Records on a number of palms at Fairchild Tropical Garden continue to be kept.

Participants who have a year's observations are invited to send in preliminary data cards, if possible in the manner suggested in *Principes* 7:43, 1963. However, it is requested that measurements be continued for at least a further year after the official end of the International Palm Year, if this is possible, in order that comparative data for two years becomes available. Assembling and interpreting the data is likely to take some time but it is hoped that a useful body of information will finally be available.

P. B. TOMLINSON

The West African Institute For Oil Palm Research

C. W. S. HARTLEY
Director 1956 - 1963

Palm oil has the unique distinction of being the commodity which replaced the traffic in slaves from the west coast of Africa. It was little known at the beginning of the nineteenth century and some quaint ideas were held by traders about the origin of the oil, some believing that it was drawn off from the roots. Almost immediately after the British prohibition of the slave trade in 1807 trading in palm oil from the coast became fully established.

British West Africa was slow, however, to recognize the need for research into the cultivation of its most important indigenous export crop. This may be attributed to three causes. Firstly, the products of the oil palm — palm oil and kernels — were supplied, apparently without difficulty, by a crop that grew in a semi-wild state and seemed to need no cultivation. Secondly, early British rule in West Africa was dominated by a paternal administration in which economic advance and the research that should preceed or accompany it did not occupy a high place. Thirdly, in the slump of the late 1920's and early 1930's, it was expenditure on technical departments that was the first to be slashed.

The demand for vegetable oils increased so rapidly from the beginning of the present century, and production from the palm groves, particularly in Eastern Nigeria and Sierra Leone, proved so great, that increased interest in the crop became inevitable after the first world war. Later, the laying down of successful plantations in the Far East and the Belgian Congo caused a sudden fear of serious competition and the West African countries were forced to consider their position. In fifteen years, exports of palm oil from Indonesia rose from a negligible quantity to around 230,000 tons per annum, not far short of double West Africa's production at that time.

In 1923, the Secretary of State for the Colonies appointed a committee to consider the best means of securing improved and increased production of oil palm products. Little came of this however and although successive West African Agricultural Conferences stressed the need both for measures to combat competition from the Far East and for research, it was not until 1939 that a research station was opened. A scheme for regionalising research on important export commodities was knocked on the head by the onset of the second world war.

47. A typical palm grove in eastern Nigeria.

It was fortunate for the future of research on the oil palm that a botanist — Mr. F. W. Toovey — had been appointed in 1935 and had worked in close conjunction with Mr. E. H. G. Smith who was the pioneer of oil palm investigations in Nigeria. Not long after the research station was opened at Benin, Mr. Toovey was sent to take charge and he was responsible both for the physical development of the station and the planning of future work. During the war little could be done, though a good deal of useful planting material was accumulated and a few important field experiments were laid down. After the war, however, consideration was given to the recruitment of a suitable body of scientists at Benin, the incorporation of an inter-territorial institute to serve Ghana and Sierra Leone as well as Nigeria, and the financing of the necessary capital and recurrent expenditure. And so it came about that The West African Institute for Oil Palm Research was brought into being by the enactment in Nigeria of Ordinance No. 20 of 1951, which took effect on 27th September of

48. Harvester climbing a wild palm with two ropes.

that year.

For all practical purposes the Institute came into being on April 1st, 1952, at the beginning of its first financial year. It took over, as its Main Station with offices, library and laboratories, the Oil Palm Research Station 18 miles north of Benin, and it developed (near Abak) a Sub-station in the heart of the palm belt of Eastern Nigeria and opened a further Sub-station at Njala in Sierra Leone. It was governed, according to ordinance, by a Managing Committee appointed by the governments of the three territories — Nigeria, Ghana, and Sierra Leone — which, in proportion to the size of their oil palm industries, provided it with funds. It is always sound policy for an industry to support its own research. In the case of W.A.I.F.O.R., the funds, for the most part, came indirectly from the sale of palm products through the Marketing Boards operating in the countries concerned.

49. Road through the Institute's Main Station. Palms on left are 19 years old, those on right 5 years old.

The improving of the oil palm industry in West Africa bristled with problems. While many of these might be solved by simple field experiments, it was clear that many others would require investigation by specialists with up-to-date equipment at their command. Plans were therefore made well before the inauguration of W.A.I.F.O.R. to recruit research workers and equip laboratories for divisions of Agronomy, Plant Breeding, Physiology, Pathology, Soils, and later Nutrition and Process Engineering. Meanwhile, however, a number of urgent agronomic problems presented themselves. In the first place, was the industry to depend on the groves, or did "improvement" imply the wholesale replanting of the groves, and the establishment of planted holdings large or small? Early grove replanting trials had not been very successful and yields compared very unfavorably with those from plantations in the Far East. Clearly all was not well with planting methods and plantation maintenance, and the

50. Agronomy and Plant Breeding buildings at the West African Institute for Oil Palm Research. Meterological compound in foreground.

simple question "how should the palm be planted" needed to be answered.

Two courses of action were therefore taken. Firstly, several studies of the palm groves were started together with palm grove replacement trials; secondly, experiments on germination, nursery practice, transplanting, pruning and manuring were rapidly put in hand. At the same time, further collections of planting materials were being made.

Much of this early work, though of considerable value, failed fully to solve the problems of oil palm planting in West Africa, and the wisdom of allowing for the establishment of the more specialized divisions became apparent. Satisfactory germination techniques were not discovered until work on the physiology of germination had been undertaken over a period of many years. Nursery practices were shown to need far more detailed study than had been contemplated

51. Pre-nursery raised concrete trays with seedlings spaced at 3 inches apart being watered from an overhead spray line giving a fine mist spray.

and the co-operation of the Agronomy, Plant Pathology and Physiology divisions was needed. Further considerable improvements were made in transplanting techniques. As to manuring, it was found that, although West Africa was the home of the oil palm, the planted palm almost everywhere suffered from nutrient deficiency diseases, while the incidence of pathogenic diseases was seen to be connected both with levels of nutrition and genetic constitution.

Germination

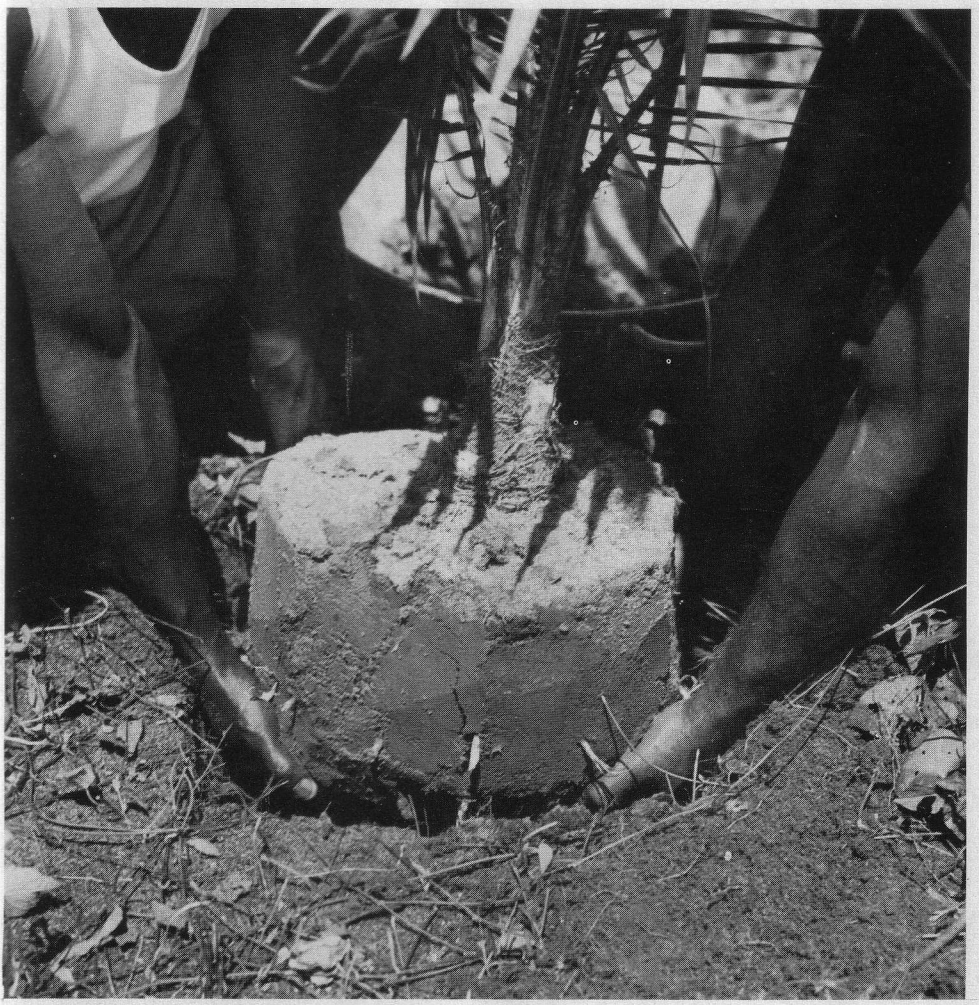
Prior to 1952, various types of heated germinator had been designed and the seed was germinated in charcoal-filled boxes. Germination was erratic and often continued for a period of nine months. Fundamental research was then undertaken on the physiology of germination and the effects of temperature, moisture content and oxygen supply were determined. From the knowledge obtained, a new method was developed.

52. Young nursery seedlings mulched with bunch refuse and irrigated.

Dry seed is pre-heated at 39.5°C in polythene bags for 80 days and then cooled and brought to the correct moisture content. Germination then takes place over a period of about two weeks and leads to the production of large quantities of uniform seedlings.

Nursery techniques

The raising of oil palm seedlings in pre-nurseries and nurseries was an uncertain undertaking. Deaths from anthracnose at the beginning of the nursery season were common while blast disease took its toll at a later stage. Plants were unthrifty and often appeared to stand still in the middle of the rains. Exhaustive experiments were undertaken which covered cultural practices, manuring, irrigation and disease control. The causes of blast were diagnosed and its relation to climatic factors established; leaf diseases were brought under control. As a result, large and robust transplantable seedlings became available two months earlier than hitherto and a special "dry-season" nursery was developed which provided seedlings in a shorter



53. Planting a one-year-old palm seedling in the field.

period though later in the planting season.

Planting in the field

In transplanting an oil palm seedling to the field, a large ball of earth has to go with it. It has been shown that if root cutting about one foot around the seedling is done four to five weeks before transplanting, not only does the plant get a better start in the field but the ball of earth is held together by the mass of roots which develop within the ball as a result of the cutting. Plants treated in this manner develop more rapidly after planting.

Maintenance of a plantation

Maintenance is usually carried out by hand labour and consists, in West Africa, of a close "ring cutlassing" around the palms and a slashing of the undergrowth to about one foot above ground level between the rows of palms. This is expensive work and efforts have been made to substitute control by me-

54. A field of uniform 4½-year-old palms at W.A.I.F.O.R.

chanical means or by weed-killers or by a combination of the two. This work is in its early days. With mechanization, a number of difficulties have to be overcome. In the first place, for mechanical maintenance to be successfully practiced the plantation needs to be on flat or gently undulating land and this land must first be cleared of timber and the majority of stumps; secondly, for the years when the palm leaves meet but are not yet high off the ground, a tractor cannot move easily through the field. A specially protected tractor has been designed for this work.

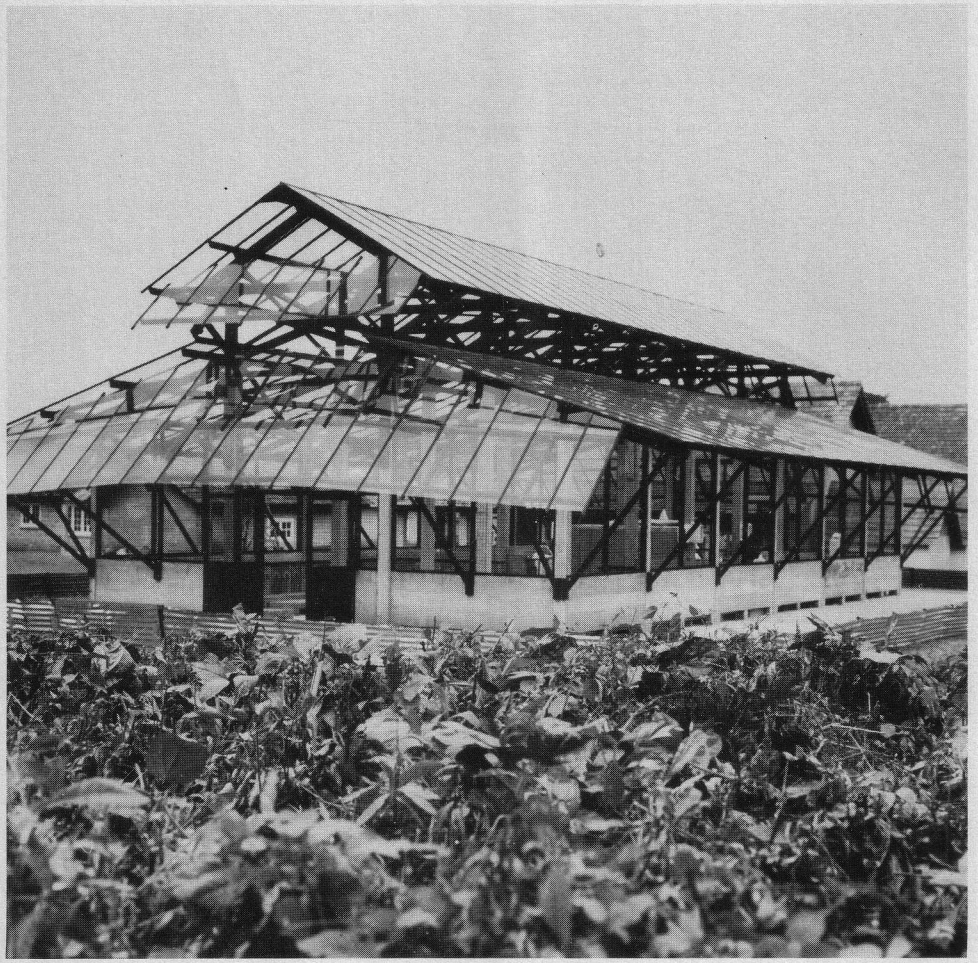
Pruning and harvesting are operations which can be considered together. If, on the one hand, a palm is not pruned, harvesting becomes difficult and expensive; on the other hand if a palm is over-pruned, bunch yield is reduced. Several pruning experiments have shown the danger of over-pruning and the minimum pruning of leaves during harvesting of bunches combined with one or two rounds a year of pruning withered leaves is recommended.

55. Prototype of specially equipped tractor for inter-row cultivation.

Oil Palm Nutrition

The Institute set up a special Nutrition Laboratory for the study of deficiency symptoms and the carrying out of leaf analysis. Leaf analysis in the oil palm presents several problems and needs to be carried on in conjunction with fertilizer experiments. The Institute's Agronomy division has a very extensive programme of fertilizer experiments on the main soil types of West Africa, and responses to potassium, nitrogen, magnesium, and phosphorus have been obtained. Of particular interest in oil palm nutrition are the potassium/magnesium antagonism and the positive interaction often obtained between potassium and phosphorus, and potassium and nitrogen. The study of soil analysis in conjunction with fertilizer experiments has also been fruitful on the acid sand soils of southern Nigeria.

All this work has shown that the use of fertilizers in the right proportions is essential for the profitable cultivation of the oil palm in West Africa and that economic responses are easily obtained. The present large series of experiments



56. The Nutrition Division glasshouse at W.A.I.F.O.R. A special design for tropical use developed in Malaya.

is designed not only to determine interactions between nutrients but also to find the most economic rates of application and the best time to apply. Trace elements are included in the design of some of these experiments.

Selection and Breeding

Serious breeding for production in the oil palm dates from the discovery, by Belgian workers, that the thin-shelled *tenera* fruit form is a hybrid of the thick-shelled *dura* and the shell-less *pisifera* forms. Until recent years the Institute's seed production contained *dura* × *dura* and *dura* × *tenera* seed as well as the *tenera*-producing *dura* × *pisifera* seed. For about five years, however, only the latter seed has been produced and production has been stepped up from around three million to eight million seed annually.

Breeding for the production of high yielding and good-quality hybrids is a slow and complicated process, a description of which would need much more

57. A well developed and productive four-year-old palm.

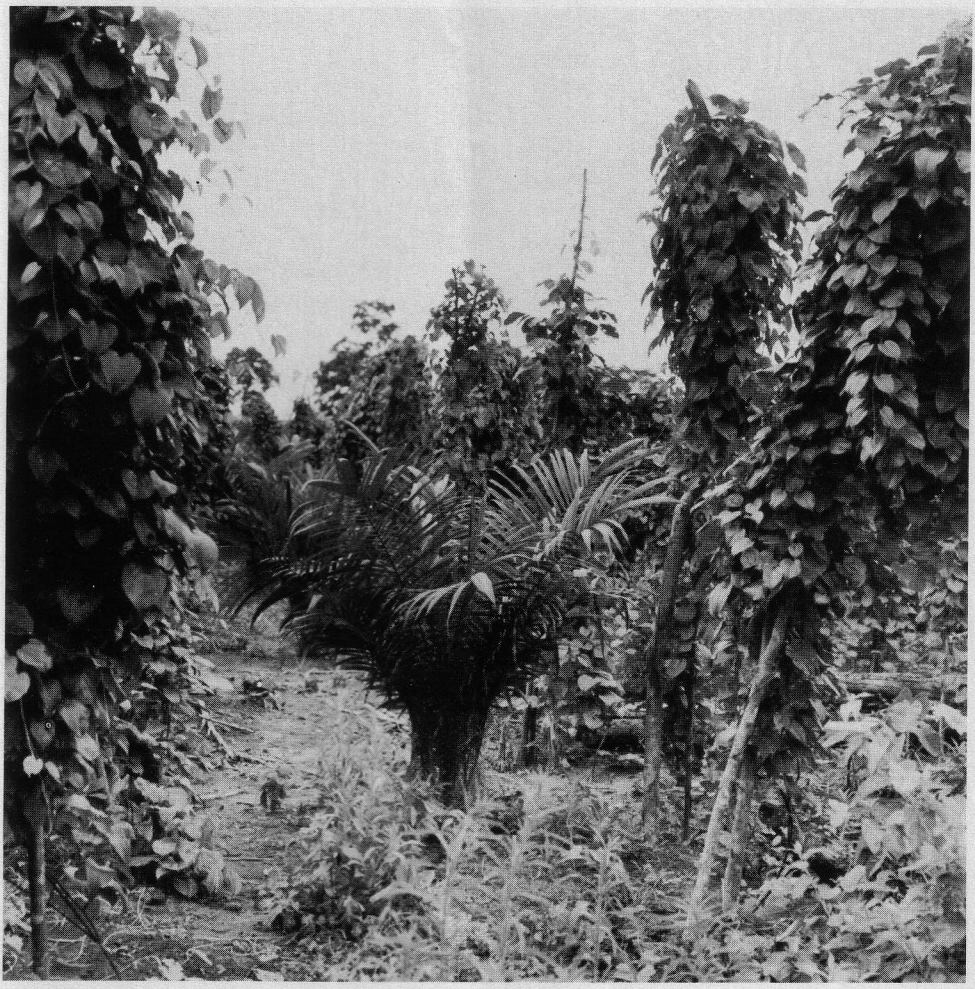
space than is available here. A paper outlining the W.A.I.F.O.R. programme and describing breeding in other parts of the world is now in the press. Briefly the aim is to breed *dura* and *pisifera* palms which when crossed will provide *tenera* progeny of good fruit quality and high bunch yield. Quality is indicated by bunch composition, i. e. the ratio of mesocarp, palm oil, shell and kernels to bunch. Palm oil is borne in the mesocarp and the proportion of oil to mesocarp itself varies and is a selection criterion. Moreover it is possible to select for high kernel at the expense of mesocarp or vice versa, low shell content being of course a desideratum in either case.

Breeding for seed production has hitherto been from individual *dura* of good performance and quality and from *pisifera* of unknown potentiality. Increasingly, however, seed is being produced by parent palms, whether *dura* or *pisifera*, proved by their progenies' performance or chosen from within good progenies. In this way higher grades of extension work seed, as it is called, have been produced and issued.

58. Seedlings from "extension work seed" ready for planting out.

Growth, Development and Flowering of the Oil Palm

The growth and development of the oil palm and its flowering habits vary very greatly from one locality to another and one progeny to another. Rapid growth means early production, while flowering habits will largely determine bunch production. The most important single factor in the latter is sex ratio — the proportion of female to total inflorescences. Physiologists, Agronomists and Plant Breeders at the Institute have been studying growth and flowering in recent years. Much new knowledge has been gained. In the first place it has been shown by growth analysis that the palm's net assimilation rate is surprisingly low. Secondly the effect of climatic factors on sex-ratio and annual yield have been studied and the concept of "effective sunshine" has been developed from rainfall-sunshine yield studies. This leaves little doubt that the large yield differences between the Far East and West Africa are mainly due to differences of climate.



59. Young palms growing between lines of yams (*Dioscorea*)

Studies of the Natural Palm Groves, and their Replacement

The research work of the Institute, as briefly described above, will be of little value to West Africa if a serious attempt is not made to modernize oil palm planting and production. Detailed studies have been carried out on the groves, their development, production, economy, etc. The story of the groves has so far only been partially related and much more information will shortly be available. The conversion of the groves into stable economic plantations efficiently controlled by the agrarian population will be a formidable task beset with social and political as well as economic difficulties. The Institute is assisting firstly by providing the high quality seed required and secondly by carrying out, after experiment, the replanting of its own and leased groves. At the same time, trials of the planting of oil palms in combination with the growing of food crops or the raising of livestock are in progress on the Insti-

60. Ndama cattle grazing on elephant grass (*Pennisetum purpureum*) between rows of palms.

tute's stations. These lines of work should be of special appeal to a peasant community. Food crops can be grown between the palm rows in the early years without detriment to the palms if certain precautions are taken. Cattle have been successfully grazed on elephant grass between widely spaced rows of palms.

Processing

Processing of fruit bunches entails the removal of fruit from the bunch, expression of oil from the mesocarp and extraction of kernels from the nuts. In peasant areas, the means used for removal of fruit from the bunch is hand picking after storage for a few days; for expression of oil, the fruit is boiled, mashed in a mortar and the oil is skimmed off after the mashed mesocarp has been boiled in water; for extraction of kernels, the nuts are hand-cracked one by one by women. A hand-operated curb type or screw-press was successfully introduced into the palm grove areas,

but this only increased the efficiency of oil extraction from around 45 per cent to less than 65 per cent of the available oil. A cheap type of mechanical mill — the Pioneer mill — has also been introduced but this has, for a number of reasons, proved an economic failure. Recently, an hydraulic handpress has been devised as a substitute for the screw-press, but it is too early to say how successful it will prove. While the hydraulic press gives a higher extraction rate than the curb-press it must be operated with a set of equipment which has been specially devised at the Institute. There is little doubt that the system can be operated very efficiently, but it remains to be seen whether it will take on in the villages.

For cracking nuts, a number of small crackers driven by petrol engines have been put on the market, but they have not been adopted in great numbers.

The poor bleachability of oil from West Africa has given cause for concern in recent years and the factors responsible for this are under active investigation.

The history of W.A.I.F.O.R. and a brief outline of the problems it has been tackling have been given above. It is disappointing to have to report that, following the attainment of self-government by the three territories served, it proved impossible to obtain agreement on the running of W.A.I.F.O.R. as a joint enterprise. The Main Station near Benin has thus reverted to Nigeria and the Sub-station in Sierra Leone has been taken over by the government of that country. The international character of the Institute has disappeared and, as a result, there will once more be staffing difficulties for a period of time. There is every hope, however, that the Nigerian portion of the Institute will be rebuilt on a sure foundation and that its vital work for the principle crop of the country will continue.

The results of the Institute's work have been faithfully recorded in its own Journal, the fourth volume of which is now in process of publication.

On The Etymology Of The Word Cocos

C. X. FURTADO
Singapore

Many explanations are given to account for the etymology of both the Portuguese word *coco* meaning "coconut" and the botanical name *Cocos* L. denoting a palm genus. The view widely current is that the root of both these words is the same and that the Portuguese who applied "*coco*" to the coconut, certainly did not derive it from the Latin *coccum* or *coccus* or the Greek *kokkos*. But De Candolle (1855) disagreed with this view. He regarded these two names as having two distinct roots; and whatever may be the origin of the *coco* in Portuguese (and he admitted the possibility of its having come from a Mexican word), De Candolle maintained that it is unrelated to *Cocos* L., which he derived from the Latin *coccus*. In support of this contention, he gave two mid-Seventeenth Century quotations where "palma indica *coccifera*" and "palma *coccos* ferens" occur. Beeler (1960), on the other hand, made *Cocos* L. to come directly from the Portuguese and Spanish word *coco*, but he derived the