

sis; makes good union with all citrus scions; trees are smaller than on Rough lemon on deep sandy soils and do not endure drought as well, while being delayed somewhat in bearing; fruit quality is very good.

SWEET LIME — about 98% nucellar; as tender to cold as Rough lemon; resistant to tristeza, but subject to gumming diseases like Rough lemon; most susceptible of all stocks to xyloporosis; makes good union with orange and grapefruit at least; growth is even more rapid on this stock in deep sands than on Rough lemon, and yields are equally good; fruit quality better than on Rough lemon, but probably not equal to sweet orange.

TRIFOLIATE ORANGE — about 70% nucellar; hardiest of all to cold; resistant to all gumming diseases, tristeza, and xyloporosis; susceptible to scab and exocortis; makes poor union with grapefruit, lemon, and some varieties of orange and mandarin, overgrowing the scion greatly; growth is slow in nursery and trees in field are dwarfed by poor unions; fruit quality excellent; has proved satisfactory in Florida only for satsumas and kumquats in the northern half of the state, but in California and Australia has attracted attention as a substitute for sour orange in low, heavy soils.

RUSK CITRANGE — 98% nucellar, but few seeds per fruit; harder than sour orange; resistant to xyloporosis, and only mildly subject to gummosis, but susceptible to tristeza; oranges are usually much dwarfed, but satsumas less so than on trifoliolate; yields and quality very good on deep sands in spite of small tree size.

THE SOLANUM NIGRUM COMPLEX IN COSTA RICA

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IN MY SEARCH for the weedy bird pepper ("*Capsicum baccatum*") in Costa Rica, I frequently found myself being deceived by "*Solanum nigrum*" which at a distance suggests

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a *Capsicum*. This happened so frequently that I resolved to make a study of this group of *Solanum* in Costa Rica. I was already aware of the work of Stebbins and Paddock (1949) in which they had found several species in the western United States masquerading under the name "*S. nigrum*". The present study then records my observations on this group in the field in Costa Rica and from material grown in the greenhouse at Indiana University. Herbarium material from the Missouri Botanical Garden, the Chicago Natural History Museum, and the National Museum of Costa Rica has also been examined. ² During my stay in Costa Rica, my work was carried on at the Inter-American Institute of Agricultural Sciences at Turrialba, and I would like to extend my thanks to Mr. Ralph Allee of that institution and to his staff for their most generous cooperation.

In his *Flora of Costa Rica*, Standley (1938) states that *Solanum nigrum*, including the variety *amethystinum*, is common in thickets and cultivated grounds extending from the upper part of the *Tierra caliente* to 3000 meters, and adds: "The plant is a highly variable one, and it is probable that careful study will show that the tropical American material is divisible into several species, none of which, perhaps, is true *S. nigrum* of the old world". He was quite correct, for in the present paper it will be shown that four distinct taxa are represented in this complex in Costa Rica none of which can be referred to *S. nigrum*.

Whether these taxa are species or subspecies of a highly variable species cannot be answered until more detailed studies have been made throughout tropical America. Within the geographical limits of Costa Rica, they all appear as distinct species, and they maintain their distinctness in cultivation; consequently binomials will be used for them here. Two of them are readily identified, but the task of assigning names to the other two is more difficult. Dunal (1852) recognized 24 species in this group in the Americas, and Bitter (1912) described 50 additional ones, mostly from South America. However, it has been found impossible

² All of my own collections cited in the following pages are deposited in the herbarium of Indiana University and duplicate material is to be distributed to various herbaria. The specimens of Tonduz and Pittier are deposited in the National Museum of Costa Rica, and all other material cited is from the Chicago Natural History Museum. I want to thank the curators of these herbaria for the privilege of examining the specimens under their care.

to match the two Costa Rican species with any of the descriptions given by Dunal and Bitter. Although type material of all of their species has not been seen, a large number of isotypes and type photographs has been examined. Therefore, it seems necessary to describe two of the species as new.

The four Costa Rican species in the *Solanum nigrum* complex may be distinguished by means of the following key:

Sepals reflexed at maturity; corolla usually 3-4 mm. long; ripe berries black

1. *S. nodiflorum*

Sepals not reflexed; corolla usually 4 mm. or more long; ripe berries green.

Leaves less than twice as long as broad; inflorescence racemiform, 5-12-flowered; corolla white or blue, usually 6-9 mm. long

2. *S. amethystinum*

Leaves more than twice as long as broad; peduncles 1.5-3 cm. long; inflorescence umbelliform, 4-8-flowered; corolla white, usually 4-6 mm. long.

Corolla usually 4 mm. long, with dark star; leaves entire, glabrate; pollen 18-22 μ in diameter

3. *S. costaricense*

Corolla usually 5-6 mm. long, with yellow star; leaves entire or with a few prominent blunt teeth, pubescent; pollen 23-27 μ in diameter.

4. *S. Leonii*

1. SOLANUM NODIFLORUM Jacq., Ic. Pl. Rar. 2: 288. 1786.

This species ranges from the western United States throughout Mexico and Central America into South America, where it apparently was described under several different names by Bitter. It is sufficiently well known so as to make a complete description here unnecessary. In addition to the characters given in the key it is also distinguished from both *S. amethystinum* and *S. Leonii* by the green, almost glabrous leaves. The inflorescence is usually umbelliform and 5 to 10 flowered in Costa Rican material. The berries have from 35 to 82 seeds and occasionally sclerotic granules are present. The leaves are extremely variable, either entire or irregularly serrate, and from 6 to 17 cm. long and 2.5 to 9.5 cm. wide.

In the 1890's this plant was collected from several sites around San José and Turrialba by A. Tonduz. Today it grows as a weed, chiefly around towns, from altitudes of 4500 feet to near sea level,

although it is rare below 1000 feet. I have it from the following localities: HEREDIA: Santa Bárbara, 3540. ALAJUELA: Grecia, 3561. SAN JOSÉ: San José, 3528, 3390, 3391; Escazú, 3589; Patarrá, 3446, 3447; Aserri, 3621; Coronado, 3661 (corolla blue). CARTAGO, 3562; Orosi, 3595; Turrialba, 3437, 3417, 3627, Tejar 3763. LIMÓN: Los Diamantes, 3787. GUANACASTE: Las Cañas, 3726, 3727.

Chromosome counts have been made on collections from three different areas, and all revealed a haploid number of $n=12$, which agrees with the determination by Stebbins and Paddock (1949) for material from western North America. The pollen grains range from 16 to 20 μ in diameter in the material cited above.

Possible hybrids of this species with *S. amethystinum* are discussed below.

2. ***Solanum amethystinum*** (Kuntze) Heiser, *stat. nov.*

Solanum nigrum var. *amethystinum* Kuntze, Rev. Gen. 2:455. 1891.

Sprawling herb to one meter high, stem usually evenly pubescent with short hairs; leaf blades ovate or ovate-lanceolate, 4.0 to 9.5 cm. long, 2.5 to 5.5 cm. wide, entire or rarely serrate, densely white pubescent when young, thinly villosulous at maturity; petioles 1.3 to 3.0 cm. long; peduncles 2.0 to 4.5 cm. long; inflorescence racemiform, 5-12-flowered, pedicels about 1 cm. long; corolla (4-) 6-9 mm. long, blue, purple, or white with dark or rarely a green star; anthers 3.5 to 4 mm. long; mature berries green, 5-7 mm. in diam.; seeds 40-45, 1 to 1.5 mm. in diam.; small sclerotic granules usually present.

Although the type has not been seen, Kuntze's description and the locality given (Irazú) leave little doubt that we are dealing with the same species.

This plant is common at altitudes of 4500 to 9000 feet in the San José-Cartago area. Unlike *Solanum nodiflorum* it is not a weed of towns although it does occasionally occur as a roadside plant. Apparently the earliest collection is from Escazú in 1889 by A. Tonduz. It was collected at Robert in 1949 by D. and B. Norby (230). My specimens come from the following localities: SAN JOSÉ: Coronado 3662; Escazú 3592, 3592; Aserri, 3617, 3619, 3620; La Carpintera, 3477. CARTAGO: Robert, 3393, 3397, 3493, 3494, 3495; between Robert and Sanatorio Durán, 3599, 3569; Sanatorio Durán, 3499, 3500; Cartago, 3566; Tejar, 3764. It has also been collected in the region of Zarcero (Prov. Alajuela) by Austin Smith (H98, H108).

The collections from near Cartago and Tejar merit special mention, for in these regions plants are found which combine certain features of *S. nodiflorum* and *S. amethystinum*. One plant (3536a) was more or less intermediate in appearance between these two species and examination of the pollen showed that over 50% of the grains were small and shriveled. Therefore it seems likely that these two species may hybridize where they come together. These putative hybrids and derivatives were found at an altitude of 4500 feet which is apparently the upper limit for *S. nodiflorum* and the lower limit for *S. amethystinum*.

The chromosome number of *S. amethystinum*, as determined from three different collections, is $n=12$, and the pollen diameter is the same as for *S. nodiflorum*.

The excellent series of specimens collected by Paul Standley and Julian Steyermark in Guatemala from altitudes of 5000 to 10,000 feet also appears to belong to this species, although in general the Guatemalan specimens are more glabrous than the Costa Rican material and the flowers are usually white.

Solanum amethystinum appears to be closely related to *S. Douglasii* Dunal of the southwestern United States and of Mexico, and may eventually prove to be merely a subspecies of it. The mature berries of *Solanum Douglasii* are black instead of green and it also generally has more deeply serrate leaves and larger flowers than *S. amethystinum*. *Solanum Douglasii* is also diploid, and it is interesting to note that Stebbins and Paddock (1949) report hybridization between this taxon and *Solanum nodiflorum* in California.

3. *Solanum costaricense* Heiser, *sp. nov.*

Herba perennis, 0.5-2.5 m. alta, erecta vel decumbens, gracilis vel tenuis; caulibus viridibus, glabris vel glabrescentibus; foliis alternis; laminis ovato-lanceolatis, 7-14 cm. longis, 4-7 cm. latis, 0.1 mm. crassis, membranaceis, integris, apice attenuatis, glabris vel sparse pilosis; petioliis 2-5 cm. longis; pedunculis ca. 2 cm. longis; inflorescentiis simplicibus, subumbellatis, cum 4-6 floribus; pedicellis 1.0-1.5 cm. longis; calyce cyathiformi, brevi-5-lobato, lobis acutis, non reflexis; corolla alba, ca. 4 mm. longa, stella in centro sita brunnea insignata; antheris 3.0-3.5 mm. longis; stylo

corollam superante, stigmatē viridi, subhemisphaerico; baccis in statu maturo viridibus, 5-8 mm. in diam.; seminibus 27-40, cum granulis scleroticis parvis.

HEREDIA: La Paz waterfall, on Vara Blanca road about 29 miles from Heredia, 4800 feet, 13 Sept. 1953, *Heiser 3536* (TYPE, IND.) Also collected in same province at La Cinchona, 3754 and by P. C. Standley 42744, north of El Copey, Prov. San José.

Although there are only three known collections of this plant, it seems sufficiently distinct to be recognized as a species. In leaf shape *S. costaricense* resembles the Colombian plant which Bitter (1912) described as *S. macrotonum*, but differs from it by having longer petioles, smaller flowers, and in being nearly glabrous. It does not seem unlikely that *S. costaricense* is endemic to Costa Rica. It was found growing with *Capsicum stenophyllum*, *C. maculatum*, and *S. Standleyanum*, which so far are known only from this country.

Examination of pollen mother cells from the type material revealed a chromosome number of $n=12$, and the pollen was found to range from 18 to 22 μ in diameter.

4. *Solanum Leonii* Heiser, *sp. nov.*

Herba perennis, 2-3 m. alta, infra lignosa, erecta vel raro procumbens, caulibus viridibus vel purpurascens, sparse pilosis; foliis alternis, laminis lanceolatis vel ovato-lanceolatis, 8-12 cm. longis, 2.5-5.5 cm. latis, .1-.2 mm. crassis, longo-decurrentibus, marginibus integris vel in medio dentatis, dentibus obtusis; in juventute pilis densissimis albidis fere tomentosis, ad maturitatem pilosis; petiolis ca. 1 cm. longis; pedunculis 1.7-3.0 cm. longis; inflorescentiis simplicibus, umbelliformibus, cum 4-8 floribus, pedicellis 1.0-1.5 cm. longis, calice campanulato, extus piloso profunde 5-lobato, lobis obtusis, non reflexo; corolla alba, ca. 4-6 mm. longa, stella in centro flava vel raro brunnea, extus dense in margine pubescente, staminibus aequalibus, antheris 3.3-4.0 mm. longis, stylo corollam manifeste superante, stigmatē capitato, viride, baccis maturis viridibus, 6-8 mm. diam., seminibus 32-44; granulis scleroticis parvis.

CARTAGO: Irazú, wooded ravine about 1/2 mile below Finca Robert, 8500 feet, 4 Oct. 1953, *Heiser 3597* (TYPE IND.).

This species is named for Dr. Jorge León of the Inter-American

Institute who has made many contributions to our knowledge of the Costa Rican flora. *Solanum Leonii* is rather abundant on Irazú from Sanatorio Durán at 7000 feet up to nearly 10,000 feet (3394, 3395, 3485, 3488, 3490, 3492, 2904). I also found a few plants on the Pan American Highway near Casa Mata (3756) and at Puente Mastate on Poas (3533). The latter two collections had corollas with dark stars, whereas all the material from Irazú had green stars. This taxon was collected on Irazú in 1888 by Pittier and in 1891 by Tonduz. More recently it has been collected at Robert by L. O. Williams and A. Molina R. (13875), and R. Holm and H. Iltis (164).

It seems likely that *S. Leonii* may occur at high altitudes throughout Central America. Material from Guatemala (Standley 66112, 67380, 67438; Steyermark 34675, 35641, 35764, 35914, and 43656) appears very similar to the plants from Costa Rica.

The chromosome number has been determined from three collections as $n=24$. Only three cells were found at diakinesis and all showed 24 bivalents. The pollen ranges from 23 to 27 μ in diameter.

One rather unusual plant (3598) was collected near Robert on Irazú which was found in a mixed population of *S. amethystinum* and *S. Leonii*. This plant approached the latter in appearance but showed certain features of the former. Meiotic studies were not made, but 90% of the pollen of this plant did not take stain, and the stainable grains were quite variable in size. It seems quite probable that this plant is a triploid hybrid between the two species.

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PINUS CARIBAEA

PINUS CARIBAEA Morelet, in the wide sense, is distributed from the southeastern United States, Florida, Georgia and Mississippi, down through some of the islands of the Bahamas and West Indies. It appears again in British Honduras from whence it extends, at low elevations and near the coast, almost to the Río San Juan on the frontier between