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THE COTTONS OF PUERTO RICO

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The Cottons of the Antillean region belong to the New World cultivated group of species of *Gossypium*. They are perennial shrubs or small trees, and they all bear spinnable lint. On them was based the first expansion of cotton growing in the New World when the mechanical inventions of the Industrial Revolution created a demand greater than the cultivations of the Old World could meet. Though Puerto Rico does not seem to have developed cotton growing to the same extent as the British Islands, which had the advantage of direct access to English markets, there is evidence that it shared to some extent in the seed exchanges whereby the cottons of the indigenous inhabitants of the West Indian Islands were supplemented by commercially desirable types from South and Central America.

The rise of the southern United States as a great cotton producing area and the attacks of cotton pests combined to reduce the profit from cotton production below that obtainable from sugar, and except in one or two isolated areas such as the Grenadine islands, the cotton crop vanished completely from West Indian agriculture. Nevertheless, cotton lint has its domestic uses, and both leaves and roots are employed in household remedies. Many people, therefore, plant a shrub in the house-yard, or encourage a volunteer seedling. In Trinidad (Hutchinson, 1943b), this appears to be the plant's chief means of survival. In Jamaica and the Leeward Islands some types belonging to the species *G. hirsutum* are established as components of the vegetation of xerophytic scrub lands, and others occur spontaneously in badly drained wooded areas on the banks of streams (e.g. Antigua "fringing forests"). Ecological specialisation between species is also evident, the South American *G. barbadense* being more frequent in moist areas and the Caribbean *G. hirsutum* var. *marie-galante* in dried zones. Thus the perennial cottons, abandoned as an export crop, have become established both as commensal plants and also as members of natural plant associations.

At the end of the nineteenth century, with the decline of the sugar industry, cotton again became a commercial crop in the West Indies. The

old perennials however, could not compete with the more recent, high quality, annual Sea Island varieties. Indeed, where Sea Island cotton became a major crop, the old types were a menace to the new, since they provided a source of contamination by mixing and hybridisation, and a host reservoir for pests such as blister mite, stainers, and later pink boll-worm. They were therefore exterminated, and in such islands as St. Vincent and Montserrat the clean-up has been so thorough that no perennial cotton has been seen for years.

Indigenous types, and those on which the cultivations of the eighteenth and nineteenth centuries were based, can only be studied in islands where Sea Island cotton has never been established, or is only of secondary interest. The cottons of Jamaica and Trinidad have already been discussed (Hutchinson, 1943a, 1943b) and the available information on early cultivations in the West Indies as a whole has been summarised by Stephens (1944). The interest of the Puerto Rican cottons is two fold. Firstly, studies of geographical distribution (Hutchinson, in press) have shown that the Greater Antilles form the northern limit of *G. hirsutum* var. *marie-galante* and the southern limit of *G. hirsutum* var. *punctatum*. The latter does not occur in Jamaica, but has been recorded from Haiti, Cuba, and (as herbarium material) Puerto Rico. Secondly, it is of some importance to see how general is the ecological distinction between *G. barbadense* and *G. hirsutum* var. *marie-galante*, and whether there is a similar distinction between these two and *G. hirsutum* var. *punctatum*. A visit to Puerto Rico in January 1944 provided an opportunity to study the distribution and ecology of its perennial cottons, and the information collected is here reported on.

It is necessary first to consider briefly the classification of the New World cultivated species. A detailed classification is given elsewhere (Hutchinson, in press). It is sufficient to say here that the results of cytological and genetic research have been used to identify those natural groups which are separated by real genetic barriers. Only these have been given species rank. Morphologically and genetically distinct sub groups which, when brought together, interbreed freely giving genetically balanced, fully fertile progeny in F_2 and later generations, are regarded as of varietal rank only. Geographical and ecological races that cannot be separated by good morphological criteria are regarded as below the limit of taxonomic differentiation, as also are the manifold variations to be found within an unselected, interbreeding crop population.

The application of these principles has resulted in reducing the species of New World cultivated cottons to two, *G. barbadense* L., the South American cotton, and *G. hirsutum* L., the Central American cotton. Both

are extremely variable. In *G. barbadense*, varietal distinctions are rather ill-defined. Besides the type, two varieties are separated, chiefly on capsule characters, var. *braziliense*, the form with very large capsules and usually kidney seeds from eastern South America, and var. *darwinii*, the wild form with small capsules from the Galapagos islands. In *G. hirsutum*, on the other hand, varietal distinctions are much more strongly marked, though since they are primarily physiological and ecological, they offer some difficulty to the herbarium taxonomist. The typical form is the early annual Upland cotton of the Mexican plateau and the Cotton Belt of the United States. Upland cottons have not been reported from Puerto Rico. In lowland Central America and round the coasts and islands of the Gulf of Mexico is to be found the shrubby perennial var. *punctatum*. It is an early fruiting type, often producing two crops a year. It branches from near the base of the main stem forming, when old, a thicket of thin flexible branches without a definite main stem or trunk. Round the coasts of the Caribbean, south on the American mainland to Brazil, and north through the Antilles is to be found var. *marie-galante*, the Mariegalante cotton of the Grenadines and the Moco of Brazil. The *marie-galante* cottons are large shrubs or small trees, almost always having a definite main stem or trunk. They are photoperiodic, flowering being confined to the months with short days, so they only produce one crop a year. These species and varieties may be recognised as follows:

- a. Staminal column long; anther filaments short, spreading, all about the same length; anthers closely packed; capsule surface usually pitted, with black oil glands in the pits—b.
 - b. Capsules usually less than 6 cm. long, broadest near the base; seeds free—c.
 - c. Capsules small, usually about 3 cm. long, finely pitted.
 - G. barbadense* var. *darwinii*
 - cc. Capsules large, well filled, usually 4–6 cm. long, usually coarsely pitted.
 - G. barbadense*
 - bb. Capsules very long, usually more than 6 cm. long, broadest near the middle, tapering to the base, coarsely pitted; seeds usually joined.
 - G. barbadense* var. *braziliense*
- aa. Staminal column short; anther filaments longer above than below, the upper ones usually ascending; anthers openly spaced; capsule surface smooth—d.
 - d. Bracteole teeth 6–14 (usually about 10); anthers rather sparsely and irregularly arranged, capsules rounded or ovate—e.
 - e. Annual sub-shrubs with few large leaves, and few vegetative branches.
 - G. hirsutum*
 - ee. Perennial, much branched shrubs with small leaves.
 - G. hirsutum* var. *punctatum*
 - dd. Bracteole teeth 3–11 (usually about 6); anthers very many, and regularly arranged on long filaments; capsules tapering; perennial shrubs or small trees, usually having a definite trunk.
 - G. hirsutum* var. *marie-galante*

The cottons of Puerto Rico have been discussed by Watt (1907), Britton and Wilson (1924), and Stahl (1936). Under *G. barbadense* should be included Watt's *G. barbadense*, *G. vitifolium* and *G. microcarpum*. Britton and Wilson's *G. barbadense*, *G. peruvianum* and *G. microcarpum*, and Stahl's *G. barbadense*. *G. barbadense* also includes the cultivated annual Sea Island cottons. *G. barbadense* var. *braziliense* is the *G. braziliense* of Watt, Britton and Wilson and Stahl.

The classification of the cottons now included under *G. hirsutum* vars. *punctatum* and *marie-galante* has been very confused, since the characteristic habit features by which they are best distinguished are not visible on herbarium material. In var. *punctatum* are included *G. purpurascens* and *G. racemosum*, both of which appear to have been described from Puerto Rican plants. Chevalier (1939) has stated that the type specimen of *G. racemosum* Poir was collected in Puerto Rico in 1796 by André-Pierre Le Dru, and he suggested that the seeds which were planted in the Museum garden in Paris and gave rise to the material on which *G. purpurascens* was based, were collected by Le Dru on the same expedition. Watt rightly regarded *G. racemosum* as a synonym of *G. purpurascens*, but he failed to recognise the group now assigned to *G. hirsutum* var. *marie-galante*. Hence, he assigned most of the Puerto Rican material he examined to *G. purpurascens*. It is difficult to determine from their descriptions whether either Britton and Wilson, or Stahl had a clear conception of the distinction between the two groups. It seems likely that Britton and Wilson's *G. hirsutum* and Stahl's *G. racemosum* are *G. hirsutum* var. *punctatum* and their *G. purpurascens* is *G. hirsutum* var. *marie-galante*, but is not possible to decide with certainty.

G. janiphaefolium Bello, which has only been collected once or twice, is referred to by both Britton and Wilson, and Stahl. Mr. R. A. Silow of this Station has examined material in the Gray herbarium, and states that it is a laciniated leaved form of *G. hirsutum* either var. *marie-galante* or var. *punctatum*. Laciniated leaved races of the former are common in Jamaica, and of the latter in Mexico.

In interpreting observations on the present distribution of cottons in Puerto Rico it is necessary to bear in mind the effect of recent attempts to exterminate "wild" cottons in the interests of the Sea Island cotton crop. In most areas the perennials have merely been reduced in number, but in the northwestern cotton area they have been practically eliminated, and the types that formerly occurred there can only be inferred from those found in neighbouring areas, and from ecological factors influencing the distribution of cottons in other parts of the island.

Perennial cottons are common in the coastal plains, uncommon in the inland hilly country, and apparently absent from higher elevations.

None were seen on the road over El Yunque between Mameyes and the Rio Blanco. On three routes across the island (Rio Piedras-Caguas-Juncos-Humacao-Maunabo; Caguas-Cayey-Salinas; Arecibo-Lares-Yauco) only one cotton shrub was seen beyond the limits of the southern plains and their foothills near Salinas and Yauco. This one plant was a *G. barbadense* type, and was found between Caguas and Cayey.

Along the north coast practically all the perennial cottons seen were forms of *G. barbadense*. Plants were recorded in house-yards at intervals from Naguabo on the east coast to Arecibo on the north coast. One plant was noted in a house-yard in Mayaguez and another in Cabo Rojo. There can be no doubt that they were formerly to be found also in the northwest district from Arecibo to Mayaguez. No kidney seeded var. *braziliense* cottons were seen, though they have been recorded by earlier collectors. Considerable variability was observed in characters of no taxonomic importance. Yellow and pale flowers, large and small petal spot, and fuzzy and tufted seed were seen, and the staple length as measured on combed halos varied from 35 to 46 mm. In the plaza in San Juan there is a very large cotton plant with large fuzzy seeds, and very coarse, short sparse lint. It is near *G. barbadense*, but presents some unusual features. It is included here pending observation in culture. *G. barbadense* was only seen in house-yards, and never recorded as occurring spontaneously in uncultivated areas. Most of the plants seen bore ripe seed cotton, but only the early capsules had burst.

The commonest cotton in Puerto Rico is *G. hirsutum* var. *marie-galante*. This is the "wild cotton" of house-yards all through the south coast region from Guayama to Lajas and Mayaguez. On the north coast it is rare, but plants were seen by the road side in dry country near Fajardo, and in house-yards in the environs of San Juan and near Vega Alta. Capsules were just bursting and plants with no ripe seed cotton were still common. Though generally found in house-yards, it was not infrequently seen in poorly drained areas on the margins of streams in the southern sugar cane belt.

Variability in *marie-galante* was very low, in marked contrast to the wide range of types found in Jamaica (Hutchinson 1943a). Most plants were glabrous or nearly so. Hairy types occur occasionally. The seeds of those examined were all clean of fuzz except for a small green tuft at one or both ends. Fuzzy seeded plants have been recorded by Dr. L. F. Martorell, but appear to be rare. The lint is of fair quality, not very copious, and was fairly uniform (about 40 mm. long) in the samples examined.

G. hirsutum var. *punctatum* was only collected in the south of the island, and appears to be comparatively rare. A considerable colony of plants

was seen growing spontaneously on poorly drained land adjacent to the airfield at Central Mercedita, near Ponce, and another colony on sandy wasteland close to the landing ground in the Guanica Insular Forest. All plants were early fruiting and when examined were covered with ripe capsules. A striking feature of both colonies was their variability. At Central Mercedita light brown and white lint, fuzzy and semi-fuzzy seed were noted, and in the Guanica Forest there were tufted and naked seeds and also a type (found by Dr. L. F. Martorell) with naked, lintless kidneyed seeds. The lint of the linted types was fairly uniform, rather more copious, but probably rather inferior to that of var. *marie-galante*, with a halo length varying from 32–40 mm. In the two collections a greater range of variation was recorded than was observed among all the var. *marie-galante* plants examined. The discovery of a lintless, kidney seeded type is of particular interest in view of Watt's (1907) comment that "Todaro was in error when he placed this plant (*G. racemosum* Poir) under his subsection *Synspermia* and figured the seeds as naked and kidneyed." Chevalier's (1939) plate shows that Poiret's type was linted, but Todaro evidently saw specimens of the form found by Martorell. The lintless kidney seeded type must have persisted in Puerto Rico for a long time.

In discussing the justification for regarding *G. racemosum* as a synonym of *G. purpurascens*, Watt referred to specimens collected in 1885 by Paul Sintenis and labelled "Salinus de Cabo Rojo in sylvis litoralibus." He commented that "the specimens collected by Sintenis are distinctly peculiar. The leaf stalks are pale pink and the flowers very small and numerous. It is spoken of as found in forests along the seashore, from which circumstance it may have been wild." He suggested that this might be Poiret's *G. racemosum* but from Chevalier's description and plate it is clear that Poiret's type was the common form of var. *punctatum*. The Salinas near the Cabo Rojo lighthouse are protected from the sea by a sand ridge, classified in the Puerto Rico Soil Survey as Palm Beach Sand. It is too dry and windswept to support a forest, but it carries an open plant community composed of shrubs, grass, and cactus. It is well known as a locality in which wild cottons occurs, and although much has been eliminated in the cotton eradication campaign, we had no difficulty in finding bushes among the cactus and scrub. At Dr. Martorell's suggestion we also looked for it at the Salinas de Guanica, which is the only other locality on the south coast where Palm Beach Sand is found, and we found the same cotton in very similar ecological conditions. This type is known as "algodón brujo," and is evidently truly wild. In vegetative characters it is as described by Watt. At the time of our visit it was fruiting freely, and many of the capsules had burst. The capsules are small, smooth, and almost round, containing small seeds with hard seed coats. The seeds bear a thick brown fuzz and a rather sparse and irregular coat of

brown lint. The Cabo Rojo sample gave a combed halo length of 27 mm. and the Guanica samples 40 mm.

"Algodón brujo" is indistinguishable from the wild cotton hitherto known as *G. taitense* Parl., *G. taitense* has been regarded as endemic in Polynesia, but there has been considerable difficulty in determining the limits of its distribution, since it cannot be distinguished with certainty from *G. hirsutum* var. *punctatum*. Watt assigned to it specimens from New Caledonia, the Philippines, Rodriguez and Madagascar, and similar types are known from Haiti, and (as herbarium material) from various localities in Central America. Watt (1907) acknowledged the difficulty of separating *G. taitense* from *G. purpurascens*, which is here included in *G. hirsutum* var. *punctatum*. Harland (1939) also remarked that it seemed too closely related to the *punctatum* cottons to have been isolated in the Pacific for a long period of time. Recent genetic work at the Cotton Research Station, Trinidad, has confirmed Harland's belief that the wild cotton of Fiji is genetically very close to the *punctatum* cottons of the Gulf of Mexico, and the discovery of a cotton indistinguishable from the Fijian form growing wild in Puerto Rico completes the case for including *G. taitense* in *G. hirsutum* var. *punctatum*.

The distribution of *G. barbadense* and *G. hirsutum* var. *marie-galante* is in conformity with their distribution in the other islands studied. *G. barbadense* is confined to the more mesophytic areas with high rainfall, and *G. hirsutum* var. *marie-galante* is common in dry, rather xerophytic areas, though it is also occasionally found where *G. barbadense* predominates. *G. hirsutum* var. *punctatum* appears to be adapted to even more xerophytic conditions than var. *marie-galante*. The Central Mercedita colony of the typical form was growing in the same sort of situation as var. *marie-galante* occupies, but the Guánica Forest colony was in a more xerophytic habitat than any in which var. *marie-galante* was found. "Algodon brujo" is a highly xerophytic race adapted to drier conditions than would be tolerated by any other Puerto Rican cotton.

All cottons are light loving plants. Seedlings are only established successfully in the open, and mature plants are rarely found where there is overhead shade. In the West Indies suitable conditions are to be found only in cultivated land and the immediate vicinity of houses, and in the natural vegetation of such areas as are too dry for the development of a complete plant cover. *G. barbadense*, which has only recently been introduced from South America, has only been recorded in house-yards, and commercial cultivations. The *marie-galante* cottons are most common in house-yards also, but they are to be found in abandoned lands that are swampy during part of the year, and in pastures. The fact that they are spontaneous in such localities cannot be regarded as evidence that they are indigenous, since all these areas owe their present status to the activi-

ties of man, and if left alone would revert to closed forest in which cottons would not survive.

Both forms of var. *punctatum* have been found in situations where they owe nothing to man. That "algodón brujo" is truly wild is beyond doubt, and the typical var. *punctatum* found in the Guanica Insular Forest occurred in a natural plant association. In both cases the plant communities are open, low scrub associations, where considerable patches of bare ground occur, offering good opportunities for the establishment of light loving seedlings. In Puerto Rico, therefore, there is every reason to believe that *G. hirsutum* var. *punctatum* is the native cotton, both *G. hirsutum* var. *marie-galante* and *G. barbadense* being either directly or indirectly dependent upon man for survival. This conclusion is in sharp contrast to that reached from a similar study of the cottons of Jamaica (Hutchinson 1943a) where the only var. *punctatum* seen was a plot planted with imported seed, and where var. *marie-galante* was found growing spontaneously in xerophytic scrub land.

Studies of *marie-galante* x *punctatum* hybrids have shown that there is no genetic barrier between them. If they were both indigenous in the Greater Antilles, and had spread thence to other areas, one would expect to find considerable intergradation, at least at the margins of their ecological ranges. The absence of intermediates, and the specialisation of the photoperiodic var. *marie-galante* to tropical regions indicates that *marie-galante* is a comparatively recent introduction, and the Greater Antilles may be regarded as on the periphery and not at the centre of its distribution. The variability of the *marie-galante* cottons of Jamaica must then be ascribed to the introduction of a wide range of types during the great development of cotton growing in the latter part of the eighteenth century. (See Stephens 1944.) The absence of var. *punctatum* from Jamaica and the Lesser Antilles shows that the Greater Antilles are on the periphery of the distribution of this variety also. In both varieties, the cultivated and house-yard cottons that are found in association with mankind have a wider geographical distribution and are found in a wider range of ecological situations than the wild races of xerophytic scrub lands, and it is evident that man has had a very large part in the dissemination of cotton through the Antillean region.

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