COCONUT SHELLS AS AN INDUSTRIAL RAW MATERIAL

II. MISCELLANEOUS USES: FUEL

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THE first article[17] of this series reviewed in some detail the present state of knowledge of the chemical composition of coconut shells. This, the second, article aims at describing uses which have been made of shells in the past and are being made at the present time.

UTILIZATION OF SHELLS AS SUCH

The uses which will be dealt with under this head can scarcely be described as industrial, but rather as domestic and ornamental.

Coconut shells have always been used in the domestic economy of coconut-growing countries in a variety of ways. To go no further back than the seventeenth century, Robert Knox[18] relates how that "..... when they (*i.e.*, the Sinhalese) meane to make a bottle of the nutt they make but a little hole in one end & keepe it tell all the meate in the inside is rotted out & then it is like a bottle without a necke, in which they keep Racke* or oyle or any other liquor: some will hold a quart. The cups or dishes is onely to split the nut in the Middle as it will doe easear than any other way & then thare is 2 Cups made of one nutt."

Old Knox overlooked the fact that the half carrying the eyes is apt to "spring a leake" when the soft eye decays and that after all only one practicable cup is obtained from one "nutt". However, half-shells continue to be used in Ceylon as drinking cups in toddy taverns, as receptacles for collecting rubber latex, fitted with handles as scoops and ladles, and as begging bowls.

Bennett (1843)[19] gives a similar account and mentions containers for oil lamps and "sportmen's liquor flasks"! He also refers to the employment in Ceylon of a coconut shell as a resonant backing for a musical instrument. "The Singhalese *Vinah* is formed of a neatly carved or polished coconut shell (of which about a third part is cut off) and covered with guana skin (*Lacerta iguana* L.); to this is fixed a solid handle of about an inch in diameter, which is generally lackered with various colors, and, on the opposite side of the shell, a sort of peg is fixed, to which two strings, one of horse-hair, and the other of fine bow-string hemp (*Sensivierra zeylanica*), are attached; these strings are passed over a wooden bridge, upon the centre of the covering, one horizontally, and the other upon an inclined plane, the slope commencing from within three inches of the extremity of the handle, where it is perforated large enough to receive a strong peg of nearly half its circumference, and of about a fourth part of its length, having at the point a notch for the reception of the strings, which, by turning the peg, are kept in a state of tension, like the strings of a violin.—This instrument is played upon with a bow. ....."

* *i.e.*, arrack.

Watt (1889),[30] says that "by Hindus, the dried shell is almost universally used as the water-bowl of their smoking-pipes or *hukah*. In Madras these shells are made into elegantly carved ornamental vases, lamps, spoons, sugar-pots, tea-pots, etc." He also gives a list of 83 different articles prepared from the coconut palm exhibited at the Colonial and Indian Exhibition in the 1880's, which includes several shell articles.

Burkill (1935),[20] has some interesting particulars of coconut shell vessels used in Malaysia. "The measure of capacity known as a 'chalok' is what a coconut scoop will hold. A 'chupak' is the amount which half a coconut shell will hold." Similarly Grisard and Vanden-Berghe (1889),[21] note that in Siam "..... les noix de coco coupées en deux sont graduées et employées comme mesures de capasité dans le trafic des graines et des liquides." Burkill adds some curious information on Malaysian folk-lore: "..... in Java, ... the coconut shell is held to be the appropriate vessel for medicines. In Sarawak, medicinal preparations in connection with births must be given in a coconut shell. Among the Malays a coconut shell vessel is used in a rice-ceremony because evil spirits must be confronted with objects which they recognize (Skeat, *J. Roy. Asiatic Soc.*, Straits Branch, 1898, 31, 13). In the Nicobar Islands a baby until two months old must only be washed in water from the shell of a young coconut (Whitehead, *In the Nicobar Islands*, 1924, p. 121).

The manufacture of such articles as have been mentioned has of course been often more than merely utilitarian, as the reference above to Watt's *Dictionary* indicates. Coconut shell is hard, takes a high polish, can be carved, if with some difficulty, decorated with lacquer, inlaid with silver or other metals, and generally used with ornamental effect. Local craftsmanship has, therefore, produced articles of frequently very attractive appearance, and characteristic of the native art of the various countries of origin.

Several early writers, including Regnaud (1856)[22] and Grisard and Vanden-Berghe[21] have noted that by washing with an alkaline solution and/or rubbing up with oil, coconut shell takes on a fine dark-brown to black shade, which enhances the attractiveness of articles made therefrom. "Gratée et polie", says Regnaud, "puis frottée d'huile ou lavée dans une solution alcaline, la noix de coco devient d'un beau noir, et se transforme, entre les mains d'un ouvrier industrieux, en toutes sortes d'ustensiles de ménage ou de simple fantaisie."

Of decorative work illustrations have been published of very ornate Indian work (lamps, goblets, flower-vases, etc.) by J. Shortt (1888),[23] of combs, ladles, bowls and stands, and water-dippers from East Africa by Hamel

Smith and Pape (1914),[24] and of more modern Ceylon ware by Pieris (1936).[25] Three good illustrations in Pieris' little volume show bangles, buttons, cuff-links, ash-trays, trinket-dishes and paper-weights; and a complete tea-set, including pot, six cups and sugar-bowl. Some of these are perhaps to be described as articles "de simple fantaisie"; the tea-set for example, is probably more ornamental than useful. Buttons and similar things such as studs are, however, practicable; Little (1908)[26] had many years before noted the occasional manufacture of buttons in Malaya, and even said, "it is proposed to send the shell to Europe for button manufacture".

It would doubtless be possible by curious literary research to extend considerably the foregoing account of domestic and ornamental uses of coconut shells; but the main features have been covered and one further reference must suffice. O. F. Cook (1910),[27] in the course of his attempt to show by botanical and historical evidence that the coconut palm had its origin in South America (a conclusion not now usually accepted), has a good plate of a small carved coconut found in a grave in the Chiriqui district of Panama. This specimen is carved in a simple design and is very attractive.

Use of Coconut Shells as Fuel

Of the enormous quantities of shells produced annually in coconut-producing countries (estimates of which are given in a later section), the uses discussed in the previous section account of course for a negligible fraction. Undoubtedly the bulk of shells produced have been and are in most countries used as fuel; they do provide for many purposes an excellent fuel, although Regnaud's comment: "Il n'y a pas au monde un combustible supérieur a la coque du coco" may be taken as rhetorical rather than factual.

Especially in countries where a well-developed plantation industry exists, shells are largely used for firing copra-drying kilns. Burkill (*loc. cit.*), for example, says that "it is the destiny of 70 per cent. of the coconut shells in Malaya to be burned for drying copra".

In Ceylon on most estates copra is dried by direct heat from burning shells in kilns of simple but effective design. Good descriptions of the procedure are given by Cooke (1932),[28] and by Pieris (1940).[29] Cooke notes that in Ceylon nuts are usually allowed to wither in storage for about a month before curing. In consequence a cleaner separation of the husks results and the shells are obtained free from adhering pith and fibre. The shells are also frequently dried before use. In this way clean-burning almost smoke-free fires are given by these shells.

The percentage of total shells used in copra drying naturally varies with conditions and with the efficiency of the kiln and its operators. Cooke (*loc. cit.*, p. 49) states that under unfavourable conditions, as with a draughty kiln or in wet weather, shell consumption may be between 75 and 100 per cent., whilst under good conditions only 25-50 per cent. may be used. In the writer's experience, Ceylon kilns do not attain the latter order of efficiency and about 60 per cent. consumption is probably normal. Lower consumption than this is only obtained in very dry districts where the copra is partly sun-dried (*cf.* Pieris, *loc. cit.*).

On small-holdings, as in S. India and to a large extent in Ceylon, shells are for the most part used as domestic fuel. On estates, any surplus left over from copra curing may also be so used, but in Ceylon, for example, there is a not inconsiderable sale to laundries, bakeries,* lime kilns, brick-yards and others requiring fuel. Cooke notices such uses and states that at the time of his enquiries (1931) the price obtainable was between Re. 0·90 and Re. 1·50 per 1,000 shells, though as much as Rs. 4·00 was paid for larger well-shaped shells for rubber tapping (see previous section).

In subsequent years Ceylon developed a considerable export business in coconut shell charcoal and the price of shells became largely dependent on the export price of charcoal, frequently being as high as Rs. 5·00 per 1,000. (Shell charcoal forms the subject of the next article in this series.) At the time of writing the price of shells at estates is round Rs. 2·00 per 1,000 whole shells.

Working with average Ceylon coconuts roughly 6,000 to 7,000 whole shells go to a ton. (Actual data are given in the next article.) Thus at the 1931 prices quoted by Cooke the fuel cost per ton was between Rs. 5·40 and Rs. 10·50, and compared favourably with other fuel when long transport was not involved. Scientific data do not appear to have been recorded on the calorific value of shells; it is likely to be over 7,500 British Thermal Units per lb.

Shells are not favoured as a boiler fuel; there seems to be a rapid corrosive effect of the vapours on fire-bars, etc., due partly to the high temperature reached and to the acid nature of the combustion products when air-intake is insufficient. (See Article IV on Products of Dry Distillation.) There is also in Ceylon a slight prejudice against their use in the cooking of food, especially meat, which the "creosotic vapours" are alleged to render tough and indigestible.

Shell Ash

The chemical composition of shell ash has been dealt with in the previous article.[17] It seems, however, desirable to conclude the present section on the use of shells as fuel, with a few supplementary remarks on the ash. Burkill is clearly wrong in stating (*loc. cit.*, p. 160) that the ash has but little manurial value, in view of its high potash content. The point is that something like a million shells are required to give a ton of ash. Furthermore, there is some loss of potash by volatization if the temperature of combustion is very high. Georgi (1941)[5] discusses the manurial value of shell ash.

Burkill quotes some uses of shell ash in Malayan native medicine, with which this article may be closed: "The ashes of a coconut shell with pepper, garlic and vinegar, make

* At the time of writing (Nov. 1943), for example, one large bakery in Colombo uses some 15,000 shells (about 2 tons) a week.

a medicament drunk after confinement (Skeat, *Mal. Magic*, 1900, p. 346). The ashes, with vinegar only, may be rubbed on the body (Ridley, in *Journ. Straits Med. Assoc.*, 1897, 5, p. 138). In the *Medical Book of Malayan Medicine* (*Gardens Bull.*, S.S., 1930, 6), the ash of coconut shell is prescribed in applications for swellings, pain in the stomach, and rheumatism; it enters also into a gargle. In no case is its presence anything but empirical, and in the treatment of swellings, the use of the eye-end of the shell suggests magic."

It is indeed difficult to see what effect the acetates formed by dissolving the ash in vinegar can have other than as a mild diuretic due to salt action.

17. Child, R., "Coconut Shells as an Industrial Raw Material. I. Composition of Shells", *Current Science*, **1943, 12,** 292–94. See this article for references 1–16, which have occasionally been re-quoted in the subsequent articles. 18. Robert Knox, *An Historical Relation of Ceylon*, etc. (Quoted from the edition published in 1911 by MacLehose & Sons, Glasgow, p. 420). 19. Bennett, J. W., *Ceylon and Its Capabilities* (London), 1843, pp. 87 & 103. 20. Burkill, I. H., *A Dictionary of the Economic Products of the Malay Peninsula* (Crown Agents for the Colonies, London, 1935), Part I, p. 609. 21. Grisard, J., and Vanden-Berghe, M., *Les Palmiers Utiles* (Paris, 1889), p. 68. 22. Charles Regnaud, *Histoire Naturelle, Hygienique et Economique du Cocotier* (*Cocos nucifera*, Linn.), Paris, 1856, p. 125. This little-known work was presented by its author, a native of Mauritius, to the Faculty of Medicine of Paris as his Thesis for a Doctorate. It is an interesting little volume, full of curious information, which deserves to be better known. 23. Shortt, J., *A Monograph on the Coconut Palm or Cocos nucifera*, 1885, Madras Govt, Press, 1888, Plates Nos. 5 & 6. 24. Hamel Smith, H., and Pape, F. A. G., *Coconuts: The Consols of the East*, "Tropical Life," Publishing Dept., London, 1914 (2nd edition), p. 350. 25. Pieris, W. V. D., *On the Uses of the Coconut Palm, with an Illustrated Guide to Coconuts* (Coconut Resesrch Scheme, Ceylon, 1936), p. 7 and Plates 37–40. 26. Little, R., "A Further Use for the Coconut," *Agric. Bull. Straits and F.M.S.*, 1908, **7,** 258. 27. Cook, O. F., "History of the Coconut Palm in America," *Contribution from the U.S. National Herbarium*, 1910, **14,** Part 2, p. 288, Plate 53, Fig. 1. 28. Cooke, F. C., "Investigations on Coconuts and Coconut Products," *Bull. No. 8 (General Science), Dept. of Agric., S.S. & F.M.S.*, 1932, pp. 22–33. 29. Pieris, W. V. D., *Methods of Copra Curing*, Illustrated leaflet, p. 8, issued by the Ceylon Coconut Board, Colombo, 1940. 30. Watt, G., *Dictionary of the Economic Products of India* (Govt. Press, Calcutta, 1889), **2,** 455, *et seq.*

RECENT WORK ON WOOD PRESERVATION AND IMPROVEMENT AT THE FOREST RESEARCH INSTITUTE, DEHRA DUN*

THE importance of protecting wood against destruction by fungi, termites, borers, marine organisms and fire needs no emphasis. The losses due to these agencies are enormous and the importance of wood preservation is obvious. In advanced countries wood preservation is synonymous with timber utilization and its economic importance is recognised. Further, but for the indirect influence of wood preservation on forest conservation, several million acres of forests would not be standing to-day in various parts of the world.

A proper understanding and practice of wood preservation demands a knowledge of several branches of science, *viz.*, chemical engineering, applied physics, chemistry, timber technology and a knowledge of wood destroying fungi, borers, termites and marine organisms, etc.

The foundations of wood preservation research in this country were laid by Sir Ralph Pearson of the Indian Forest Service about thirty years ago. With very limited equipment at his disposal, he carried out experiments on the treatment of railway sleepers and on various types of preservatives.[1] As a result of this work the first commercial treating plant was started by the N.W. Railway. This good work was continued by later officers and among work carried out by them may be mentioned the examination of the treatment characteristics of various species of Indian timbers,[2] natural durability tests, accelerated service tests,[3] service tests on treated sleepers,[4] the development of a new specification for the treatment of coniferous sleepers,[5] which enabled the Forest Department to obtain 50 per cent. more sleepers from the same volume of timber as were obtained before, and the evolution of the preservative Ascu[6] which aroused considerable interest.

The Forest Research Institute is equipped with four pressure cylinders wherein timber, varying in length from 3 to 40 feet, can be treated by all the standard pressure processes, five open tank plants, and a laboratory where all chemical, physical and chemical engineering work connected with the experiments can be carried out.

Toxicity Tests

In co-operation with the Mycologist, experiments are in progress to find out the most suitable fungi for use in toxicity tests. The reaction of Indian fungi to the more important preservative chemicals is being investigated. Toxicity tests on a commercial sample of cashew shell oil showed that, contrary to popular belief, the oil is not sufficiently toxic to wood-destroying fungi.[7] The toxicity of various types of Indian creosotes[8] and ascu[9] to wood-destroying fungi has been studied. Tests on the natural durability of various timbers and accelerated service tests on several preservatives have been carried out in the Institute's test yards.[10]

Preservatives

An important and extended investigation, recently undertaken, deals with the most suitable quality of creosote for use in this country. Several types of creosotes, and creosote fractions, have been and are being subjected to

* Contributed at the request of the Editor, *Current Science*.