

## Resources of Genus *Camellia* Sect. *Theopsis* and Sect. *Eriandria*

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### Abstract

With the development of cluster-flowering camellia breeding, resources of *Camellia* Sect. *Theopsis* and Sect. *Eriandria* are being more and more concerned, not only for breeding, but also for taxonomy study. In this paper, advances of taxonomy study in genus *Camellia* Sect. *Theopsis* and Sect. *Eriandria* are summarized. Meanwhile, their in-situ and ex-situ studies are pushing forward. **Key words:** cluster-flowering camellias, *Camellia* Sect. *Theopsis*, *Camellia* Sect. *Eriandria*, taxonomy.

### Introduction

During the past ten years, we have begun to breed more cluster-flowering camellias, and species of *Camellia* Sect. *Theopsis* and Sect. *Eriandria* are being collected from the wild, from botanical gardens, and nurseries. But we always confused by which species it is? Which name should we use? It's really a big problem for breeding. The more observations and studies that we did, the more questions and phenomenon have arisen. Consequently, we are paying more attention to the taxonomy study of these species, in order to make breeding and further studies more reliable and repeatable.

### 1. Taxonomy studies in *Camellia* Sect. *Theopsis* and Sect. *Eriandria*

In 1826, *Camellia euryoides* Lindley, the first species in Sect. *Theopsis*, was named and published, and new species were gradually published. Up to now, there have been three important studies on *Camellia* taxonomy: "A Revision of the Genus *Camellia*" (Sealy, 1958); "A Taxonomy of the Genus *Camellia*" (Chang, 1981) and "Camellias" (Chang, 1984); and "Studies on Genus *Camellia* in the World" (Ming, 2000). In order to show the similarities and differences of them, Table 1 was summarized and the details analyzed.

#### 1.1 Taxonomy study by Sealy

In Sealy's revision, there are 29 species in Sect. *Theopsis* and six species in Sect. *Camelliopsis*. Six species in Sect. *Camelliopsis* were changed to Sect. *Eriandria*. *C. maliflora* and *C. indochinensis* in Sect. *Theopsis* were both believed to be moved from Sect. *Theopsis*. The 27 species in Sect. *Theopsis* and six species in Sect. *Eriandria* are listed in Table 1 for further analysis and discussion.

Among these 33 species, the significant difference is that *C. assimiloides*, *C. villicarpa*, *C. punctata* and *C. lawii* – based on their tomentose ovary -- were transferred to Sect. *Eriandria* by Chang and Ming. For other species, Chang thought that *C. synaptica* and *C. acutisepala* should be reduced separately to *C. tsaii* var. *synaptica* and *C. forrestii* var. *acutisepala*, and there is no other difference among other species. In Ming's study, eight species in Sect. *Theopsis* and two species in Sect. *Eriandria* were revised, which are shown in Table 1.

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### 1.2 Taxonomy study by Chang

In Chang's study, Subgen. *Metacamellia* Chang was considered to be a new subgenus which including Sect *Theopsis* and Sect *Eriandria*. Furthermore, Ser. *Cuspidatae* Chang, Ser. *Gymnandrae* Chang and Ser. *Trichandrae* Chang were classified based on the androecium characters in Sect *Theopsis*. With the development of plant investigation in China from the 1950s, 44 species in Sect *Theopsis* and 17 species in Sect *Eriandria* were recorded in the publication of "A taxonomy of the genus *Camellia*"; it's a pity that only 14 species in Sect *Eriandria* were detailed.

Some 46 species in Sect. *Theopsis* that are distributed in China and 14 species in Sect. *Eriandria* were detailed in the publication of "Flora of China" (Chang, 1998). When adding *C.lutchuensis* T. Itôiko, which is distributed in Japan, *C.crassipetala* (Chang, 1984), *C.pseudo-elongata* Chang (Chang, 1991) and *C.tubiformis* (Chang, 1992) into these two sections, 49 species in Sect. *Theopsis* and 15 species in Sect. *Eriandria* in total are listed in Table 1.

Compared with Sealy's study, the most significant difference is the publication of new species. Compared with Ming's study, the new publications were almost reduced to the already published species except *C.viridicalyx*, *C.longicalyx*, *C.tsingpienensis* var. *pubisepala* and *C.candida*.

In addition, *C.lanceisepala* L. K. Ling recorded in "Flora of Fujian" (Lin, 1987) was not contained by Chang's study, while it was reduced to *C.longicalyx* by Ming. Another three new species which were named as species of *Theopsis* family were published (Hu, 1965), including *Theopsis euonymifolia* Hu, *Theopsis longipedicellata* Hu and *Theopsis lungyaiensis* Hu. All these three species were not mentioned in either of Chang's and Ming's studies.

### 1.3 Taxonomy study by Ming

In 2000, Ming published his study in the book "Studies on *Camellia* in the World", in which 19 species in Sect. *Theopsis* and 9 species in Sect. *Eriandria* are listed and detailed, including 2 new species and 3 new varieties named by Ming. They all belong to Subgen. *Thea* Chang. This taxonomy is adopted in the latest publication of "Flora of China" (<http://www.efloras.org>).

For Ming's consideration, many new species named by Chang are the same species which had been published before, and revisions are made which were shown in Table 1. For example, *C.triantha* Chang, *C.percuspidata* Chang, *C.membranacea*, *C.parvilapidea* Chang and *C.assimilis* Champ are all reduced to *C.caudata* Wallich. In addition, *C.rosaeflora* is a cultivated plant and is

Table 1 Taxonomy study in *Camellia* Sect. *Theopsis* and Sect. *Eriandria*

Sealy		Chang		Ming	
<b>Sect. <i>Theopsis</i></b>					
No.	Latin Name	No.	Latin Name	No.	Latin Name
ST-1	<i>Camellia stuartiana</i> Sealy	CT-1	<i>Camellia stuartiana</i> Sealy	MT-1	<i>Camellia stuartiana</i> Sealy
ST-2	<i>Camellia elongata</i> (Rehd. & Wil.) Rehder	CT-2	<i>Camellia elongata</i> (Rehd. & Wil.) Rehder	MT-2	<i>Camellia elongata</i> (Rehd. & Wil.) Rehder
ST-3	<i>Camellia trichoclada</i> (Rehd.) Chien	CT-3	<i>Camellia trichoclada</i> (Rehd.) Chien	MT-3	<i>Camellia trichoclada</i> (Rehd.) Chien
ST-4	<i>Camellia crassipes</i> Sealy	CT-4	<i>Camellia crassipes</i> Sealy	MT-4	<i>Camellia crassipes</i> Sealy
ST-5	<i>Camellia fraternal</i> Hance	CT-5	<i>Camellia fraternal</i> Hance	MT-5	<i>Camellia fraternal</i> Hance
ST-6	<i>Camellia lutchuensis</i> T. Itô	CT-6	<i>Camellia lutchuensis</i> T. Itô	MT-6.1	<i>Camellia lutchuensis</i> T. Itô
ST-7	<i>Camellia transarisanensis</i> (Hay.) Cohen Stuart	CT-7	<i>Camellia transarisanensis</i> (Hay.) Cohen Stuart	MT-7	<i>Camellia transarisanensis</i> (Hay.) Cohen Stuart
ST-8	<i>Camellia tsingpienensis</i> Hu	CT-8.1	<i>Camellia tsingpienensis</i> Hu	MT-8.1	<i>Camellia tsingpienensis</i> Hu
ST-9	<i>Camellia costei</i> H. Léveillé	CT-9	<i>Camellia costei</i> H. Léveillé	MT-9	<i>Camellia costei</i> H. Léveillé
ST-10	<i>Camellia rosthorniana</i> Handel-Mazzetti	CT-10	<i>Camellia rosthorniana</i> Handel-Mazzetti	MT-10	<i>Camellia rosthorniana</i> Handel-Mazzetti
ST-11	<i>Camellia euryoides</i> Lindley	CT-11	<i>Camellia euryoides</i> Lindley	MT-11.1	<i>Camellia euryoides</i> Lindley
ST-12	<i>Camellia tsaii</i> Hu	CT-12	<i>Camellia tsaii</i> Hu	MT-12	<i>Camellia tsaii</i> Hu
ST-13	<i>Camellia forrestii</i> (Diels) Cohen Stuart	CT-13.1	<i>Camellia forrestii</i> (Diels) Cohen Stuart	MT-13.1	<i>Camellia forrestii</i> (Diels) Cohen Stuart
ST-14.1	<i>Camellia cuspidata</i> (Kochs) Wright	CT-14	<i>Camellia cuspidata</i> (Kochs) Wright	MT-14.1	<i>Camellia cuspidata</i> (Kochs) Wright

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ST-1 4.2	<i>Camellia cuspidata</i> var. chekiangensis Sealy	CT-1 4.1	<i>Camellia cuspidata</i> var. chekiangensis Sealy	MT- 14.2	<i>Camellia cuspidata</i> var. chekiangensis Sealy
ST-1 4.3	<i>Camellia cuspidata</i> var. grandiflora Sealy	CT-1 4.2	<i>Camellia cuspidata</i> var. grandiflora Sealy	MT- 14.3	<i>Camellia cuspidata</i> var. grandiflora Sealy
ST-1 5	<i>Camellia</i> <i>synaptica</i> Sealy	CT-1 2.1	<i>Camellia tsaii</i> var synaptica (Sealy) Chang	MT- 15	<i>Camellia synaptica</i> Sealy
ST-1 6	<i>Camellia dubia</i> Sealy	CT-1 5	<i>Camellia dubia</i> Sealy	MT- 9	<i>Camellia costei</i> H. Léveillé
ST-1 7	<i>Camellia acutisepala</i> H. T. Tsai & K. M. Feng	CT-1 3.2	<i>Camellia forrestii</i> var. acutisepala (Tsai et Feng) Chang	MT- 13.2	<i>Camellia forrestii</i> var. acutisepala (Tsai et Feng) Chang
ST-1 8	<i>Camellia</i> <i>transnokoensis</i> Hayata	CT-1 6	<i>Camellia</i> <i>transnokoensis</i> Hayata	MT- 6.1	<i>Camellia lutchuensis</i> T. Itô
ST-1 9	<i>Camellia parvilimba</i> Merrill & Metcalf	CT-1 7	<i>Camellia parvilimba</i> Merrill & Metcalf	MT- 11.1	<i>Camellia euryoides</i> Lindley
ST-2 0	<i>Camellia nokensis</i> Hayata	CT-1 8	<i>Camellia nokensis</i> Hayata	MT- 11.2	<i>Camellia euryoides</i> var. nokoensis (Hayata) Ming
ST-2 1	<i>Camellia tsofui</i> Chien	CT-1 9	<i>Camellia tsofui</i> Chien	MT- 11.2	<i>Camellia euryoides</i> var. nokoensis (Hayata) Ming
ST-2 2	<i>Camellia handelii</i> Sealy	CT-2 0	<i>Camellia handelii</i> Sealy	MT- 7	<i>Camellia</i> <i>transarisanensis</i> (Hay.) Cohen Stuart
ST-2 3	<i>Camellia rosaeflora</i> Hooker	CT-2 1	<i>Camellia rosaeflora</i> Hooker		
		CT-2 2	<i>Camellia</i> <i>viridicalyx</i> Chang et S. Y. Liang	MT- 16.1	<i>Camellia</i> <i>viridicalyx</i> Chang et S. Y. Liang
		CT-2 3	<i>Camellia longicalyx</i> Chang	MT- 17	<i>Camellia longicalyx</i> Chang
		CT-8. 2	<i>Camellia</i> <i>tsingpienensis</i> var. pubisepala Chang	MT- 8.2	<i>Camellia tsingpienensis</i> var. pubisepala Chang
		CT-2 4	<i>Camellia longicarpa</i> Chang	MT- 15	<i>Camellia synaptica</i> Sealy

CT-2 5	<i>Camellia subacutissima</i> Chang	MT- 9	<i>Camellia costei</i> H. Léveillé
CT-2 6	<i>Camellia buxifolia</i> Chang	MT- 10	<i>Camellia rosthorniana</i> Handel-Mazzetti
CT-2 7	<i>Camellia callidonta</i> Chang	MT- 12	<i>Camellia tsaii</i> Hu
CT-2 8	<i>Camellia parvicuspidata</i> Chang	MT- 14.1	<i>Camellia cuspidata</i> (Kochs) Wright
CT-2 9	<i>Camellia minutiflora</i> Chang	MT- 6.2	<i>Camellia lutchuensis</i> var. <i>minutiflora</i> (Chang) Ming
CT-1 7.1	<i>Camellia parvilimba</i> var. <i>brevipes</i> Chang	MT- 11.1	<i>Camellia euryoides</i> Lindley
CT-3 0	<i>Camellia microsepala</i> Chang	MT- 14.3	<i>Camellia cuspidata</i> var. <i>grandiflora</i> Sealy
CT-3 1	<i>Camellia longicuspis</i> S. Y. Liang	MT- 14.3	<i>Camellia cuspidata</i> var. <i>grandiflora</i> Sealy
CT-3 2	<i>Camellia acutissima</i> Chang	MT- 14.3	<i>Camellia cuspidata</i> var. <i>grandiflora</i> Sealy
CT-3 3	<i>Camellia lancilimba</i> Chang	MT- 14.2	<i>Camellia cuspidata</i> var. <i>chekiangensis</i> Sealy
CT-3 4	<i>Camellia campanisepala</i> Chang	MT- 14.2	<i>Camellia cuspidata</i> var. <i>chekiangensis</i> Sealy
CT-3 5	<i>Camellia trichandra</i> Chang	MT- 14.4	<i>Camellia cuspidata</i> var. <i>trichandra</i> (Chang) Ming
CT-3 6	<i>Camellia lancicalyx</i> Chang	MT- 8.2	<i>Camellia tsingpiensis</i> var. <i>pubisepala</i> Chang
CT-3 7	<i>Camellia parvicaudata</i> Chang	MT- 8.2	<i>Camellia tsingpiensis</i> var. <i>pubisepala</i> Chang
CT-3 8	<i>Camellia parviovata</i> Chang	MT- 8.2	<i>Camellia synaptica</i> var. <i>parviovata</i> (Chang) Ming
CT-3 9	<i>Camellia crassipetala</i> Chang	MT- 12	<i>Camellia tsaii</i> Hu

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CT-4 0	<i>Camellia lipoensis</i> Chang et Xu	MT- 10	<i>Camellia rosthorniana</i> Handel-Mazzetti
CT-4 1	<i>Camellia jiuyishanica</i> Chang	MT- 14.2	<i>Camellia cuspidata</i> var. <i>chekiangensis</i> Sealy
CT-4 2.1	<i>Camellia septempetala</i> Chang	MT- 14.3	<i>Camellia cuspidata</i> var. <i>grandiflora</i> Sealy
CT-4 2.2	<i>Camellia septempetala</i> var. <i>rubra</i> Chang et L. L. Qi	MT- 14.3	<i>Camellia cuspidata</i> var. <i>grandiflora</i> Sealy
CT-4 3	<i>Camellia pseudo-elongata</i> Chang	MT- 12	<i>Camellia tsaii</i> Hu
CT-4 4	<i>Camellia truncata</i> Chang	MT- 13.1	<i>Camellia forrestii</i> (Diels) Cohen-Stuart
	<i>Camellia lanceisepala</i> L.K. Ling	MT- 17	<i>Camellia longicalyx</i> Chang
	<i>Camellia pentamera</i> Chang	MT- 13.3	<i>Camellia forrestii</i> var. <i>pentamera</i> (Chang) Ming
		MT- 18	<i>Camellia cupiformis</i> Ming
		MT- 19	<i>Camellia glabricostata</i> Ming
		MT- 16.2	<i>Camellia viridicalyx</i> var. <i>linearifolia</i> Ming
		MT- 8.3	<i>Camellia tsingpienensis</i> var. <i>macrophylla</i> Ming

**Sect. *Eriandria***

No.	Latin Name	No.	Latin Name	No.	Latin Name
SL-2 4	<i>Camellia punctuate</i> (Kochs) Cohen Stuart	CE-1	<i>Camellia punctuate</i> (Kochs) Cohen Stuart	ME-1	<i>Camellia punctuate</i> (Kochs) Cohen Stuart
SL-2 5	<i>Camellia lawii</i> Sealy	CE-2	<i>Camellia lawii</i> Sealy	ME-2	<i>Camellia lawii</i> Sealy
SL-2 6	<i>Camellia villicarpa</i> Chien	CE-3	<i>Camellia villicarpa</i> Chien	ME-3	<i>Camellia villicarpa</i> Chien
SL-2 7	<i>Camellia assimiloides</i> Sealy	CE-4	<i>Camellia assimiloides</i> Sealy	ME-4	<i>Camellia assimiloides</i> Sealy

SE-1	<i>Camellia caudata</i> Wallich	CE-5	<i>Camellia caudata</i> Wallich	ME-5	<i>Camellia caudata</i> Wallich
SE-2	<i>Camellia salicifolia</i> Champion ex Bentham	CE-6	<i>Camellia salicifolia</i> Champion ex Bentham	ME-6	<i>Camellia salicifolia</i> Champion ex Bentham
SE-3	<i>Camellia melliana</i> Handel-Mazzetti	CE-7	<i>Camellia melliana</i> Handel-Mazzetti	ME-7	<i>Camellia melliana</i> Handel-Mazzetti
SE-4	<i>Camellia cordifolia</i> (Metcalfe) Nakai	CE-8	<i>Camellia cordifolia</i> (Metcalfe) Nakai	ME-8	<i>Camellia cordifolia</i> (Metcalfe) Nakai
SE-5	<i>Camellia assimilis</i> Champion	CE-9	<i>Camellia assimilis</i> Champion	ME-5	<i>Camellia caudata</i> Wallich
SE-6	<i>Camellia wenshanensis</i> Hu	CE-10	<i>Camellia wenshanensis</i> Hu	ME-8	<i>Camellia cordifolia</i> (F. P. Metcalfe)
		CE-11	<i>Camellia candida</i> Chang	ME-9	<i>Camellia candida</i> Chang
		CE-12	<i>Camellia cratera</i> Chang	ME-4	<i>Camellia assimiloides</i> Sealy
		CE-13	<i>Camellia trigonocarpa</i> Chang	ME-4	<i>Camellia assimiloides</i> Sealy
		CT-415	<i>Camellia triantha</i> Chang	ME-5	<i>Camellia caudata</i> Wallich
		CT-416	<i>Camellia percuspidata</i> Chang	ME-5	<i>Camellia caudata</i> Wallich
		CT-417	<i>Camellia membranacea</i> Chang	ME-5	<i>Camellia caudata</i> Wallich
		CT-418	<i>Camellia parvilapidea</i> Chang	ME-5	<i>Camellia caudata</i> Wallich
		CT-419	<i>Camellia subglabra</i> Chang	ME-5	<i>Camellia caudata</i> var. <i>gracilis</i> (Hemsley) Yamamoto ex H. Keng
		CE-14	<i>Camellia edentata</i> Chang	ME-5	<i>Camellia caudata</i> var. <i>gracilis</i> (Hemsley) Yamamoto ex H. Keng
		CE-15	<i>Camellia tubiformis</i> Chang	ME-5	<i>Camellia caudata</i> var. <i>gracilis</i> (Hemsley) Yamamoto ex H. Keng
				ME-8	<i>Camellia cordifolia</i> var. <i>glabrisepala</i> Ming





not included in Sect. *Theopsis*, *C.pentamera* Chang in Sect. *Corallina* is revised as *C.forrestii* var *pentamera* (Chang) Ming.

Generally, except *C.stuartiana* Sealy, *C.elongata* (Rehd. & Wil.) Rehder, *C.trichoclada* (Rehder) Chien, *C.crassipes* Sealy, *C.fraterna* Hance, *C.salicifolia* Champion and *C.melliiana* Handel-Mazzetti, the other species more or less have some revision among different taxonomy studies of the genus *Camellia*.

In addition, two new species were published after 2000, including *C.renshanxiangiae* C. X. Ye et X. Q. Zheng (Ye et al., 2000) and *C.quangcuongii* L. V. Dung, Son & Nhan (Luong et al., 2016), which are not analyzed in this paper.

## 2. In-situ and ex-situ studies in *Camellia* Sect. *Theopsis* and Sect. *Eriandria*

Following the records of difference species by Sealy, Chang, and Ming, we went to Yunnan, Guangxi, Guangdong, Sichuan, and other provinces for in-situ resource investigations in *Camellia* Sect. *Theopsis* and Sect. *Eriandria*. The ex-situ cultivation and observation was carried out in Shanghai Botanical Garden, including morphology, palynology and other studies, so as to confirm or describe their main characters and considerable variations.

### 2.1 In-situ investigation

During the wild investigation, we went to the type specimen collection location to try to find the species for further studies. It's a pity that few of the new species recorded were not found because of urban development or farming, such as *C.membranacea* Chang in Yunnan, *C.longicalyx* Chang in Guangxi, or *C.parviovata* in Sichuan, We still try our best to find them for further studies.

The most interesting phenomenon is that original habitats of some species

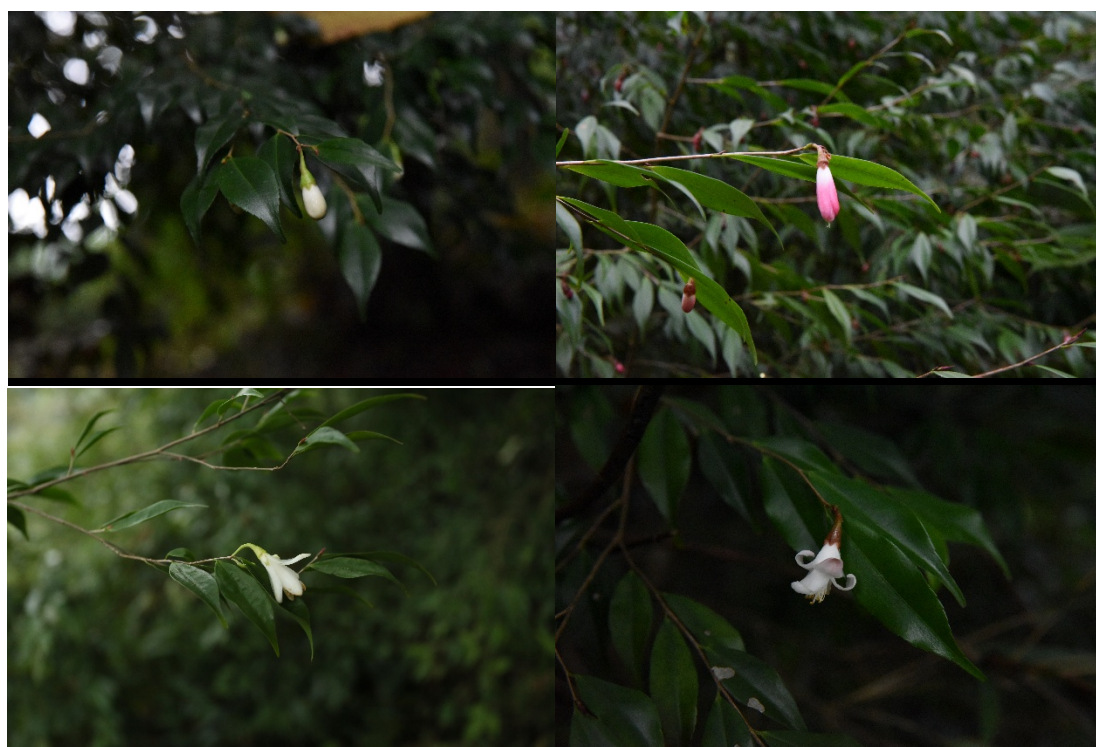


Fig. 1 Variations of *Camellia elongata* in original habitat

are unchanged, and in the same place, which may have important reference for taxonomy or phylogeny researches. These include *C.tsaii* var *synaptica* (Sealy) Chang and *C.lawii* Sealy among the samples from Hubei, *C.buxifolia* Chang and *C.villicarpa* Chien among the samples from Sichuan, They have the similar habitat and they have the similar leaves or flowers. On the other hand, tomentose or glabrous ovary distinguishes them from different sections. In addition, we also found considerable variations among the species, such as *C.elongata* (Rehd. & Wil.) Rehder with white or pink flowers, green or red pedicel and calyx samples (Fig. 1). *C.cordifolia* (Metcalf) Nakai with different size of flowers, tomentose or glabrous sepals, and so on, are also observed.

## 2.2 Ex-situ observation

We use scions for grafting, protected cultivation with single-layer in winter and shade in summer are also done. Then, observation and records were made for comparison each year, and the morphological characteristics are being improved. For the big population species, we individually numbered each plant sample and changes were observed on different plant in the same population,

Generally, there are no difference on their qualitative characters when we cultivated the species in Shanghai, while the quantitative characters more or less changed. In particular, the flower sizes are always bigger than descriptions of specimens or plants in the original habitat. This may be a difficulty for species identification in different habitats or cultivation conditions, as leaf or sepal length are all one of the index points among Sealy's, Chang's and Ming's taxonomy.

Till now, except for the 18 species that we had collected and identified (Zhang, 2018), *C.villicarpa* Chien, *C.lawii* Sealy, *C.forrestii* (Diels) Cohen Stuart and other species have been identified and added to our ex-situ collection (Fig. 2). In addition, about 80 specimens had been made for further identification and study.



**Fig. 2** Part of the new collection under ex-situ cultivation (Left: *C. lawii*, Right: *C. forrestii*)

## 3. Conclusion

In conclusion, we can see that there are many differences among these three main taxonomy studies, especially between Chang's and Ming's. We considered that some of the revisions are reasonable, such as *C.wenshanensis* being revised as

*C.cordifolia*. However, for some of them we have reservations about the revision, such as *C.buxifolia*: its androecium characters described are different than those of *C.rosthorniana*. Variation among the merged or revised species, variations among the same species at different or same habitat, detailed morphological characters of some species all need further studies.

Species of *Camellia* Sect. *Theopsis* and Sect. *Eriandria* are really very important and valuable resources in China and there are still much work to be explored. Meanwhile, their applications for clustering flowering camellia breeding are continued by our team and new cultivars are being selected.

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