

光桐品系之初步研究

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A PRELIMINARY STUDY OF THE VARIETIES OF ALEURITES FORDII HEMSL.

By P. C. YIEH, W. L. CHIA, and H. C. HOH

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¹ The junior author, H. C. Hoh, was especially responsible for the compilation of all records and the writing of the paper.

Introduction

Varietal study has been extensively used to establish new strains in fruit-bearing trees, but its application to the study of t'ung tree seems to be seldom attempted. Thus the field remains open for investigation. Ever since t'ung tree was domesticated in China, its geographical diversity of edaphic and climatic conditions is rather complicated. These external factors, in addition to its monoecious and entomophilous nature, cause t'ung trees to produce many interesting varieties. The progeny descended therefrom may or may not inherit the desirable characteristics. If such phylogenetic obscurity is not elucidated, the tasks of ascertaining a favorable type and perfecting its desirability through horticultural technics are scarcely possible.

Although very little scientific work has been done on this subject, a résumé of the past achievements is deemed necessary. McClure (1930, p. 234) first brought to our attention three varieties: Maan Nin T'ung (萬年桐), Tso Nin T'ung, (早年桐), and Ng Nin T'ung, (五年桐), though he emphasized that the names used neither bear permanent characteristics nor any apparently sound basis. Mowry (1932, pp. 26-31) studied the Florida t'ung trees which probably came from Hankow and noticed three different shapes of fruits, which were named as *Florida*, *Craig* and *Moore* varieties, and were technically described. Of Mowry's three varieties, only the *Florida* is being met frequently in the field, while the other two, according to our observations, seem to occur only in some odd individual trees. Later on some Chinese authors (Liu, 1938, p. 8, and others) mentioned about Ta Mi Tung', (大米桐), Hsiao Mi T'ung, (小米桐), Ch'ai T'ung, (紫桐), and Shih Ping T'ung, (柿餅桐), but the descriptions are rather incomplete.

Since the previous information on this subject is rather meagre and unsatisfactory, further investigations are therefore necessary in order to establish the strains and to improve them by scientific means. Special effort has been made by the authors to study the problems taxonomically and horticulturally. The work reported here is only preliminary in nature. Four new varieties, *Tsouiana*, *prolifera*, *maliformis* and *apiculata* are proposed and botanically described. Prominent characteristics of the flowering habit, and fruiting conditions are described, and the chemical analyses of each variety are presented for comparison. The samples under investigation were gathered from normally grown plants in Fowling, (涪陵), and Pei-pe (北碚), of Szechuan Province, two of the important t'ung regions in China. The observations were limited to a period of three years only, even during this period, difficulties came up

' Unless quoted verbatim from the literature, the romanized forms follow the system used in Giles (1912).

from time to time and interruptions were frequent. Hence the data given in this paper are rather incomplete in some respects.

Description of the Species

Aleurites Fordii Hemsley in Hooker's Icon. Pl. XXIX. tt. 2801, 2802 (1906); in Kew Bull. Misc. Inform. 1906, 120; 1914, 3; in Bull. Imp. Inst. V. 134 (1907).—Pax in Engler. Pflanzen-reich. IV. 147, 1. 132 (1910).—Dunn & Tutcher in Kew Bull. Misc. Inform. add. ser. x 234 (Fl. Kwangtung & Hongkong) (1912).—Fairchild in U.S.D.A. Circ. No. 108, with gifts. (1913).—Wilson in Bull. Imp. Inst. XI. 447, tt. 9, 10, 11, 12, 13 fig. 2 (1913).

Elaeococca verrucosa A. de Jussieu, Euphorb. Tent. 38, t. 11. fig. 35 (1824), quoad fruct. et semen.

Dryandra oleifera Wallich, Cat. No. 7958 (nomen nudum) (Non Lamarck) (1832).

Aleurites cordata Hooker f., Fl. Brit. Ind. V. 384 (non R. Brown) (1887).—Hemsley in Journ. Linn. Soc. V. 433 (1894) exclud. Synon. et specimenibus ex Hainan et Hongkong partim.—Pax in Bot. Jahrb. XXIX, 430 (1900).—Pampaninin in Nuov. Giorn. Bot. Ital. n. ser. XVII. 410 (1910).—Leveille, Fl. Kouy-Tcheou 157 (1914).

Aleurites verniciflua Leville, Fl. Kouy-Tcheou, 157 (1914), an etiam Baillon?

A flat-topped, much-branched tree, 3-12 m. high, with or without a central trunk, the stem deliquescent, the young tip of stem dull, olive green, somewhat mottled with darkish area, glabrous, not glaucous, the bark grayish, dotted with whitish lenticels; leaves deciduous, the petiole 17.3-21.3 cm. long, yellowish, sparsely hispidulous at the base, the blade glossy green, ovate to heart-shaped, 19-21.5 cm. long, 22-24 cm. wide, the apex acuminate, the base cordate or round, the upper surface yellow pubescent in young leaves, later glabrous, the lower surface tomentose in young leaves, later glabrous, the margin entire or with one-two lobes, the shallow sinus between the lobes usually with a cup-shaped gland at its base, the veins seven, prominent, palmately arranged, the glands on tip of the petiole large, brownish or yellowish green (var. *Tsouiana* only), convex, sessile, usually 2, sometimes 1-4 or wanting; flowers typically monoecious, sometimes incompletely dioecious, or polygamous, appearing on shoots of previous season's growth before or during the leaves, in large, mixed, panicle cymes, the shy-bearing type showy, attractive, many-flowered, blossoming before the leaves, the prolific type dull, greenish white, few-flowered, opening during the leaves; pistillate buds usually terminal, solitary on central axis of the mixed panicle sometimes on the apical lateral branches, large, green, oblong, pubescent, surface typically marked by several prominent ridges on the tip, base swollen, the pistillate flowers usually open first at the central, terminal axis, later in lateral, the pedicel about 1.1 cm. long, woolly at apex, accrescent as the mature of fruits, the sepals 2-3, equal, distinct above, but

united at the base into a cup-shaped calyx, the corolla regular, showy, rotate, larger, the petal usually 6-9 in central, 5-7 in lateral flowers, distinct, obovate, white to yellowish, usually epipetalous (var. *maliformis* only), 2.1-2.3 cm. long, staminoides 4-6, in a single whorl, alternate with the petals, the ovary woolly, 3- or 12-celled, the ovules axile, one in each cell, the style 3-4, papillose throughout, the stigma bifid, the fruit oval, obcompressed or subglobose, the apex acuminate, longly pointed or retorted, the base attenuate or obsolete, the surface rather smooth or slightly, not prominently striate, the seeds 3-12, broadly oblong, grayish brown, the seed coat woody, the endosperm white, copious, the cotyledon large, embedded in the endosperm, the embryo large; staminate bud and flower differing from the pistillate ones in the following characteristics: the buds usually lateral, sometimes central, terminal smaller, lanceolate, reddish, smooth, glabrous, the flowers opening later on lateral, earlier on central, the pedicels about 1.5 cm. long, slender, the corolla smaller, the petals usually 5 in lateral, 6-8 in terminal flower, tinted with red and yellow at the base, the stamens in three whorls, the outermost consisting of 4-5 distinct staminoides, alternate with the petal, the intermediate whorl of 5-6, distinct, fertile ones, the inner whorl of 1-6, longer, monadelphous, fertile ones, the anthers apicifixed, extrorse; perfect flowers sometimes occurred in mixed inflorescences and differing from both pistillate and staminate flowers in two characteristics: the stamens inserted at base of the pistil, usually from 1-10, irregularly arranged in one or two whorls, fertile or unfertile, sometimes coalescent with pistil; the ovary normal or deformed.

Key to the Varieties

- A. Tree 3-4 m. high, central trunk early failed to develop, lateral branches sprouting profusely in first or second year after seeding; young leaves pale yellow at first, later yellow at the abscission time; petiolar glands yellowish green; base of petal yellow tinted; fruit at maturity yellowish brown, ovoid, longitudinal diameter about 4.8 cm., latitudinal diameter about 4.20 cm.
.....1. *Aleurites Fordii* Hemsl. var. *Tsouiana*.
- AA. Tree 4-10 m. high, with central, excurrent trunk, young leaves glossy green at first, later reddish at the abscission time; petiolar glands reddish; base of petal of staminate flower tinted with reddish strips, and of pistillate ones, yellowish green; fruit at maturity green or reddish to brown, oval, obcompressed, or globose, longitudinal diameter 4.06-6.62 cm., latitudinal diameter 3.25-6.60 cm.,
 - B. Tree 4-5 m. high, sparsely branched, young branch usually fascicled; inflorescence scanty, few-flowered; flowers usually fascicled, epipetalous; fruit usually solitary, typically obcompressed, apex shortly acuminate or retorted, base shortly attenuate or obsolete, longitudinal diameter 4.6-5.7 cm., latitudinal diameter 5.67-6.6 cm., air-dry weight about 31.9 grams; seeds usually 6-12.....2. var. *maliformis*

BB. Tree 5-10 m. high, prolific; inflorescence profuse, few- or many-flowered; fruits usually clustered, ovoid to subglobose; seeds rarely over 6.

C. Tree highly prolific; fruit at maturity usually green, mostly in cluster, typically ovoid, surface smooth, apex narrowly pointed, base shortly attenuate, longitudinal diameter 4.06-5.93 cm., latitudinal diameter 3.25-3.66 cm., air-dry weight about 16.5 grams 3. var. *prolifera*.

CC. Tree moderately prolific; fruit at maturity reddish to brown, typically subglobose, surface strongly striated, apex longly pointed, base attenuate, longitudinal diameter 5.4-6.62 cm., latitudinal diameter 4.56-6.54 cm., air dry weight 19.2-27.3 grams. 4. var. *apiculata*.

Taxonomic Treatment of the Varieties

1. *Aleurites Fordii* Hemsl. var. *Tsouiana*, var. nov.

Arbor circ. 3 m. alta, trunco e typo perbreuiore, ramulis annotinis vetustioribusque profusis, cortice pallide fulvoviridi. Folia in abscissione pallide Fulva, vix rubro-fulva, glandulis petiolaribus fulvo-viridibus. Petala corollae basi fulva. Fructus maturi fulvi, 4.8 cm. longi et 4.2 cm. diametro.

Szechuan: Cultivated on Hsi Shan P'ing Station, (西山坪農場), Hoh No. 20 (type), deposited in the herbarium of this institution; Hsi Shan P'ing Station No. 1405 (living type), Varietal Garden of the Institute, No. KS-185, all originally came from Provincial Forestry Station, Loh-yung District, (維容), Kwangsi.

This variety seems, as far as our knowledge goes, to be endemic to Kwangsi. It is peculiar with the presence of a unique yellow coloration instead of being the usual red. It is named in honor of Dr. P. W. Tsou, (鄒秉文), former Vice-chairman of the Foreign Trade Commission, Ministry of Finance, who is very enthusiastic in promoting the tung oil industry in China.

2. *Aleurites Fordii* Hemsl. var. *maliformis*, var. nov.

Arbor 3-5 m. alta, parce ramificata. Inflorescentia pauca, floribus plerumque duplicibus, pedunculo crasso, 5-7 cm. longo. Fructus praecoces, solitarii vel raro 6-fasciculati, tenuiter sulcati, 4.6-5.7 cm. longi et 5.67-6.6 cm. diametro, 31.9 gr. grav., spice breviter acuminati, basi breviter attenuati, vel interdum obsoleti; semina magna. 5-12.

Szechuan: cultivated beside the farm on gentle slope of purple brown loamy soil, Sha Ch'i Kou, (沙溪溝), Fowling, (倍陵), vernacular name Shih Ping Tung, (柿餅桐), Hoh No. 8 (type); on Hsi Shan P'ing Station Nos. 94, 473, 402 and 407 (living type).

Kwangsi, Chekiang, Kweichow, Hupeh, Hunan, and Anhwei.

3. *Aleurites Fordii* Hemsl. var. *prolifca*, comb. nov.

var. *Florida* Mowry in Univ. Fla. Agri. Expt. Sta. Bull. 247 (1932).

Arbor robusta, prolifica, planicoronata, 5-10 m. alta. Inflorescentia confertiflora. Fructus maturi virides, praeumque fasciculati, apice acuminati et basi breviter attenuati, 4.06-5.93 cm. longi et 3.25-3.66 cm. diametro, 16.5 gr. grav.; epicarpio laevi, distincte et longitudinaliter striati.

Szechuan: cultivated beside farm on gentle slope of purple brown soil, Sha Ch'i Kou, Fowling, vernacular name Mi Tung, (米桐), Hoh No. 6 (type); Hsi Shan P'ing Station No. 63 (living type).

Kwangsi, Kweichow, Kwangtung, Hupeh, Hunan, Chekiang and Anhwei.

The present variety is apparently synonymous to var. *Florida*, which has been named and described by Mowry (loc. cit.) in 1932. It does really originate in several provinces in China, not as a genetic mutation which seems to have occurred a few years ago in Florida, U. S. A. For the sake of retaining the significance of the epithet to its native home and its popular vernacular name, the writers propose the new name "*prolifca*" instead of the old one "*Florida*."

4. *Aleurites Fordii* Hemsl. var. *apiculata*, var. nov.

Arbor planicoronata, 5-7 m. alta. Fructus saepe solitarii, vel raro in infructescentia 6-fasciculati producti, maturi rufi vel altrorubri, subglobosi vel oblongo-obovoidei, praecocices, apice longe acuti et basi breviter attenuati, 5.4-6.62 cm. longi et 4.56-6.54 cm. diametro, 19.2-27.3 gr. grav.; epicarpio paululum crispo, depresso striato, apice uno annulo depresso instructo.

Szechuan: cultivated beside farm on gentle slope of purple brown loamy soil, Sha Ch'i Kou, Fowling, vernacular name Ch'ai Tung, (柴桐), Hoh No. 11 (type); Hsi Shan P'ing Station, Nos. 527, 284, 607, 608, and 809 (living type).

Kwangsi, Hupeh, Hunan, Chekiang, Anhwei, Kweichow and Kwangtung.

Flowering Habit

The var. *prolifca* is used extensively as a commercial stock in China, and represents a type of the species, therefore the study of this subject is chiefly centered on this variety. Its flower primordium and growth origin are confined to the terminal bud, of which the differentiation of large parts takes place in the latter part of June of the previous year. These predetermine the annual bearing capacity of the tree. If the crop of the previous year were abundant, small yield would be forthcoming in the current season. This is probably due to lack of plant nutrients. Under such conditions, the differentiation of flower-buds is scarcely developed. An interval of one or more years would be needed for the tree to recuperate before a fruitful season could recur. These accounted well for the occurrence of the phenomenon of alternate bearing in this variety.

In the vicinity of Chungking, blossoming commences around the last ten days of March; and the time varies from March 23rd to 28th due to the variation in temperature. In most cases, blossoming climbs up rapidly after the 3rd day and drops gradually after the 6th and ends in another week. Hence, the whole period of blossoming under the prevailing climatic conditions in this locality does not exceed twenty days (see Table I).

TABLE I. DAILY BLOSSOMING OF VAR. *Prolifica* ON
MA CHIA TAO (馬家沱), 1942-1943

Tree No. 55				Tree No. 56		
	Staminate Flower	Pistillate Flower	Hermaphroditic Flower	Staminate Flower	Pistillate Flower	Hermaphroditic Flower
Year 1942						
3/26	16	3	1	6	—	—
27	95	63	—	314	2	3
28	131	180	2	525	18	18
29	302	201	3	1026	109	46
30	406	154	3	1704	159	83
31	58	71	2	273	104	6
4/ 1	505	89	1	1864	163	13
2	186	40	4	933	121	31
3	165	3	—	913	65	23
4	282	1	—	717	21	3
5	18	2	—	38	2	1
6	23	—	—	110	4	—
7	43	—	—	191	1	—
8	24	—	—	53	—	—
9	4	—	—	11	—	—
10	1	—	—	9	4	—
Total	2,261	807	20	8,697	773	227
Year 1943						
4/3	—	29	—	151	5	2
4	—	42	—	87	17	4
5	29	3	—	178	28	6
6	12	4	—	265	43	8
7	3	2	1	402	27	6
8	1	2	—	67	54	7
9	3	2	—	36	11	1
10	20	5	—	122	27	4
11	1	2	—	85	25	2
12	—	—	—	61	6	—
13	—	—	—	17	5	—
Total	69	91	1	1,471	248	40

The sexual development of tung flower may be dealt more clearly with reference to its positions of which three kinds are noted: (1) central apical; (2) lateral apical and (3) lateral of side-pedicels. In the first case, the central apical flower usually has a strong tendency to be pistillate, under which grow a number of staminate ones. This female flower in the fully-grown plant usually grows up and sets fruit; but in seedling state, it might develop into two different ways, of which the observation of Dickey et al, (loc. cit.) is in line with ours; firstly, the flower fails to develop and the central pedicel ceases to make any further elongation; and secondly, the pedicel is able to extend to a certain degree, yet the flower is also unfertile and dies prematurely. Under certain conditions, this central apical flower occurs to be staminate or hermaphroditic instead of being pistillate, thereby the male flower, not only opens before the others, but also displays two prominent characteristics closely similar to the female one; firstly, the number of petals is 6-8, seldom five; secondly, corolla expands from 2.5 cm. to 3.5 cm. (cf. lateral male which is 2-2.5 cm.). In the second case, the lateral apical flower is usually staminate, but might sometimes be either pistillate or hermaphroditic. If it is pistillate, a reduction of petals from 8 to 5, associated with the narrow expanding of corolla (cf. apical central female flower), is observed. Again, if it is hermaphroditic, the corolla variation is just the same as those in the previous case. Of the hermaphroditic flower, in case of female domination, the stamens are not well developed; while in the case of male domination, rudimentary ovary is found. Besides, some fertile hermaphroditic flowers also occur. The blossoming of either lateral apical pistillate or hermaphroditic flower is usually later than the central apical pistillate one in the inflorescence. The only exception to this is when the central apical flower is hermaphroditic. In the third case, the lateral flower of side-branch is mostly staminate, and any sexual aberration has, so far, not been observed.

From the previous statements, it is quite clear that the central apical position is typical for the femaleness, and the lateral position of side-pedicels for the maleness. This development is quite clearly marked. Under certain conditions, the typical femaleness may reverse to maleness, however, the change of typical maleness to perfect femaleness has so far not been observed. This indicates the direction of sexual change and measures must be found accordingly to the control of its further development. Schaffner (1921) and others has long studied this subject of other plants, and suggestions have been made to encourage the development of female flowers by improving its growing conditions. Along the same direction, Abbott (loc. cit.) has further hinted upon an histological study on this species that the percentage of pistillate flowers depends upon the vigor of the tree; more female flowers are produced on trees making vigorous growth than on trees showing less vigor. Although very little is known at present about this fact, it is suggested that further efforts should be made to find out ways by means of which the differentiation of flower-buds could be stimulated.

It is further learned that despite a large number of staminate flowers born on an inflorescence, many would absciss precociously. Due to its enormous production,

its exact ratio to other kinds of flowers must be found in order to explain its inter-relationship with the fruiting of female flowers. In prosecuting the scheme, every inflorescence was picked down, and then spread on the ground for computation. The result (see Table II) reveals that the number of flowers may vary from a few to a hundred on an inflorescence, and inflorescences containing 28 to 57 flowers are the most common. The total amount of flowers is 36,269 which are arranged by categories in Table II. Of 36,269 flowers, staminate number 35,926; hermaphroditic 315; and pistillate 33, which give to the total number a percentage of 99, 0.08 and 0.099 respectively. These data are representative only of the var. *prolifera*. In var. *apiculata*, comparatively few flowers and inflorescences are found; while in var. *maliformis*, such reduction is even more obvious.

TABLE II: FLOWER SEX, NUMBER AND INFLORESCENCE ON A TREE
OF VAR. *Prolifera* AT MA CHIA TAO, 1942.

Range of flower number per inflorescence	Inflorescence number	Flower number	Staminate flower	Pistillate flower	Hermaphroditic flower
5 — 10	9	68	62	—	6
11 — 19	43	665	645	1	16
21 — 30	80	2,138	2,113	2	23
31 — 40	156	5,608	5,565	4	39
41 — 50	216	9,751	9,661	4	85
51 — 60	131	7,523	7,483	4	38
61 — 70	69	4,503	4,457	5	48
71 — 80	34	2,568	2,547	6	15
81 — 90	15	1,289	1,274	—	15
91 — 97	10	939	915	6	18
103 — 115	11	1,217	1,204	1	12
Total	774	36,269	35,926	33	315

The effects upon fruiting are shown by the data given in Table III. In making this study, the following procedure was used. Whenever staminate blossoms opened they were deflowered every afternoon after computations have been made. Simultaneously the female and hermaphroditic flowers, after being counted, were stained with a little colored varnish at the pedicels as a sign to prevent repetition. The respective number of these kinds of flower after being plucked and stained, was recorded according to its sex. The process was repeated until the flower expanding was complete. Toward the harvesting season, the number of fruits in relation to its infructescence

was registered, so that the reciprocal relationship of flowering and fruiting was readily deduced. In Table I, tree No. 56 had 773 female and 227 hermaphroditic flowers which made up a total amount of 1,000 individuals expectantly to bear out a corresponding amount of fruits, but actually only 213 (see Table III) matured. The same condition was found existing on tree No. 55 which produced 374 fruits against 827 female and hermaphroditic flowers inclusively. This seems to suggest that during the course of fruiting occurs an interesting relationship between fruits set and number of flowers. The more the flowers, the less the fruits are to be expected. This agrees well with the work of Reed (seen in Chandler's, p. 179), who found in Lisbon lemon that the flower in a small inflorescence had a greater chance of developing into a mature fruit than one on a large inflorescence. The reason was explained by Chandler (loc. cit.) as being probably due to less competition among the flowers in the same inflorescence.

TABLE III. FRUIT HARVESTED FROM VAR. *Prolifica* ON
MA CHIA TAO, 1942

Fruit-bearing per Infructescence	Tree No. 55		Tree No. 56	
	Infructescence	Fruits	Infructescence	Fruits
1	68	68	112	112
2	33	66	19	38
3	26	78	11	33
4	20	80	5	20
5	9	45	2	10
6	5	30	—	—
7	1	7	—	—
Total	162	374	149	213

Fruiting Conditions and Fruits

The number of fruits on a branch, as far as we know, does not seem to be an inherent property of any strain, so the conventional practice of using fruiting type in varietal study should be applied with caution. According to our observation, both solitary and clustered fruitings occur on the same tree, and absolute solitary fruiting on individual trees has not been found so far. The number of solitary fruit is much more common than that of the clustered one. As the fruit number increases on an infructescence, the number of infructescences is usually decreased. This phenomenon is clearly shown by the trees recorded in Table IV. When we study the desirability of a t'ung tree, it is, therefore, necessary to take both the fruit-bearing condition and the number of infructescences into consideration.

TABLE IV. FRUITING CONDITIONS OF THE VARIETIES ON
FOWLING DISTRICT, 1940

Fruit-bearing per Infructescence	Var. <i>Prolifica</i> Tree No. C		Var. <i>Maliformis</i> Tree No. 8		Var. <i>Apiculata</i> Tree No. 11	
	Infructescence	Fruit	Infructescence	Fruit	Infructescence	Fruit
1	271	271	226	226	263	263
2	177	354	19	38	9	18
3	140	420	—	—	2	6
4	119	476	1	4	—	—
5	84	420	—	—	—	—
6	93	558	—	—	2	12
7	44	308	—	—	—	—
8	24	192	—	—	—	—
9	20	180	—	—	—	—
10	5	50	—	—	—	—
11	2	22	—	—	—	—
Total	979	3,251	246	268	276	299
Fresh Weight ¹ (kilograms)	82.21		23.40		20.90	

¹ Fresh weight is taken few days after harvesting.

Prior to the discussion of the data obtained, a brief survey of each plant growth is hereby given. All the trees grow on a gentle slope of purple brown loamy soil, either along the field side or amidst the field. Of var. *prolifera*, tree C was planted amidst the field at Shuang T'ang Wan, (雙塘灣), Fowling. It benefits from the fertilizers applied for other crops planted in its neighbourhood. The tree, about twenty years old, has a trunk circumference of one foot and one inch, a height of thirteen feet and two inches, and a crown expansion of ten feet and three inches by nine feet and seven inches. Tree 11 of var. *apiculata* is grown beside the field on a gentle slope at Sha Ch'i Kou, Fowling; age, about twenty; trunk circumference, one foot and four inches; height, nine feet and six inches; and crown expanding, eleven feet and five inches by six feet and five inches. Tree 8 of var. *maliformis* flourished in a similar site as the previous one at the same region, but is a few years older. Its growing condition is indicated by a trunk circumference of one foot and two inches, a height of fourteen feet and a crown of seven feet and eight inches by seven feet nine inches.

The producing capacity of each individual tree are shown in Table IV. Var. *prolifera* is of high productivity, capable of yielding several thousands of fruits. Both the number of its infructescences and fruits are usually more than that of the other

varieties. It is frequently found that a cluster of this variety has more than six fruits. Such lavish production explains itself why it must exact a liberal amount of fertilizers and other proper managements. Poor results might be forthcoming in addition to the loss of biannual bearing in case of not giving proper attention in time. Firstly, some of the previous season's heavy fruiting shoots will probably succumb on account of exhaustion. Secondly, the fruit may become very small and the kernel fail mostly to develop to full size. This last-mentioned result has been confirmed by an actual counting of the seeds against the estimate number calculated (see Table V) from seeds of 962 fruits. For such reasons, the variety could not be grown successfully without sufficient supply of proper fertilizers, and thinning of flowers and fruits, and adequate pruning. Var. *apiculata* also has four or five, or sometimes up to six fruits on one infructescence, yet the production, as a whole, is comparatively low. The bud-differentiation of next season therefore, can make its usual resumption without any interruption as the var. *prolifera*. Var. *maliformis*, quite different from the previous two varieties, is usually solitary. Its yield is low but constant. Due to its regular crop and many seeded fruits, some planters are inclined to select it as a stock in their orchards. In extensive culture, both the two last-mentioned varieties have been used by certain planters as well as that of var. *prolifera*, because they are not in need of an elaborate management.

TABLE V. ABORTIVE SEED OF VAR. *Prolifera* AS REVEALED
BY ITS SEED-CONTAINED NUMBER, 1940

Name of the Tree	Tree B	Tree C	Tree F	Tree J
Total Number of Fruits.	1,326	3,251	2,341	3,783
Estimate Seeds Contained in One Fruit	3.74	3.74	3.74	3.74
Total Seeds from Estimate Unit	4,959	12,158	8,755	14,148
Total Seeds from Actual Counting	2,508	11,173	8,405	12,114
Percentage of Seed Abortion	49.42	8.10	3.99	14.37

Fruit analyses are not only indispensable for the work of identification, but also reveal certain relationship among parts of the fruit; this may ultimately lead to some decision upon its desirability. Hence this subject must not be overlooked. Var. *prolifera* and var. *apiculata* have usually 4 or 5 seeds rarely 6 (see Table VI), while var. *maliformis* has as many as eight seeds, or even more. This many-seeded nature of the last-named variety would compensate, in part, for their smaller number of fruits. If means could be found to turn most terminal shoot to produce more female flowers, the

TABLE VI. NUMBER OF SEEDS CONTAINED IN FRUITS
FROM 1940 CROPS OF THE VARIETIES

Seeds Contained in One Fruit	Var. <i>prolifca</i>		Var. <i>maliformis</i>		Var. <i>apiculata</i>			
	Tree No. 6		Tree No. 8		Tree No. 11 ¹		Tree 13	
	Fruit No.	Seed No.	Fruit No.	Seed No.	Fruit No.	Seed No.	Fruit No.	Seed No.
2	2	4	—	—	12	24	—	—
3	15	45	—	—	20	60	1	3
4	34	136	—	—	32	128	16	64
5	19	95	15	75	5	25	38	190
6	—	—	27	162	—	—	12	72
7	—	—	20	140	—	—	3	21
8	—	—	8	64	—	—	—	—
Total	70	280	70	441	70	237	70	350
Mean		4		6.3		3.4		5

tree, even though usually producing solitary fruits, will be of increasing importance. This fruit, quite different from the three varieties just mentioned, has the thickest husk and heaviest weight. Its fruit index is less than one (see Table VII.). This is the quotient

TABLE VII. MEASUREMENT OF FRUITS FROM 1940 CROPS

Name	Longitudinal Diameter (cm.)	Latitudinal Diameter (cm.)	Fruit Index	Thickness of Husk (cm.)
Var. <i>prolifca</i> Tree No. 6	4.06-5.93	3.25-3.66	1.10-1.15	0.40-0.60
Var. <i>Tsouiana</i> ¹ Tree No. 1405	4.80	4.20	1.14	0.21
Var. <i>maliformis</i> Tree No. 8	4.60-5.70	5.67-6.60	0.81-0.86	0.62-0.70
Var. <i>apiculata</i> Tree No. 11	5.49-6.62	5.05-6.54	1.01-1.08	0.59-0.62
Var. <i>apiculata</i> Tree No. 13	5.40-6.55	4.56-5.91	1.10-1.18	0.59-0.62

¹ From 1942 crop.

of longitudinal diameter over the latitudinal diameter. Even with the thickest husk, this fruit still has the highest oil content of 21.31 and 24.23 per cent on air-dry and oven-dry basis respectively (see Table VIII.). Var. *apiculata* did not attract us more in other respects than in the oil content of seeds, which give a percentage of 44.44. While var. *prolifca*, in addition to gaining already much popularity in the yield

performance, is also in possession of the highest oil content in kernels on either an air-dry or oven-dry basis.

TABLE VIII. CHEMICAL ANALYSES OF FRUITS FROM 1940
CROPS OF THE VARIETIES

	Var. <i>prolifera</i> Tree No. 6	Var. <i>maliformis</i> Tree No. 8	Var. <i>apiculata</i> Tree No. 11. Tree No. 13	
<i>Fruit:</i>				
Average Weight of Fruits (gm.)	16.50	31.90	27.30	19.20
Weight of Husk to Fruit (%)	44.85	41.06	50.55	53.12
Weight of Testa to Fruit (%)	23.63	23.20	15.93	19.80
Weight of Kernel to Fruit (%)	31.52	35.74	33.52	27.08
Moisture of Husk (%)	14.14	18.54	20.58	18.19
Moisture of Air-dry Fruit (%)	11.10	12.05	13.89	13.32
Oil Content of Air-dry Fruit (%)	20.00	21.31	20.43	17.17
Oil Content of Oven-dry Fruit (%)	22.50	24.23	23.72	19.18
<i>Seed:</i>				
Average Weight of Seeds (gm.)	2.14	3.13	3.97	2.09
Weight of Testa to Seed (%)	42.86	39.36	32.22	42.22
Weight of Kernel to Seed (%)	57.14	60.64	67.78	57.78
Moisture of Testa (%)	18.65	11.88	11.63	11.30
Moisture Air-dry Seeds (%)	8.63	7.53	7.06	7.80
Oil Content of Air-dry Seeds (%)	36.26	36.16	41.30	36.63
Oil Content of Oven-dry Seeds (%)	39.69	39.10	44.44	39.73
<i>Kernel:</i>				
Average Weight of Kernels (gm.)	1.37	1.94	2.69	1.21
Moisture Content of Kernel (%)	4.87	4.71	4.89	5.24
Oil Content of Air-dry Kernel (%)	63.46	59.63	60.94	63.40
Oil Content of Oven-dry Kernel (%)	66.70	62.57	64.08	66.90

Judging from all data enumerated above, we come to the following conclusions. Var. *prolifera* appears to be a hopeful strain in the commercial plantation. Excellent performance could be expected provided liberal fertilization and other proper cares are given timely. Var. *maliformis*, on account of its peculiar morphological and genetical variation, might offer many opportunities to bring about a great variety of mutations. From the standpoint of breeding and selection, it is worthwhile to further investigate this variety.

Summary

I. Four new varieties of *Aleurites Fordii* Hemsl. are proposed as *Tsouiana*, *maliformis*, *prolifera* and *apiculata*, each of which is described botanically and horticulturally.

II. Flowering study reveals two important points: (1), a close relationship existing between the number of flowers and the number of fruits setting, from which could be derived an estimate of the forthcoming crop; (2), occurrence of sexual change which is manifested in the variation of floral organs.

III. Both singled and clustered types of fruiting occur on the same tree, and absolute solitary fruiting on individual trees has not yet been found.

IV. Present information suggests that the var. *prolifera* probably is a hopeful strain for commercial plantations and the var. *maliformis* an interesting object for scientific research.

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