

THE IDENTITY OF AMAZONIAN AND TRUJILLO COCA

TIMOTHY PLOWMAN¹

In the course of preparing a taxonomic treatment of the cultivated species of *Erythroxylum*², it has become necessary to make some nomenclatural additions and changes.

The cultivated coca plants of South America are generally considered to belong to two species of *Erythroxylum*: *E. Coca* Lam., which includes so-called Bolivian or Huánuco coca, and *E. novogranatense* (Morris) Hieron., which is Colombian coca (Plowman, 1979a). Both of these species have one distinct cultivated variety. Since they were first recognized, these varieties have been the source of considerable taxonomic confusion and misinterpretation in both the botanical and pharmaceutical literature.

The coca which is typical of the Amazon basin, known as Amazonian coca, is a variety of *Erythroxylum Coca*. Trujillo coca, which is grown primarily on the north coast of Peru, is a variety of *E. novogranatense*. Both of these varieties will be discussed in greater detail in separate papers now in preparation. My intention here is to identify these cultivated taxa with correct scientific names, descriptions and with the designation of types. In view of the current broad interest in coca and its derivatives, it is essential to stabilize the names of the plants without further delay.

AMAZONIAN COCA

Erythroxylum Coca is the most important commercial species of coca, furnishing by far the greatest portion of the world's

¹Assistant Curator, Botany Department, Field Museum of Natural History, Chicago, Illinois 60605, and Research Associate, Botanical Museum of Harvard University, Cambridge, Massachusetts 02138.

²Botanists have not been consistent in the spelling of the generic name of coca. For a discussion of the correct orthography of *Erythroxylum*, see Plowman (1976).

supply of coca leaves and cocaine. This species is native to the *montaña* region of the eastern Andes, extending from Ecuador south to Bolivia. It is cultivated mostly between 500 and 1500 m. elevation in an area characterized by a favorable tropical environment with high rainfall, moderate temperatures, and well drained, mineral-rich soils.

A distinct variety of *Erythroxylum Coca* is also found in South America but has been largely ignored by both botanists and anthropologists. This is the coca of the Amazon valley, which continues to be cultivated today on a small scale by a number of Indian tribes in the western Amazon of Brazil, Colombia and Peru. The history, cultivation, method of use and alkaloid chemistry of Amazonian coca was discussed recently in a paper read before the 43rd International Congress of Americanists (Plowman, 1979b).

Amazonian coca is readily distinguished from typical *Erythroxylum Coca* (*E. Coca* var. *Coca*) of the Andean foothills. The Amazonian variety grows typically as a tall, spindly shrub with long, weak branches and relatively large, elliptical leaves. The leaves are usually blunt or rounded at the apex in contrast to *montaña* coca which usually has more or less pointed leaves. The parallel longitudinal lines found on the leaf undersides and usually considered characteristic of *E. Coca* are often faint or even lacking in the Amazonian variety. Furthermore, the flowers of Amazonian coca have a shorter, thicker pedicel and a markedly denticulate staminal tube.

Erythroxylum Coca is a self-incompatible, distylous species with both long-styled (pin) and short-styled (thrum) morphs, which occur in approximately equal numbers (Plowman, unpublished data; Ganders, 1979). However, most populations of Amazonian coca contain only the short-styled morphs, with the exception of one or two collections from the easternmost Amazon in Brazil. The occurrence of only short-styled morphs in the Amazonian variety results from the fact that the plants are propagated vegetatively by cuttings, in contrast to Andean coca which is grown mainly from seeds. In Amazonia, entire plantations may be based on a single short-styled clone.

Since only one stylar form is present in Amazonian coca, there is, under field conditions, no fertilization in this obligately

outcrossing species. As a result, Amazonian coca rarely if ever produces viable seed. Even though fruits may be formed, at times in abundance, the seeds are devoid of embryos and/or endosperm and will not germinate.

Amazonian coca appears to cross readily with long-styled morphs of its Andean counterpart. Experimental reciprocal crosses in the greenhouse produced normal offspring. These plants have not yet reached flowering size, so their degree of fertility cannot be reported at this time.

Amazonian coca is apparently known only in cultivation and is incapable of competing with the dense secondary vegetation which grows up after cultivated plots are abandoned. In this feature, it further differs from Andean *E. Coca*, which frequently escapes and forms a component of the forest understory in forested areas around coca plantations (Plowman, 1979a).

Amazonian coca also differs in the manner of preparation of the leaves for chewing. The leaves are always toasted to dryness and pulverized in a mortar and pestle. The resulting powder is then mixed with the ashes of leaves of *Cecropia* or *Pourouma* species (Moraceae).

Martius made the first collections of Amazonian coca during his sojourn in the Brazilian Amazon in 1819–1820. He described in detail the unique preparation and use of the plant (Spix & Martius, 1831) and later published a description and illustration of Amazonian coca under the name *Erythroxylum Coca* Lam., since he considered it to be the same as the Peruvian plant described by earlier authors (Martius, 1843).

There has been only one other attempt to name Amazonian coca scientifically; and this was the result of an unfortunate error in identification. In the 1870's, a variety of coca was introduced from Europe into cultivation on the island of Java. In 1890, this plant, which became known in the trade as "Java coca", was described as a new variety by the Dutch botanist Burck working at the Botanical Gardens at Bogor (Buitenzorg). Burck named the plant *Erythroxylum Coca* var. *Spruceanum* commemorating Richard Spruce, the famous English botanist who made extensive plant collections in the Amazon region in the mid-19th century.

In 1889, Morris a botanist at the Royal Botanic Gardens at

Kew, published an article³ in which he described another new variety of coca, *Erythroxylum Coca* var. *novogranatense*, which is the basionym of *E. novogranatense*. In his article, Morris also discussed the relationships of other cultivated coca plants and remarked that specimens of Java coca "corresponded exactly" to herbarium specimens of coca at Kew collected by Richard Spruce on the Rio Negro in 1851⁴. On the basis of this statement, Burck injudiciously chose the name "Spruceanum" for Java coca.

The resemblance of Java coca to Spruce's original collection, which I have studied at Kew, is entirely superficial. Morris's identification was based merely on the variable characters of leaf shape and the lack of the characteristic parallel lines on the underside of the leaves. Spruce's collection at Kew is labeled "No. 73, 'Ipadú', sitio on the Rio Janaurí (affluent of the Rio Negro)", and clearly represents Amazonian coca as delimited here. This herbarium specimen also serves as a voucher for the first of two samples of coca powder which Spruce sent to the Kew Museum (Spruce, 1853a).

The holotype of *Erythroxylum Coca* var. *Spruceanum* Burck is a specimen preserved at the Herbarium Bogoriense in Bogor, Indonesia. Isotypes are found in the Institute for Systematic Botany in Utrecht, and at the Rijksherbarium in Leiden. All of these specimens belong to *Erythroxylum novogranatense*, and the name *E. Coca* var. *Spruceanum* is placed in synonymy with it. This identification agrees with the treatment of Payson who revised *Erythroxylum* for the Flora Malesiana in 1958. Even though Burck indirectly cited the Spruce collection as a paratype, this specimen must be excluded from the type material of *E. Coca* var. *Spruceanum*, since it belongs to a different species and does not conform to the type.

I would here like to name Amazonian coca as *Erythroxylum coca* var. *ipadu*, after the widely used Brazilian name of the plant, and offer the following description:

³Morris' original article of 1889 was unsigned and was erroneously attributed by Burck and others to Dr. Thistelton Dyer, then Director at Kew.

⁴Although Morris reported the date of Spruce's coca collections as 1854, Spruce began his studies and collections of coca as early as 1851, as reported two years later in a letter to Sir William Hooker (Spruce, 1853b).

Erythroxylum Coca var. **Ipadu** Plowman var. nov.

Ab *Erythroxylum Coca* typico ramis fortiter erectis virgatis, ramentis paucis vel nullis, foliis apice rotundatis, lineis abaxialibus obscuris, pedicellis brevioribus, stamineo urceolo valde 10-denticulato, stigma promienti, ovato-oblonga differt.

TYPE: **PERU**: Dept. Loreto: Prov. Maynas. Río Ampiyacu, Puca Urquillo and vicinity, approx. lat. 3°05', long. 71°55'. Cultivated shrub 2.5 m tall in open coca plantation in jungle clearing, interplanted with *yuca* and fruit trees. Branches slender, erect, then arching, leaves mostly near the tips, bright green. Flowers cream. N.v. *jibína* (Witoto). 5 Apr 1977. T. Plowman, R. E. Schultes & O. Tovar 6663 (holotype, ECON; isotypes, F 1824462, GH, K, MO, S, U, US, USM).

Slender shrub to 3 m. tall. Single trunk to 2 cm. in diameter. Bark light greyish brown with fine longitudinal cracks. Branches strongly erect, spindly, sometimes arching over with age. Branchlets straight, not knobby at the nodes, light yellowish green becoming reddish brown, with lenticular or elongated lenticels. Ramenta⁵ inconspicuous, sparse or sometimes absent, if present found only at the base of new shoots. Leaves present mostly at the branch tips, the blade elliptic to broadly elliptic or elliptic-ovate, apically obtuse to rounded, basally obtuse to acute, sometimes briefly attenuate, 35–115 mm long, 20–42 mm wide, firmly membranaceous, dark to medium green above, pale glaucous green beneath, dull to somewhat shiny above, dull beneath, midrib yellowish green, with an acute adaxial ridge, lateral nerves often prominulous above, abaxial longitudinal lines obscure or wanting, central panel often faint or concolorous. Petiole 2–4 mm. long. Flowers in axils of past season's growth, usually on naked stems but sometimes axillary in subterminal leaf axils, 1–5(6) per node, scattered or sometimes crowded, creamy white to yellowish throughout, odorless. Pedicel short, thickened distally, 2–4 mm long, to 1.5 mm in diameter. Lamina of petals spreading, sometimes suberect and not fully opening, incurved at apex. Margin of staminal cup markedly 10-denticulate, the

⁵The term "ramenta" was first used by Martius (1843) for the persistent, often congested, scale-like structures which frequently cover the twigs of *Erythroxylum* species. Morphologically, ramenta are simply stipules which are produced without accompanying leaves.

teeth short, triangular. Short-styled flowers predominant, style short 1.5–2 mm. long, stigma large, ovate-oblong, 1 mm long, 0.5 mm broad, bright yellowish green. Drupe 7–8 mm long, 4–6 mm in diameter, embryo and endosperm usually aborted. Chromosome number $n = 12$.

ETYMOLOGY: This variety is named for the Brazilian vernacular name of Amazonian coca.

COMMON NAMES: *idapú*, *ypadú* (Amazonian Brazil), *coca* (Amazonian Peru), *jibína* (Witoto, Peru), *ípi* (Bora, Peru), *pátu* (Cubeo, Colombia), *botô* (Makú, Brazil).

DISTRIBUTION: Cultivated in the Amazon basin of Peru, Colombia and Brazil, along the Amazon River and its major tributaries.

SPECIMENS STUDIED:

BRAZIL: AMAZONAS: Basin of Rio Iça, near San Antonio, “padu” or “coca”, Dec 1935, *Krukoff* 7645 (NY); Rio Purús basin, Rio Uneixi, Makú Indian village, 300 km above mouth, “botô” (Makú), 23 Oct 1971, *Prance et al.* 15572 (ECON, INPA, K, NY, U, US); Rio Juruá, Marary, Sep 1900, *Ule* 5039 (K, L); Rio Solimões, Tefé, Lago de Tejé, Mujeira, “padu”, 13 Jul 1973, *Lleras et al.* P16681 (GH); Tefé, “padu”, “ipadu”, 16 Jul 1972, *PLK & Urbana* 12231 (INPA); Tefé, Fazenda Experimental, 20 Feb 1973, *PLK & Marilene* 12553 (INPA); “prope Ega et São Paulo d’Oliveira”, 1819–1820, *Martius s.n.* (M); “in sylvis Japurensibus”, “ypadu”, 1819, *Martius S.N.* (M); Ilha Parauary, 20 Oct 1874, *Traill* 77 (K); Rio Negro, Providentia, “ipadú”, Jul 1888, *Prinzessin Therese von Bayern s.n.* (M); Rio Negro, Cucuí, 7.5.1973, *Silva et al.* 1310 (F); Rio Janauari, “paidú”, *Spruce* 73 (K); Manaus, Igarapé do Buião, “ipadu”, 5-7-1958, *Coelho s.n.* (F). PARÁ: Belém, “ipadu”, Sep–Oct 1961, *Pires* 51919 (NY, US). [Belém, São José to the Arsenal, 1828–1830], *Burchell* 9588 (K); Belém, Botanical Garden, Museu Goeldi, 15 May 1908, *Baker* 70 (A, BO, GH, LE, MO, NY, US); Rio Guamá, Apr 1899, *E. Poisson s.n.* (P); Santarem, May 1929, *Dahlgren & Sella* 36 (F).

COLOMBIA: PUTUMAYO: Río Putumayo, entre Puerto Asís y Puerto Leguísamo, 300–400 m, 14–15 Oct 1954, *García-Barriga et al.* 18713 (COL). AMAZONAS: Leticia, camino a Tarapacá, km. 17, 18 Jul 1965, *Lozano & Ospina* 488 (COL); Tikuna village, km. 12 on trail from Leticia to La Pedrera, 14 Apr 1975, *Cabrera* 3367 (COL). Río Igaraparaná, La Chorrera, 180 m, 6 Jun 1942, *Schultes* 3899 (ECON); Río Igaraparaná, “kudu jibina” (Witoto), 1 Mar 1974, *Idrobo* 6859 (COL, ECON); Río Igaraparaná, 15 km. abajo de La Chor-

ra, "jibina", 12 Feb 1974, *Idrobo 6775* (COL). VAUPÉS: Río Piraparaná, Raudal, 4 Sep 1952, *Schultes & Cabrera 17169* (A, COL, ECON, F); Río Piraparaná, San Miguel, environs of Catholic mission, 23 Oct 1976, "caña patu", "hokquhe", 23 Oct 1976, *Davis 119* (ECON, F), "ña k kwahe" (Barasana), *Davis 120n* (ECON, F); Río Apoporis, Soratama, Raudal Jirijirimo, below mouth of Kananarí, 900 m, 21 Jan 1952, *Schultes & Cabrera 14979* (ECON); Río Apoporis, Jino-Gojé, entre los Ríos Piraparaná y Popeyaká, alt. 250 m, 3–11 Sep 1952, *García-Barriga 14453* (ECON); Río Kanarí, "pa-toó" (Kabuyayi), 6-8-1951, *Schultes & Cabrera 13415* (F); Río Kananarí, Cerro Isibukuri, 250–750 m, 13 Jun 1951, *Schultes & Cabrera 12419* (AAH, F, GH). Río Kubyú, 2 hrs. upriver from confluence with Río Vaupés, "hokí pátu" (Cubeo), 9 Apr 1975, *Davis 10* (ECON, GH, K, MO, P, US), "káríka pátu" (Cubeo), *Davis 11* (ECON, F, MO, US) "pátu", *Davis 12* (F), "wehki pátu", *Davis 13* (ECON, F, MO, NY, S, U); same locality, 12 Apr 1975, "káríka pátu", *Davis 18* (ECON, F, US); "hokí pátu", *Davis 19* (ECON, F, K, NY, MO, US), "wehki pátu", *Davis 20* (ECON, US); lower Río Kubyú, 1 Apr 1975, *Zarucchi et al. 1145* (ECON, F). Bocas del Carurú, Casa Álvarez, 240 m, 25 Sep 1939, *Cuatrecasas 7012* (F).

PERU: LORETO: Prov. Maynas: Río Napo, Negro Urco, 1 mile downriver, "jibe" (Witoto), 17 Aug 1966, *Martin 1318* (ECON); Mishuyacu, near Iquitos, Apr 1930, *Klug 1117* (F, NY, US); Iquitos, alt. 120 m, "coca", 10 Oct 1929, *Ll. Williams 3551* (F); Morona Vieja, mouth of Quebrada Versalles, 11 km. N.O. de Iquitos, 17 Aug 1966, *Torres 167* (ECON, F); road from Iquitos to Río Nanay, 12 Jun 1966, *Martin 1001* (ECON); Río Nanay, road to Picuruyacu, near house of José Piña, 4 Aug 1966, *Martin 1209* (ECON). Río Ampiyacu, 24 Sep 1972, *Croat 20864* (DUKE, F, K); Pebas, Río Amazonas, 18 Apr 1977, *Plowman et al. 6922* (ECON, F, K), *Plowman et al. 6923* (ECON, F, MO), *Plowman et al. 6924* (ECON, F, US); Brillo Nuevo, Río Yaguasyacu, affluent of Río Ampiyacu, "ipi" (Bora), 12 Apr 1977, *Plowman et al. 6748* (ECON, F, K, NCU, USM), *Plowman et al. 6750* (ECON, F, USM), "huangana coca", *Plowman et al. 6802* (ECON, F, GH, K, USM), "mojarra coca", "tsi-paa" (Bora), 1 May 1977, *Plowman et al. 7136* (ECON, F, K, NCU, USM), "pelejo coca", "daa-llimú" (Bora), *Plowman et al. 7137* (ECON, USM); Florida, Río Putumayo, mouth of Río Zubineta, alt. 200 m, Mar–Apr 1931, *Klug 2002* (A, F, GH, MO, NY).

TRUJILLO COCA

Trujillo⁶ coca is a variety of coca cultivated on the desert coast of Peru and in the adjacent arid valley of the Río Marañón. This plant has been grown there for at least 3000 years and is ecologically well adapted to its desert habitat, which both ancient and modern farmers watered with complex irrigation systems (Plow-

⁶The older spelling of the Spanish name Trujillo is "Truxillo" and is often encountered in the earlier literature. "Trujillo" is the correct form.

man, 1979a). Archeological and ethnohistorical evidence demonstrates that Trujillo coca was once cultivated in most if not all the coastal river valleys of Peru (Rostworowski, 1973).

In the pharmaceutical trade, Trujillo coca has also been referred to as "small-leaved" or "Peruvian" coca to distinguish it from "Bolivian" or "Huánuco" coca (referring to the species *Erythroxylum Coca*). Even in pre-Conquest Peru, Trujillo coca was recognized as a distinct variety and was called "tupa" coca, meaning "royal" or "noble" coca, to distinguish it from "mamox" coca, which was the name applied to the "large leaved" coca grown on the eastern slopes of the Andes, i.e. *E. Coca* (Rostworowski, 1973; Plowman, 1979a).

Trujillo coca is still cultivated on a small scale, especially in the region around Trujillo on the north coast of Peru. It constitutes less than 5% of the total coca production in Peru but is the principal variety used in the beverage industry owing to its high content of essential oils and flavors.

The identity of Trujillo coca became the object of much debate and confusion when the leaf first appeared in world pharmaceutical markets in the 1880's. The controversy centered on the botanical identification of the sundry commercial varieties of coca and involved a number of prominent botanists and pharmacists of the day, including E. R. Squibb, E. M. Holmes, D. Morris, W. Burck and H. H. Rusby. The history of this controversy is long and complicated and resembles the early attempts to identify the botanical sources of quinine and curare.

Much of the difficulty in identifying commercial coca leaves stemmed from the lack of experience of early workers with the plants in the field. Instead, they were attempting to describe and name samples of dried leaves encountered in commerce or isolated living plants of unknown provenience, cultivated in conservatories and experimental gardens.

My purpose here is not to elaborate all the intriguing details in the history of the identification of coca. This will be treated in depth in a separate paper which is in preparation. However, it is necessary to describe the events which have obfuscated the identification of Trujillo coca, in order to clarify its present taxonomic position and correct name.

As early as 1889, Trujillo coca was associated with *Erythroxy-*

lum novogranatense (as *E. Coca* var. *novogranatense*) by Morris at Kew, who stated that his new variety approached "very nearly (although not so coriaceous) as what are known in commerce as Trujillo leaves". In 1900, H. H. Rusby, then Professor at the New York College of Pharmacy, described Trujillo coca as a new species, *Erythroxylum truxillense*. He asserted that this coca differed from both *E. Coca* of Lamarck and from *E. Coca* var. *novogranatense* of Morris (which Rusby erroneously wrote as "neo-granatense"). Neither Rusby nor his English-speaking contemporaries were aware that Hieronymus, working in Berlin, had made the correct combination *Erythroxylum novogranatense* in 1895 in identifying the Colombian coca collections of F. C. Lehmann.

In his rambling and confused paper of 1900, Rusby discussed several different kinds of coca, both wild and cultivated, which he had encountered both in his extensive travels in South America and in the pharmaceutical trade. Rusby departed from acceptable taxonomic procedures, even then in common practice, of describing plants clearly and concisely and of citing specific collections as types or otherwise authentic specimens. He described his *E. truxillense* casually and in prose discourse. His brief description of the "Trujillo" or "small green leaf which we get directly from Peru" was given as follows: "It is mostly from $3 \times 1\text{-}1/4$ to $4 \times 1\text{-}1/2$ cm. It is obovate, with narrowed base, mostly acute or acutish at the apex and minutely apiculate. In commercial leaves the lateral lines are commonly faint or even wanting". He also provided an illustration of this leaf in his Fig. 14.

Rusby did not cite a type specimen of commercial Trujillo coca. However, his intention was to describe the Trujillo leaf found in the New York pharmaceutical trade, and a specimen of this material should be designated as a lectotype. No such specimens are preserved today at the New York Botanical Garden where the best set of Rusby's herbarium is deposited. However, an appropriate specimen has been discovered among Rusby's vast materia medica collection now housed at the Harvard Botanical Museum. This entire collection was transferred to Harvard in 1973 "on indefinite loan from the New York Botanical Garden."

In 1979, Susan Marie Rossi began at the Botanical Museum the task of curating and re-cataloguing Rusby's collections of medicinal plant products, contained largely in glass jars. She recovered, among other coca specimens, a jar labeled "No. 2684, *Erythroxylon truxillense* Rusby, Trujillo coca, small coca, native of Peru and cultivated. The commercial drug presented by E. Merck & Co., New York City." This specimen corresponds to a listing in Rusby's catalogue (1921) of plant products included in the now defunct Economic Museum of the New York Botanical Garden. The provenience of this specimen is confirmed by the occasional presence in the sample of leaves of *pacay*, *Inga Feuillei* D. C. This leguminous tree, a native of Peru, is commonly planted as a shade tree in plantations of Trujillo coca and its leaves often appear as a contaminant of commercial Trujillo leaf. This sample, identified by Rusby, is the most appropriate of Rusby's collections to serve as the lectotype of his species *E. truxillense*.

In addition to his cursory description of *Erythroxylum truxillense*, Rusby created further confusion by describing a living plant which he found in flower at the conservatory of the New York Botanical Garden in August, 1900. He knew nothing of the origin of this plant but likened it to his *E. truxillense*, but not without some reservations. He provided a brief description of it and stated that this plant was "unquestionably the same thing which Dr. Burck speaks of as Java coca and for which he proposes the name *E. Coca Spruceanum*."

Rusby made an herbarium specimen of this living plant and deposited it at the New York Botanical Garden herbarium labeled *E. truxillense* Rusby. The following year (1901), he provided further descriptive details of the plant and published a line drawing of it (Rusby 1901, fig. 2). From both the specimen and the drawing, it is certain that this plant represents typical Colombian coca, *E. novogranatense* var. *novogranatense*.

It is likely that the living plant which Rusby confused with Trujillo coca was derived from progeny of the "Kew Plant" originally named by Morris, in spite of Rusby's contention that his plant did not match Morris's *E. Coca* var. *novogranatense*. We now know that *E. novogranatense* is at least partially self-compatible (Plowman, unpublished data; Ganders, 1979) and

spontaneously produces prodigious amounts of seed. Seeds of the original "Kew Plant" were sent out to conservatories and botanical gardens throughout the world, and it is likely that some of them found their way to the New York Botanical Garden.

In short, the specimen which Rusby collected in cultivation must be excluded as a type of *Erythroxylum truxillense*. It was misconstrued by Rusby as being identical with the Trujillo leaves of commerce. In spite of his extensive field experience with coca in South America dating from 1885, Rusby never visited Trujillo and never saw or collected Trujillo coca in the field. Since this plant is grown only in a limited area in South America and is not cultivated in other countries, it is understandable that Rusby failed to recognize the subtle differences between the dried leaves of commerce and the living specimen of *E. novogranatense* in the greenhouse.

Most botanists since the time of Rusby have agreed that the cultivated coca plants belong to two closely related species of *E. Coca* and *E. novogranatense* (Schulz, 1907; Payens, 1958; Towle, 1961; Gentner, 1972; Machado, 1972; Plowman, 1979a). Until recently Trujillo coca was generally included within *E. novogranatense*. But no botanists had ever studied Trujillo coca in the field or had examined herbarium specimens collected in Peru. The only exception to this were studies of archeological coca leaves from coastal Peru, which certainly represent Trujillo coca (Harms, 1922; Griffiths, 1930; Towle, 1961; Plowman, 1979a).

The first documented herbarium specimens of Trujillo coca which I have found in major herbaria are those collected by Augusto Weberbauer in 1914 in the Province of Pataz in Peru, along the upper Río Marañón. These were originally identified as *Erythroxylum Coca*. No further specimens of Trujillo coca were made until the 1960's when interested botanists began to sample the local varieties of coca. From these recent collections, it is finally possible to assess intelligently the taxonomic status of Trujillo coca.

From herbarium studies, transplant experiments, chemical analyses and anatomical studies, it may be affirmed that Trujillo coca is in fact best placed in the species *E. novogranatense*. However, it differs from the typical form of this species suffi-

ciently to justify treating it as a distinct variety within *E. novogranatense*.

Disjunct populations of Trujillo coca have recently been discovered in northwestern Ecuador and adjacent Colombia, where it is occasionally grown as a medicinal dooryard plant. These populations are of great interest because of their geographical isolation from plants in coastal Peru and because of their proximity to areas where typical Colombian coca is grown. Furthermore, they are growing in wet, montane habitat which is ecologically very different from the arid Peruvian coast. Continuing efforts by police authorities to annihilate coca in Ecuador now threaten these last remnant populations with extinction before they can be fully studied and before their possible role in the evolutionary history of coca can be properly assessed.

In 1972, Machado, in his treatment of the Peruvian species of *Erythroxylum*, attempted to reduce Rusby's *E. truxillense* to a variety of *E. novogranatense*, making the new combination *E. novogranatense* var. *truxillense*. Lamentably, this combination was not validly published, a fact which I overlooked in previous publications (Holmstedt et al., 1977; Plowman et al., 1978; Plowman, 1979a). Article 33.2 of the International Code of Botanical Nomenclature (Stafleu et al., 1978) plainly states that new combinations made on or after Jan. 1, 1953, must be accompanied by clear indication of the basionym (in this case, *E. truxillense* Rusby) and a full and direct reference given to its author and the original publication with page or plate reference and date. Machado (1972) neglected to include either the basionym or the original reference to Rusby's publication.

I would therefore like to validate the combination *Erythroxylum novogranatense* var. *truxillense* here. I also append a new description of the variety and designation of the lectotype. It should also be noted that Machado's new species *Erythroxylum Hardinii*, published in 1969, is placed in synonymy with *E. novogranatense* var. *truxillense* on the basis of its morphology, leaf venation and anatomy.

Erythroxylum novogranatense* var. *truxillense* (Rusby) Plowman, *comb. nov.

Erythroxylum truxillense Rusby, Druggists Circular & Chemical Gazette 44: 220. t. 14. 1900. 45: 49. 1901.

LECTOTYPE: "Truxillo coca, small coca. Native of **Peru** and cultivated." The commercial drug presented by E. Merck & Co., New York City. Accession No. 2684, Economic Museum of the New York Botanical Garden, no date. Specimen of dried leaves in a glass jar. (lectotype, ECON; isotypes consisting of small samples of this collection deposited at F, NY, USM).

Erythroxylum Hardinii E. Machado, Anales Ci. (Lima) 7(1-2): 14. 1969.

TYPE: **PERU**: Dept. San Martín, "Quebrada cerca de Crisnejas y el pueblo de Uchiza. Aparentemente en el lugar y sitios alendados se cultivo hace mucho tiempo." 15 Feb 1965, *E. Machado 1256* (holotype, US 2803917; photograph of holotype, F, neg. 55486; isotypes, MOL, NCSC).

Shrub to 3 m. tall, usually with multiple trunks reaching 4 cm. in diameter. Bark greyish brown with transverse and longitudinal cracks. Branches relatively dense, erect and spreading, straight or bending with age, light reddish to greyish brown, becoming longitudinally fissured. Branchlets straight, slender, not markedly zigzag in extension growth, nodes scarcely knobby, usually as thick as the internodes, stems mostly smooth but sometimes minutely scaly-ramentaceous, light green becoming reddish or greyish brown, lenticels punctate or rarely lenticular, usually not breaking the surface. Internodes alternatively extended 6–20 mm. long, or shortened during ramenta production, 1–3 mm. long. Ramenta often present but short, occurring mainly at the base of new shoots or on slow-growing short shoots, inconspicuous. Stipules scarcely diverging from axis, membranaceous, pale green, turning light brown with age and disintegrating, keels in young stipules entire or rarely minutely fimbriate towards apex. Leaves usually persisting on the branches, weakly distichous, blade plane, narrowly elliptic to oblong-lanceolate, sometimes elliptic, apically acute to obtuse or rounded, basally acute to attenuate, 20–65 mm. long, 10–25 mm. wide, membranaceous, medium to light green above, pale green to glaucous green beneath, midrib flat adaxially or with only a slight medial ridge, pale green, often drying whitish beneath,

lateral nerves and veinlets usually obscure above, rarely prominent, abaxial longitudinal lines and central panel usually inconspicuous or obscure. Petiole 1–5 mm. long. Flowers in axils of previous season's growth, often near the tips of the branchlets or sometimes among the persisting leaves, usually 1–3(10) per node, scattered, if congested then only briefly, with a strong, foetid odor resembling raw pumpkin. Pedicels long, 3–11 mm. long, median length 9 mm. Petals fugaceous or sometimes persisting, appearing rotate, 3.5–5 mm. long, 2–3 mm. wide, the lamina subcymbiform or the midrib depressed above, yellowish green to cream, ligule creamy white. Staminal cup half the length to equaling the calyx. Drupe ovoid to ellipsoid, sometimes fusiform, obtuse to acute at apex, 10–13 mm. long, 4–7 mm. in diameter. Whole plant, especially the leaves, suffused with odor of wintergreen (methyl salicylate). Chromosome number $2n = 24$.

ETYMOLOGY: The variety is named for the city of Trujillo in northern Peru, near the area of primary cultivation and from which the leaves are exported.

COMMON NAMES: *coca de Trujillo*, *tupa* (Peru); *coca* (Ecuador).

DISTRIBUTION: Cultivated in northern Peru on the western slopes of the Andes and in the valley of the Alto Río Marañón. Disjunct populations known from northwestern Ecuador and adjacent Colombia.

SPECIMENS STUDIED:

COLOMBIA: NARIÑO: Río San Juan, across river from Maldonado, 2000 m., "coca", 26 Jan 1977, *Boeke 854* (F); Tumaco, 9 May 1926, *O.F. Cook 98* (US).

ECUADOR: CARCHI: Maldonado, 1450–1650 m., "coca", 2 June 1978, *Madison et al. 4920* (F, SEL); Environs of Chical, 12 km. below Maldonado, along Río San Juan, 1200 m., "coca", 25 May 1978, *Madison et al. 4447* (F, NCU, SEL).

PERU: AMAZONAS: Prov. Chachapoyas: Río Utcubamba, km. 6 from La Caclid, 1600 m., 25 Feb 1976, *Plowman 5563* (ECON, F, USM), *Plowman 5564* (ECON, F, K, USM), *Plowman 5565* (ECON, F, NCU, RB, USM). Yumbay, above Balsas near Hornopampa, alt. 1100 m, 27 Feb 1976, *Plowman 5583* (ECON, F, K, NCU, US, USM), *Plowman 5587* (ECON, F, USM), *Plowman 5588* (ECON, F, NCU, USM), *Plowman 5589* (ECON, F, USM), *Plowman 5590* (ECON, F, K, USM).

Prov. Contumaza: Dist. Simbrón, Fundo Farrat, 8 Jan 1966, *Machado 2960*

(NCSC), *Machado 2961* (MOL), *Machado 2962* (MOL), *Machado 2963* (NCSC). DEPT. HUÁNUCO: PROV. LEONCIO PRADO: Pumahuasi, Fundo "Villa Gloria", Experimental planting of Ing. Rodolfo Collantes, 830 m., "coca de Trujillo", 6 Apr 1976, *Plowman 5828* (ECON, F, K, USM), 19 Jul 1967 *Machado 1051* (NCSC), *Machado 1201* (NCSC), *Machado 1214* (NCSC), *Machado 1239* (NCSC); 20 Jul 1967, *Machado 2573* (NCSC). LA LIBERTAD: Prov. Bolívar: Laderas del Río Marañón, Mar 1965, *Machado 2989* (MOL). Prov. Otuzco: Hacienda Collambay, between Simbal and La Cuesta, 800 m., 2 Sep 1973, *López & Sagástegui 7999* (GH); 850 m., 3 Mar 1976, *Plowman 5603* (ECON, F, UPS, USM), *Plowman 5604* (ECON, F, USM), *Plowman 5605* (ECON, F, USM), *Plowman 5606* (B, ECON, F, USM, VT), *Plowman 5607* (ECON, F, USM), *Plowman 5608* (ECON, F, USM), *Plowman 5609* (ECON, USM), *Plowman 5610* (ECON, F, USM), *Plowman 5611* (ECON, F, USM), *Plowman 5612* (ECON, F, K, NCU, USM), *Plowman 5613* (ECON, F, K, USM), *Plowman 5614* (ECON, F, U), *Plowman 5616* (ECON, F). PROV. PATAZ: Río Marañón, abajo de Pataz, 1400 m, 18 Aug 1914, *Weberbauer 7079* (MOL); Cerca del Río Marañón, 18 Feb 1965, *Machado 2987* (NCSC); Cerca de Tayabamba, orillas del Río Marañón, 2 Mar 1965, *Machado 2934* (MOL), *Machado 2935* (MOL); Cerca de Huancaspata, orillas del Río Marañón, 15 Jan 1966, *Machado 2929* (MOL); Prov. Trujillo: Laderas de la Vertiente Occidental, Mar 1965, *Machado 1248* (NCSC); Hacienda del Sr. Lopez, 1965, *Machado 1018* (NCSC); Simbal, El Sacramento, 580 m, 3 Mar 1976, *Plowman 5600* (ECON, F, USM), *Plowman 5601* (ECON, F, USM), *Plowman 5602* (ECON, USM), 17 Apr 1967, *Ferreyra s.n.* (ECON, USM), 16 Apr 1967, *Ferreyra s.n.* (USM); Simbal, La Banda, 500–600 m, "tupa", 17 Apr 1967, *Ferreyra s.n.* (ECON, USM); Simbal, San Lorenzo, 500–600 m, "tupa", 16 Apr 1967, *Ferreyra s.n.* (ECON, USM); Simbal, Las Animas, "tupa", "Coca de Trujillo", 17 Apr 1967, *Ferreyra s.n.* (ECON, USM); Simbal, Fundo de Rosario Gutierrez, "tupa", 17 Apr 1967, *Ferreyra s.n.* (ECON, F, USM); Simbal, 4 Mar 1976, *Plowman 5618* (ECON, F, USM); 3 km. from Simbal, "tupa", 16 Apr 1967, *Ferreyra s.n.* (ECON, USM). LIMA: Lima, Universidad Nacional Agraria de La Molina, Jardín Botánico, 6 Apr 1975, *Plowman 5209* (BH, ECON, F), 6 Feb 1976, *Plowman 5388* (BH, COL, ECON).

ACKNOWLEDGMENTS

Part of the research reported in this paper was conducted at the Botanical Museum of Harvard University under a contract with the U. S. Department of Agriculture (No. 12–14–1001–230). Post-doctoral fellowship support was also received from the Katharine A. Atkins Fund at Harvard University. Field work on Amazonian coca was carried out as part of Phase VII of the Alpha Helix Amazon Expedition 1976–1977 and was funded by the National Science Foundation Grant No. 76–80874.

I am particularly grateful to Professor R. E. Schultes of

Harvard University for his continuing encouragement and support of coca research and for providing access to the H. H. Rusby collections. I would like to thank Susan Marie Rossi for her long hours spent in searching for Rusby's invaluable coca collections. Drs. Ramon Ferreyra and Oscar Tovar of the Museo Nacional de Historia Natural in Lima graciously gave valuable advice and assistance in field work. I also wish to thank the curators of the herbaria (cited according to the standard abbreviations of Holmgren and Keuken, *Index Herbariorum*, 1974) who kindly supplied herbarium specimens on loan for this study.

REFERENCES

- Burck, W., 1890. Opmerkingen over de onder den Naam van *Erythroxylum Coca* in nederlansch Indie gecultiveerde gewassen. *Teysmannia* 1: 385-398, 449-464. t. 1-3.
- Ganders, F. R., 1979. Heterostyly in *Erythroxylum Coca* (Erythroxylaceae). *J. Linn. Soc. Bot.* 78: 11-20.
- Gentner, W. A., 1972. The Genus *Erythroxylum* in Colombia. *Cespedesia* 1: 481-554.
- Griffiths, C. O., 1930. Examination of coca leaves found in a pre-Incan grave. *J. Pharm. Pharmacol.* 3: 52-58.
- Harms, H. von, 1922. Übersicht der bisher in altperuanischen Gräbern gefundenen Pflanzenreste. *Festschrift Eduard Seler*. Stuttgart. p. 180.
- Hieronymus, G., 1895. *Plantae Lehmannianae in Guatemala, Costarica, Colombia et Ecuador collectae*. *Bot. Jahrb. Syst.* 20, Beibl. 49: 35.
- Holmstedt, B., E. Jäättmäa, K. Leander & T. Plowman, 1977. Determination of cocaine in South American species of *Erythroxylum* using mass fragmentography. *Phytochemistry* 16: 1753-1755.
- Machado, E., 1969. Erythroxylaceae Novae II. *Anales Ci. (Lima)* 7(1-2): 14-17.
- Machado, E., 1972. El género *Erythroxylum* en el Perú. *Raymondiana* 5: 5-101.
- Martius, C. F. P. von, 1843. Beiträge zur Kenntnis der Gattung *Erythroxylum*. *Abh. Akad. München* 3: 367-369. t. 6.
- Morris, D., 1889. Coca. *Bull. Misc. Inform. (Kew)* 25: 1-13.
- Payson, J. P. D. W., 1958. Erythroxylaceae. *Flora Malesiana* 5: 543-552.
- Plowman, T., 1976. Orthography of *Erythroxylum* (Erythroxylaceae). *Taxon* 25: 141-144.
- Plowman, T., L. Rüdénberg & C. W. Greene, 1978. Chromosome numbers in neotropical *Erythroxylum* (Erythroxylaceae). *Bot. Mus. Leaflet. Harvard Univ.* 26: 203-209.
- Plowman, T., 1979a. Botanical Perspectives on Coca. *J. Psyched. Drugs* 11: 103-117.
- Plowman, T., 1979b. Amazonian Coca. Paper presented before the 43rd International Congress of Americanists, Aug. 15, 1979, Vancouver, Canada.

- Rostworowski de Diez Canseco, M., 1973. Plantaciones prehispánicas de coca en la vertiente del Pacífico. *Revista Mus. Nac. (Lima)* 39: 193–224.
- Rusby, H. H., 1900. The botanical origin of coca leaves. *Druggists Circular & Chemical Gazette*, November: 220–223.
- Rusby, H. H., 1901. More concerning Truxillo coca leaves. *Druggists Circular & Chemical Gazette*, March: 47–49.
- Rusby, H. H., 1921. Guide to the Economic Museum of the New York Botanical Garden. *Bull. New York Bot. Gard.* 11 (41): 1–138.
- Schulz, O. E., 1907. Erythroxylaceae. In A. Engler, ed. *Das Pflanzenreich* 4 (134): 1–164.
- Spix, J. B. von & C. F. P. von Martius, 1831. *Reise in Brailien*. München. 3: 1169, 1180.
- Spruce, R., 1853a. Journal of a Voyage up the Amazon and Rio Negro. *J. Bot. Kew Gard. Misc.* 5: 212.
- Spruce, R., 1853b. Botanical objects communicated to the Kew Museum from the Amazon River, in 1851 and 1852. *J. Bot. Kew Gard. Misc.* 5: 240.
- Stafleu, F. A., et al., 1978. *International Code of Botanical Nomenclature*. IAPT Regnum Vegetabile 97. Utrecht.
- Towle, M. A., 1961. *The Ethnobotany of Pre-Colombian Peru*. Wenner-Gren Foundation. New York.

PLATE 9



Plate 9. *Erythroxylum Coca* var. *Ipadu*. Original specimen of Richard Spruce (no. 73), collected on the Rio Janauari, affluent of the Rio Negro, Brazil. From the Royal Botanic Gardens, Kew.

PLATE 10

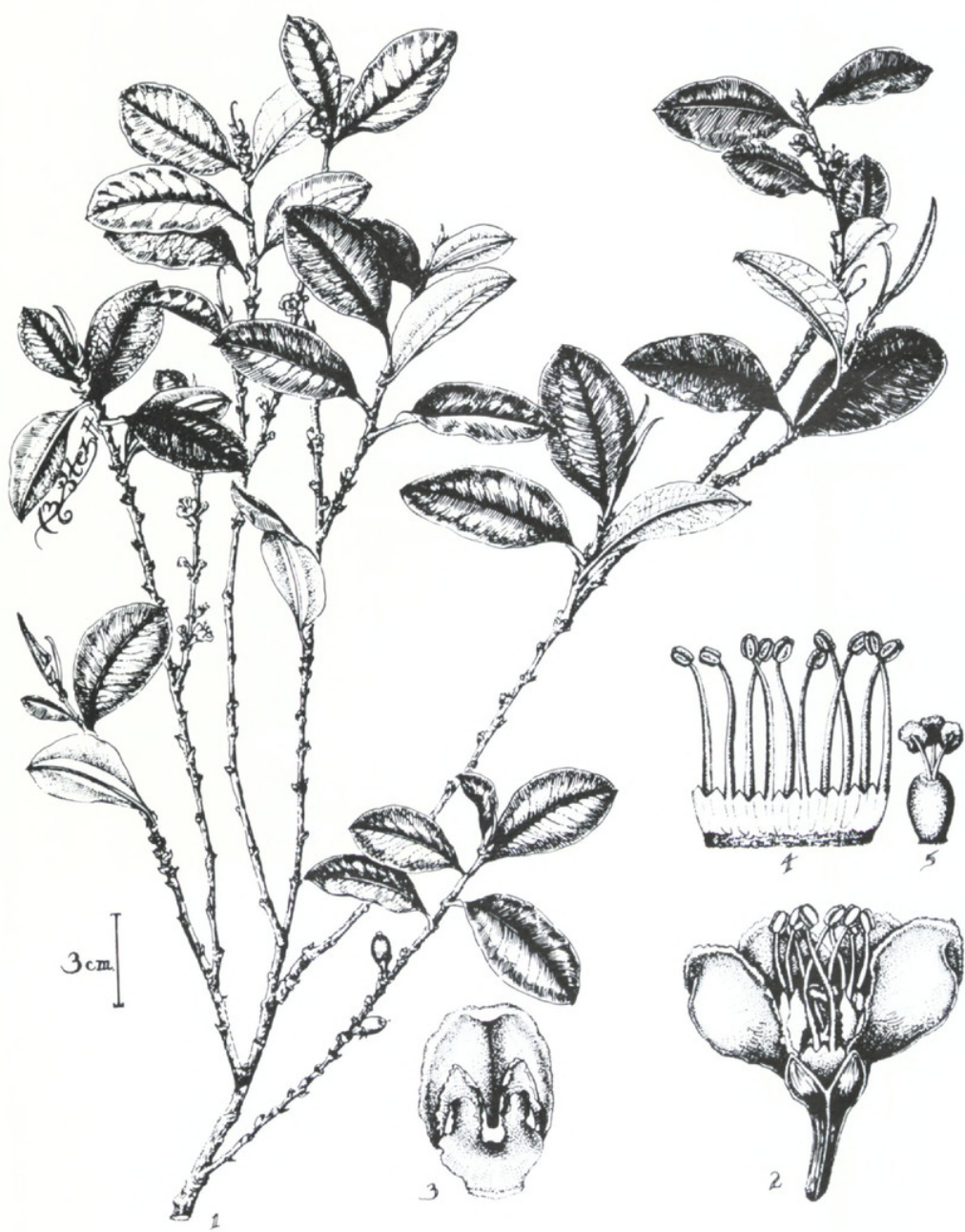


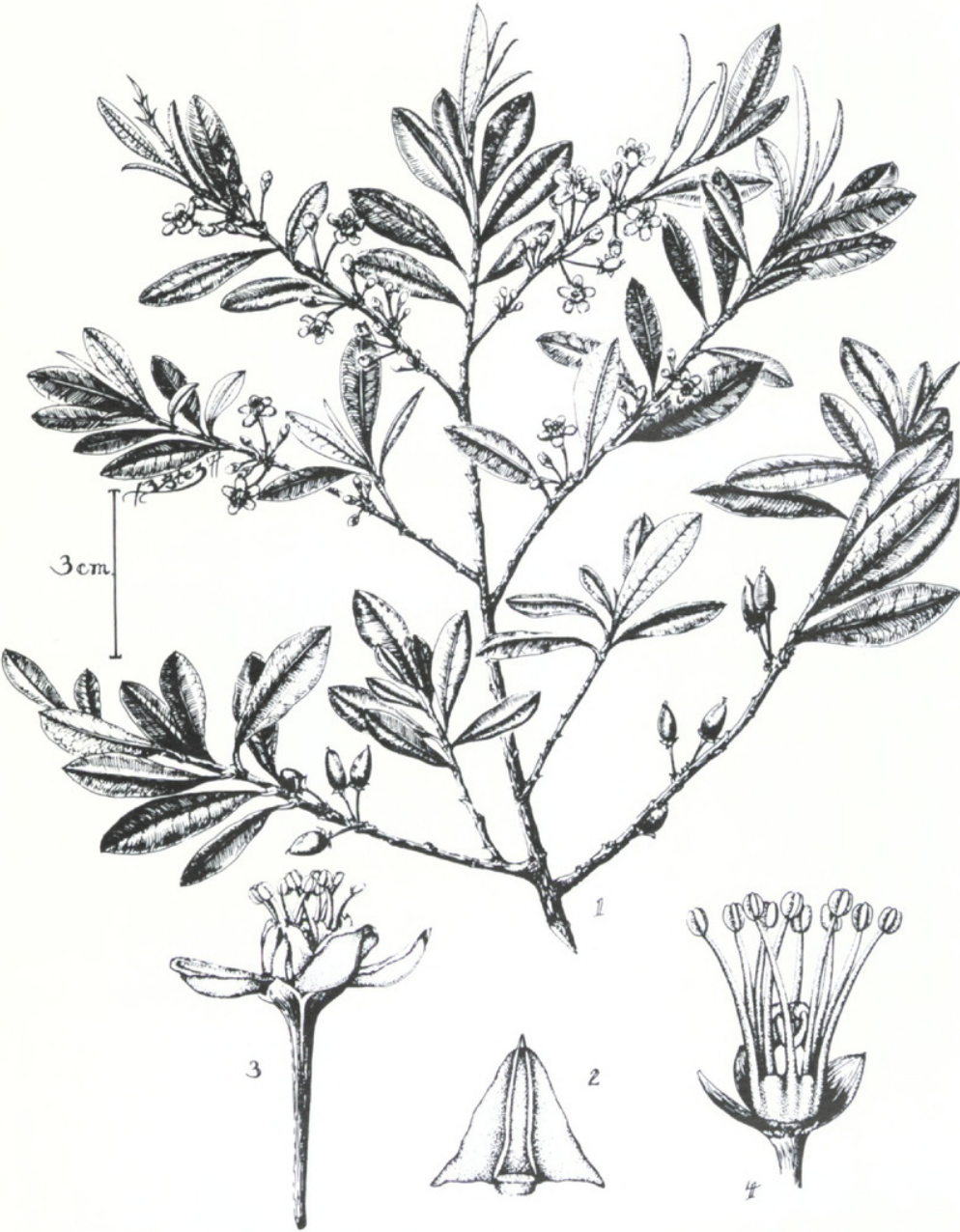
Plate 10. *Erythroxylum Coca* var. *Ipadu*. 1, Habit of plant. 2, flower with one petal removed. 3, petal showing ligule, adaxial view. 4, androecium, staminal tube opened up showing denticular margin. 5, gynoecium, showing large ovoid-oblong stigma. Drawing by L. T. Bates.

PLATE 11



Plate 11. *Erythroxylum Coca* var. *Ipadu*. Habit of plants in cultivation, Brillo Nuevo, Río Yaguasyacu, affluent of Río Ampiyacu, Prov. Maynas, Dept. Loreto, Peru. Photograph by R. E. Schultes.

PLATE 12



ERYTHROXYLUM novogranatense var. truxillense
(Rusby) Plowman

Plate 12. *Erythroxylum novogranatense* var. *truxillense*. 1, habit of plant, with flowers and fruits. 2, stipule, abaxial view. 3, flower, lateral view. 4, flower with petals and one sepal removed. Drawing by L. T. Bates.

PLATE 13



Plate 13. *Erythroxylum novogranatense* var. *truxillense*. Flowering branch of Trujillo coca at Collambay, Dept. La Libertad, Peru (*Plowman 5606*). Photograph by T. Plowman.

PLATE 14



Plate 14. *Erythroxylum novogranatense* var. *truxillense*. Plantation of Trujillo coca showing the use of *pacay* (*Inga Feuillei*) as a shade tree. Simbal, Dept. La Libertad, Peru (*Plowman 5600*). Photograph by T. Plowman.



Plowman, Timothy. 1979. "The Identity of Amazonian and Trujillo Coca."
Botanical Museum leaflets, Harvard University 27(1--2), 45–68.
<https://doi.org/10.5962/p.295220>.

View This Item Online: <https://www.biodiversitylibrary.org/item/31871>

DOI: <https://doi.org/10.5962/p.295220>

Permalink: <https://www.biodiversitylibrary.org/partpdf/295220>

Holding Institution

Missouri Botanical Garden, Peter H. Raven Library

Sponsored by

Missouri Botanical Garden

Copyright & Reuse

Copyright Status: Public domain. The BHL considers that this work is no longer under copyright protection.

License: <http://creativecommons.org/licenses/by-nc-sa/3.0/>

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.