certainly brought to light a constructional defect in the flying machines of his day. So too in science. Cautious Dædalus will apply his theories where he feels most confident they will safely go; but by his excess of caution their hidden weakness can not be brought to light. Icarus will strain his theories to the breaking-point till the weak joints gape. For a spectacular stunt? Perhaps partly; he is often very human. But if he is not yet destined to reach the sun and solve for all time the riddle of its constitution, yet he may hope to learn from his journey some hints to build a better machine.

A. S. EDDINGTON

THE HAWAIIAN OLONA

IN SCIENCE (N. S. 48: 236–38, September 6, 1918) was published a paper by the writer, entitled "The Olona, Hawaii's Unexcelled Fiber Plant." This was later reprinted by the *Literary Digest,* and evidently aroused widespread interest concerning this remarkable fiber. The writer received letters from many parts of the world, requesting further information. Since his previous account he has been furnished with the following statement, by Dr. N. Russel, of Olaa, Hawaii, and originally published in the report of the Hawaii Agricultural Experiment Station for 1902. As this report is out-of-print and unavailable to most students, Russel's excellent account is presented herewith:

Some fifty years ago about 1,000 natives were living on the margin of the virgin forest and pahoe-hoe rock along the trail connecting Hilo town with the crater of Kilauea, island of Hawaii, in a spot corresponding to the present 22-mile point of the volcano road. Making of "kapa" (native cloth) out of "mamake" bark (*Pipturus albidus*), of olona fiber for fishing nets out of *Touchardia latifolia,* and capturing "O-U" birds for the sake of the few precious yellow feathers under the wings, of which luxurious royal garments were manufactured—those were the industries on which they lived.

For the reasons common to all the native population of the islands, viz., the introduction of new germs of disease—syphilis, leprosy, tuberculosis, smallpox, etc.—this settlement gradually dwindled away, and in 1862 the few surviving members migrated to other localities. At present only patches of wild bananas, taro, and heaps of stones scattered in the forest indicate the places of former habitation and industry. I have heard, however, that as late as the seventies Kalakaua still levied a tax in olona fiber from the natives of Puna and Olaa districts, which fiber he sold at high prices to Swiss Alpine clubs, who valued it for its light weight and great strength.

Touchardia grows abundantly in Olaa forests, presenting a kind of a natural plantation. It very successfully holds its own in competition with ferns and other elements of the undergrowth in the shade of "ohia" trees (*Metrosideros polymorpha*). The deep shade, very porous soil, considerable moisture, with a yearly rainfall of 180 inches pretty evenly distributed, are the natural conditions. By removing some of the undergrowth, scattering seed, and probably by planting cuttings, the number of plants on the same area could be greatly increased with but very small expense. Since plants of medium age (about 18 months old) supply the best fiber, natives in gathering used to turn down the older ones with the foot, laying the whole plant on the ground to force new shoots and sprouts.

I was familiar with the plant and its properties for years, but did not pay any further attention to it as a possible object of industry for the reason that to all appearances the same difficulties in mechanical extraction of fiber will be met as in the case of ramie, for which no satisfactory machine has been found. Recently my interest in the matter was again aroused by Mr. Jared G. Smith, of the Hawaii Experiment Station. Considering that *Touchardia* seems to be free from resinous matter, upon his suggestion I decided to examine the subject more in detail. For this purpose an old native, born and raised in the settlement above mentioned, was interviewed. Together with him I proceeded into the forest along twenty-two miles side trail. In my presence

he picked the plants, stripped them of the bark, and with his own olden tools manufactured the sample of fiber.

My object was to ascertain what kind of plants he selects, and to see the primitive method of manufacture, with the idea that this method might furnish some suggestions for the construction of the machine. We had hardly made a dozen steps in the woods along the twenty-two-mile trail when a rich harvest of *Touchardia* was found. We found both male and female plants that could be distinguished only by inflorescence. Whereas male flowers are situated on relatively strong, repeadedly forking cymes, growing out of the base of the leaves, female ones look like so many flattened lumps of green dough planted at the base of the top branches. Both plants are taken indiscriminately. Careful discrimination is made, however, in regard to the age of the plant; neither too young nor too old ones are taken. The bark of the old ones is somewhat knotty, woody, and short jointed, and, as I have mentioned, such plant is turned down to the ground to force it to give new shoots. The best stems are not thicker than the finger, about one year and a half old, with the bark of a chocolate-brown color, with distanced scars of former leaves, straight and high (8 to 10 feet), devoid of leaves except on the top. Such stems are cut with the knife near the root and below the crown. Their bark strips easily as a whole from bottom to the top. The ribbon obtained is hung over the neck of the gatherers. There is also a plant with the leaves very much like those of *Touchardia,* the "hopue"; but this one generally grows to a large-sized tree, has different flower, and light-grayish color of the bark. Neither previous soaking nor drying are resorted to before the extraction. The bark is used raw.

The implements used are: (1) A wood board made of "naou" tree, characterized by its dark color, hardness, compactness, evenness, and absence of knots. This board is about 6 feet long by 2 to 3 inches wide. It has a very light curve in both directions—in width and length; is wider at one end and obtusely pointed at the other. (2) A plate of fish bone of "honu" fish, about 8 inches long by 2½ wide, and is also slightly curved in both directions. Its lower margin is sharpened under 45° like the edge of a chisel.

The process of manufacturing is as follows: The "naou" board is fastened on the ground with rocks at the narrow end to prevent any forward sliding, the curved surface uppermost. The broader end is a little elevated by another piece of rock. The board is moistened with water. A ribbon of bark from one plant is taken. Its bottom end is first fastened by treading on it with the toe of the right foot, the top end raised vertically by the left hand, so as to tightly stretch the band. Holding the fish plate by the right hand in its middle, the sharp end of the bone is passed upward along the inner surface of the ribbon, which operation is intended for flattening the curled ribbon and taking off the slimy substance covering the inner surface. Then the ribbon is stretched horizontally upon the naou board, the bottom end toward the wider end of the board and the operator, and held tightly to it by the two fingers of the left hand, the outer surface of the bark upward, the inner sticking to the board. Then the fish plate, held in the right hand by the middle at 45°, with its sharp end downward and forward, squeezing the ribbon between the tool and the board, is repeatedly passed toward the pointed end of the board, by which motion the flesh is scrapped off, leaving a ribbon of fiber. From one to two minutes are required to free the bark of one plant. The operation of scraping is easy, the fiber evidently being located on the inner surface. The fiber thus obtained is dried in the sun.

Besides manufacturing fishing nets, natives used to make of it the best of their fishing lines. I am told that whalers in former times paid high prices for olona for making lines for whales. There is an old native in Hilo who still uses the line that was made and used by his grandfather.

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