscent anthers; ovary many-loculed; fruit a berry that does not split open . . . . . **1. Actinidia**  
 b. Tree or shrub; flowers with stamens basally adnate to petals and poricidally dehiscent anthers; ovary normally 3- or 5-loculed; fruit a berry that may split open loculicidally . . . . . **2. Saurauia**

**1. ACTINIDIA**

*Actinidia* Lindl. (1836) 439; Dunn (1911) 394; H.L. Li (1952) 1. — Type: *Actinidia callosa* Lindl.

Woody vines. *Plants* dioecious. *Inflorescences* axillary, cymose, or flowers solitary. *Sepals* (3 or 4 or) 5; *petals* (4 or) 5; *filaments* connate at base, pubescent, anthers with longitudinal dehiscence; *ovary* tomentose, carpels numerous. *Fruits* with lenticels or not.

## KEY TO SPECIES OCCURRING IN VIETNAM

- 1a. Floral branchlets pubescent, especially the young parts, often densely so . . . . . 2  
 b. Floral branchlets glabrous . . . . . 4  
 2a. Lamina base rounded to cordate; sepals densely tomentose . . . . . 3  
 b. Lamina base acute; sepals glabrous . . . . . **4. A. indochinensis**  
 3a. Lower surface of lamina scattered setose along main veins . . . . . **6. A. petelotii**  
 b. Lower surface of lamina densely stellate . . . . . **3. A. fulvicoma**  
 4a. Lamina base ± acute to cuneate . . . . . 5  
 b. Lamina base cordate . . . . . **2. A. fortunatii**  
 5a. Lamina ovate to obovate or broadly elliptic, c. two times longer than broad . . . 6  
 b. Lamina narrowly elliptic to narrowly obovate, c. 3 times longer than broad . . .  
 . . . . . **7. A. rubricaulis**  
 6a. Lower surface of lamina stellate-pubescent, flowers yellowish . . . **5. A. latifolia**  
 b. Lower surface of lamina glabrous except for barbate vein axils, flowers white . . .  
 . . . . . **1. A. callosa**

**1. Actinidia callosa** Lindl. (1839) 439.

**Actinidia callosa** Lindl. var. **discolor** C.F. Liang — Fig. 12

*Actinidia callosa* Lindley var. *discolor* C.F. Liang (1984) 315. — Type: *Li Zhong-ti* 603855 (holo IBK n.v.), China, He-xian, 500 m, 11 Oct. 1959.

Woody vines. *Branchlets* glabrous. *Petioles* purple, 2.5–7 cm long, glabrous. *Lamina* chartaceous, maturing coriaceous, obovate or broadly elliptic, 5.5–11 by 3.5–5.5 cm, glabrous, adaxially blackish, abaxially brownish green, apex abruptly or shortly acuminate, acumen 0.5–1.5 cm long, base cuneate, lateral veins 6–8 pairs. *Inflorescences* glabrous, 2–4-flowered or flowers solitary; peduncles 0.5–1.2 cm long; bracts subulate, 1–2 mm; pedicels 0.5–1.65 cm long. *Flowers* white; sepals 5, ovate, 3.5–4.5 by 1.8–2.5 mm, glabrous; petals 5, obovate, 5.5–8.5 by 2.5–4.5 mm; stamens 30–50,





Fig. 12. *Actinidia callosa* Lindl. var. *discolor* C.F. Liang. Branch (Phuong et al. HNK708). Illustration by N.Q. Hung.

filaments 2.5–4 mm long, anthers 1.5–2 mm long; ovary ellipsoid, 1.5–2.2 by 0.8–1.4 mm, brownish pubescent; styles (staminate flower) 0.4–0.6 mm long or (pistillate flower) 2–3 mm long. *Fruits* subglobose to oblong-ellipsoid, 1.5–3.5 cm long, glabrous when mature; calyx caducous.

*Distribution* — Mai Chau area in Vietnam. Also common in China (including Taiwan).

*Habitat & Ecology* — Primary broad-leaved evergreen dry forest along tops of highly eroded remnant karst hills. Altitude 1100–1400 m. Flowering: April to May; fruiting: June to September.

Note — The occurrence of *A. callosa* var. *discolor* in Vietnam represents a new record for the species in the country. The specimens (*Phuong et al. HNK708, Hiep et al. 795*) agree well with the Chinese specimens and with Liang's original description (Liang, 1984). Liang (1984) recognized seven varieties of *A. callosa* from China; these are distinguished, among others, by differences in leaf and fruit shape; these need re-evaluation.



Fig. 13. *Actinidia fortunatii* Finet & Gagnep.  
a. Branch; b. cross section of fruit (all: *Soejarto et al. 13928*). Illustration by N. Q. Hung.

## 2. *Actinidia fortunatii* Finet & Gagnep. — Fig. 13

*Actinidia fortunatii* Finet & Gagnep. (1906a) 574. — Type: *J. Cavalerie & Fortunat 2350* (iso A), China, Guizhou, 8 June 1905.

Woody vines c. 5 m, whole plant glabrous. *Petioles* purple, 1.5–3.5 cm long. *Lamina* chartaceous, broadly ovate to ovate-cordate, 6–12 by 3.5–5 cm, adaxially green, abaxially glaucous, apex acuminate, margins distantly serrulate, base cordate, lateral veins 5–7 pairs. *Inflorescences* 1–3-flowered; peduncles 0.3–1.2 cm long; bracts subulate, 2–3 mm long; pedicels 0.5–1 cm long. *Flowers* reddish; sepals 5, ovate, 3–4.5 by 2.5–3.5 mm; petals 5, obovate, 4–6 by 3–4 mm; stamens 35–60, filaments 2–3.5 mm long, anthers 1–1.2 mm long; ovary ovoid, 1.5–2 by 2.5–3 mm; styles 1.8–2 mm long. *Fruits* ellipsoid, 1–2 cm long; calyx persistent.

Distribution — Tam Dao National Park in Vietnam. Also common in China.

Habitat & Ecology — Mountain slopes in tropical monsoon rain forest. Altitude c. 1000 m. Flowering: March to May; fruiting: June.

Note — *Actinidia fortunatii* differs from the other *Actinidia* species currently known in Vietnam in having purple petioles, glabrous lamina with a cordate base, and a glaucous lower leaf surface.

## 3. *Actinidia fulvicoma* Hance

*Actinidia fulvicoma* Hance (1885) 321; Dunn (1911) 409; H.L. Li (1952) 57. — Type: *Henry 22293* (holo n.v.), China, Lo-fau-shan, May 1883.

*Actinidia fulvicoma* Hance var. *hirsuta* Finet & Gagnep. (1906b) 52 (Mém. 4) 18 — Type: *Bodinier 2427* (holo n.v.), China, Kouy-tcheou, Yang-ya, 20 July 1898.

Woody vines 4–8 m. *Branchlets* reddish brown-tomentose to -hirsute. *Petioles* 1–4.5 cm long, densely reddish brown-tomentose to -hirsute. *Lamina* membranaceous, becoming coriaceous, ovate to broadly ovate to ovate-elliptic, 5–13 by 2.5–5.5 cm, apex acuminate, acumen 0.5–1.5 cm long, margins setose-serrulate, base rounded to cordate, adaxially scattered to densely tomentose along major veins, abaxially densely tomentose along major veins, stellate-pubescent along minor veins, lateral veins 6–9 pairs. *Inflorescences* 1–4-flowered, densely covered with reddish brown tomentum; peduncles 0.4–1.5 cm long; bracts subulate to linear, 1–3 mm long; pedicels 0.7–2 cm long. *Flowers* white; sepals 5, ovate to obovate, 4–7.5 by 2.5–3.75 mm, abaxially densely reddish tomentose, adaxially glabrous; petals 5, white, obovate to narrowly obovate, 4.5–12 by 4–8 mm; stamens 35–55, filaments 2.5–4.5 mm long, anthers ovate, 1–1.5 mm long; ovary subglobose, 2.5–4.5 by 1.2–2.5 mm, densely tomentose; styles 2.5–4.5 mm long. *Fruits* ovoid to oblong-conoid, 1.5–2 cm long, tomentose, turning glabrescent; calyx persistent.

Distribution — Bach Ma National Park, in Kontum Province, and in Ha Giang Province (close to China) in Vietnam. Also in China.

Habitat & Ecology — Primary evergreen broad-leaved monsoon forest on sandstone, gneiss and limestone slopes. Altitude 1100–1400 m. Flowering: March to June; fruiting: June to August.

Note — This is the first record of the occurrence of *A. fulvicoma* in Vietnam. Specimens of this species agree well with the original description of the species, including the description by Finet & Gagnepain (1906b). Some specimens have been misidentified as

*A. petelotii*. The species is characterized by its usually yellowish brown indumentum (tomentose to hirsute), consisting of branched (stellate) and unbranched trichomes on the abaxial surface of the leaf blade.

#### KEY TO THE VARIETIES

- 1a. Branchlets and petioles densely tomentose-pubescent, flowers with small petals, 4.5–6.5 by 4–5 mm ..... **a. var. fulvicoma**  
 b. Branchlets and petioles densely hirsute-pubescent, flowers with larger petals, 9–12 by 7–8 mm ..... **b. var. hirsuta**

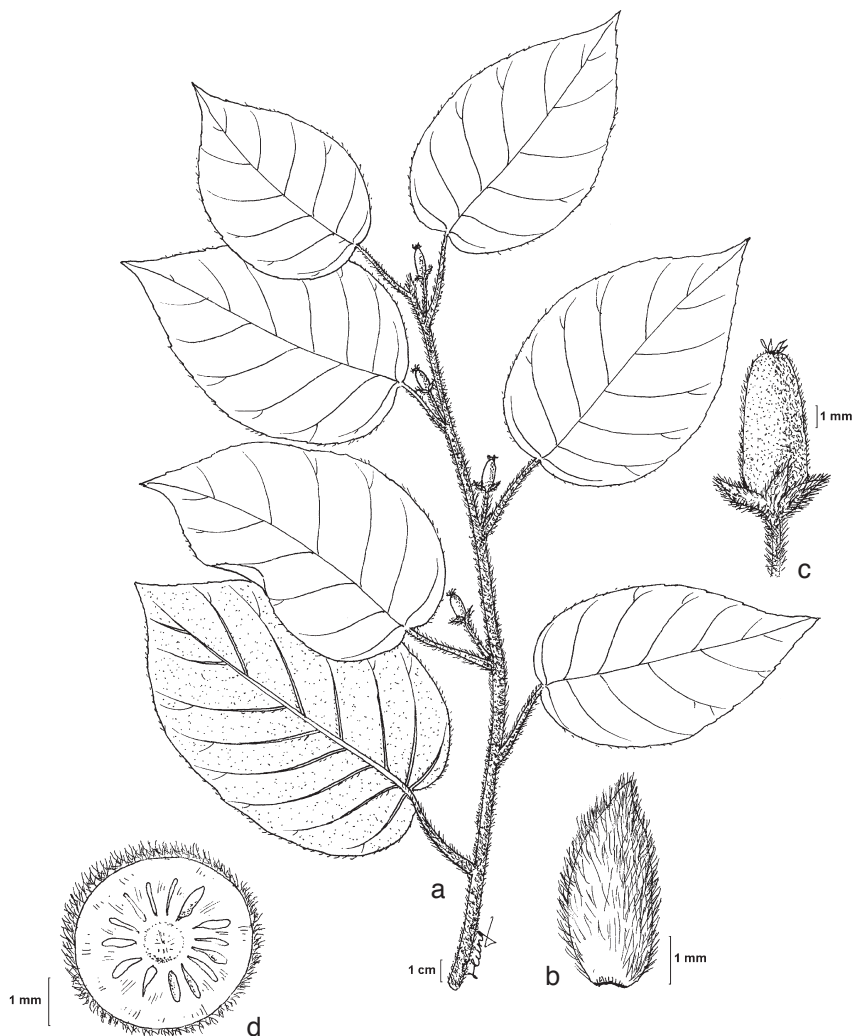


Fig. 14. *Actinidia fulvicoma* Hance var. *hirsuta* Finet & Gagnep. a. Branch; b. bract; c. fruit; d. cross section of fruit (all: Dao 33). Illustration by N.Q. Hung.

**a. var. fulvicoma**

*Branchlets* reddish brown tomentose. *Leaf lamina* ovate to narrowly ovate, 5–8 by 2.5–5.5 cm, adaxially primary and secondary veins densely tomentose, abaxially densely long-stellate hairy on tertiary veins. *Inflorescences* 1–≥4-flowered; peduncles 0.4–1 cm long; bracts subulate, 1–3 mm long; pedicels 0.7–2 cm long. *Sepals* obovate, 4–5.5 by 2.5–3 mm; petals obovate, 4.5–6.5 by 4–5 mm; filaments 2.5–4.5 mm long; anthers 1–1.2 mm long; ovary globose, 2.5–3 by 1.2–2.5 mm; styles 2.5–4 mm long.

Distribution — Bach Ma National Park, in Kontum Province.

Habitat & Ecology — Limestone mountains in primary evergreen broad-leaved highland forest. Altitude 1100–1350 m.

**b. var. hirsuta** Finet & Gagnep. — Fig. 14

*Branchlets* densely hirsute pubescent. *Leaf lamina* ovate to broadly ovate, 6.5–13 by 4.2–9.5 cm, adaxially scattered tomentose throughout, abaxially densely stellate hairy on tertiary veins. *Inflorescences* 1–≥3-flowered or flower solitary; peduncles 0.5–1.5 cm long; bracts linear, 1–2 mm long; pedicels 1–1.5 cm long. *Sepals* ovate, 5.5–7.5 by 2.5–3.75 mm; petals obovate, 9–12 by 7–8 mm; filaments 3–4.5 mm long; anthers 1.3–1.5 mm long; ovary globose to subglobose, 3.5–4.5 mm long; styles 4–4.5 mm long.

Distribution — Ha Giang Province (close to China) in Vietnam. Also in China (Tung Kay Shan).

Habitat & Ecology — Close to China on hill in subtropical monsoon forest. Altitude up to 1000 m.

**4. Actinidia indochinensis** Merr. — Fig. 15

*Actinidia indochinensis* Merr. (1938) 53; C.F. Liang (1984) 236. — *Actinidia callosa* Lindl. var. *indochinensis* (Merr.) H.L. Li (1952) 48; Hó (1999) 408, f. 1640; Bân (2003) 433. — Type: *Petelot 5938* (holo A; iso NY, P, US), Vietnam, Lao Cai, Sapa, April 1936.

Woody vines c. 5 m. *Branchlets* brownish purple, slightly puberulent, with scurfy reddish spots and white lenticels. *Petioles* pale yellow, 1.3–2.5 cm long. *Lamina* chartaceous, becoming coriaceous, elliptic to elliptic-obovate, 4.5–8.5 by 2.5–5.4 cm, apex shortly acuminate, margins finely serrulate, base cuneate, adaxially green, glabrous, abaxially with scattered red spots, puberulent, lateral veins 5–7 pairs. *Inflorescences* 3–5-flowered, or flowers solitary, covered by scattered glandular red dots and short hairs; peduncles 0.5–1 cm long; bracts linear, 0.5–1 mm long; pedicels 0.4–1 cm long. *Flowers* white; sepals 5, ovate, 4–6 by 3–4 mm, scattered puberulent; petals 5, obovate, 7.5–11 by 4–6.5 mm, glabrous; stamens 40–65, filaments 2.5–3.3 mm long, anthers 1.3–1.5 mm long; ovary globose, densely tomentose, styles 3–4 mm long. *Fruits* subglobose to oblong-ellipsoid; calyx caducous.

Distribution — Lao Cai-Sapa area in Vietnam. Also in China.

Habitat & Ecology — Steep mountain slopes in tropical monsoon rain forest. Altitude 1600–2000 m. Flowering: March to April; fruiting: May to November.



Fig. 15. *Actinidia indochinensis* Merr. a. Branch; b. cross section of fruit (all: Cuong 2046). Illustration by N.Q. Hung.

**5. *Actinidia latifolia* (Gardner & Champ.) Merr. — Fig. 16**

*Actinidia latifolia* (Gardner & Champ.) Merr. (1922) 330; H.L. Li (1952) 50; C.F. Liang (1984) 255; Hô (1999) 408, f. 1642; Bân (2003) 434. — *Heptaca latifolia* Gardner & Champ. in Hooker (1849) 243. — *Actinidia championi* Benth. (1861) 26. — Type: *J.G. Champion s.n.* (holo n.v.), China (including Hong Kong).

*Actinidia tonkinensis* H.L. Li (1943) 366; Hô (1999) 409, f. 1644; Bân (2003) 434. — Type: *Tsang 29907* (holo A; iso K, P), Quang Ninh, Lung Wan, Dan-ha, May 18–July 5, 1940.

Woody vines to 5–9 m. *Branchlets* glabrous with lenticels. *Petioles* 1.5–7 cm long, glabrous or with short stellate hairs. *Lamina* chartaceous, ovate to broadly ovate, 8–13 by 5–10 cm, apex acute to short-acuminate, margins minutely and remotely callose-serrulate, base broadly cuneate to rounded, adaxially glabrous, abaxially with short stellate hairs, lateral veins 6 or 7 pairs. *Inflorescences* 8–15-flowered, brownish

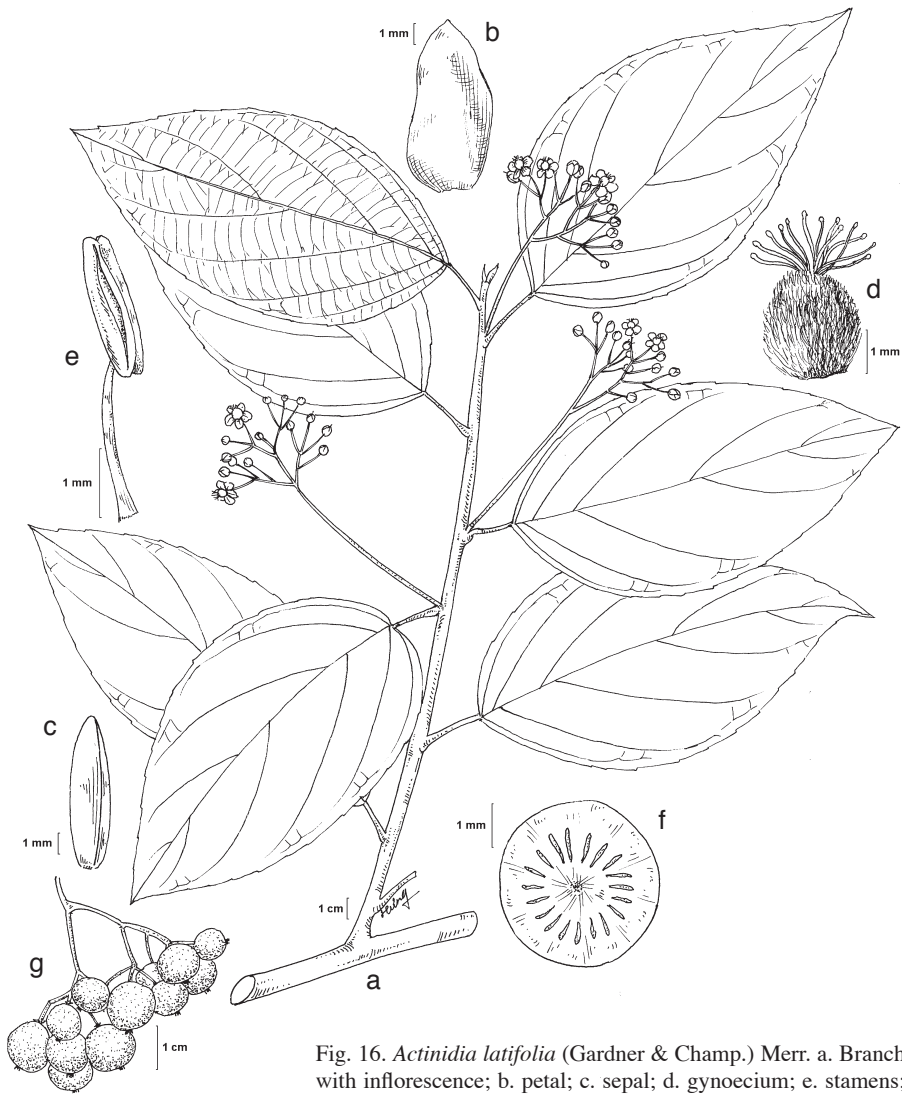


Fig. 16. *Actinidia latifolia* (Gardner & Champ.) Merr. a. Branch with inflorescence; b. petal; c. sepal; d. gynoecium; e. stamens; f. staminate flower; g. fruits (a–f: Cuong 2050; g: Cuong 2048). Illustration by N.Q. Hung.

puberulent; peduncles 2–8 cm long; bracts linear, 1–2 mm long; pedicels 0.5–1.5 cm long. *Flowers* yellowish; sepals 5, ovate, 4–5 by 2–3 mm, abaxially brownish tomentose, adaxially puberulent; petals 5, elliptic to obovate, 6–8 by 2.5–3.5 mm; stamens 26–50, filaments 1.5–3.5 mm long, anthers 0.6–1 mm long; ovary globose, 1.5–2.5 mm long, densely tomentose; styles 1.5–3 mm long (female flower), 0.3–0.5 mm long (staminate flower). *Fruits* globose to ovoid; calyx persistent.

*Distribution* — Vietnam. Also in Thailand, Cambodia, Laos, China (including Taiwan), Singapore, and Borneo.

Habitat & Ecology — Evergreen primary tropical and subtropical rain forests. Altitude 900–1800 m. Flowering: April to June; fruiting: July to November.

Note — The combination '*Actinidia latifolia* var. *indochinensis*' made by Li (1952: 52) was an error. The basionym cited "*Actinidia indochinensis* Li (1943) 366" is erroneous since the reference cited (Li, 1943: 366) is the place of publication of *A. tonkinensis* Li; there is no "*Actinidia indochinensis* Li". Elsewhere in the same publication, Li synonymised *A. indochinensis* Merr. (with correct bibliographic citation) under *A. callosa*.

## 6. *Actinidia petelotii* Diels

*Actinidia petelotii* Diels (1931) 213; Gagnep. (1938) 28; Hô (1999) 409, f. 1643; Bân (2003) 434. — Type: *Petelot* 3829 (holo P; iso A, NY, US), Vietnam, Lao Cai, Sapa, Aug. 1930, fr.

Woody vines to 6–8 m. *Branchlets* covered by dense, reddish setose pubescence. *Petioles* reddish green, 1.5–2.5 cm long, also covered by dense, reddish green setose pubescence. *Lamina* ovate to narrowly ovate, 9–14 by 6–9 cm, apex acute to acuminate, acumen 0.75–1.5 cm long, margins finely serrulate, base cordate to subcordate or rounded, adaxially glabrous, abaxially scattered setose along main veins, lateral veins 6–8 pairs. *Inflorescences* cymose or flowers solitary, densely setose; peduncles 0.5–1.3 cm long; bracts linear, 2–3 mm long; pedicels 1–1.7 cm long. *Flowers* white; sepals 5, ovate, 5–6 by 2–3 mm, abaxially setose; petals 5, obovate, 6–7.5 by 3.5–4.5 mm, glabrous; stamens 38–55, filaments 1–2.5 mm long, anthers ovate, 0.8–1 mm long; ovary ovoid, 1.5–2 mm long, styles tomentose, 0.7–1.2 mm long. *Fruits* ovoid to oblong-ovoid, 2–2.5 by 0.6–0.8 cm, scattered setose; calyx persistent.

Distribution — Lao Cai and Cao Bang areas in Vietnam.

Habitat & Ecology — Granitic mountain slopes, primary evergreen broad-leaved forest on limestone formation. Altitude 1500–2000 m. Flowering: March to May; fruiting: June.

Note — *Actinidia petelotii* is clearly distinct from other Vietnamese *Actinidia* species in its densely reddish setose hairs on the young branches, petioles, and main and lateral veins; the lamina is ovate and reddish green when young.

## 7. *Actinidia rubricaulis* Dunn — Fig. 17

*Actinidia rubricaulis* Dunn (1906) 2. — Type: *Henry* 10696 (iso A, MO), China, Yunnan, Feng Chen Lin, Red river, alt. 7000 ft, n.a., fl.

*Actinidia callosa* Lindl. var. *coriacea* Finet & Gagnep. (1906b) 52. — *Actinidia coriacea* (Finet & Gagnep.) Dunn (1911) 405; Hô (1999) 408, f. 1641; Bân (2003) 434. — Type: *M. Delavay* 5152 (iso K), China, Yunnan, 1893, fl.

Woody vines to 10 m. *Branchlets* reddish white, glabrous. *Petioles* reddish, 2–3 cm long, glabrous. *Lamina* chartaceous, elliptic to narrowly elliptic to obovate, turning coriaceous at maturity, 10–16 by 3–5 cm, glabrous, apex acuminate, 0.5–1 cm long, margins loosely serrulate, base cuneate, lateral veins 6–8 pairs. *Inflorescences* glabrous, 3-flowered or flower solitary; peduncles 0.5–1.3 cm long; bracts subulate, 1.5–2 mm; pedicels slender, reddish, 1.5–2 cm long. *Flowers* reddish; sepals 5, ovate, 4–5 by 2–3.5 mm, glabrous; petals 5, whitish red, 7–10 by 4–7 mm; stamens 40–55, filaments 3–4.5 mm long, anthers 1–1.5 mm long; ovary ovoid to oblong-ellipsoid,





Fig. 17. *Actinidia rubricaulis* Dunn. Branches (Petelot 6343). Illustration by N.Q. Hung.

1.6–2.5 mm long, pubescent, styles 0.5–3 mm long. *Fruits* ovoid, glabrous at maturity; calyx persistent.

*Distribution* — Lao Cai-Sapa and Fan Si Pan Mountain areas in Vietnam. Also in China.

*Habitat & Ecology* — Streamsides on limestone slopes in tropical monsoon rain forest. Altitude 1600–1700 m. Flowering: March to May; fruiting: June to September.

*Note* — Finet & Gagnepain (1906b) described *A. callosa* var. *coriacea*, but Dunn (1911) thought that it was a separate species and compared it with *A. rubricaulis*. The former differs in having more thickly coriaceous leaves. However, the leaves of both taxa are glabrous and similar in shape and texture. The flowers are also similar in having densely tomentose ovaries. Here *A. callosa* var. *coriacea* (= *A. coriacea*) is relegated to synonymy under *A. rubricaulis*.

## 2. SAURAUIA

*Saurauia* Willd. (1801) 407. — Type: *Saurauia excelsa* Willd. — Gen. cons., ICBN 2006.

Trees or shrubs. *Branchlets* and leaves mostly pubescent, trichomes of various types and sizes, forming a dense or sparse indument cover. *Inflorescences* normally crowded around tip of branchlets or spreading lower down the branchlets, ranging from short, dense and sessile cymose clusters of 1 cm to wide-spreading thyrsopaniculate clusters of 35 cm in length. *Flowers* bisexual, but functionally unisexual; calyx pubescent to glabrous, corolla glabrous; stamens numerous, filaments adnate to corolla at base, anthers seemingly poricidal; ovary globose, prominent or obsolete, normally glabrous, (3–)5-loculed, styles prominent or obsolete. *Fruits* globose to ovoid berries that sometimes split open loculicidally, pulp mucilaginous, seeds numerous; calyx persistent.

### KEY TO SPECIES OCCURRING IN VIETNAM

- 1a. Inflorescences short, up to 6 cm long, often forming dense clusters on the branchlets, sometimes trichotomous, flowers less than 20 per cluster . . . . . 2
- b. Inflorescences long and wide-spreading, 12–30 cm long, flowers 25–40 per cluster . . . . . **3. *S. napaulensis***
- 2a. Branchlets scattered pubescent, leaf lamina less than 2.5 times longer than wide; flowers white or pink . . . . . 3
- b. Branchlets abundantly and coarsely setose-pubescent, leaf lamina 3 or 4 times longer than wide; flowers reddish . . . . . **2. *S. macrotricha***
- 3a. Lower surface of lamina practically glabrous, with scattered strigose trichomes limited to main and lateral veins . . . . . 4
- b. Lower surface of lamina covered by dense, brown to yellowish brown tomentum throughout . . . . . **4. *S. petelotii***
- 4a. Ovary glabrous, 3- or 4- (or 5-)loculed, styles 3 or 4 (or 5) . . . . . 5
- b. Ovary tomentose, 5-loculed, styles 5 . . . . . **1. *S. armata***
- 5a. Peduncle 1–20 mm long; flowers 6.5–10 by 5.5–8.5 mm, styles 3, 4.5–7 mm, free to fused at base about one-third their length . . . . . **6. *S. tristyla***
- b. Peduncle 5–55 mm long; flowers 4.8–7.5 by 4.5–5.5 mm, styles 4 or 5, 1.5–3.2 mm, connate at base more than half their length . . . . . **5. *S. roxburghii***

### 1. *Saurauia armata* Kurz — Fig. 18

*Saurauia armata* Kurz (1873) 59. — Type: Burma (K? n.v.).

*Saurauia dillenioides* Gagnep. (1938) 25. — Type: *Poilane* 25776 (iso P), M. Toung, Phong Saly, 500 m, 20 April 1936, fl.

Shrubs to treelets 3–5 m tall. *Branchlets* covered with scattered strigose indumentum. *Petioles* 2–3 cm long, scattered strigose. *Lamina* coriaceous, obovate to narrowly obovate, 20–45 by 12–25 cm, apex acute to shortly acuminate, acumen 0.4–0.5 cm long, margins entire at base, mucronulate-serrulate toward the apex, base cuneate, adaxially glabrous, abaxially scattered strigose along major veins, lateral veins 16–21 pairs. *Inflorescences* 1–2 cm long, 1–3-flowered, flowers sometimes solitary; peduncles subsessile to 1 cm long; bracts obovate, 6–8 by 4–5 mm, with scattered tomentose

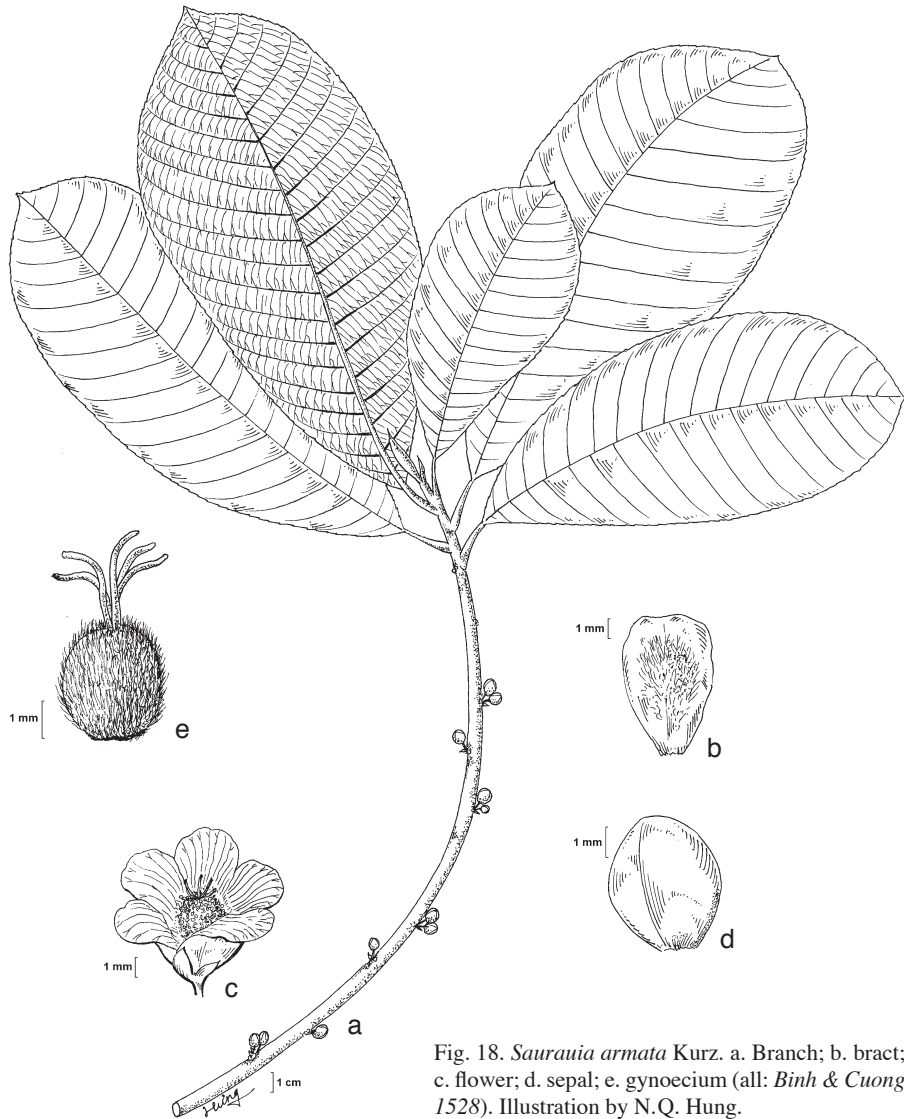


Fig. 18. *Saurauia armata* Kurz. a. Branch; b. bract; c. flower; d. sepal; e. gynoecium (all: *Binh & Cuong 1528*). Illustration by N.Q. Hung.

indumentum; pedicels 0.7–1.5 cm long. *Flowers* white; sepals 5, ovate to suborbicular, puberulent, 7–10 by 5–8 mm; petals 5, white, ovate, 10–15 by 8–9 mm; stamens 30–50, filaments 1.5–2 mm long, anthers c. 2 mm long; ovary subglobose to ovoid-oblong, 5-loculed, densely tomentose; styles 5, 2–3.5 mm long, free almost throughout their length. *Fruits* tomentose-pubescent.

*Distribution* — Vietnam in Lai Chau and Dien Bien. Also in China.

*Habitat & Ecology* — Limestone mountain slopes in tropical monsoon evergreen forest. Altitude 500–1200 m. Flowering: April to June; fruiting: dates not known.

## 2. *Saurauia macrotricha* Kurz — Fig. 19

*Saurauia macrotricha* Kurz (1873) 60; Dyer in Hook.f. (1874) 287; C.F. Liang (1984) 301; Hô (1999) 410, f. 1647. — Type: *Anderson 1287* (iso K), China, Yunnan, 2 April 1868, fr.

Treelets 4–5 m tall. *Branchlets* densely covered with reddish pubescence. *Petioles* 1–2 cm, setose-pubescent. *Lamina* chartaceous, lanceolate to narrowly elliptic, 15–32 by 5–10 cm, apex acuminate, acumen to 1–2.5 cm long, margins finely serrulate, base cuneate, adaxially covered with setose trichomes along main veins, abaxially the whole surface setose-pubescent, lateral veins 16–26 pairs. *Inflorescences* 1.5–2 cm long,

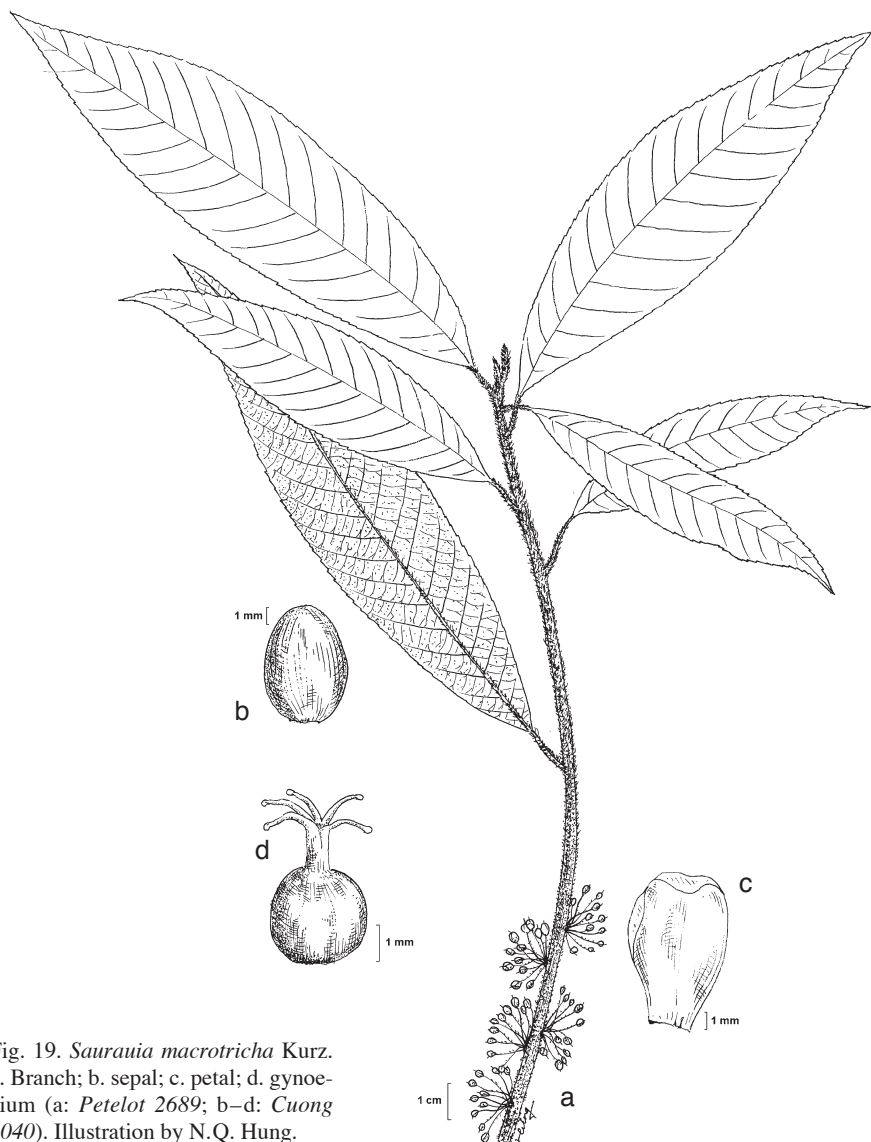


Fig. 19. *Saurauia macrotricha* Kurz. a. Branch; b. sepal; c. petal; d. gynoecium (a: *Petelot 2689*; b–d: *Cuong 2040*). Illustration by N.Q. Hung.

10–15-flowered; peduncles 0.3–0.5 cm long; bracts linear, 1–2 mm long; pedicels 0.8–2 cm long; peduncles, pedicels, and bracts setose-pubescent. *Flowers* reddish to red; sepals 5, rounded-ovate to -elliptic, reddish, 5.5–8 by 4–6.5 mm, glabrous; petals 5, obovate, reddish pink, 5–6.5 by 4.5–6.5 mm; stamens 39–43, filaments 1.5–2.5 mm long, anthers 1–1.5 mm long; ovary subglobose, 5-loculed, 3–4 by 2.5–4 mm, glabrous; styles 5, 3.5–4 mm long, fused at base, free on the upper half. *Fruits* globose, glabrous.

*Distribution* — Lao Cai-Sapa area in Vietnam. Also in India, Myanmar, China, and Thailand.

*Habitat & Ecology* — Along streamsides and on limestone mountain slopes in tropical monsoon rain forest. Altitude 1000–1728 m. Flowering: May to July; fruiting: dates not known.

*Note* — *Saurauia macrotricha* is distinct from other Vietnamese species in its densely setose branchlets, lanceolate to narrowly elliptic lamina, with the upper surface covered by scattered setose trichomes along the major veins, while the lower surface is densely setose throughout. Additionally, the flowers are red to reddish pink, on setose-pubescent inflorescences.

### 3. *Saurauia napaulensis* DC.

*Saurauia napaulensis* DC. (1822) 421; Wall. (1831) 77; Dyer in Hook.f. (1874) 286; Gagnep. (1938) 27; C.F. Liang (1984) 289; Hô (1999) 410, f. 1648; Bân (2003) 435. — Type: *Wallich Cat. No. 14691* (iso NY).

*Saurauia griffithii* Dyer var. *annamica* Gagnep. (1938) 27. — Syntypes: *Evrard 2192* (K, P), Dalat, 11 Dec. 1924, fl.; *Poilane 16783* (P), Laos, 30 August 1929, fr.

Treelets 5–10 m tall. *Branchlets* densely strigose-pubescent on the younger parts. *Petioles* 2–4 cm long, strigose-pubescent. *Lamina* coriaceous, elliptic to narrowly elliptic, 15–25 by 4–10 cm, apex shortly acuminate, acumen 0.5–0.8 cm long, margins mucronulate-serrulate, base cuneate, adaxially covered by very fine stellate trichomes when young, becoming glabrescent to glabrous, abaxially covered by somewhat appressed arachnoid pubescence throughout when young, major veins also strigose-pubescent, lateral veins 16–25 pairs. *Inflorescences* lax and wide-spreading, (12–)25–35 cm long, 20–40-flowered; peduncles 9–16 cm long; bracts subulate to linear, 3–4 mm long; pedicels 1–2.5 cm long; peduncles, branches, pedicels, and bracts scurfy pubescent, bracts may become glabrescent. *Flowers* reddish-pink; sepals 5, rounded-ovate to -obovate, 6.5–7.5 by 4.5–5.5 mm, scattered puberulent outside, glabrous inside; petals 5, obovate, 10–15 by 5–7.5 mm; stamens 30–60, filaments 2.5–3.5 mm long, anthers 2–3 mm long; ovary subglobose, 5-loculed, 1.5–2 by 1.3–1.7 mm, glabrous; styles 5, 0.8–1.2 mm long, basally connate half of their length. *Fruits* globose and angled, glabrous.

*Distribution* — Lao Cai, Hoa Binh, Nha Trang, and Kon Tum Provinces in Vietnam. Also in India, Nepal, Bhutan, Myanmar, Thailand, Laos, Malaysia, and China.

*Habitat & Ecology* — Along streamsides and on slopes in tropical monsoon rain forest. Altitude 500–1900 m. Flowering: May to July; fruiting: August to November.

*Note* — *Saurauia napaulensis* is clearly distinct and easily recognizable from other Vietnamese species in its long and wide-spreading, long-peduncled inflorescences, with a high number of flowers per inflorescence, dense brownish arachnoid pubescence on the lower surface of the lamina when young, and its reddish pink corolla.

#### 4. *Saurauia petelotii* Merr. — Fig. 20

*Saurauia petelotii* Merr. (1924) 426. — Type: *Petelot 669* (holo UC n.v.; iso A, NY, P, US), Viet Nam, Cao Bang, Pia Quac, 800 m, July 1922, fl., fr.

Treelets 4–8 m tall. *Branchlets* covered with brown scurfy pubescence, trichomes of strigose type. *Petioles* 2–6 cm long, scattered strigose to puberulent. *Lamina* coriaceous, ovate to obovate or elliptic-obovate, 12–29 by 6.5–12.5 cm, apex shortly acuminate, acumen 0.4–0.6 cm long, margins subentire at base, finely and laxly serrulate toward apex, base cuneate, adaxially blackish when dry, glabrous, abaxially densely tomentose-pubescent, lateral veins 20–25 pairs. *Inflorescences* 2–4 cm long, 10–20-flowered; peduncles to 0.8 mm long; bracts linear, 2–3 mm long; pedicels 0.8–1 cm long; peduncles, pedicels and bracts scurfy pubescent. *Flowers* pinkish white; sepals 5, elliptic-ovate, 3–4 by 2–3.5 mm, glabrous; petals obovate, 4.5–5.3 by 2–4 mm; stamens 40–55, filaments 1–5 mm long, anthers 0.6–1.2 mm long; ovary subglobose,

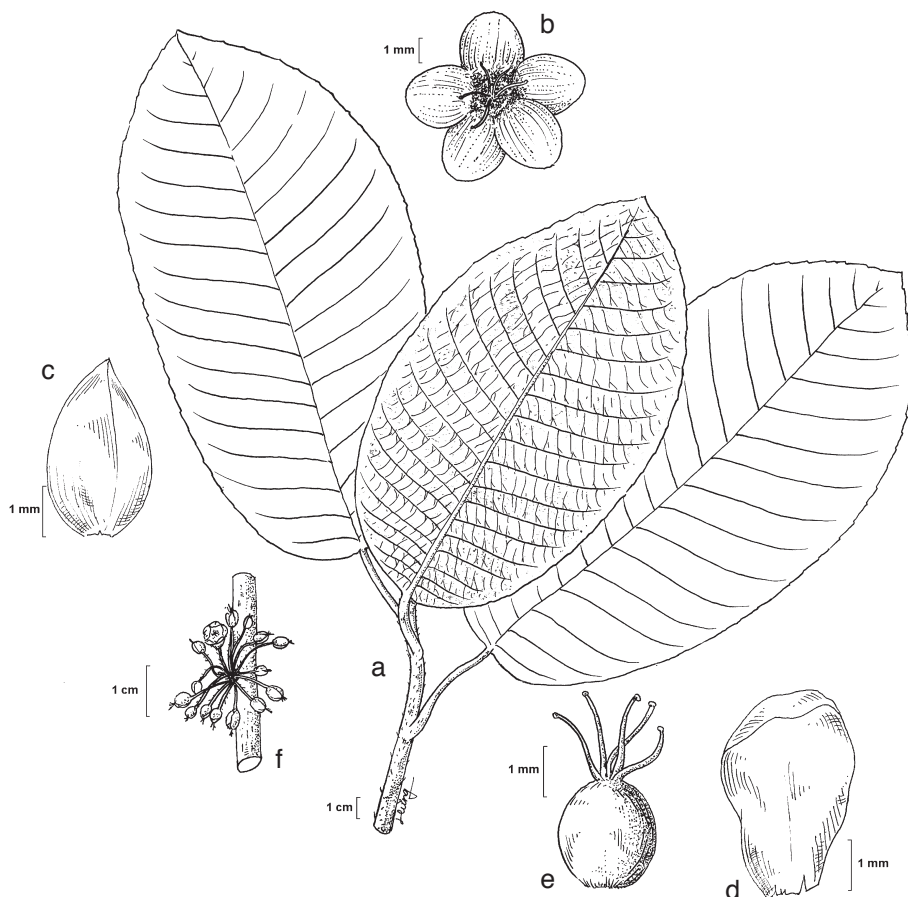


Fig. 20. *Saurauia petelotii* Merr. a. Branch; b. flower; c. sepal; d. petal; e. gynoecium; f. inflorescence (a: *Petelot 669*; b–f: *Cuong 2038*). Illustration by N.Q. Hung.

5-loculed, 1.5–2 by 1.2–1.6 cm, glabrous; styles 5, 2–2.5 mm long, fused at base, free for most of their length. *Fruits* subglobose, glabrous.

*Distribution* — Cao Bang, Lao Cai, and Kontum in Vietnam. Also in Myanmar, Thailand, and China.

*Habitat & Ecology* — Limestone mountain slopes in evergreen tropical rain forests. Altitude 1000–1600 m. Flowering: April to July; fruiting: August to September.

*Note* — This species is easily distinguished by its densely tomentose-pubescent leaves underneath and its densely pubescent ovary.

### 5. *Saurauia roxburghii* Wall.

*Saurauia roxburghii* Wall. (1831) 40; Dyer in Hook.f. (1874) 287; Gagnep. (1938) 26; Hô (1999) 410, f. 1649. — Type: *Wallich Cat. No. 1467* (iso F), Sillet, 1829, fl.

*Saurauia poilanei* Gagn. (1938) 25. — Type: *Poilane s.n.* (n.v.), Vat-tron, Luong Dien, Thua Thien Hue.

Treelets 5–8 m tall. *Branchlets* scattered strigose, younger parts scurfy pubescent. *Petioles* 2.5–4.5 cm long, scattered strigose. *Lamina* membranaceous to chartaceous, obovate to broadly elliptic, 10–26 by 5–10.5 cm, apex acuminate, acumen 0.5–1.5 cm long, margins finely serrulate to serrate, base cuneate to rounded-cuneate, adaxially glabrous, abaxially scattered strigose along major veins, lateral veins 9–17 pairs. *Inflorescences* 1.5–8 cm long, normally densely crowded, 3–12-flowered; peduncles 0.6–5.5 cm long; bracts ovate to linear, 1–2 mm long; pedicels 0.4–2.75 cm long; peduncles, pedicels and bracts scurfy pubescent. *Flowers* pink; sepals 5, ovate to rounded ovate to obovate, 3.5–5.5 by 2.5–4.5 mm, puberulent at base outside, glabrous on the upper part; petals 5, pink, obovate, 5–7 by 2.5–3.8 mm; stamens 20–45, filaments 1–2 mm long, anthers 0.5–0.85 mm long, ovary ovoid, (3- or) 4- (or 5-)loculed; styles (3 or) 4 (or 5), 1.5–3.2 mm long, connate at base half to three-fourth their length. *Fruits* glabrous.

*Distribution* — Throughout Vietnam. Also in Nepal, India, Myanmar, Thailand, Cambodia, Laos, China (including Taiwan), Japan, and Malaysia.

*Habitat & Ecology* — Secondary and primary evergreen tropical rain forest. Altitude 150–1700 m. Flowering: April to June; fruiting: August to October.

*Note* — *Saurauia roxburghii* is very closely related to *S. tristyla*, which can be distinguished by its more densely crowded inflorescences, its smaller flowers, its 4 or 5 styles, which are fused at base half to three-fourth their length. On the other hand, *S. tristyla* is characterized by the lax nature of the inflorescences and its more consistently 3-styled ovary.

### 6. *Saurauia tristyla* DC.

*Saurauia tristyla* DC. (1822) 423, t. 4; Dyer in Hook.f. (1874) 287; Gagnep. (1938) 25; C.F. Liang (1984) 296; J.J. Peng & F.Y. Lu (1996) 661, f. 291. — Type: *Wallich 1466* (iso K), India, fr.

Trees 6–10 m tall. *Branchlets* scattered strigose-pubescent, denser on the younger parts. *Petioles* 2–4.5 cm long, scattered strigose. *Lamina* membranaceous to chartaceous, obovate to elliptic-obovate, 9–20 by 4–8.5 cm, apex acuminate, acumen 0.5–1.5 cm long, margins finely serrulate to serrulate-denticulate, base cuneate, adaxially glabrous,

abaxially scattered strigose along major veins, lateral veins 8–13 pairs. *Inflorescences* 1.2–5 cm long, normally lax, 1–10-flowered; peduncles 1–3 mm long; bracts ovate-lanceolate to obovate, 0.5–1 mm long; pedicels 1.8–2.2 cm long. *Flowers* pinkish-white; sepals 5, glabrous, broadly ovate to obovate, 5–7.5 by 3.6–5.5 mm; petals 5, ovate to oblong, pink to pale-pink, 7–9 by 4–5 mm; stamens 22–35, filaments 2–3.5 mm long, anthers 1.5–1.8 mm long; ovary globose, 1.6–2.8 by 1.6–2.5 mm, 3- (or 4-) loculed; styles 4.5–7 mm long, 3 (or 4), free to fused at base about one-third their length. *Fruits* glabrous, 3-lobed, ovoid.

*Distribution* — Hue, Quang Tri, and Kontum provinces of Vietnam. Also in Laos, Thailand, China (Taiwan), Philippines, Malaysia, Indonesia.

*Habitat & Ecology* — Evergreen tropical rain forest, often on soil and rocky limestone mountain slopes. Altitude 50–1200 m. Flowering: April to July; fruiting: August to November.

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## IDENTIFICATION LIST

*Actinidia*

- A1 = *callosa* var. *discolor*  
 A2 = *fortunatii*  
 A3 = *fulvicoma* var. *fulvicoma*  
 A4 = *fulvicoma* var. *hirsuta*  
 A5 = *indochinensis*  
 A6 = *latifolia*  
 A7 = *petelotii*  
 A8 = *rubricaulis*

*Saurauia*

- S1 = *armata*  
 S2 = *macrotricha*  
 S3 = *napaulensis*  
 S4 = *petelotii*  
 S5 = *roxburghii*  
 S6 = *tristyla*

- Anderson 1287: S2 — Averyanov 7: S3; 152: S3; 461: S3; 938: S5; 1340: S4; 1720: S3; 1761: A3; 2695: A7; 4073: A6; 4514: S3; 4567: A6; 5283: A3; 5588: S6.
- Bac 2100: S4 — Balick & Nanakorn 3435: S3 — Bartholomew 36: S3 — Beaman 9576: S6 — Binh & Cuong 1528: S1.
- Cavalerie & Fortunat 2350: A2 — Chang 4878: A1 — Charoenchai 296: S5 — Chen Shaoqing 15863: A7 — Chen-Huanyong 10679: A4 — Chew 878: S6 — Chun 51334: A2 — Chung 7270: A6 — Clarke 37966: S2 — Clemens 3406: S5; 4049: S5; 27831: A6 — Croat & Dzu 77850: S5 — Cuong 652: S5; 2031: A3; 2032: S6; 2033: A3; 2035: S6; 2036: A3; 2037: S5; 2038: S4; 2039: S3; 2040: S2; 2041: A6; 2043: A7; 2044: S2; 2045: A8; 2046: A5; 2047: A7; 2048: A6; 2049: A5; 2050: A6; 2051: A8; 2052: A6.
- d'Alleizette 201800: A6 — Daniel 4740: S5; 4949: S3 — Dao 33: A4 — Delayay 163: S3; 5152: A8 — Dran 734: S5.
- Evrard 2192: S3.
- Fang 2113: A8 — Farges 1946: A8 — Feng 11006: S3 — Forest 1158: S4 — Fosberg 37984: S5 — Fung 20096: A6.
- Gao 1794: A6 — Geesink 7674: A6 — Geesink & Santisuk 5415: S5 — Gressitt 1453: A6 — Guang-Team 721: A4.
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- Keenan 3933: S4 — Kerr 7766: A6; 14455: S6; 15548: A6; 15561: S6; 20871: S5 — Kiah 35014: A6 — Kingdon 20980: S2 — Koelz 4535: S3 — Koyama 48722: S3.
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