A second lot of 5 crystals made from a corresponding mother liquor by evaporation at room temperature gave the following angles which are normal:

14 faces, l	$\wedge$	l	39°	20′	—	39°	40′	mean 39° 32′
5 faces, m	$\wedge$	m	71	0	—	71	15	mean 71 8
6 faces, q	$\wedge$	q	45	26	—	45	40	mean 45 30

The prisms of the rapidly-grown crystals represent thinner wedges than normal, as if the tendency toward skeletal growth parallel to the b axis had caused an actual lengthening of that axis.

The optical dispersion (α and β), of one crystal from each lot was determined from natural faces (m), and several less accurate determinations of refractive index made on crystals having good l faces. No differences of refractive index greater than ±0.001 were found. Chemical tests do not indicate any solid solution.

TABLE 2

DISPERSION OF POTASSIUM TRITHIONATE.

λ	α ±0.0001	β ±0.0001	γ ±0.002
436	1.5040	1.5805	1.621
486	(1.4993)	(1.5732)	1.612
546	1.4954	1.5673	
578	1.4941	1.5649	
589	(1.4934)	(1.5641)	1.602
656	1.4909	1.5607	
691	1.4903	1.5591	1.596

$2V_{Na}$ measured 72° ± 3°, with no noticeable dispersion. The above indices make $2V = 70° \pm 1°$.

BOTANY.—*On the origin of chicle with descriptions of two new species of Achras.* H. PITTIER, Bureau of Plant Industry.*

Many statements in cyclopedias, handbooks, and even special treatises, considered as facts, are really the expression of mere rumors collected by travellers and reproduced without the necessary discrimination.

Thus we find in almost all the literature of cacao, that this product is the crop of a tree scientifically called *Theobroma cacao*

* Published with the authorization of the Secretary of Agriculture.

L., whereas it is a fact that the larger portion of the cacao beans seen in the world market proceeds from another species, *Theobroma leiocarpa*, described fully fifty years ago by the Swiss botanist Bernouilli.[1]

The general idea is also that the Central-American rubber originates from a single species, *Castilla elastica*. In reality, as far back as 1903,[2] O. F. Cook called attention to the existence of several distinct rubber-producing species of Castilla, of which he published no less than four in 1905.[3] In 1910, the writer took up the same subject and completed to a certain extent Cook's work, with the addition of a few more species.[4] Among other things, he showed that *Castilla elastica* is a species with a very limited area in the states of Vera Cruz, Tamaulipas, and Michoacan, Central Mexico, and that most of the seeds used in building up the plantations of Ceylon and other countries in the East and West Indies and South America, proceeded from the several species scattered over Central America. Nevertheless, the notion is generally maintained that Castilla rubber is the exclusive product of *Castilla elastica*. Even the distorted name *Castilloa*, with the addition of a superfluous vowel, passes stereotypically from old publications to those of more recent date.

So far, the origin of another Tropical American product, the *chicle*, has not been questioned. It was admitted everywhere that *Achras Zapota* L., an important fruit tree known as *sapodilla* or *naseberry* in English, and in Spanish as *zapotillo*, *chicozapote*, and *níspero*, was also the only producer of this substance, which is the base of the American chewing gum and is also applied to several other uses. On the authority of travellers like Morelet and of other authors, I myself recorded that species as "abundant in the lowlands of Tabasco and Chiapas and the western part of Yucatan" (see footnote 4) as well as in Jamaica and parts of Venezuela, without ever suspecting that I was contributing to the further spreading of a fallacy.

[1] In Denkschr. Schweiz. Naturforsch. Ges. **29**: 1–15, pl. 1–7. 1869.

[2] *The culture of the Central-American rubber tree*, U. S. Dept. Agr., Bur. Pl. Ind., Bull. **49**.

[3] Science, n. ser. **18**: 438. 1903.

[4] Contr. U. S. Natl. Herb. **13**: 247–279, pls. 22–43, figs. 45–54. 1910.

My first doubts originated in Venezuela in 1917, when a friend, with a certain botanical knowledge acquired under the late Dr. Ernst, reminded me of the fact that *chicle* is one of the export products of the Orinoco Valley, adding that he had seen one of the trees from which the gum is extracted and did not believe it to be *Achras Zapota*, but perhaps a Mimusops, not unlike the *pendare*, the *purvio*, or the *masarandú*, from which the Venezuelan balata gum is obtained.

At the time, however, I gave little attention to the subject: everybody said that the chicle was obtained from the *níspero* tree and *níspero*, that is to say, Achras Zapota, it had to be. But very recently, in May of the present year, on the occasion of an official exploration of the region between the rivers Motagua and Chamelecon in Guatemala and Honduras, respectively, I came face to face with one of the so-called *nósperos*, which I could not, at first, recognize as a species of Achras. The tree, nearly one meter in diameter at the base and at least 35 meters high, was met on the first hills on the trail from Los Amates to El Paraiso, beyond La Francia, in the Molhá valley. At first sight, it had the appearance of a Mimusops, but the numerous, freshly detached corollas which covered the soil under the tree completely lacked the dorsal lobular appendages which are characteristic of this genus. Of course, this indicated a close relationship with Achras Zapota, except that the corollas were rotate or almost so, while in the latter they are tubulose; but the fact that Achras has been so long considered as a monotypic genus helped on the moment to discard the idea of its belonging to this genus.

At the time the study of the floral details could not well be pursued further, so I simply resolved to obtain more complete materials, and meanwhile started on another line of investigation. I had with me no less than six *monteros*, *i. e.*, woodsmen, some from Honduras, the others from Guatemala, and five of them had worked at the extraction of chicle. On my asking about the name of the tree, the unanimous answer was *níspero;* all agreed, too, that the fruit was edible, like that of the chicozapote; but when I asked whether this níspero and the chicozapote

were identical, the opinion was divided, one of the men explaining that there were several kinds (*varias clases*) of *nísperos*, two of which were bled for the milk. These two grew wild in the forest but the one cultivated near the houses for the fruit was never tapped, nor used as timber. Of the former two, one is met with on the valley flats and is better than the other, which always grows on hills. On my asking in what the difference consisted, I was told that the milk of the tree growing in lower exposures needed one boiling only, while the other required two. Just here, let me state that I know nothing about the technique of the raw chicle preparation, and the expedition in question was such a hurried one that I had no time to go deeper into the subject than to obtain from other persons full confirmation of the above data.

Further information tends to verify the above and to show that chicle is really the product of several species, belonging possibly to more than one genus, of the Sapotaceae. From notes taken by G. N. Collins in his expedition to Yucatan and Tabasco in 1913, it appears that there are differences in the chicle-producing trees, both in the leaf and fruit characters and in the quality of the gum. The trees growing above the 300-meter contour line, although similar in every other way to those growing at lower altitudes, do not produce latex. We have seen that in the Motagua Valley, the latex of trees on the hills is somewhat different from that of trees on the flats. Mr. Collins gives also the information that the average yield is 9 pounds per tree, and reaches up to 25 pounds. To show the importance of the product, we may add here that Mr. Collins' informant exported three million pounds of the gum during 1912.

Another tree having a floral structure identical with that found in Guatemala, and also described below, was discovered in the calcareous zone of the Chagres Valley in Panama. If we admit that both species really belong to Achras, it becomes out of the question to continue considering this genus as monotypic, and since it is now increased to three members, there is no reason why other species having so far escaped botanical collectors,

may not exist in Colombia and Venezuela, the flora of which countries is very imperfectly known.

Lastly it appears from the "Notes on Useful Plants of Mexico," published by Dr. J. N. Rose,[5] as well as from the reports of the *Comisión Catastral y de Estudio de los Recursos naturales del Estado de Sinaloa* (March, 1919), that other Sapotaceae, such as *Calocarpum mammosum* Pierre, *Bumelia Palmeri* Rose, and perhaps certain species of Lucuma, are to be included among the chicle-producing plants. Rose, however, emphasizes the importance of *Achras Zapota* as the main source of the chewing gum, though he adds also that the chicle extracted from *Calocarpum mammosum* is the best gum for masticatory purposes. According to the *Comisión Catastral de Sinaloa*, chicle is obtained there from the fruits of the *bebelamas*, which has just been mentioned under the name of *Bumelia Palmeri*. This tree was also collected in Sinaloa in 1891 by Dr. Edward Palmer, and in 1910 by Rose, Standley, and Russell, but no mention is made of its properties, further than the note by Palmer that children are very fond of the berries.

That the wood of Achras Zapota is not generally used as building material or for other purposes, mainly on account of its being very scarce, is confirmed by reports obtained by me in several Central and South American countries. This wood, being heavy, fine grained, and hard, takes a beautiful polish. But the tree is spared on account of its fruits; furthermore, it seldom reaches adequate dimensions. Although there are trees no less than 20 meters high, most of the height goes into the crown; the trunk is rather short and only about 40 cm. in diameter at most. Ernst[6] refers to its being employed in Venezuela for making barrel staves, but there are other *nísperos* in that country, and the same conclusion may have been drawn. The wood of the *níspero* (*Achras chicle*) noticed by me in the Motagua Valley is considered by the natives as incorruptible and may have been used by the Mayas for the door lintels of their monuments. In the rain forests of the Atlantic coast of Panama, I have

[5] Contr. U. S. Nat. Herb. **5**: 222. 1897.

[6] La Exposicion nacional de Venezuela en 1883: p. 218. 1884.

noticed that while most fallen trees are quickly reduced to mould, the trunks of the balata-producing Mimusops, called also *níspero*, would lie almost indefinitely, keeping in perfect condition.

From what has been explained so far, the following conclusions can be drawn:

1. The *nísperos* of Central and South America include several species of Achras, Mimusops, and other genera of the Sapotaceae, so that the name does not necessarily correspond to *Achras Zapota*.

2. The chicle of commerce is not extracted exclusively, if at all, from the latter species, but mainly from other trees with the same vernacular name.

3. The famous door lintels of the ruins of Yucatan were not made from the wood of *Achras Zapota*, but more likely from one of the other *nísperos* in the region.

4. The neotropical genus *Achras* is not monotypic. Besides *A. Zapota* L., it includes up to the present, two more Central American species, and others may come to light when the flora of northern South America is thoroughly listed.

5. Considering the importance of the product, a further, careful investigation of the facts, *in loco*, that is to say, in the valleys of the Motagua and Rio Dulce, in Peten, Yucatan, and Tabasco, is necessary, and should cover the months of April, May and June, so that specimens in flower and fruit, as well as wood samples, could be procured.

Following are the descriptions of the two new species of Achras:

Achras Chicle Pittier, sp. nov.

A large, deciduous laticiferous tree, reaching a height of 25 m. and over, with a basal diameter of 50 cm. and over, the trunk straight, with a rugose or scaly bark, the crown high and elongate, the branchlets thick and glabrous.

Leaves alternate, petiolate, coriaceous, congested on the new growth at the end of the branchlets; petioles subterete, narrowly canaliculate, puberulent, 2.5 to 3 cm. long; leaf-blades obovate-elliptic, long-cuneate at the base, subacute at the apex, 12 to 20 cm. long, 4 to 7 cm. broad, glabrous, dark green and dull above, light green and almost glaucescent beneath; costa impressed above, very prominent beneath, the primary veins numerous, parallel, inconspicuous. Stipules not seen.

Flowers very numerous, congested at the end of the branchlets, the pedicels 1.4 to 1.8 cm. long, puberulous; sepals 6 (3 + 3), those of the

outer whorl imbricate, ovate, slightly connate at the base, rounded at the apex, grayish pubescent without, glabrous and purplish within, about 7 mm. long and 3.5 mm. broad, those of the inner whorl valvate, oblong, obtuse at the apex, densely grayish pubescent without, purplish and glabrous within, 7 mm. long and 2.5 to 3 mm. broad; corolla rotate, 6-lobulate, glabrous, white, the tubular part 1.5 mm. long, the lobes exappendiculate, ovate-lanceolate, obtuse, about 6 mm. long and 4 mm. broad; stamens and staminodes connate at the base, inserted at the same height, 2 to 2.5 mm. from the base of the corolla, the former slightly exserted, the filaments terete, attenuate, about 5 mm. long, the anthers extrorse, dorsifixed ovate or ovate-lanceolate, cordate at the base, obtuse, about 3 mm. long; staminodes petaloid, ovate-acuminate, broad at the base, subacute, about 4.5 mm. long, irregularly toothed or laciniate; pistil 8 to 8.5 mm. long, substipitate, the ovary globose-depressed, deeply sulcate, minutely fulvo-pubescent, about 1 mm. high, 2 mm. in diameter, 7-, 8- or 9-celled, the cells uniovulate; style slender, slightly attenuate, about 7 mm. long, adpressed, hairy at the base, glabrous higher, the apical stigmatic surface papillose, minutely tuberculate.

Fruit globose-depressed, about 3.5 cm. long and 4 cm. in diameter, the pedicel thick, about 2 cm. long. Skin brown-ferruginous, almost smooth; mesocarp and dissepiments fleshy, succulent, with 4 to 6 seeds, more or less. Seeds large, compressed, ovate, slightly curved, brownish and dull, 2.3 cm. long, 1.4 to 1.7 cm. broad, 6 to 7 mm. thick, the margin smooth, slightly thickened, with a small, narrow, inconspicuous cicatricula.

Type in the U. S. National Herbarium, collected in flower at Vega Grande near Los Amates, Department Izabel, Guatemala, at about 200 meters above sea-level, May, 1919, by H. Pittier (no. 8537).

At first sight, this species reminds one of the Mimusops of the *manilkara* group, an impression that is not sustained by a closer examination of the corolla, in which the absence of dorsal appendages is instantly noticed. This detail, added to the presence of six petaloid staminodes, places this species among the Sideroxyleae rather than among the Mimusopeae. Furthermore, the genus Achras seems to be indicated by the hexamerous floral envelopes and androceum. But the corolla is plainly rotate, with a very short tube (almost 4 times shorter than the lobes) and not urceolate with the tube half as long as the lobes; the margin of the lobes is entire and not sinuate, the design of the staminodes is quite distinct, the stamens and style are exserted, and the ovary cells do not seem ever to be more than 9. If the dorsal appendages of theCorolla were present, we would have a perfect Mimusops, without them, but with the sepals distinctly biseriate, the corolla tube very short, the ovary cells at the most 9, I felt reluctant at first to place the tree under Achras. On the other hand, the fruit

and other characters indicate such a close relationship that I am confident the decision to place the species in this genus will be supported by further study. It seems preferable to introduce a few slight modifications in the generic definition rather than to create a new division in the already oversplit and somewhat confused order Sapotaceae.

Achras calcicola Pittier sp. nov.

A deciduous, laticiferous tree, 15 to 25 meters high, often over 1 meter in diameter at the base, the trunk usually straight, covered with a 2 cm. thick, rimose bark, the crown reduced, depressed, the branching divaricate; latex white; wood hard, reddish.

Leaves alternate, petiolate, congested at the end of the branchlets, coriaceous, entirely glabrous; petioles terete, canaliculate, 2 to 3 cm. long; leaf-blades obovate-oblong, cuneate-attenuate at the base, shortly obtuse-acuminate at the apex, 8 to 18 cm. long, 3 to 6 cm. broad, dark green and dull above, pale green beneath, the costa impressed on the upper face, prominent beneath, the primary veins numerous and inconspicuous.

Flowers numerous, pedicellate, congested at the base of the leaves at the end of the branchlets; pedicels more or less pubescent, about 1 cm. long; sepals 6 (3 + 3), ovate or ovate-oblong, attenuate toward the apex, the exterior ones 5.5 mm. long, 3.5 to 4 mm. broad, densely fuzzy-pubescent without, the interior ones a little longer and narrower, pubescent at the apex, ciliate on the margin; corolla white, broad campanulate or almost rotate, glabrous, 6-lobulate, the tubular part 1 mm. long, the lobes ovate-acute, 3.5 to 4 mm. long, imbricate, sometimes denticulate on the margin, exappendiculate; stamens and staminodes 6, connate at the base, inserted at the apex of the tube; stamens as long as the corolla lobes, the filaments terete, apiculate, about 2.5 mm. long, the anthers extrorse, dorsifixed, emarginate at the base, obtuse, about 3 mm. long; staminodes petaloid, ovate, bifid, about 4 mm. long, the margin irregularly denticulate; pistil 4.5 to 5 mm. long, the ovary globose-depressed, more or less distinctly sulcate, 9-celled, stiff-hairy; style obtuse, glabrous. Fruit not known.

Type in the U. S. National Herbarium, no. 678503, collected in flower, in the dry forests on Eocene limestone around Alhajuela, Chagres Valley, Panama, May, 1911, by H. Pittier (no. 3457).

This species differs from *Achras Zapota* L. in the acuminate leaves, the smaller flowers, the broadly open corolla with short tube, the insertion, size, and shape of the stamens, and the 9-celled ovary. It shows more affinities with *Achras Chicle*, just described, but has smaller flowers, the parts of which also differ in shape and size.