A New Synthetic Allopolyploid Naranjilla, *Solanum indianense* (Solanaceae)

Charles Heiser
Department of Biology, Indiana University, Bloomington, Indiana 47405, U.S.A. cbheiser@bio.indiana.edu

Jorge Soria
Avenida La República 700, Quito, Ecuador. jasv@intertelec.net

Carlos Miller
Department of Biology, Indiana University, Bloomington, Indiana 47405, U.S.A. millerc@indiana.edu

Gregory Anderson
Department of Ecology and Evolution, University of Connecticut, U-43, Storrs, Connecticut 06269, U.S.A. ander@uconnvm.uconn.edu

ABSTRACT. The chromosomes of two nearly sterile hybrids (*Solanum quitoense* × *S. sessiliflorum*) have been doubled by colchicine treatment and the resulting tetraploids are described as a new species, *S. indianense*. The parents, now grown in Ecuador under the names Puyo and Palora, are dignified with cultivar status.

RESUMEN. Los cromosomas de dos híbridos casi estériles (*Solanum quitoense* × *S. sessiliflorum*) han sido duplicados mediante tratamiento con colchicina y los tetraploides resultantes se describen como nueva especie, *S. indianense*. Los padres que se cultivan actualmente en Ecuador, bajo los nombres de Puyo y Palora, son reconocidos bajo la categoría de cultivares.

Key words: cocona, Ecuador, hybrid, naranjilla, polyploidy, *Solanum*.

Over 90% of the naranjilla, much esteemed for its fruit juice, grown in Ecuador today comes from the F_1 hybrids *Solanum quitoense* Lamarck × *S. sessiliflorum* Dunal var. *sessiliflorum* and *S. quitoense* × *S. sessiliflorum* var. *georgicum* (R. E. Schultes) Whalen. The former is commonly known under the name Palora and the latter as Puyo from the places where they were first grown in Ecuador. These nearly sterile diploid hybrids are propagated vegetatively. A discussion of their origins may be found in Heiser (1993) and Heiser and Anderson (1999). Both of these hybrids had their chromosomes doubled by colchicine in the greenhouses of Indiana University. The tetraploids, propagated by seed, are described as a new species.

Solanum indianense C. Heiser & J. Soria, sp. nov. [*Solanum quitoense* Lamarck × *S. sessiliflorum* Dunal]. TYPE: U.S.A. Indiana: Bloomington, cultivated in the greenhouse of Indiana University (tetraploid Palora), 15 Feb. 2004, *C. Heiser CP1-1* (holotype, MO; isotypes, IND, QCNE).

Plantae hybrido *Solano quitoensi* × *S. sessilifloro* similes sed prope omnibus partibus majoribus; pollinis grana diametro 26–28 μm; 60% vel plus tingibilia; frutus 60-seminalis vel plus, seminibus plus quam 3.0 mm longis; chromosomatum numerus tetraploideus ($n = 24$).

Lignescent perennials 1.5–2.8 m high, unarmed, vegetative parts green, rarely with red or purple tinges; stems woolly, with sessile to stalked stellate trichomes (stellae), stalks 1–6 mm, lateral rays 5 to 9, 0.4–11.7 mm long, midpoints shorter than or nearly equaling rays. Leaves felty-pubescent, very large, blades to nearly 1 m long, broadly ovate, repand, cordate at base with 5 to 7 major veins on either side; the repand margins with 5 to 6 deltoid, acute- or obtuse-tipped lobes at lateral vein terminations; interlobal sinuses often with 1 to 3 smaller, tooth-like lobes; adaxial leaf surface with mostly sessile stellae with elongate midpoints 1–2 mm long and reduced lateral rays 0.05–0.3 mm long, a distinct class of smaller stellae present or lacking; major veins with both stalked and sessile stellae, stalks to 1 mm; abaxial leaf surfaces densely tomentose with interwoven stalked and sessile stellae, usually lacking midpoints and with well-developed rays of varying length, sometimes over 1 mm long; petioles typically ¼ to ⅓ the length of the blade, inflorescence 3- to 20-flowered; the lowermost 4 to 6 flowers perfect; subsequent ones female-sterile; pseudoaxis 0.7–22 mm long; pedicels 4–12 mm long in flower; calyx broadly campanulate, green, stellate-pubescent; calyx lobes broadly ovate, acute tipped, 14–19 mm long; corolla white, 4.8–6.2 cm across, divided to near base into ovate or ovate-lanceolate lobes, externally stellate-pubescent; anthers 10–14 × 3–5 mm; style glabrous, 8–11 × 1.5–2.0 mm, berries 1 to 5 per inflorescence, globose, 4.2–7.0 cm diam., 4-locular, orange when ripe with light green to orange flesh, densely stellate-pubescent at maturity, hairs soon deciduous, pericarp stellae sessile with elongate midpoints, 0.6–1.2 mm long with 9 to 15 lateral rays near base about 0.2 mm long; seeds from ca. 60 to 150 or more, light tan, lenticular, broadly ovate, 3.0–3.8 mm long. Chromosome number, $n = 24$.

The following key should serve to distinguish the new species from the other large-fruited members of *Solanum* sect. *Lasiocarpa* cultivated in the Americas.

Key to Large-Fruited Cultivated American Species of *Solanum* Sect. *Lasiocarpa*

1a. Leaves and stems prickly . . . . 1. *S. quitoense*
1b. Leaves and stems unarmed.
  2a. Berries deep red or brown to orange-red or orange, usually over 5.0 cm diam. with pubescence of very readily deciduous, soft stellate hairs with midpoints rarely longer than 1 mm; fruit flesh orange; young leaves and stems green; mostly grown below 500 m . . . . 2. *S. sessiliflorum* var. *sessiliflorum*
  2b. Berries orange, small to large, with pubescence of deciduous, slightly harsh stellate hairs with midpoints often longer than 1 mm; fruit flesh orange to green; young leaves and stems purplish, reddish or green; mostly grown above 900 m.
    3a. Fruit flesh usually deep green; fruit diam. 4.5–5.5 cm; midpoints of stellae of most fruit hairs over 3.5 mm long; young leaves and stems with strong reddish or purplish cast; pollen 19–21 μm, over 90% of pollen taking stain; seeds several hundred, usually less than 3.0 mm long . . . . 1. *S. quitoense*
    3b. Fruit flesh orange or light green; fruit small to large; midpoints of stellae of fruits less than 2 mm long; young leaves and stems green or slightly reddish or purplish; pollen of various sizes, frequently less than 90% stainable; seeds usually 100 or less, usually over 3.0 mm long.
      4a. Fruit flesh very light green or orange; berries small to large.
        5a. Berries naturally less than 3.8 cm diam. (nearly to 6.0 cm when sprayed with 2,4-D); pollen stainability less than 40%; pollen around 21 μm, tricolpate; seeds few or none . . . . 3. *S. quitoense* × *S. sessiliflorum* "Puyo"
        5b. Berries 4.0 to 5.4 cm diam.; pollen stainability seldom less than 70%; pollen 26–28 μm; some grains tetracolpate; seeds 60 or more . . . . . 4. *S. indianense* (tetraploid Puyo)
      4b. Fruit flesh orange; fruits usually over 5.5 cm diam.
        6a. Seeds few or none; pollen stainability 40% or less; pollen around 21 μm, tricolpate . . . . 3. *S. quitoense* × *S. sessiliflorum* "Palora"
        6b. Seeds 60 or more; pollen stainability usually over 70%, pollen 26–28 μm, some grains tetracolpate . . . . . 4. *S. indianense* (tetraploid Palora)

1. *Solanum quitoense*. The prickly naranjilla dominates the area of cultivation from Colombia to Guatemala. Unarmed plants are grown in Ecuador and Colombia. This species is also grown as an ornamental in the United States. In Latin America the naranjilla may escape from cultivation and establish weedy populations (Whalen et al., 1981).

Two autotetraploids of a naranjilla have been secured by colchicine treatment. The plants have produced few fruits and still fewer seeds. Three nearly sterile hybrids have been secured in a cross with *S. indianense* as the male parent.

2. *Solanum sessiliflorum*. The typical variety, usually known as cocona, is grown primarily in the eastern lowlands of the northern Andean countries extending into Brazil (Whalen et al., 1981). Unlike *S. quitoense* it is quite variable, particularly in characters of the fruit. Escapes from cultivation are not uncommon (Whalen et al., 1981).

3. *Solanum quitoense* × *S. sessiliflorum* var. *georgicum* "Puyo" and *S. quitoense* × *S. sessiliflorum* var. *sessiliflorum* "Palora." These F_1 hybrids, which are propagated by cuttings, are mostly intermediate between their parents, although some characters are slightly larger than in either of the parents because of hybrid vigor. The Puyo hybrid normally produces a rather small fruit (3.0–3.8 cm diam.), but spraying the flowers with a dilute solution of 2,4-D gives a much larger fruit. This prac-

tice has become a regular part of its culture in Ecuador.

4. *Solanum indianense.* As can be seen from the key, the two tetraploids that constitute this new species are propagated by seeds and are very similar to their diploid progenitors, which are discussed in #3 above. Their very thick stems usually readily distinguish the tetraploids from the diploids but it is difficult to give precise measurements because stem size is influenced by soil fertility. The tetraploids are more variable than their diploid progenitors in height, presence and amount of red pigment in the leaves and stems, fruit size, flesh color, fertility, and time of flowering. The great variability can probably be explained by chromosome behavior at meiosis. Thirty-five cells were examined in one of each of the two tetraploids. From 12 to 24 bivalents were found with the other chromosomes associating in up to six quadrivalents (rarely as trivalents and univalents). If regular pairing (24 pairs) occurred with normal segregation of the chromosomes, little or no variation would be expected (Stebbins, 1971). Other causes of variation are also now known in neopolyploids (Schranz & Osborn, 2004).

It is too early to propose cultivar names for the new species. Both of the tetraploids, as well as hybrids between them, are now being grown in Ecuador. From these plants, selections will be made with more desirable combinations of characters that will become more widely grown and deserving of names. With selection we can also anticipate better chromosome pairing and an increase in fertility (Ramsey & Schemske, 2002).

Discussion

Nearly a hundred years ago when it was discovered that colchicine could induce polyploidy, there was great hope that newly created polyploids would add greatly to our cultivated crops. Only a few have proven successful and these usually only after many years of work (Simmonds & Smartt, 1999). There is some reason to believe that *Solanum indianense* may be successful, for it should be able to outperform its chief competition, the diploid hybrids, neither of which can be readily improved as they rarely reproduce sexually. In addition to becoming established as cultivated plants, it is possible that plants of *S. indianense* will become weedy escapes.

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