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STUDIES IN THE GENUS *HEVEA* II

BY

RICHARD EVANS SCHULTES¹

THE REDISCOVERY OF *HEVEA RIGIDIFOLIA*

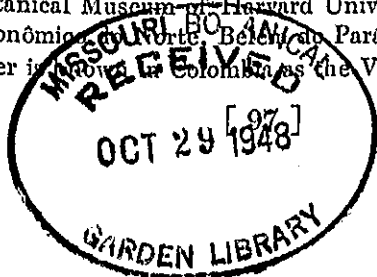
IN 1852, Richard Spruce made the type collection of the extraordinary *Hevea rigidifolia* near the confluence of the Rios Uaupés² and Negro in the Amazonas of Brazil. Nearly a century has passed since this achievement, but, apparently until recently, no other collection has been made, and the species has remained known solely from the information derived from a study of the type material.

In March, 1944, during an extensive cytogeographic survey carried out in the Amazon Valley for the United States Department of Agriculture and in collaboration with the Instituto Agrônômico do Norte, Dr. John T. Baldwin, Jr. discovered *Hevea rigidifolia* and introduced it into cultivation at Belém do Pará.

In 1945, Felisberto Camargo, director of the Instituto Agrônômico do Norte, sent his botanical explorer, Senhor Ricardo de Lemos Fróes, to the upper Rio Negro

¹Botanist, Division of Rubber Plant Investigations, Bureau of Plant Industry, Soils and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture; Research Fellow, Botanical Museum of Harvard University; Collaborator, Instituto Agrônômico do Norte, Belém do Pará, Brasil.

²This river is known in Colombia as the Vaupés.



and lower Rio Uaupés area, where Spruce had collected so extensively, for an investigation of *Hevea* and several other genera of economic plants.

In July, 1946, in Belém, I had the pleasure of studying a number of the specimens of *Hevea* which Fróes collected on this trip and which Dr. Adolpho Ducke had determined (cf. Ducke in Bol. Técn. Instit. Agron. Norte no. 10 (1946) 13). The scope and quality of the collection are such that I am moved to compliment the collector most highly on his accomplishments and Dr. Camargo for his part in bringing about this valuable contribution to our knowledge of *Hevea* in one of the most isolated regions of the Amazon Valley.

Without a doubt the most outstanding achievement of Fróes' trip was his rediscovery of *Hevea rigidifolia*. Four excellent and extensive collections were made in three localities, all rather near the type locality. These collections greatly increase our understanding of this species which is certainly (with the possible exception of *Hevea microphylla* Ule (Schultes in Bot. Mus. Leaflet. Harvard Univ. 13 (1947) 1-9) the most distinct of the whole genus. One of the collections includes several valves of the capsule and two seeds, both of which structures have hitherto been unknown; and another collection includes seedling material.

In May, 1947, Fróes recollected *Hevea rigidifolia* in sterile condition from a locality where he had found it two years previously. According to Senhor Fróes, two thousand seedlings of *Hevea rigidifolia* from this locality (Serra de Tunuhy) have been established at Belterra.

The Fróes collections of *Hevea rigidifolia* are important from several points of view. They indicate that the species is probably a very highly restricted endemic. It is evident also from a comparison of the collections with the type material that the species is apparently rather

stable, showing variations which are surprisingly slight for the genus. On the basis of a study of this new material, we can now attempt to discuss the relationships of *Hevea rigidifolia* with other species. Furthermore, the examination of the Fróes material has convinced me more firmly than ever that it is imperative to bring this species, which has a number of unusual characteristics found in no other species, into cultivation on a large scale for investigations in selection and hybridization and to study even more intensively its relationships.

There have been four descriptions of *Hevea rigidifolia*, including the original, but they have all been based on the type collection. The original description is very short and has proved to be inadequate, in view of the complications which are presenting themselves in the detailed and critical studies of the genus as to its subspecific concepts and phylogenetical relationships. The second³ and third⁴ descriptions, those of Mueller-Argoviensis, are

3 " . . . foliolis coriaceis margine recurvis, alabastris masc. cylindrico-conicis angustis, calycibus pro $2/3$ longitudinis partitis, laciniis triangulari-lanceolatis acute acuminatis, disci masc. glandulis lanceolato-subulatis glabris, antheris 6-10 irregulariter biserialiter verticillatis, columna supra-staminali integra glabra, stigmatibus breviuscule stipitatis . . . Arbor 30-pedalis. Foliola circ. 9-12 cm. longa, 4-5 cm. lata, lanceolato-elliptica, acute acuminata, basi acuta, subtus subglaucescentia, supra-laevigata, glabra, multo crassiora quam in congeneribus. Costae primariae crassae, secundariae tenuiores, subtus prominentes; venae validiusculae, subdeplanatae. Paniculae amplae, albido-v. cinereo-tomentellae. Calyces masc. aperiens 4 mm. aequantes v. paulo longiores, foeminei aperti usque 7 mm. longi, intus circa fundum minute subulato-glanduligeri; lacinae longe et anguste acuminatae."

4 " . . . foliolis coriaceis margine recurvis; alabastris masc. cylindrico-conicis angustis; calycibus pro $2/3$ v. $3/5$ longitudinis partitis, laciniis e base triangulari anguste lanceolatis acute acuminatis; disci masc. glandulis lanceolato-subulatis glabris; antheris 6-10 irregulariter biverticillatis, columna suprastaminali angusta glabra; stylo brevi distincto, ovario glabro.

"Arbor 30-pedalis. PETIOLI validi, foliola aequantes v. iis longiores,

greatly amplified from the original of Spruce and have served until the present time; the third (1874) was reproduced with only slight alterations by Pax.⁵

In the following notes, I have thought it advisable to offer a new description, based upon the three previous ones, but extended and altered to conform with the additional information resulting from further observations and studies of the typical material and from an examination of the Baldwin and Fróes collections. The fact that it has been necessary to make only minor changes is at once a tribute to the accurate work of Spruce, Mueller-Argoviensis and Pax on the type collection and an indication of the unusual stability of this species-concept.

apice valide biglandulosi. FOLIOLA circ. 9-12 cm. longa, 4-5 cm. lata, oblongato-elliptica, acute cuspidato-acuminata, basi acuta, rigidiora quam vulgo in genere, supra laevigata et nitida, utraque pagina glabra, subtus e glaucescente palliodora et validiuscule venulosa, venae vix prominentes; costae majores utroque latere circ. 12, primariae validae et valde prominentes. PANICULAE amplae, floribundae, micranthae, cinereo v. fere albo-tomentellae. CALYCES masc. aperientes 4 mm. aequantes v. paulo longiores, feminei aperti usque 7 mm. longi, utriusque sexus intus inferne praesertim vellereo-tomentelli. GLANDULAE disci florum masc. elongatae, erecto-patulae, acuminatae, basi tantum connatae et more ovarii et columnae suprastaminalis omnino glabrae. OVARIIUM ovoideum, stylo brevi stigmatibus paulo longiore valido terminatum, teres et laeve, glaberrimum. Fructus ignoti."

⁵ "Arbor ad 10 m. alta. Petiolus validus, foliola aequans vel superans, apice valide biglandulosus; foliola 9-12 cm. longa, 4-5 cm. lata, oblongo-elliptica, cuspidato-acuminata, basi acuta, valde coriacea, margine revoluta, supra laevia et nitida, utraque pagina glabra, subtus glaucescenti-pallida, valide venulosa; costae utroque latere ca. 12. Paniculae amplae, floribundae, cinereo- vel albo-tomentellae. Alabastri cylindrico-conica, angusta. Calyx ♂ 4 mm. longus, ♀ 7 mm. longus, utriusque sexus intus tomentellus; lobi triangulares, acuminati; disci glandulae ♂ lanceolato-subulatae, glabrae, acuminatae, basi tantum connatae; antherae 9-10, irregulariter biverticillata; columna staminalis glabra, ultra antheras longius producta; ovarium glabrum; stylus brevis. Fructus ignoti."

Hevea rigidifolia (Spruce ex Bentham) Mueller-Argoviensis in *Linnaea* 34 (1865) 203; in DC. Prodr. 15, pt. 2 (1866) 718; in Martius Fl. Brasil. 11, pt. 2 (1874) 300—Hemsley in Hooker's Icon. Pl. 26 (1898) t. 2573, figs. 11, 12, 13—Pax in Engler Pflanzenr. IV, 147 (Heft 42) (1910) 124—Ducke in Arch. Instit. Biol. Veg. Rio Janeiro 2, no. 2 (1935) 235; in Bol. Técn. Instit. Agron. Norte no. 10 (1946) 13.

Siphonia rigidifolia Spruce ex Bentham in Hooker's Journ. Bot. 6 (1854) 371.

ORIGINAL DESCRIPTION:

"*S. rigidifolia*, Spruce, MS. ; foliis ellipticis crasso-coriaceis glabris, paniculis pulveraceo-tomentosis, calycibus subacuminatis, antheris 5-8 ad basin columnae irregulariter subverticillatis.—*Ramuli* glabrati. *Foliola* breviter petiolulata, 5 poll. longa, $2\frac{1}{2}$ poll. lata, acute acuminata, margine recurva, basi cuneata, multo crassiora et rigidiora quam in caeteris speciebus, subtus punctis crebris albicantia. *Paniculae* pyramidatae, semipedales. *Flores* pallide flavi, masculi 2 lin., foeminei 3 lin. longi. *Antherae* S. *luteae*. Stylus evidentior.

"A milky tree of 30 feet in height, from the caatingas of the Rio Uaupés R. Spruce."

EXTENDED DESCRIPTION:

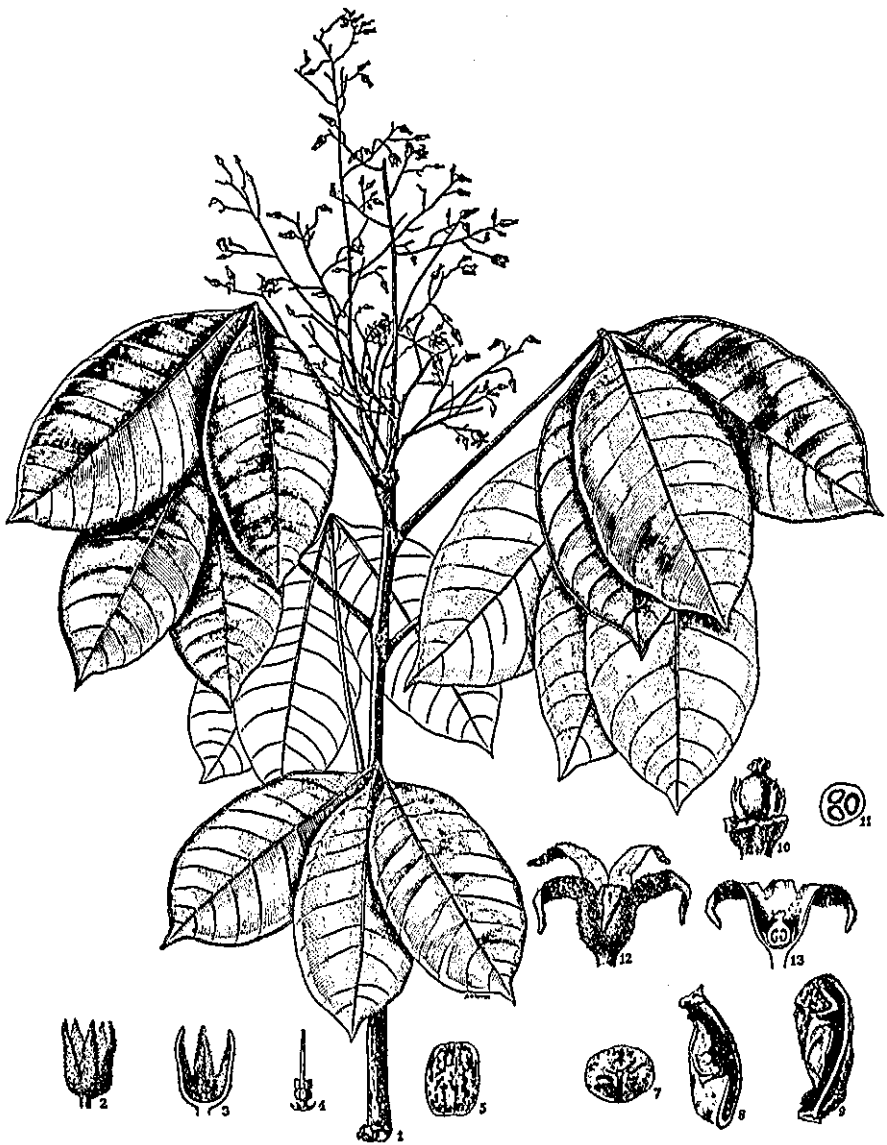
Arbor parva usque ad triginta ped. alta, 3.5 ad 10 poll. in diametro, latice albo. *Petiole* robusti, 8-24 cm. (maxima pro parte 13-17 cm.) longi, 1-3 mm. in diametro, teretes, cortice glabro rubicundulo-brunneo vel stramineo-brunneo, tenuiter striati, basi leviter subcarnoso-dilatati, apice valide biglandulosi. *Petioluli* robustiores, 3-13 mm. (maxima pro parte 5-7 mm.) longi. *Foliola* valde reclinata, statu adulto valdissime coriacea (et multo rigidiora quam illa in genere vulgo visa), perfecte oblongato-elliptica vel saepe elongato-elliptica, basi cuneata vel saepe valde rotundata, apice acute cuspidato-acuminata, margine conspicue recurvata, 6-19.5 cm. (maxima pro parte 10-13 cm.) longa, 3.5-8.5 cm. (maxima pro parte 4.5-6.5 cm.) lata, supra laevigata, pallide cinereo-viridia,

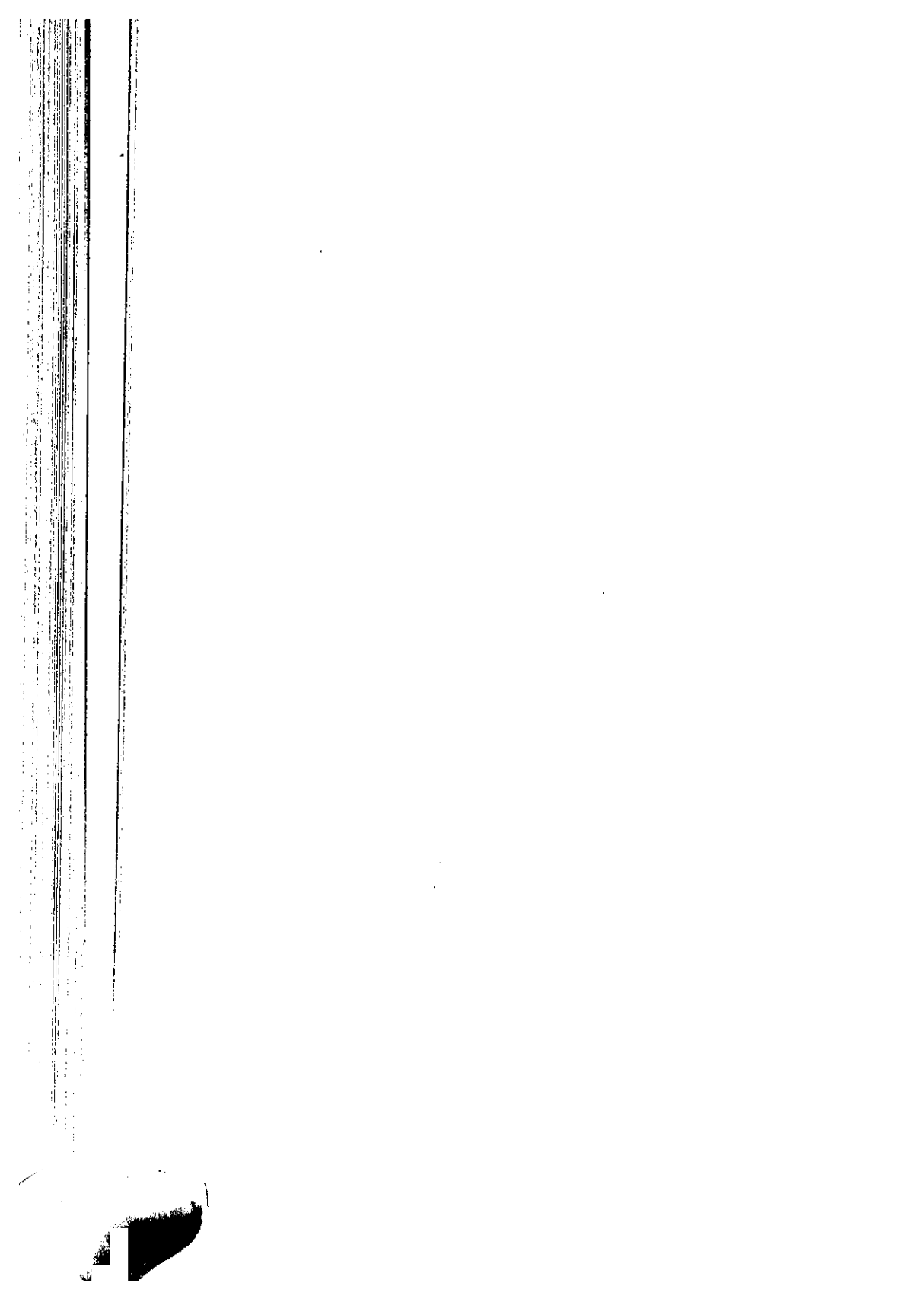
EXPLANATION OF THE ILLUSTRATION

PLATE VIII. *HEVEA RIGIDIFOLIA* (*Spruce ex Benth.*)
Muell.-Arg. 1, terminal branch with inflorescence,
one third natural size. 2 and 3, staminate flowers,
natural size. 4, stamen, one and one third times
natural size. 5 and 7, seeds, one third natural size.
8 and 9, valves of the capsule, one third natural
size. 10 and 11, ovary, two and two thirds times
natural size. 12 and 13, pistillate flowers, one and
one third times natural size.

Drawn by A. N. FERRAZ

PLATE VIII





valde nitida, omnino glabra, infra glaucescens pallidiora crebro-tessellatis punctis albicantia et validiuscule venulosa, costis subtus prominenter elevatis, glabris (specialiter primariis), secundariis utrinque duodecim ad quindecim. *Paniculae* amplae, elongatae, folia subaequantes, aliquid rigidae, floribundae, minute cinereo-vel fere albotomentellae. *Alabastra masculina* anguste et longe cylindrico-conica, valde acuminata, calycis segmentis apice valde et conspicue imbricatis contortisque; *feminea* multo majora, acuminata. *Calyces* pro genere satis crassiusculi, masculini aperiens 3.5-4.6 (plerumque 4) mm. longi, feminei 6-8 mm. longi, extus densissime albotomentelli, intus usualiter glabri sed raro vel apicem versus vel fundum versus parce minute pulveraceo-tomentelli, utroque sexu per $\frac{2}{3}$ vel $\frac{3}{5}$ longitudinis partem partiti, laciniis e basi triangulari anguste lanceolatis, apice acute acuminatis, marginibus integris involutis, pallide luteis; laciniarum florum femineorum apicibus valde retortis. *Antherae* plerumque sex (raro septem ad decem), irregulariter biverticillatae, parvae; columna suprapetalina angusta, gracilis, glabra, usque ad 2 mm. ultra antheras producta. *Disci glandulae* florum masculinorum elongato-subulatae, erecto-patulatae, glabrae, acuminatae, basi aliquid connatae; florum femineorum magnae, irregulariter elongato-linguiformes, usque ad 1 vel 1.2 mm. longae, valde erectae, glabrae. Ovarium ovoideum, 1 mm. \times 1.5 mm., glaberrimum sed nunc minute punctulatum, brevi cum stylo stigmatibus; stigmata congesta, subglobosa, crasso-conflata, glabra. *Coccorum valvae* lignosae, usque ad 5 cm. longae, 1.7-2 cm. latae; epicarpium tenue sed probabiliter vivo fibroso-striatum; endocarpium 2 mm. crassum, sicco valde contortum. *Semina* regulariter elliptico-ovoidea, valde angulosa, aureo-brunnea cum maculis irregularibus magnisque, ferrugineo-brunneis, 2.5-2.9 cm. \times 1.6-1.9 cm. \times 1.8-2.2 cm., raph-

ide prominenti et faciebus satis amplis. In terris saxosis, semi-xerophyticis, in plantarum societate quae in lingua brasiliense "caatinga" nominatur, in locis usque ad circa mille pedes altitudine crescit. Nomen vulgare "seringueira" vel "seringueira da serra" est.

COLLECTIONES EXAMINATAE:

BRAZIL: Estado do Amazonas, prope Panuré [Ipanoré] ad Rio Uaupés, Oct. 1852-Jan. 1853, *Richard Spruce 2527* (TYPE COLLECTION).

BRAZIL: Estado do Amazonas, Jauareté, Uaupés, Rio Negro. "Árvore de 9 m., 25 cm. [diam.]; folhas coriáceas, um tanto pendentes. "Seringueira." Oct. 22, 1945, *Ricardo de Lemos Fróes 21253*.

BRAZIL: Estado do Amazonas, Iraruca, Rio Içana. "Árvore, 7 m., 15 cm. [diam.]. Casca fina, latex branco, abundante, coagulavel. Folhas pendentes, coriáceas." Nov. 16, 1945, *Ricardo de Lemos Fróes 21394*.

BRAZIL: Estado do Amazonas, adjacências da serra de Tunuhy, estando-se até a 308 metros de altitude. "Rica em látex branco, coagulavel." Nov. 14, 1945, *Ricardo de Lemos Fróes 21401*.

BRAZIL: Estado do Amazonas, Serra Tunuhy, [Rio] Içana, Rio Negro. May 5, 1947, *Ricardo de Lemos Fróes 22303*.

BRAZIL: Estado do Pará, Belém do Pará. "Seedling cultivated in Instituto Agrônômico do Norte, collected by J. T. Baldwin, Jr., at Montepelago, Rio Uaupés, Estado do Amazonas, March 1944. Sterile." August, 1947, *Richard Evans Schultes 8663*.

The distribution of Hevea rigidifolia

The small number of stations now known for *Hevea rigidifolia* indicate that it is, with all probability, a highly restricted endemic, for the rather extensive collections of *Hevea* which have been made in other regions⁶ in the Amazon Valley have never yielded this species.

Hevea rigidifolia appears to be centered near the confluence of the Rio Negro with the Río Vaupés, or, more precisely, in the triangular sector formed by the lower course of the Río Vaupés, the Rio Negro above its con-

⁶ *Hevea rigidifolia* is erroneously attributed "am mittleren Orinoko" in *Pflanzenr.* IV. 147 (Heft 42) (1910) 124.

fluence with the Vaupés and the Colombian border. Since this species is endemic to caatingas, however, its dispersal is necessarily interrupted and usually confined to the hinterlands. Therefore, further explorations may and doubtlessly will increase our knowledge of its range. Inasmuch as the Fróes collections from Jauareté were made exactly on the Colombo-Brazilian boundary, it is safe to include *Hevea rigidifolia* in the enumeration of Colombian species of the genus (Schultes in Bot. Mus. Leaf. Harvard Univ. 12 (1945) 11). In 1945, I published the following remarks in this connection (here translated from the Spanish) (in Rev. Acad. Col. Ciénc. Exact. Físico. Nat. 6: nos. 22-23 (1945) 336): "This species, collected by the English botanist, Richard Spruce, in caatingas in the lower Vaupés near Panuré, Brazil, is represented in herbaria only by the type collection. The type locality at Panuré is very near the boundary between Colombia and Brazil and, for this reason, it seems probable that *Hevea rigidifolia* will also be found in the Vaupés of Colombia below Mitú." It should be sought in the Río Querarí as well.

For the same reason, I suspect that in time we shall also be able to assign *Hevea rigidifolia* to the Venezuelan flora. It should be expected to occur in the general vicinity of the Piedra de Cocuy. Pittier (Manual de las plantas usuales de Venezuela (1926) 262) indicates that *Hevea rigidifolia* forms a part of the Venezuelan flora, but I strongly suspect that this statement is based upon collections of the very thick-coriaceous *Hevea pauciflora* (Spruce ex Bentham) Muell.-Arg. var. *coriacea* Ducke,

⁷In the small but critically interesting collection of *Hevea* which Paul H. Allen, of the Missouri Botanical Garden, made in this general area in 1943 and 1944 for the Rubber Development Corporation, *H. rigidifolia* is not represented. (See Baldwin in Amer. Journ. Bot. 34 (1947) 263 for reference to Allen 3049.)

frequent in the Orinoco area, which have been erroneously determined.

In spite of the fact that *Hevea rigidifolia* may probably occur within the boundaries of three different countries, I am of the opinion that, with the single exception of *H. minor* Hemsl., it represents the species which is most narrowly restricted in range⁸ and possibly one of the oldest of the genus.

It is of interest to note that *Hevea rigidifolia* is sometimes found on caatingas at relatively high elevations. The Fróes 21401 collection from Serra de Tunuhy was made at an altitude of approximately one thousand feet above sea level. I have found that in the peculiar habitat of the caatinga flora of these open sandstone mesas or campinas in the adjacent areas of Colombia, the greater the altitude above the forest floor the more intense the conditions of and response to xerophytism. Thus, the higher one finds the diminutive xerophytic *Hevea nitida* Mart. ex Muell.-Arg. var. *toxicodendroides* (R. E. Schultes et Vinton) R. E. Schultes (in Bot. Mus. Leaflet Harvard Univ., 13 (1947) 9-11), the more reduced it is in all its vegetative parts. It is significant that the specimens in Fróes 21401, from a tree growing so high above the jungle surroundings, shows no special vegetative adaptations correlated with increased intensity of heat, radiation, drought or other xerophytic conditions.

According to Senhor Fróes, *Hevea rigidifolia* is found on the flat sandstone mesas as well as on the lightly forested slopes formed by the talus from the eroded cliffs of the hills. The collection Fróes 21401 was made in the light "talus-forest" of Serra de Tunuhy, the tree grow-

⁸The range of *Hevea camporum* Ducke, the specific status of which is now under question by Dr. Adolpho Ducke (in Bol. Técn. Inst. Agron. Norte no. 10 (1946) 19), is not known but may be less extensive than that of any other.

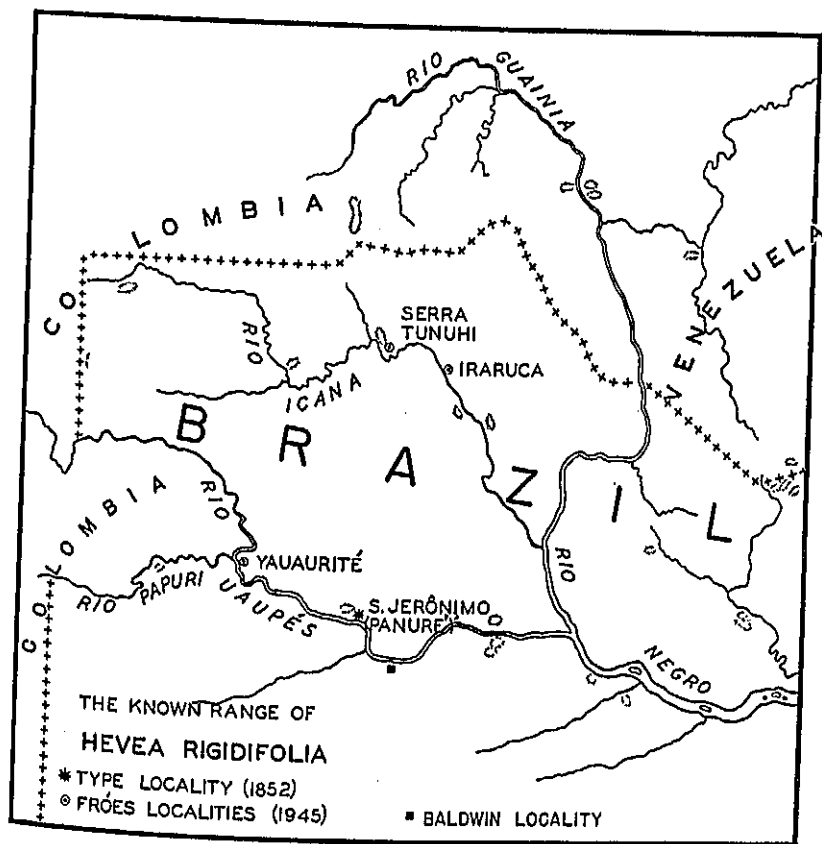
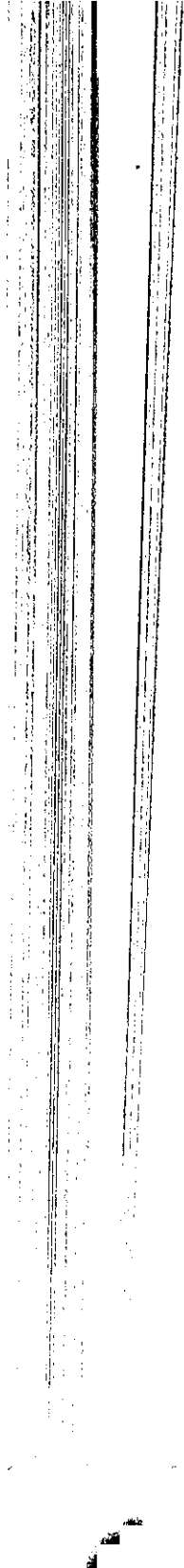


FIG. 12. Map showing the known range of *HEVEA RIGIDIFOLIA* (Spruce ex Benth.) Muell.-Arg.



ing in gravel and among huge, scattered blocks under severe conditions of chersophytic drought. Senhor Fróes described the habitat to me as follows: "*Hevea rigidifolia* in this locality (Serra de Tunuhy) is fair-sized because it is under a light forest; the crown of the slender *Hevea* protrudes above the forest seeking light. . . . I estimate that the mesa-like top of Tunuhy is 1000 feet above the forest floor, but I ascended only about 600 feet, where I collected number 21401."

Variability of Hevea rigidifolia

The present study of the variability of important specific characters of *Hevea rigidifolia* is based upon an examination of: (1) the type and a duplicate type in the Royal Botanic Gardens at Kew; (2) a photograph of a specimen of the type collection from the Delessert Herbarium; (3) one duplicate type preserved in each of the following institutions: Gray Herbarium of Harvard University; the New York Botanical Garden; the British Museum of Natural History; the Fielding Herbarium at Oxford University; the Herbarium at Cambridge University, and the Herbarium Amazonicum Musei Paraensis (Museu Goeldi) in Belém do Pará; (4) thirty-six specimens of the four Fróes collections; (5) a young individual introduced to cultivation at the Instituto Agronômico do Norte by Baldwin in 1944. Furthermore, I have also had the opportunity of questioning Senhor Fróes in great detail about the habit and habitat of the trees from which his collections were made.

It is clearly apparent from a study of these collections from five different localities that *Hevea rigidifolia* is an exceptionally stable species. It is indeed unusual to find a concept of such stability in this very variable genus. Unless later investigations with large quantities of seed

should indicate otherwise, there seem to be no varieties or forms of the concept, a condition which does not appear to exist in any other well-known species with the possible exception of *H. microphylla*. All of the collections indicate that *Hevea rigidifolia* is a small tree, usually between twenty and thirty feet in height. However, there is apparently considerable variation in the diameter of the trunk which may measure, according to Fróes, from eight to twenty-five centimeters; this variability in the size of the trunk is found in a large number of small trees which grow under the xerophytic conditions of caatingas.

The leaflets of *Hevea rigidifolia* are apparently always of the same consistency, color and glaucescence; their adult size is very constant, varying usually from 10 to 18 cm. in length and 4.5 to 6.5 cm. in width; they are always peculiarly and strongly recurved-marginate; their tips are consistently long and sharply cuspidate-acuminate; there is never any trace of pilosity in the axils of the nerves; the number of secondary nerves is twelve to fifteen. Occasionally (as in Fróes 21394) the strongly rounded base of the leaflets departs from the cuneate condition which is usual in this species; this is, curiously enough, the only vegetative variation of importance which was noted, except for a very slight divergence from a perfectly oblongate-elliptic shape (as in some specimens of Fróes 21253).

The inflorescences in all of the collections are peculiarly rigid, are profusely flowered, and are more or less equal or subequal to the leaves.

No variations of any sort in the form of the staminate buds is apparent; all are very strongly cylindrical-conic, conspicuously acuminate, and densely clothed with a white indumentum. The pistillate flowers, with the spreading and sharply recurved narrow acuminate tips

of the calyx lobes, show no variation. Size in the flowers is also constant.

I have studied five staminate flowers from various specimens of the type collection and thirty-six, taken at random, from the Fróes collections. The number of anthers is extremely constant, being six in all cases but two. In these cases seven anthers were found, the unusual insertion of an extra anther indicating abnormality. I am at a loss to explain Mueller-Argoviensis' statement that the number can vary between six and ten, unless a rare or abnormal condition existed in the material which he studied (necessarily material of the type collection). Hemsley (in Hooker's Icon. Pl. 26 (1898) t. 2573, fig. 11) indicated six anthers, irregularly inserted in two verticils. Spruce, in the original description, described them as they are in *Hevea guianensis* Aubl. var. *lutea* (Benth.) Ducke & Schultes, which has most frequently five, less frequently six, but rarely (and probably abnormally) seven or eight. It is evident from a study of the new collections that the number of stamens is normally and quite constantly six.

No variation of any appreciable degree was noted in the size, shape, and insertion of the lobes of the staminate disk. In all of the flowers examined, they are large, very long-acuminate, and conspicuously spreading. It is of interest to note that the disk lobes in *Hevea rigidifolia* are larger than in any other species.

An examination of three pistillate flowers from the duplicate type at the Gray Herbarium, two from the type at Kew, and fifteen from the several Fróes collections has served to emphasize the stability of all the important characters, with the exception of the indumentum of the inner surface of the calyx. The calyx lobes are invariably divided about two thirds or three fifths of their length; the tomentulose indumentum of the exterior of the calyx

lobes is surprisingly constant in density; the interior of the lobes is almost always perfectly glabrous; the ovary is completely glabrous, sometimes very slightly punctate; the style is very much abbreviated and thickened; the stigma lobes are unusually large and carnose, covering the short style; the annular disk is consistently very large and conspicuous, very irregularly deep-laciniate, the tongue-shaped segments often up to 1 or 1.2 mm. in length—probably the largest of any species of *Hevea*.

All but three of the pistillate flowers which I examined were completely glabrous within. In the three exceptions, I found an extremely sparse tomentulose indumentum on the *upper half* of the inner surface of the calyx, especially near the apex of the lobes. Seibert (in Ann. Mo. Bot. Gard. 34 (1947) 341, pl. 38), has illustrated the pistillate calyx as very remotely tomentulose on the upper half of its interior surface. Hemsley (loc. cit. fig. 12) published a drawing of an open pistillate calyx of *Hevea rigidifolia* showing a tomentulose condition on the entire inner surface of the lobes, but this was an error. I have examined the original sketch which is attached to the type sheet at Kew and have found that the interior surface of the pistillate calyx is drawn as tomentulose *only near the apex* of the lobes. The dissected flower on which this sketch was based agrees with the original drawing. It should be noted that the original sketch of *Hevea rigidifolia* was redrawn and, unfortunately, altered in preparing the plates for publication.

Mueller-Argoviensis (in Martius Fl. Brasil. 11, pt. 2 (1874) 300) stated that the calyces of both staminate and pistillate flowers are "intus inferne praesertim vellereotomentelli."⁹ Pax (in Engler Pflanzenr. 4, 147 (Heft 42)

⁹In an earlier description of *Hevea rigidifolia*, Mueller-Argoviensis (in DC. Prodr. 15, pt. 2 (1866) 718) indicated that the pistillate calyx was "intus circa fundum minute subulato-glanduligeri." (See footnote 3.)

(1910) 124) repeated this, stating: "calyx. . . utriusque sexus intus tomentellus." I find it difficult to reconcile this with my own observations on flowers from both the type and from the new material, but I think we may be justified in assuming that there is some variability in this character and that the normal condition is a glabrous interior of the pistillate calyx.

Hemsley (loc. cit. fig. 13) has also published a sketch of the ovary showing a sericeous indumentum covering all parts of the ovary. Mueller-Argoviensis (loc. cit.) and Pax (loc. cit.) both indicate "ovarium glabrum"; this coincides with my own observations.

Relationships of Hevea rigidifolia

There has been some difference of opinion with regard to the closest affinities of *Hevea rigidifolia*. Mueller-Argoviensis, in his description of *Hevea nitida*, wrote: "evidenter affinis *H. rigidifoliae* et *H. brasiliensis*." In a detailed consideration of generic subdivisions in *Hevea*, Huber (in Bol. Mus. Paraense 4 (1906) 622, 632) included *Hevea rigidifolia* in the section *Bisiphonia*, series *Luteae*, together with *H. lutea* (Benth.) Muell.-Arg.,¹⁰ *H. cuneata* Hub.,¹¹ *H. Duckei* Hub.,¹² *H. paludosa* Ule, *H. apiculata* Baillon¹³ and *H. Benthamiana* Muell.-Arg.

Huber's statements regarding the relationships of *Hevea rigidifolia* should be of interest because of his vast knowledge of the genus, although it is probably true that, due to his confusion of an unusual variant of *H. Benthamiana* from the Rio Negro with *H. rigidifolia*,

¹⁰ Now considered to represent *Hevea guianensis* var. *lutea*.

¹¹ A poorly understood concept representing possibly a form of *Hevea guianensis*.

¹² Now included by Ducke as a synonym of *Hevea Benthamiana*.

¹³ Probably a variant of *Hevea guianensis*.

he did not, at that time, clearly delimit the former from the latter species. He wrote (loc. cit. 682), translated: "Pertaining undoubtedly to the *Luteae* series because of the disposition of the anthers, *Hevea rigidifolia* occupies, from other points of view, a special position in this group In its whitish pubescence and acuminate staminate buds, the inflorescence strongly suggests *Hevea brasiliensis* (HBK.) Muell.-Arg. Furthermore, the segments of the disk of the staminate flower are more strongly developed in this species [i.e. *H. rigidifolia*] than in any other species." Later, the same investigator (in Bol. Mus. Paraense 7 (1913) 202) indicated that the position of *Hevea rigidifolia* in the *Luteae* series was open to some doubt; and (loc. cit. 206) that it might be necessary to remove *H. microphylla* Ule¹⁴ and *H. minor* from series *Intermediae* (he considered series *Luteae* and *Intermediae* to represent provisional classifications and not natural groups) and, together with *H. rigidifolia*, form a new group which would be characterized by a strong development of the segments of the staminate disk.

Ducke more recently stated (in Arch. Instit. Biol. Veg. Rio Janeiro 2, no. 2 (1935) 235): "According to the descriptions, the specie [i.e. : *Hevea rigidifolia*] differs from *H. Benthamiana* principally by its glabrous rigid coriaceous leaflets with recurvate margin; the discus and the anthers (6 to 10) do not seem to differ in any essential character from those of the typical *Benthamiana*." After having had occasion to see the Fróes material, Ducke (in Bol. Técn. Instit. Agron. Norte no. 10 (1946) 13) wrote in regard to *Hevea rigidifolia* "distinguese, de uma *Benthamiana* de folhas inteiramente glabras, pela consistencia rigidamente coriacea das mesmas. . . . as flores masculinas são mais longamente acuminadas e

¹⁴ Until recently confused with *Hevea minor*.

mais estreitas que em qualquer especimen de *Benthamiana*, por mim visto.”

The extensive Fróes material, with its abundance of flowers, enables us to evaluate more critically and more extensively than has hitherto been possible the relationships of *Hevea rigidifolia*. It would appear quite probable that *Hevea rigidifolia* occupies a somewhat intermediate position between *Hevea pauciflora* var. *coriacea*¹⁵ and *H. Benthamiana*,¹⁶ having, florally at least, closer affinities with the latter than with the former.

The extremely heavy coriaceous nature and the glaucescence of the leaflets of *Hevea rigidifolia* as well as the glabrous condition of the lower surface of the leaflets

¹⁵ In the present article, I am using the concept *Hevea pauciflora* var. *coriacea* in the sense in which it has been established and used by Ducke (in Arch. Instit. Biol. Veg. Rio Janeiro 2, no. 2 (1935) 239). The concept has also been used in this sense in several of my previous papers (in Bot. Mus. Leaflet. Harvard Univ. 12 (1945) 1-82; in Rev. Acad. Colomb. Ciénc. Exact. Físico-Quím. Nat. 6, no. 22-23 (1945) 331-338; in Rev. Fac. Nac. Agron. (Medellin) 6, no. 22 (1946) 18-45). I suspect that what has been considered as *Hevea pauciflora* var. *coriacea* represents a concept deserving varietal distinction. Baldwin calls this *H. confusa* (Baldwin: in Journ. Hered. 38 (1947) 54; Baldwin & Schultes in Bot. Mus. Leaflet. Harvard Univ. 12 (1947) 335). Until it is possible to investigate the entire *Hevea pauciflora* complex critically, however, I believe it is advisable to maintain Ducke's treatment of it. A complete study of the *H. pauciflora* var. *coriacea*—*H. rigidifolia*—*H. nitida*—*H. confusa* problem and of the relationships between these concepts is urgently needed and must be carried out before a clear understanding of the genus as a whole can be expected. Ducke has recently (in Bol. Técn. Instit. Agron. Norte no. 10) (1946) 18) indicated doubt as to whether *Hevea confusa* should be maintained as a variety of *H. pauciflora* or incorporated with *H. pauciflora* var. *coriacea*.

¹⁶ The writer believes that *Hevea Benthamiana* and *H. Spruceana* (Benth.) Muell.-Arg. are distantly allied species and that some relationship could, therefore, be expected to exist between *H. rigidifolia* and *H. Spruceana*. Since it appears, however, to be of a minor degree, a detailed analysis of this relationship will not be discussed in the present study.

combine with other general similarities in vegetative characters to indicate a rather close relationship with its companion of the caatingas, *H. pauciflora* var. *coriacea*. It is worth pointing out, incidentally, that while coriaceous leaflets are very possibly a manifestation of xerophytic caatinga conditions in both of these species, as in many other plants, there are sufficient similarities in vegetative characters to indicate that this is due to some affinity and not to an ecological parallelism between *Hevea rigidifolia* and *H. pauciflora* var. *coriacea*.

The seed of *Hevea rigidifolia* does not appear to be similar to that of *H. pauciflora* var. *coriacea*. It is larger, broader in relation to its length, and much less sharply angular. However, one seed preserved with the collection Fróes 21253 curiously approaches the shape and size which, so far as we know, is usual for *Hevea pauciflora* var. *coriacea*, being smaller, narrower, and very sharply angular in cross section. (This seed may have been included erroneously in Fróes 21253, because it does not match any other seeds in the same collection. Furthermore, Fróes 21253 was growing in close proximity to Fróes 21249 which appears to be referable to the *Hevea pauciflora* var. *coriacea* complex, and a confusion as to the source of this seed would not be difficult.) Ducke (in Bol. Técn. Instit. Agron. Norte no. 10 (1946) 13) indicates that the seed of *Hevea rigidifolia* is similar in shape and size to that of typical *H. pauciflora*. If this unique seed actually belongs to *Hevea rigidifolia*, it might suggest some relationship with *H. guianensis* var. *lutea* or *H. nitida* which have similar angular seeds. We cannot draw any definite conclusions, however, on the basis of the few known seeds of *Hevea rigidifolia*.

In floral characters, however, there is less to point to a close affinity between *Hevea rigidifolia* and *H. pauciflora* var. *coriacea*. This is especially true when the dif-

ferences in such critical characters as the number of stamens, the size of the anthers, the length of the supra-staminal column, the size and form of the glandular lobes in the staminate flower, and the condition of the annular disk in the pistillate flower are taken into consideration. The very different form of the masculine buds—short, obtuse, even somewhat truncate in *Hevea pauciflora* var. *coriacea*, but extremely long and acuminate with the tips of the segments peculiarly spiral-imbricate in *H. rigidifolia*—likewise would tend to indicate that the affinity between the two might not be exceptionally close.

The young leaflets and seedling leaves of *Hevea rigidifolia*, as in some specimens of *Fróes 21253*, are strikingly similar to the adult leaflets of *H. pauciflora* var. *coriacea*, although the shape and size of the adult leaflets of *H. rigidifolia* are peculiar and cannot be easily confused with those of any other species.

In connection with the relationship of *Hevea rigidifolia* and *H. pauciflora* var. *coriacea*, it is pertinent to discuss several interesting collections which, in some respects, would superficially appear to be rather intermediate between the two concepts. As stated above, in March, 1944, Dr. John T. Baldwin, Jr. discovered *H. rigidifolia* and introduced it into cultivation (Baldwin in *Am. Journ. Bot.* 33 (1946) 215-216). There is one young individual growing vigorously in the collection at the Instituto Agrônômico do Norte (Pl. IX).

Baldwin made chromosome studies in the field and prepared herbarium material, but unfortunately there appears to be some confusion in the determination of several of his herbarium collections. In two articles (*Journ. Hered.* 38 (1947) 59; *Am. Journ. Bot.* 34 (1947) 261) Baldwin cites his collections 3669 and 3670 as representing *Hevea rigidifolia*. I have studied a specimen of Baldwin 3670 which is preserved in the Herbarium of

the Arnold Arboretum. It clearly represents one of the numerous variants of *Hevea pauciflora*. A good photograph of *Baldwin 3669*, a specimen of which I have not seen, has been published (in *Am. Journ. Bot.* 34 (1947) 264, fig. 2). It represents the same variant of the *Hevea pauciflora* complex as *Baldwin 3670*. Although these collections, with fruit but lacking flowers, exhibit similarities in certain characters with typical *Hevea rigidifolia*, it is highly inadvisable, in my opinion, to consider them as representing this peculiarly distinct species.

Several valves of the capsule which accompany *Baldwin 3670* would appear to be typical of *Hevea rigidifolia* in the shape and size of the few seeds, for both approach somewhat the analagous fruiting material of *Fröes 21253*. The ligneous valves of *Hevea rigidifolia* are peculiar to that species, being large, long and narrow with unusually thick endocarp, and very strongly twisted due to the explosive opening of the capsule; whereas in *Hevea pauciflora* var. *coriacea* the valves are smaller, as broad as long and have relatively thick and strong ligneous walls which are not in the least distorted during the explosive shedding of the seed. The peduncle of the fruit, preserved in *Baldwin 3670*, is like that of *Hevea rigidifolia*. However, it is in a study of the leaflets, so extraordinarily constant in typical *Hevea rigidifolia*, that doubts arise as to the real identity. Although the under surface of the leaflets of *Baldwin 3670* is armed with the minutely tessellate, waxy scales which lend the peculiar dull waxy-gray color to that part of the leaf of *Hevea rigidifolia*, the individual scale-like mosaic points are much smaller in the Baldwin collection than is normal for *Hevea rigidifolia*. It is, however, principally in the texture and general appearance of the leaflets that *Baldwin 3670* deviates most from typical *Hevea rigidifolia*. The leaflets are long and narrowly lanceolate-elliptic, departing from the very

characteristic and constant oblong-ovate shape; the tips do not have the very long and pronounced cuspidate acumen so typical of *Hevea rigidifolia*; the upper surface is, in life, apparently much duller and somewhat less glaucescent; the lower surface is not so whitish; the margin is very much less conspicuously inrolled; the petiolules are extremely abbreviated, whereas one of the major characteristics of *H. rigidifolia* is the presence of an unusually long petiolule; and the texture, in general, is far less coriaceous. The leaflets of *Baldwin 3670* are very close indeed in shape, size and texture to those of *Hevea pauciflora* var. *coriacea*.

Baldwin (in Journ. Hered. 38 (1947) 56) has stated that *Hevea pauciflora* "is probably the prototype of *H. brasiliensis* and was likely one of the parents of *H. rigidifolia*." Later, the same investigator went much farther and wrote: (in Am. Journ. Bot. 34 (1947) 265) "... *H. rigidifolia* (and certain other species) may have originated from intergeneric hybridization of *Hevea* and *Cunuria*. For this hypothesis, *H. pauciflora* (from which it is considered that *H. brasiliensis* evolved) and *Cunuria crassipes* with purplish fruit are selected as possible parents." I cannot accept these assumptions for which no shred of evidence is advanced. Baldwin (loc. cit. 265) advances, apparently as arguments for his reasoning, a miscellany of observation and speculation when he states: "At Montepelago . . . and at Iraruca . . . purplish-fruited *Cunuria crassipes* grows adjacent to *H. rigidifolia*. The leaflets of this species of *Hevea* are cunurioid. On top of the hill at Montepelago, is a huge tree referable to *H. pauciflora*, and that tree is buttressed just as representatives of *Cunuria* are buttressed. Seed of *H. rigidifolia* and of *H. pauciflora* are much alike. Those of *H. confusa*, though smaller, fall in this group. Under influence of the elements, the seed of *H. rigidifolia* lose

their color pattern and assume the uniform brownish-red hue of *Cunuria* seed. That the natives recognize in the seed of *H. pauciflora* resemblance to those of *cunury* may be of significance."

Another very interesting collection is *Allen 3049* from the Río Papurí, an affluent of the Vaupés, which forms part of the Colombo-Brazilian boundary. The leaflets are somewhat like those of typical *Hevea rigidifolia*, but the seed and capsule valve suggest those of *H. pauciflora* var. *coriacea*. The seeds, smaller than usual for the *Hevea pauciflora* complex, are very strongly angular, and the valves, long in relation to their breadth, are not twisted. The leaflets, less coriaceous than in typical *Hevea rigidifolia*, are unusually obovate and very shortly cuspidate; they are extremely large. Of this collection Baldwin (in *Am. Journ. Bot.* 34 (1947) 268) writes: "... is a puzzling specimen. R. J. Seibert has annotated it as a possible hybrid of *H. pauciflora* (or *H. confusa*) and *H. rigidifolia*... carpels of old fruit, which seem referable to *H. confusa* Hemsl. and which could have been wrongly associated with the collection... My inclination is to consider the material... as *H. confusa* with influence from *H. rigidifolia*."

A third collection of significance in this problem is *Fröes 21249*. This likewise represents a variant of the *Hevea pauciflora* complex, but not the same variant as *Baldwin 3669, 3670* and *Allen 3049*. This extensive collection has leaflets which suggest, in several minor characters, those of *Hevea rigidifolia*, but its flowers indicate its true affinities. Upon superficial examination of the leaves, I annotated this collection in July 1946 as *Hevea rigidifolia*, but later, detailed examination of the flowers disclosed my error. Baldwin (loc. cit. 268) has considered this collection to represent *Hevea rigidifolia*, stating: "*Fröes 21249* shows influence of *H. confusa*. This col-

lection and *Allen 3049* resemble certain of my specimens of *H. confusa* from along the Rio Negro." In May, 1947, he annotated two specimens in the Herbarium of the Instituto Agronômico do Norte (16736, 16737) as "*H. rigidifolia* with influence from *H. confusa*." It is indeed of interest that *Fróes 21249* was found growing in close proximity to an individual of *Hevea rigidifolia* (*Fróes 21253*).

It is suggestive that some relationship may exist between *Hevea rigidifolia* and *H. nitida*. Baldwin (in Journ. Hered. 38 (1947) 59) considers *Hevea rigidifolia* "and *H. confusa* [*H. pauciflora* var. *coriacea*], *H. pauciflora* and *H. viridis* [*H. nitida*] to be expressions of the same complex." There is not only a similarity in the seed, but also the general coriaceous and reclinate condition of the leaflets could be interpreted as indicative of some degree of affinity. The floral characters of the two species, however, do not approach each other in any essential respect. The flowers of *Hevea nitida* indicate, in my opinion, a very close relationship with *H. brasiliensis*, thus removing *H. nitida* from any immediate phylogenetic proximity to *H. rigidifolia*.¹⁷

The resemblance of the seed of *Hevea rigidifolia* to that of one form of *H. brasiliensis* of the upper reaches of the Solimoes must be interpreted as coincidental. The "similarity" between the flowers of *Hevea rigidifolia* and *H. brasiliensis* which Mueller-Argovienensis intimated when he wrote in the description of the latter: "facies florum ut in *H. rigidifolia* sed structura diversa" is entirely superficial and, from a phylogenetic point of view, probably insignificant.

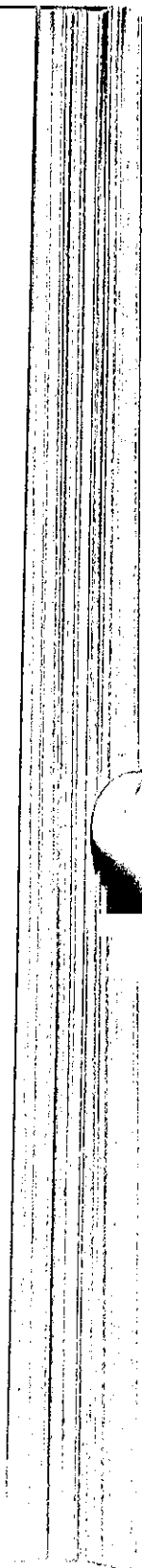
There does appear to be a likeness between the nor-

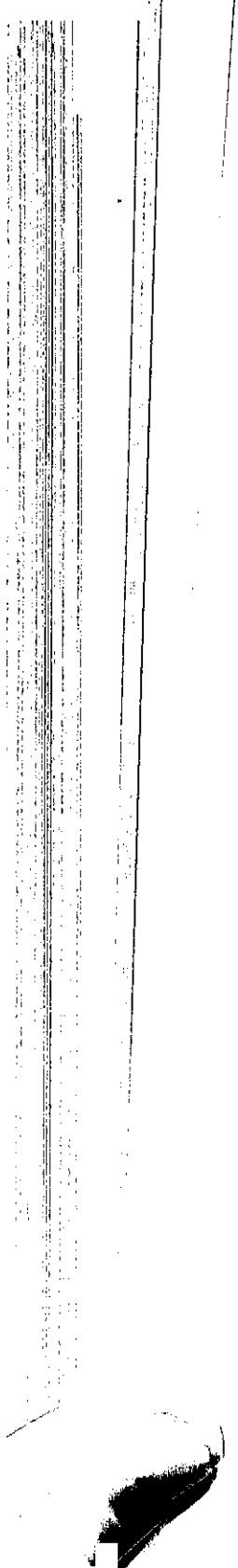
¹⁷ Baldwin (loc. cit. 59) considers *H. pauciflora* var. *coriacea* (*H. confusa*) and *H. nitida* (*H. viridis*) so closely allied that they "may eventually be combined." I cannot subscribe to this opinion.

EXPLANATION OF THE ILLUSTRATION

PLATE IX. A seedling of *HEVEA RIGIDIFOLIA* (*Spruce ex Benth.*) *Muell.-Arg.*, growing in the garden of the Instituto Agronômico do Norte at Belém do Pará, Brazil.

PLATE IX





mal seed of *Hevea guianensis* var. *lutea* and that of *H. rigidifolia*, especially in shape and in coloration. The seed of the former is, however, smaller than that of the latter. This similarity may be significant, but we cannot draw any definite conclusions on the basis of the few known seeds of *Hevea rigidifolia*.

The flower of *Hevea rigidifolia* does indeed show, in several characters, an approach to that of *H. guianensis* var. *lutea*; this was suggested by Spruce in the original description when he stated: "antherae *S. luteae*." None of the floral characters, however, indicates any degree of close affinity. Moreover, the habits and habitats, and therefore probably also the history, of the two concepts are very unlike in all respects, for the one is a widely distributed forest giant growing on well-drained ground along the banks of rivulets or brooks, whereas the other, apparently a highly restricted endemic, is usually a small tree of xerophytic caatingas.

In floral characters, *Hevea rigidifolia* does, as Ducke has pointed out, resemble *H. Benthamiana* very closely. In *Hevea rigidifolia* the staminate buds are extremely acuminate and cylindric-conic; in *H. Benthamiana* they are commonly acuminate, although the latter does not have the segments apically spirally twisted as does the former. Although the flowers of the former are much larger than those of the latter, the general form of the urceolus of the staminate flower is markedly similar. There are, however, several rather important differences which do serve to separate the two. In *Hevea rigidifolia* the number of anthers, surprisingly constant, is very low (normally only six), the suprastaminal column is conspicuously slender and elongate, and the ovary is completely glabrous; whereas, in *H. Benthamiana*, the anther number is variable (usually from six to nine), the column is short, and the ovary is densely white-sericeous. In both

species, however, the lobes of the disk in the staminate flower are similar, being rather elongate, very acuminate and conspicuously erect-spreading. The lax and irregularly spreading long-acuminate tips of the calyx lobes of the female flower of *Hevea rigidifolia*, however, has no similarity to any of the forms of *H. Benthamiana* known to me; indeed, the female flower of *Hevea rigidifolia*, which, upon superficial observation would seem to be somewhat like that of *H. microphylla*, appears to be unique in the genus in this interesting characteristic.

The characters of the ligneous valves of the fruit have hitherto not been utilized taxonomically, but it is of great interest to note in passing that those of *Hevea rigidifolia* are very like those of most of the known forms of *H. Benthamiana* in having an unusually thin endocarp. The long and narrow shape of the valves of *Hevea rigidifolia* is very different from that which is commonly seen in *H. Benthamiana*, but it does remind one of the shape of the valves of *H. Spruceana*. Ducke (in Bol. Técn. Instit. Agron. Norte no. 10 (1946) 13-14) indicates that a specimen collected by him in 1905 on the Rio Negro at Barcellos and distributed by Huber as "*Hevea rigidifolia*" is a form of *H. Benthamiana* var. *subglabrifolia* Ducke with perfectly glabrous leaflets. (See also Ducke in Arch. Instit. Biol. Veg. 2, no. 2 (1935) 235 and in Arquiv. Serv. Florest. Rio de Janeiro 2, no. 1 (1943) 86.)

Recently in Belém, I had occasion to study a remarkable collection of *Hevea Benthamiana* from the Rio Negro which Ducke has determined as representing a perfectly glabrous form of var. *subglabrifolia*.¹⁸ I believe that further study will possibly indicate that this collection represents a distinct variety. The reclinate leaflets

¹⁸ Brazil: Amazonas, Rio Negro infer., loco Acajutuba. "Igapó secus rivulum ad marginem campinae. Arbor 18-20 m.; latex flavidus, parum copiosus." March 22, 1941, Ducke 1963.

are extremely coriaceous with strongly recurvate margins, as in *Hevea rigidifolia*, and although they are much smaller and more narrowly lanceolate-elliptic, they could very easily be misidentified (without fertile parts) as *H. rigidifolia*. The seeds and capsules of this collection, however, unquestionably belong to the concept *Hevea Benthamiana*; they are much smaller than in typical *Hevea Benthamiana*, but they are perfectly ovoid and are yellowish or light golden tan with large reddish brown or brownish black spots. The tree, eighteen or twenty meters tall, had sparse yellowish latex. It grew along a brooklet at the edge of a savanna. According to Ducke, the coriaceous character of the leaflets of this variant was gradually lost as one penetrated farther into the more densely forested igapó. This collection, as the analagous Barcellos material mentioned above, provides us with interesting data for a consideration of xerophytic parallelisms in *Hevea*. It is entirely possible, too, that this unusual form of *Hevea Benthamiana* which, at our present state of understanding, we call a parallelism, may be fundamentally significant as indicative of some actual relationship between *Hevea Benthamiana* and *H. rigidifolia*.

*Possible economic and scientific importance
of Hevea rigidifolia*

Little is known of the economic value of *Hevea rigidifolia*. Ducke (in Rev. Bot. Appl. 9 (1929) 628) intimated that the species "semble fournir du caoutchouc," but naturally he could make no mention at that time as to whether or not it was ever exploited. Huber (in Bol. Mus. Paraense 4 (1906) 633) stated that *Hevea rigidifolia*: "foi designada ao Sr. Ducke como fornecendo borracha bôa," but this statement was made in reference to a collection from Barcellos which was misidentified as *H. rigidifolia* (Ducke loc. cit.). Jumelle ("Les plantes

a caoutchouc et a gutta' (1903) 132) repeated Huber's statement that *Hevea rigidifolia* yields a good rubber. La Rue (USDA Bull. 1422 (1926) 8) included *Hevea rigidifolia* in a list of species yielding "fair to good rubber," but there seems to be no basis for this statement. Spruce (in Hooker's Journ. Bot. ser. 3, no. 6 (1854) 371) merely remarked that it is "a milky tree of 30 feet."

Pittier (loc. cit.) enumerated three species of *Hevea* for the flora of Venezuela: *H. Benthamiana*, *H. minor* and *H. rigidifolia*, but, as stated above, it is doubtful that his report of the last-named species is based on correctly determined material; it refers probably to *H. pauciflora* var. *coriacea*. However this may be, Pittier writes that (translated) "of the three, the two first seem to give good rubber, but we know nothing about the third. It is probable that all take part in rubber production in the country."

The field data annotated on *Fróes 21394* indicate merely "latex branco, abundante, coagulavel," and *Fróes 21401* adds that the species can be "rica em latex branco, coagulavel."

In writing of several of his caatinga collections, Fróes ("Excursão botânica ao alto Rio Negro" Mss. report to Dr. Felisberto C. de Camargo (June 4, 1946) 23) states (translated): "The Heveas of the forest at Javarité (21231, 21249, 21251, 21253) which are also common in the stretches of forest at Caiary-Aiary are low, measuring hardly 5 or 6 meters by 10 to 12 centimeters in diameter at breast height, with heavy and reclinate foliage, with medium-sized fruits as can be seen from the specimens collected in the region of the Rio Içana, in caatingas similar to those of Caiary-Aiary; they certainly must be little known because of the restriction of this species to its peculiar habitat. These forms of *Hevea* have, in themselves, no commercial importance because besides

their small size they are poor producers of latex, and the latex itself is of inferior quality. However, they would be of scientific value because of their rarity."

It would seem from this statement, and from others in the same report which indicate that the greater part of the upper Rio Negro production of rubber is from *Hevea Benthamiana*, that we are justified in inferring that *Hevea rigidifolia* furnishes none of the rubber produced in the area. This does not, however, assist in the appraisal of the quality of the rubber, for it is clear that the principal reason for not utilizing *Hevea rigidifolia* would be its small size. It might possibly be true that, as in the case of *Hevea nitida* var. *toxicodendroides*, its latex could be of high quality even though almost unobtainable due to the diminutiveness of the plant.

The fact that in its native state *Hevea rigidifolia* is of no commercial interest does not, however, indicate that it is devoid of importance to the scientific program of Hevea-investigation now in progress cooperatively between the United States Department of Agriculture and several Latin American countries. I consider that one of our most urgent tasks is the introduction of extensive living material of *Hevea rigidifolia* from several different localities to one or several of our experimental nurseries.

The differences between *Hevea rigidifolia* and the species commonly exploited, especially *H. brasiliensis*, are so great that we would be justified in expecting a number of interesting, and perhaps even revolutionizing, characteristics to appear as a result of an intensive program of selection and breeding.

This small tree is native to isolated sterile (cretaceous) sandstone caatingas on the pre-cambrian granitic Brazilian shield where the pH is probably rather highly acidic and where conditions of psammophytic and chersophytic drought prevail even during the rainy season. How this

species will react in growth as well as in quality and yield of latex when planted on a rich soil with an abundant availability of water is certain to be enlightening.¹⁰ Selection should be carried out to some extent in the caatingas in order to secure for scientific study the most outstanding individuals from several points of view. A still more rigorous and accurate selection can be practiced in nurseries if large numbers of seedlings are planted and studied under controlled conditions. The potentialities of this species as a fast grower, outstanding yielder, disease-resistant strain, drought-resistant material, root-stock, crown-budding stock, as well as in numerous other respects, are certainly worth investigation.

The very fact that *Hevea rigidifolia* is one of the most distinct of the dozen or more species of the genus is indicative of the value which it might have in a plant-breeding program. This is especially true when one considers the possibilities which might arise as a result of chromosome incompatibility.

It is likewise imperative that we collect ample specimens of the coagulated latex from *Hevea rigidifolia* in its native state for chemical examination and later chemical comparison with latex from the same species cultivated under varying ecological conditions. It is possible that, as in the case of *Hevea nitida* in the igapós of the Vaupés of Colombia, of *H. Spruceana* and of *H. pauciflora* var. *coriacea*, the rubber of *Hevea rigidifolia*, of itself, will be of little or no commercial value. The rapid progress in the study of the synthetic elastomers, however, is creating a demand for rubbers of varying properties for use as "fillers" and the latex of no species of *Hevea* should be overlooked as a potential raw material for utilization in the synthetic rubber industry.

¹⁰ The individual introduced by Baldwin in 1944 to Belém do Pará, planted on very light white sandy soil, exhibits an unusually slow growth. It is, at three years, only about five feet tall.