Bull. Univ. Osaka Pref., Ser. B.
大阪府立大学紀要，農学・生物学 Vol: 21, 1969

Taxonomic Problem of Citrus Fruits in the Orient

Tyôzaburô TANAKA

The conclusion of taxonomic problem (classification and nomenclature) of Citrus fruits can be attained only through the completion of local Citrus flora of all the growing countries since the monograph of the complete group is nothing but the accumulation of detailed survey of each locality which has it's own local Citrus flora. Such monograph will involve all unit species of the group represented by accurate identification and authentic nomenclature, correctly arranged in systematic order based upon natural classification of the whole group. The disagreement in the prevailing opinions on Citrus classification is primarily based upon the lack of such complete monographic knowledge rather than the attitude of handling unit species through adverse taxonomic concepts.[9] Imperfect knowledge on the whole Citrus fruits must be the real factor causing the mistaken conclusion as to the constitution of the membership of the group of this fruit tree. The situation will become very clear when we disclose the interrelation of Citrus geography between the Pacific region and India, or the Orient.

Before entering into the detail on the subject, one must be thoroughly aware of the fact that the Citrus fruits are not represented by a few species as in other fruit trees, as instanced by so-called PAEDA group of little known which occupies largest Citrus area in the Pacific region reaching to New Caledonia and Fiji, and is represented by at least a dozen distinct species. They may include some cultigens but it is meaningless to discriminate them from indigens, and the same thing can be said with all other Citrus as BAILEY wisely pointed out[1].

Another thing should be kept in mind is the fact that the most important pomological species are the products of chance seedling, and we cannot omit them in handling the group systematically. For instance, the Japanese citriculture is represented by the Satsuma mandarin (*Citrus Unshiu* MARC.) and many countries in the West Indies by the Grapefruit (*C. paradisi* MACF.) The representative of Indian citriculture is also a cultigen Santara, *C. reticulata* BLANCO(Sintoris of Luzon 1837), and that of Fukien, China, the Dancy type tangerine (*C. Tangerina* HORT. ex TANAKA), and some Mediterranean countries owe their prosperity upon the Willowleaf Mandarin, *C. deliciosa* TEN. and so on. So well known Lemon (*C. Limon* BURM. f.) has never been found really wild in Western Himalaya foothills and we scarcely know that the Lime (*C. aurantifolia* SWINGLE) is perhaps a native of Malay forests but all cultivated elsewhere. The Gigantic Citron (*C. Medica* LINN.), the type of the genus, never can exist wild by bearing such huge-sized extravagant fruit, and was first named by THEOPHASTUS from cultivated plant in Iran, where no wild Citrus can exist. These circumstances clearly tell the *Citrus* species are mostly cultigens and will involve an immence number of distinct unit species known from CONFUCIUS and THEOPHRASTUS period (5th and 3rd centuries, B.C.) down to a few centuries ago when the Grapefruit and Satsuma mandarin sprung up. The cultigen number one on the record, the Paradise Apple of Europe, *Citrus aurata* RISSO[4], is so well discussed in early European literatures, and

*) Contribution No. 20, from Tanaka Institute of Citriculture and Horticultural Science, College of Agriculture, University of Osaka Prefecture, Nakamozu, Sakai-shi, Osaka, Japan.

very important Bergamot orange (*C. Bergamia* RISSO et POIT.) is its worthy successor in Europe, both of which we cannot disregard for the sake of being cultigens. If we have to omit these cultigens, there will remain no monograph to cover all known Citrus fruits existing not only in their native countries but in Europe, the West Indies, or elsewhere.

Citrus fruits do not occur wild in Australia, so the group must have had appeared on the globe before Australia separated from the Asiatic continent at least 30 million years ago but have remained until rather recent years in the stage of PAPEDA, section which bears distinct inflorescence, extra large petiole wing, and granular pulp vesicles as Australian *Microcitrus* has. Under tropical situation, its evolution must have been very slow and difficult as we see in the fact that compound-leaved *Citropsis* of Africa lost its inflorescence and pinnate foliage after it had reached to cool Sierra Leone area in the form of *Citropsis Tanakae* SWINGIE.[5] The same thing must have happened to Citrus when it was ascending to cool mountains of the Asiatic continent. While remaining in the tropics, it must have consumed a considerable time to transform into the form of Lime (Section LIMONELLUS) which pocesses elastic linear pulp vesicles enclosed within papillate fruit of strong citral aroma, still keeping petiole wing and small inflorescence. It always associates with PAPEDA in distribution throughout Malaysia up to the Philippines, but not reaching Hainan, Forosa and South China.

While the the lime was abundant in the continent, it ascended to cooler hill regions and developed into two directions; one by the complete drop of petiole wing associated with the elongation of fruit and the accentuation of anthocyanin pigmentation in the flower, resulting into the creation of the section CITROPHORUM or Lemon-Citron group. The other direction went toward the Shaddock group (section CITROPHORUM) through the elephantization of organs and compiete disappearence of citral aroma and giving up fruit elongation. From the second, under cool Himalayan condition, it is easy to presume that the Orange group (section AURANTIUM) must have occurred by simple reduction of the size of organ and by the increase of carotenoid pigmentation of the fruit. The evolution of these four sections from original PAPEDA must have happened successively in Eastern Himalaya, as we find all representative members still in wild forms, as instanced by the existence of primitive citron *C. nana* TANAKA in eastern Bhutan, both wild Sour and Sweet oranges (*C. Aurantium* LINN. and *C. sinensis* OSBECK) in Naga hills, Asam, where the most primitive Mandarin (section ACRUMEN) *C. indica* TANAKA most abundantly occurs.[7]

The Mandarin orange is decidedly characterized by the complete drop of inflorescence, bearing solitary or fascicled flowers, and such nature always happens in some posterior forms in *Citropsis, Atalantia* and *Severinia*, perhaps an adapted character in cooler climate. We see in the Yangtze valley, where much hardier Citrus fruits dominate, a particular Citrus section OSMOCITRUS appears, which is represented by *C. Junos* SIEB. ex TANAKA, having very broad distribution next to PAPEDA (*C. macroptera* MONT., *C. Hystrix* DC.) It is accompanied by deciduous Chih, *Poncirus trifoliata* RAFIN., and very small Kumquat orange, *Fortunella japonica* SWINGLE, all losing inflorescence. We will later discuss on the secondary development of the Mandarin group and *Fortunella* along the Pacific Arc on the Chinese coast.

The multiplicity of forms of Citrus fruit is thus most conspicuous in easternmost India especially in Assam, as all seven sections of *Citrus* are present there, even one of the OSMOCITRUS, *C. ichangensis* SWINGLE, was recently found wild in Naga hills[5]. The Shaddock (*C. grandis* OSBECK) was once collected in Garo hills, Assam, by BRANDIS which was marked as wild,[3] but DUTTA[2] says the place must have

been on an abandoned garden site and never can be wild. WATT[10] reports, however, that the Shaddock is most abundant in Rangpur, Dinajpur and Bogra districts, just at the west of Garo hills. Probably nomadic Garo people found it somewhere in Assam, or received from other Mongoloid tribe of still far eastern area talking the same Tibeto-burman language.

It is very interesting to know that these three most important Citrus, the Sour and Sweet Oranges and the Shaddock, were introduced into Ssuch'wan province of China as early as the lst century of the present era, being designated by Chinese terms Ch'êng 橙, Kan 甘 (Huang kan 黃柑 of 3rd cent.), and most classical Yu 橘, respectively.[6] Since these most representative Citrus fruits are native to northern tribesmen territory in India, they reached very slowly to the Hindustan territory of India proper, and they were first recorded as late as 1519 in Emperor BABER's Memoirs. In China, on the contrary, CONFUCIUS knew two Citrus. Yu 柚 and Chü 橘 in 5th century, B.C., and LU's Spring and Autumn Annals of 3rd century, B.C., mentioned about the beauty of both Citrus. This classical Yu seems not to be the Shaddock, as the fruit being said to be of the size of Sour orange (Ch'êng) and more acid, which unquestinably means the present *Citrus Junos* so common in the Yangtze valley, and Chü, a small Mandarin, presumably a primitive type of the present *C. Kinokuni* HORT., very popular throughout the region as well as maritime middle Chekiang. Contrasting to so slow recognition of the value of Citrus in India, Citrus fruits were very well treated in China by eminent authors, thereby leading the European authorities to a mistaken idea that China might be the native home of these important fruit trees.[8]. This be further proved by the fact that East Himalayan Citrus, such as *C. reticulata* BLANCO, *C. Limonia* OSBECK and *C. madurensis* LOUR. have been all recorded in China before 4th century under the names Hu kan 壺柑, I mu tzu 宜母子, and Chi k'o ch'êng 給客橙 (or Lu chü), respectively.

This interior Citrus belt, from Nepal and Assam to Chinese Ssuch'wan and Chekiang, extending over 3500 kilometer, has enough heat unit to support most citrus, but cold winter climate prevented eastward advance of PAEDA, Lime and most Citrons to reach the Yangtze valley, hence these are not represented in the Citrus flora of the interior China. They have invaded China evidently through much warmer Pacific route as history tells, but the first two failed to establish, while *C. Limonia* played an important role to supply acid juice as OSBECK poiuted out in 1757 reported. The presence of such Pacific passage can be proved by the presence of the most primitive citron, *Citrus nana* TANAKA, found both in Assam and the Philippines, in addition to the common occurrence of another flat citron Tihitihi, *C. odorata* WESTER, in Malay Peninsula and the Philippines; even the true lime was once collected in Bonin within the Japanese territory.

To contrast with the continental Assam and the Yangtze route, this *Pacific passage* brought an important development of Citrus fruits, not only through the conveyance of PAPEDA, Lime and Citrons, but contributed to carry down continental Chinese element to the coastal China to reach the Malay Peninsula, especially in later developed Mandarin group and the genus *Fortunella,* both unquestionably temperate, or at least extra-subtropical element of Citrus fruits. There is an evidence that the most important Indian Mandarin Santara, *C. reticulata,* became known in China not through inland route but along *southern maritime passage* as several 4th century Chinese literatures (such as Nan fang ts'ao mu chuang and Fêng t'u chi) speak of it from southern country, which was later picked up in the official Herbal (Hsin chiu pên ts'ao of 7th century) as Hu kan 胡柑, supposed as evidently showing it a distinct southern (literary Iranian) Citrus. This the present Pan kan or Pon kan of S. China

and Formosa. Through the painstaking field study, the species was proved to be identical with the Philippine Sintoris of BLANCO, 1837. (This very important fact was overlooked by most eminent botanist and horticulturist including my teacher W.T. SWINGLE.) This is now known as Batangas Mandarin, and Djeroek Garut of Java, and Jamanaran of Ceylon: and 椪柑, the best known in the Orient.

There is no wonder why the most important Yangtze valley Mandarin, Mi chü 蜜橘, *C. Kinokuni* HORT. ex TANAKA, became the highest economic Citrus in maritime Chekiang province, because it has contributed to originate still more excellent Mandarines, such as Tsao chieh 早橘, *C. Kinokuni* var. *subcompressa* TANAKA, Pên ti tsao 本地早, *C. succosa* HORT. ex TANAKA, Man chieh 槾橘, *C. tardiferax* HORT. ex TANAKA, and the famous Ou River Mandarin 甌柑, *C. suavissima* HORT. ex TANAKA, among which only Kinokuni and *C. succosa* succeeded to reach Japan several centuries ago.

Although it is a secondary development, this enormous differentiation of sweet Mandarins on coastal China failed to attract attention of the Europeans by the lack of faithful comparison with similar Indian Mandarin oranges, such as Kaula (*C. crenatifolia* LUSH.), Ladu (*C. paratangerina* HORT. ex TANAKA), Reshni (*C. Reshni* HORT. ex TANAKA), Kokni (*C. lycopersicaeformis* TANAKA), besides the Santara orange. Such comparison requires very intimate investigation and critical discussion, but effort has never been paid by previous Western authors in Citrus fruit. From this respect early Chinese herbalists are worth credited to their early introduction of two popular vermillion Mandarins of Himalayan origin into China, the Huang chü 紅橘 *C. Tangerina* HORT. ex TANAKA and Chu sha chü 朱沙橘, *C. erythrosa* HORT. ex TANAKA, both being common in India and coastal China, and the former reached down to Jolo Island, Mindanao, to Hainan, Fukien, Formosa, Japan, finally to Florida and South America. Of course, both are very common in Japan with still undescribed few forms.

Another serious overlook of former Citrus investigators is the presence of the most tropical Mandarin Ssu ui kom 四會柑 *C. suhuiens* HORT. ex TANAKA of Kwangtung province. This Citrus is not known in Formosa, but it forms the most important Citrus in Hainan, Thailand (Som kiao wang), S. Vietnam (Mandarine de Siam), Java (Djeroek Paseh), and Malay Peninsula (Mandarin of the English)! This Citrus sometimes may accompany a smaller, similarly tight-skinned mandarin, simply called Quat 橘 in Canton area, including Hongkong island, which is called Yu pi chü 油皮橘 in Formosa, *C. oleocarpa* HORT. ex TANAKA, also commonly found in Thailand. but not in Java and Ceylon. The former Citrus was successfully introduced into Saharanpur area of India and recently into the Philippines under the name Sinkom. Probably their origin will be cultigens but their withstanding to hot and moist tropical climate is quite remarkable and is not comparable to any kind of Mandarines in importance, except the King orange, *C. nobilis* LOUR. of Assam and South Vietnam, successfully introduced into Florida some 80 years ago. The last species reached South China (Chekiang province), Okinawa, and South Japan under very hardy smooth-fruited form var. *Kunep* TANAKA.

The most important feature of this maritime Arc of Citrus fruit distribution is the very peculiar development of Kumquat group (genus *Fortunella*), which reached to the highest differentiation in the form of large fruited *F. obovata* TANAKA (Foochow Kumquat, or Chang chou chü 長壽橘) but is simultaneously existing in very simple forms like *F. Hindsii* SWINGLE and *F. polyandra* TANAKA. *F. Hindsii* is an inhabitant of Chekiang, Fukien, Kwangtung and Hongkong in wild state, which was known from 11th century under the name Chin tou 金豆. *F. polyandra*, approaching more

to Citrus, is distributed still wider, ranging from Swatow area on uppermost Kwangtung province, to Hainan, Thailand (Pattani) and Malay Peninsula (Malacca, Negri Sembilan, Perak, Johore and Pahang). The most interesting thing is that the former kumquat is a natural tetraploid, very rare existence throughout all Citrus furits, so it may be more advanced form rather than a primitive one. The other one is nearly associating with rather rare continental existence of *C. macroptera* in Malaya (in Perak, Pahang, Kelantan and Malacca), which is performing extremely wide distribution throughout Pacific territory down to New Guinea, New Caledonia and Fiji.

CONCLUSION:—Citrus fruit made a primary development along the Sub-Himalayan tract where all representative Citrus sections are present from primitive section PAPEDA to the most advanced section ACRUMEN, covering the most economic Citrus, like the true Citron (Bajoura, or Sanskrit Vijapura, *C. limonimedica* LUSH.) Lime, Limonia (Rangpur lime), Sour and Sweet oranges, Shaddock, and Mandarin oranges, with still undomesticated OSMOCITRUS, *C. ichangensis*. Through the last species, this area naturally continues to the Yangtze valley Arc, which is varified by the fact that *C. Junos*, its ally, known from CONFUCIUS's time, distributes throughout the valley, reaching beyond the west bank of the River Mekong at 28°, N.L. This Assam rote seems to have contributed to convey the most important Citrus eastward, such as the Sour and Sweet oranges and the Shaddock into China, and made their own development with the indigenous Mandarin, Kumquat and Trifoliate orange (*Poncirus*). This area, the Orient, in the broad meaning, has been very little touched by the Western Citrus investigators but actually coastal China was indebted to their development through receiving these three most important Citrus, in addition to the Indian Santara orange which is most probably originated in central Nepal near Butwal[3], and became known in China from the South through many literatures written before 5th century. We might call this passage as Pacific Arc, or Pacific Route, through which some thender Citrus like *C. Limonia, C. Limon* (Hsiang mêng 香檬 of Chi wu ming shi t'u k'ao, 1848) and Bajoura Citron (Hsiang yüan 香緣 of Shou shi t'ung k'ao, 1742, and still earlier works) reached China. This route is more important, however, as the most tropical Chinese Mandarin oranges, i.e., *C. suhuiensis* and *C. oleocarpa* were carrying down. This is really a Mandarin route, as we see another important Tangorlike Citrus Tankan 桶柑 (*C. Tankan* HAYATA) is located. As to the secondary development of such Mandarin Arc along Pacific coast has been reported at the the 9th Congress at Bangkok[8] and will need no further comment.

A few Citrus workers are satisfied to solve taxonomic problem of Citrus fruit by handling only a couple of dozen species to represent the whole group, but with such limited knowledge, or poor accession of matertal, we never can satisfactorily understand the richness of Citrus flora of interior India and China as well as the Orient territory, and no clear-cut solution is possible to clarify the very intimate relations existing between the members widely dispersed in the whole Indian and Pacific ocean territories. This paper is prepared to present a proof how complicate the situation is and that the satisfactory conclusion on Citrus problem can only be reached through the complete recording of all members of Citrus under the rule of writing a monograph of entire Citrus fruits.

REFERENCES

1) BAILEY, L.H. Various Cultigens, and Transfers in Nomenclature. *In* Gentes Herb. 1 (3) 113-136, 1923.

2) BHATTACHARIA, S. C. and S. DUTTA. Classification of Citrus fruits of Assam. New Delhi, 1956.

3) TANAKA, Tyôzaburô. Species Probmen in Citrus. Tokyo, 1954. (*refer* p. 60, 131)
4) TANAKA, T. Origin and Dispersal of Citrus Fruits, having their Centre of Origin in India. *In* Indian. Hort. 15 (3/4) 101-115, 1958.
5) TANAKA, T. Origin of Citrus Fruits with reference to Himalaya Region. *In* Proc. Hort. Ass'n. Japan. 28 (2) 71-75, 1959.
6) TANAKA, T. Botanical-georaphic Orientation of Citrus Fruits with reference to their historical Background. *In* ibid. 28 (4) 291-296, 1959.
7) TANAKA, T. A Contribution to the Knowledge of Citrus Classification. Report 3. *In* Citrologia (Osaka), p. 107-114, 1961.
8) TANAKA, T. Historical and geographic Background to the Course of Development of present Citrus Industry. *In* Proc. 9th Pacific Sci. Congr., 1957, 8: 60-63 (Issued 1964): revised in Citrologia, p. 1-7, 1961.
9) TANAKA, T. Hodgson's Citrus Classification discussed. *In* Bull. Univ. Osaka Pref. Ser. B. 18: 25-29, 1966.
10) WATT, G. Commercial Products of India. London, 1908. (*refer* p. 324)