night-blindness is a food deficiency disease. This is rather a different thing from traditional knowledge of the value of liver in treatment. To the best of my recollection, the Newfoundland fishermen, while they knew how to cure night-blindness by liver, did not clearly understand that it was caused by their poor diet, and in other parts of world knowledge of the method of treatment does not seem to have involved recognition of etiology. The passage may, therefore, be worthy of a place in the history of ophthalmology and nutrition.

1. *Jour. Hyg.*, 1930, **30**, 357.

COCONUT SHELLS AS AN INDUSTRIAL RAW MATERIAL

III. ESTIMATED WORLD PRODUCTION

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THE first of this series of articles[17] dealt with the chemical composition of coconut shells; and the second[31] with miscellaneous uses of shells as such and with their value as fuel.

It is convenient at this stage to consider briefly the world output of coconuts and the corresponding availability of coconut shells, since in discussing (in latter articles) potential utilization of shells it is necessary to have a working idea of the quantities produced.

World Production of Coconuts

Estimates of world production are not very precise. Fairly good statistics are available for the Philippines prior to the Japanese occupation, and the writer's estimates (1939)[32] for Ceylon are believed to be reasonably near the truth. Statistics are usually available for exports of coconut products from countries of origin; local consumption is, however, very difficult to estimate.

Probably the most ambitious attempt to assess world production of coconuts has been that of Leo Schnurmacher, Inc., of the Philippines (1938)[33] and the following table is to a large extent adapted from their publication:

TABLE I

Annual Production of Coconuts (Estimated)

Country	Area Planted (Acres)	% of World Total Acreage	No. of Trees (*1000's*)	Trees per Acre	Bearing Trees (*1000's*)	Annual Production of nuts (1000's)	Nuts per bearing *tree per yr.*	Nuts per Acre per *year*
Netherlands Indies ..	2,943,700	30·6	169,159	57	152,243	6,000,000	39	2038
Philippines ..	1,571,500	16·3	120,696	77	90,363	4,299,000	48	2736
India ..	1,475,900	15·3	83,917	57	78,815	3,032 600	38	2055
Ceylon ..	1,100,000	11·4	60,500	55	51,425	1,853 200	36	1685
Malaya ..	609,200	6·3	24,357	40	24,039	1,309,100	54	2149
New Guinea ..	296,000	3·1	14,372	49	11,538	438,500	38	1480
Others ..	1,622,300	17·0	84,863	52	62,245	2,598,300	42	1602
	9,618,300	100·0	557,864	58	470,665	19,530,700	42	2030

The estimates in Table I attempt to include locally consumed products, and so are considerably higher than those of Snodgrass (1928)[34] or of the International Institute of Agriculture (1939),[35] which are only concerned with commodities entering world commerce.

It will be observed that, according to Table I, six major producing countries account for the bulk of world production, and it is certain that these countries provide over 90 per cent. of coconut products entering world trade.

Average Weight of Shells

Coconuts vary considerably in size, the greatest differences being varietal. Varieties range from the dwarf types, which may weigh as little as 250 grams per husked nut, to the large San Ramon nut of the Philippines, which when husked may weigh as much as 2,000 grams. The weight of the shells, though of course greater for the larger nuts, does not run exactly parallel to the weight of husked nuts. In general, as would be expected on mathematical grounds, the weight of the shell forms a smaller proportion of the total weight of husked nut in the case of the larger varieties. Thus, H. S. Walker (1906)[36] gave for San Ramon nuts an average of 20 per cent. for the ratio of shell weight to husked nut weight; for average Ceylon nuts the figure is about 25 per cent., and for dwarf nuts it may reach 35 per cent. This general rule is not a rigid one, since varietal differences in shell thickness occur. For example the Ceylon "Bodiri" type of nut has a very thin shell, and the "Porapol" type, similar in size, has a very thick one However, within a population drawn from one variety the general rule has some application, as will be seen in the fuller discussion below.

* It should be noted that in the whole of this discussion, unless otherwise stated, the reference is to ripe nuts stored in the field one month before husking, as usual in Ceylon estate practice.

Apart from varietal differences, the size of nuts is affected by soil conditions, elevation and climate. In discussing these factors, it is for two reasons convenient to confine attention to the medium-sized nuts of the tall palms widely grown in Ceylon; these are the economic type most commonly grown; and for them more accurate information is available than for other types.

It was shown by Cooke (1934)[37] that there is a high correlation between weight of husked nut and wet meat. Pieris (1935)[38] extended this to copra; very high correlations were demonstrated between weight of husked nuts and of copra therefrom and Pieris concluded that for purposes of field experimentation 32 per cent. could be taken as the ratio between weight of copra and of husked nuts.* It must be noted, however, that this figure is only applicable to nuts from tall Ceylon palms growing under normal soil and climatic conditions; Pieris' work covered a range of husked nut weight of 650 to 950 grams. H. S. Walker's figures (*loc. cit.*) show that the ratio is much lower for the large San Ramon nuts, and later unpublished observations of Pieris (1943) that it may reach 40 per cent. for dwarf nuts. Child and Salgado (unpublished observations, 1944) have further shown that, even within the same population, the copra/husked nut ratio is higher for the smaller nuts, *i.e.*, that it follows the same general rule as the shell/husked nut ratio, although the range is not quite so wide; their data is summarised below. Within the "normal" range covered by Pieris' original work, the 32 per cent copra ratio is sufficiently accurate for practical purposes, and similarly a ratio of 25 per cent. for the shell/husked nut ratio is a sufficiently close approximation [*cf.* Child, (1940)].[40]

Drought markedly affects nut size, and Park (1934)[39] has published figures showing that the yield of copra per thousand nuts markedly declines for about a year after severe drought with a maximum effect about six months after the drought; he quotes records from an estate near Puttalam, Ceylon, where the average outturn was roughly 500 lbs. copra and where after a severe drought in 1931 nuts picked in February-March 1932, gave only 325 lbs copra per 1,000 nuts. Nut size and corresponding copra outturn are adversely affected, though less markedly than by drought, by inferior soil conditions and are to some extent improved by adequate manuring.

Child and Salgado (see above) have examined the figures for 54 lots of nuts from the plots of a manurial experiment, in all 5,023 nuts. When these were grouped according to husked nut weight into nine lots of six plots each, the following results were obtained (Table II *a*). The only notable effect of manuring was the increase in nut size produced by application of potash fertilizers, though there is some evidence that excessive applications of nitrogen *reduce* nut size.

Table II(*a*) may be translated into practical terms. It is usual to estimate the commercial value of nuts by the number required to yield a standard weight of copra, *e.g.*, in Ceylon nuts per candy of 560 lbs., in Malaya per picul of

TABLE II(*a*)

No. of Nuts	Average Wt. Husked Nut. Grams	Average Wt. of Copra per nut Grams	Average Wt. Shell per nut Grams.*	Copra Wt. % / Husked Nut Wt.	Shell Wt % / Husked Nut Wt.
401	534	190	157	35·5	29·4
463	607	207	164	34·0	27 0
387	650	220	169	33·8	26·0
595	680	222	173	32·7	25·4
662	704	226	177	32·2	25·1
624	730	241	180	33·0	24·6
665	767	247	190	32·1	24·8
570	817	259	200	31·7	24·5
653	857	269	208	31·4	24·3
General 5023 Average	719	234	182	32·6	25·3

133 1/3 lbs., and in general statistics per long ton of 2,240 lbs. Similarly, in Ceylon at least, shells are valued on the number of whole-shells to a ton. Extrapolation of the data in Table II(*a*) gives the following:—

TABLE II(*b*)

Nuts to give of Copra :—			Wt. of 1,000 Husked Nuts in Lbs.	Wt. of 1,000 Whole Shells in Lbs.*	No. of Whole Shells to a Ton
1 Picul	1 Candy	1 Ton			
225	950	3800	1880	456	4910
240	1000	4000	1760	432	5190
250	1050	4200	1625	409	5480
260	1100	4400	1530	387	5790
275	1150	4600	1440	373	6000
285	1200	4800	1375	365	6140
300	1250	5000	1305	358	6260
310	1300	5200	1235	351	6380
320	1350	5400	1165	344	6510
335	1400	5600	1125	340	6590

WORLD AVAILABILITY OF COCONUT SHELLS

In computing world statistics it has been customary to take 5,000 nuts as representing a long ton of copra (*cf.* Child[32]). It is convenient to take a corresponding approximate figure of 6,000 shells to a ton in estimating production of these. On this basis the following estimates may be made of production of coconut shells in the six major producing countries:

* The weights given are all of shells from copra-drying kilns; they are thus in a drier condition than if (as in desiccated coconut manufacture) the shells are chipped off from the nut before drying Figures for such fresh chipped shells from nuts of out-turn 1,100 candy have given 27–28 per cent. for the shell/husked nut ratio against 25 per cent. for dry shells. The lower figure is preferred for the practical table as most shells will come from copra drying.

TABLE III
Annual Production of Coconut Shells (Estimated)

	Tons
Netherlands Indies	1,000,000
Philippines	700,000
India	500 000
Ceylon	300,000
Malaya	220,000
New Guinea	73,000
	2,793,000

This production of nearly three million tons annually is, of course, negligible in comparison with that of such raw materials as coal or timber, and a sense of this proportion must be maintained in any consideration of the scope of coconut shells as an industrial raw material. In each country, too, the utilization of shells will depend not only upon production but upon availability and concentration of supplies. A large proportion of production in Malaya and New Guinea is from comparatively large well-managed plantations, whilst in India small-holdings account for most of the coconuts; collection of shells in bulk would, therefore, be easier in the former. Again in Ceylon there exist, more than in the other countries, considerable factories (oil-milling and desiccating) which handle nuts in quantity and where in consequence shells are already collected. These factors must all be taken into account—together with such forms of utilization as already exist (*e.g.*, for copra drying—see Ref. 31).

31. Child, R., "Coconut Shells as an Industrial Raw Material. II. Miscellaneous Uses. Fuel", *Curr. Sci.*, 1944, **13**, 4–6 See this article for references 17–30, and the previous article (ref. 17. *Curr. Sci.*, 1943, **12**, 292–294), for references 1–16 32. Child, R., "Ceylon's Coconut Crops", *Tropical Agriculturist (Ceylon)*, 1939, **92**, 330–335. 33. *Review of Coconut Products for 1938.* Leo Schnurmacher, Inc., Manila, Commonwealth of the Philippines, 1939, 22. Table N. 34. Katharine Snodgrass, "*Copra and Coconut Oil*", *Fats and Oils Studies*, No. 2, Food Research Institute, Stanford University, California, April, 1928, Chapter III, 26–34. 35. International Institute of Agriculture. *Studies of Principal Agricultural Products on the World Market*, No. 4. *Oils and Fats: Production and International Trade*—Part **I**, (Rome, 1939), 165–199. 36. Herbert S. Walker., "The Coconut and its Relation to the Production of Coconut Oil", *Philippine J. Sci.*, 1906, **1**, 58–82. 37. Cooke, F.C. "The Relationship between Weights of Coconuts, Husked Nuts and 'Meat," *Malayan Agric. J.*, 1934, **22**, 539–40. 38. Pieris, W. V. D., "Studies on the Coconut Palm—II. On the Relation between the Weight of Husked Nuts and the Weight of Copra," *Tropical Agriculturist (Ceylon)*, 1935 **85**, 208–20 39. Park, M., "Some Notes on the Effect of Drought on the Yield of Coconut Palms", *Ibid.*, 1934, **83**, 141–150. 40. Child, R., "Coconut Shell Charcoal", *Coconut Research Scheme (Ceylon) Leaflet No. 6*, March 1940, pp. vii & 1 diagram. Reprinted in *Journal of Coconut Industries (Ceylon)*, 1940, **4**, No. 2 (June), pp. 77–84, in *Travancore Economic Journal*, 1940, **19**, 573–78, and in *New Guinea Agricultural Gazette*, 1941, **7**, 61–65.

SIMILARITIES BETWEEN THE EXCITATION PHENOMENA IN UNSTRIATED MUSCLE AND THOSE IN THE RETINA

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THERE is a close resemblance between the excitation phenomena in unstriated muscle, and those in the retina; the resemblance may be superficial, but there is probably an underlying unity between excitation processes in tissues, which are physiologically widely divergent. The excitation phenomena in the retina described herein, are summarised from Hartridge (1941).

In unstriated muscle, there are two antagonistic excitabilities (Singh, 1938); there appear to be similar antagonistic excitabilities in the retina. This antagonism in the retinal response may be in the individual rods and cones, or in groups of rods and cones or may be in the nervous elements higher above. In unstriated muscle, these antagonistic excitabilities appear to be located in the individual muscle fibres, and it is quite possible, that in the retina, they are located in the individual cones and rods.

Adaptation and Fatigue.—In plain muscle, these two phenomena are identical. If the eye, after being in the dark, is rapidly exposed to light, it becomes light adapted. *Mytilus* muscle and frog stomach similarly become adapted to alternating current. In the eye fatigue to one colour, results in hyper-excitability to the complementary colour. In plain muscle too, adaptation and fatigue of one excitability results in hypersensitiveness to the antagonistic excitability; in *Mytilus* muscle, adaptation and fatigue to alternating current, results in hyper-excitability to potassium (Singh, 1944).

The After-Image and the A.C. Off-Contracture.—As a result of a stimulus the region of the retina affected gives a response which is followed by a second or after-image. During the after-image, the area is incapable of reacting with normal intensity to a like stimulus, but shows increased excitability to a stimulus of the opposite kind.

A corresponding phenomenon is seen in unstriated muscle. A contraction produced by alternating current or by increase in the osmotic pressure of the saline, is followed by an antagonistic contraction on cessation of the stimulus. On cessation of the current, the muscle is less responsive to it, but hyperexcitable to potassium, *i.e.*, excitable to the same stimulus, but hyperexcitable to stimulus of the opposite kind.

The after-image of the first impression is removed by the second impression. Similarly the A.C. off-contracture is neutralised by a second stimulation with alternating current.