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COCOA GROWERS' BULLETIN

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Contents

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Editorial

In this issue we are including some extracts from an early work on cocoa, originally published in French in 1719, which describes the practices current at that time in the West Indies, probably Martinique. These extracts are worth re-reading because the methods described therein and the warnings given are still relevant. In establishing a cocoa farm one would still seek "a virgin soil", though one might not describe it as "indifferently fat, light and deep"; the methods of clearing and planting are much the same, though most planters would avoid manioc and use other plants for initial shade.

Apart from initial shade, the book is remarkably silent on the subject, although the importance of shelter from strong winds is stressed. This must have been of greater importance in Martinique, where cocoa-growing is said to have declined after a hurricane in 1727, and cocoa may have been established in small fields on hilly land, as in Grenada, and under these conditions top shade is not a vital necessity.

Reading these passages, and bearing in mind the conditions in Martinique, one wonders whether we have learnt a great deal about the cultivation of cocoa in the past 200 years.

G. A. R. Wood.

W. R. Grace and Co.

This is the fifth in a series of articles on the larger cocoa and chocolate manufacturers. The first four dealt with Cadbury, Nestlé, Rowntree and Suchard.

W. R. Grace & Co. is a highly diversified company engaged in many pursuits around the world. Industrial and speciality chemicals, agricultural chemicals and chemicals for packaging and plastics categorise activities in this broad field; much emphasis being given to applications to the food problems of mankind, from fertilisers to finished product packaging.

Paper manufacture, petroleum, mining, transportation and foods comprise other spheres of industry in which the company has substantial interest.

Beginning in Peru in the early 1850s primarily as a trading concern, W. R. Grace & Co. has for many years been engaged in the manufacture of chocolate, confectionery, biscuits, sugar and other foods in South America. Agricultural and manufacturing activities in these fields are conducted in Peru, Colombia, Chile, Bolivia and Costa Rica.

More recently, W. R. Grace & Co. began to extend its food activities to the United Kingdom and Europe (1962), the Republic of Ireland (1963), the United States (1964), and Singapore (1965). While dairy products, soft drinks, and snack foods are included, food activities have so far been concentrated in the manufacture of chocolate and confectionery products, to the point where Grace has become one of the world's major consumers of cocoa beans. Although these cocoa beans come from virtually all cocoa-growing countries, the great bulk originate in Central West Africa and Brazil.

The first of these chocolate and confectionery members to join the Grace family of companies recently was C. J. Van Houten & Zoon, N.V., one of the oldest chocolate and cocoa manufacturers in the world. From its main plant at Weesp, Holland, and from its manufacturing branches or affiliates in West Germany, France, Belgium, Japan and Singapore, Van Houten offers a variety of high quality chocolate confections and cocoas through its international chain of sales companies and agencies.

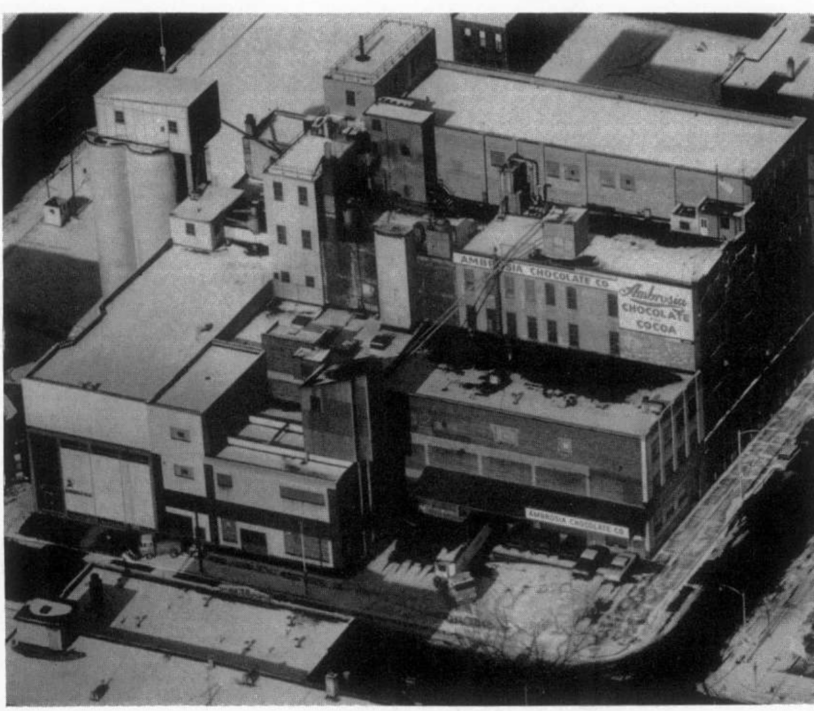
Van Houten invented the original "Dutch" process (alkalized) cocoa powder that has done much over the last 100 years to popularise this wholesome beverage, and still offers today the same quality products to consumer and industry alike in both the original form and in the modern adaptation, "instant cocoa". Its chocolate confections range from solid and filled chocolate bars and tablets through enrobed candy and expanded bars to pastilles and bon-bons.

Late in 1964, another Netherlands company, N. V. Cacaofabriek De Zaan, joined Van Houten as a member of Grace food enterprise. De Zaan is one of the world's larger and more modern producers of cocoa powder and cocoa butter, primarily for distribution in Europe and the United States. While De Zaan also manufactures proprietary chocolate and cocoa products, and offers soft drinks and snacks through its subsidiary, Raak Drankenindustrie, its forte is in industrial cocoa powders and cocoa butter.

Regarded by many as the most sophisticated and versatile cocoa powder manufacturer in the industry, De Zaan is known throughout the world for its great variety of cocoas covering a broad range of colours and flavours. The

The factory of N. V. Cacaofabriek De Zaan, Holland.

The Ambrosia Chocolate Factory at Milwaukee.



intent here, of course, is to stimulate per capita consumption by providing food and beverage manufacturers with chocolate flavours and colours to please every segment in the broad spectrum of consumer desire.

A significant proportion of the chocolate and candy production in the Republic of Ireland is manufactured by Urney Chocolates Limited and its subsidiary, Liam Devlin. Urney joined the Chocolate and Confectionery Division of W. R. Grace & Co. in 1963, adding skill and experience in chocolate manufacture to the growing group. Urney manufactures high quality couvertures for industrial use, and serves the chocolate industry in many countries with its milk chocolate crumb, an intermediate product composed of chocolate mass, sugar, and milk from Ireland's green pastures.

Urney Chocolates' major endeavour is to supply both the home and the export consumer markets with a full range of confectionery products, primarily chocolate, the latter ranging from solid and filled chocolate bars to chocolate specialties and bon-bons.

Late in 1964, the Chocolate and Confectionery Division of W. R. Grace & Co. was joined by the Ambrosia Chocolate Company of Milwaukee, Wisconsin, U.S.A., and its subsidiary, the Hooton Chocolate Company of Newark, New Jersey, U.S.A. These two units, with Ambrosia's branch plant in Charlotte, North Carolina, produce no direct branded consumer items, but supply manufacturers of confectionery, ice cream, syrups, biscuits and cookies, etc. with chocolate and confectioners' coatings, chocolate liquor (mass), cocoa butter and powders, cookie drops, chocolate flavours, and frozen novelty coatings.

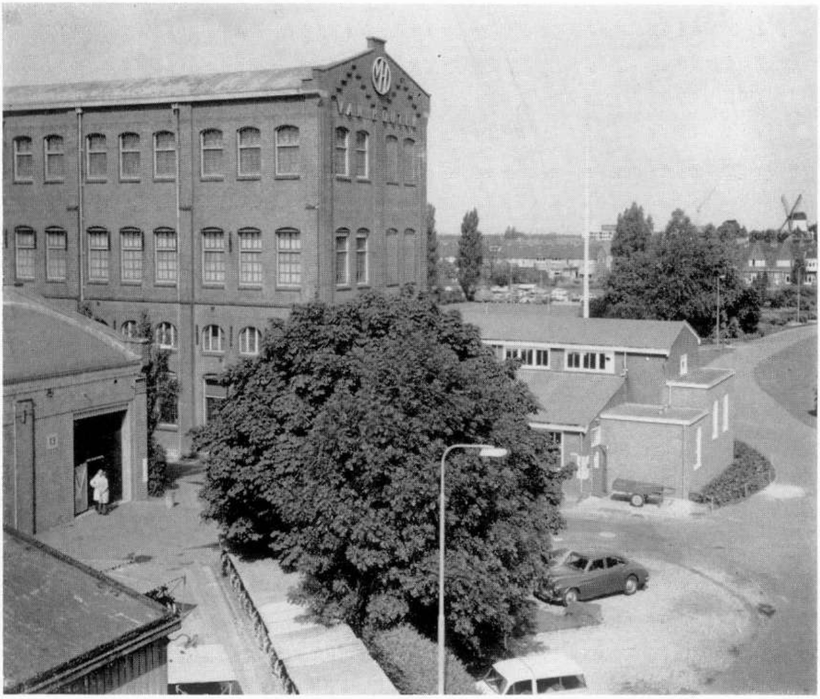
The Ambrosia-Hooton complex, suppliers to the chocolate-using industries in the U.S.A. for more than 70 years, are specialists in the economical production of all quality levels of "industrial" chocolate and cocoa-powder products. Science and artistic skills are directed toward aiding consumer goods manufacturers to offer chocolate food products to satisfy all types of consumer taste preferences and economic levels.

In the latter part of 1965, W. R. Grace & Co. acquired the controlling interest in Sheng Huo, a chocolate and candy manufacturer in Singapore, and the new factory, the only one in the Singapore-Malaya area, started operations at once. Its purpose is two-fold: to supply more economically chocolate, cocoa and confectionery products of the quality already known in the area through imports; and to furnish a greater variety of chocolate products to people who could never before afford to enjoy the "food of the gods".

Grace's Chocolate and Confectionery Division is dedicated to the belief that its own best interest and that of cocoa bean producers can both be served by the same objective: to increase consumption of cocoa bean products by offering the consuming public the greatest variety of the highest quality chocolate products at the lowest possible prices consistent with a fair economic return to all concerned—from the cocoa bean farmer to the retailer who completes the chain leading to the ultimate consumer.

To accomplish this goal, efficient use of the most modern techniques available to all "links in the chain"—again from the cocoa bean farmer to the retailer—is required in a world food market where an endless variety of non-cocoa bean products is constantly being offered with keen competition.

Competition is the primary well-spring and source of imaginative thinking, of technological development in all phases of business activity, whether this be at the farm, or in the development of new products at the factory, or in new marketing techniques developed to pursue changing shopping habits of the



The main factory of C. J. Van Houten and Zoom at Weesp, Holland.

consumer. Centres of creative thinking tend to be limited to centres of independent authority and responsibility. Hence, each member of W. R. Grace & Co.'s Chocolate and Confectionery Division operates with a practical maximum of independent authority; yet with a freedom of idea interchange that multiplies the effectiveness of each in its efforts to promote the consumption of chocolate products.

Full knowledge of all matters that might affect these general objectives includes constant contact with cocoa-growing countries, in order to be familiar with their needs and their problems, and to acquaint them with the problems and needs of manufacturers in our mutual efforts to increase the acceptability of cocoa bean products to consumers. This contact is maintained on a personal representative basis and through participation in cocoa agriculture research conducted or supported by American, European and international chocolate and cocoa manufacturing associations.

Review of Production and Consumption

A. P. Williamson, Cadbury Brothers Limited

Production

The out-turns of the recent main crops are now known and the March F.A.O. statistics have been published. The only significant change from their October figures, which we reproduced in our last Bulletin, is a big reduction in the estimate of the 1965-66 crop. It is now put at 1,260,000 tons or 17 per cent down on 1964-65, but this still represents the second highest total on record. It is now clear that 1964-65 was an exceptional year.

The West African crop was over 25 per cent less than last year but this was counteracted by small but steady rises in Asia and Oceania, and more particularly by a big rise in Brazilian production. The exact size of the latter will not be known for some time as their summer or Temporao crop is as important as the main crop. If the forecast of 160,000 tons is achieved, production in Bahia will be back to the levels of the late 1950s.

WORLD COCOA PRODUCTION AND GRINDING FIGURES

issued by the F.A.O. in March, 1966

(Thousand metric tons)

PRODUCTION

	1963/64	1964/65	1965/66 (estimate)
Africa	898·8	1,194·2	886·9
South America	196·2	206·9	248·2
North and Central America ...	87·6	90·7	85·0
Oceania	22·5	25·0	31·8
Asia	7·4	7·8	8·1
World Total	1,212	1,525	1,260
Principal Countries:			
Ghana	427·7	580·0	422·0
Nigeria	220·3	298·3	188·0
Ivory Coast	98·2	147·0	120·0
Cameroon	85·0	91·2	85·0
Fernando Po/Rio Muni	31·0	34·8	29·0
Brazil	121·5	117·0	160·0
Ecuador	36·0	48·0	45·0
Dominican Republic	44·7	40·0	36·0
Mexico	17·2	22·5	23·0
New Guinea and Papua	17·0	21·0	27·0

GRINDINGS

	1964	1965	1966 (forecast)
Western Europe	540·8	594·8	614·6
North America	281·8	301·6	323·5
Australia/N.Z./S. Africa	20·3	21·0	21·6
Japan	26·1	23·0	25·0
Eastern Europe/U.S.S.R.	121·8	150·0	161·0
China	5·0	12·0	14·0
Central and South America ...	129·2	135·9	132·8
Africa (ex. S. Africa)	46·3	77·8	103·7
Asia (ex. China and Japan) ...	13·2	13·5	13·6
World Total	1,184	1,330	1,410
Principal Countries:			
United States	266·5	284·6	305·0
West Germany	140·0	155·0	162·0
Netherlands	104·0	118·1	116·0
United Kingdom	88·4	102·2	105·0
U.S.S.R.	66·2	90·0	95·0
France	63·4	63·1	66·0
SURPLUS/DEFICIT			
Production > Grindings ...	28	195	—
Production < Grindings ...	—	—	150

Grindings

Under the stimulation of lower prices the 1965 grindings were up to expectations, and showed a 12 per cent rise on 1964. A further 6 per cent rise is forecast by the F.A.O. for 1966, and if this is achieved the world surplus of 195,000 tons in 1965 will have changed to a deficit of 150,000 tons in 1966.

This change in the demand-supply position has already had its effect on prices, and they now stand at around £200 per ton or over twice the level ruling last July. If the rise continues we can expect to see a definite slowing down in the rate of increase of consumption towards the end of 1966. There may even be a fall away from existing levels.

Analysis of Consumption

Grindings are the usual measure of consumption and on a world-wide basis they give a very accurate picture of the level of usage. If regional trends are being studied, however, they must be treated with caution as they represent only the first stage of the manufacturing process, and the trade in partly processed cocoa products is becoming much more significant.

An examination of the situation in producing countries is of interest. In 1965 their total grindings were 210,000 tons and of these only 76,000 tons were consumed locally, the remaining 134,000 tons being exported as cocoa butter or paste to the traditional consuming countries. In 1960 the total exported in this way was only 87,000 tons but by 1968 the capacity in producing countries is expected to be over 350,000 tons.

Thus traditional consumers of raw cocoa beans may purchase a greater part of their requirements in the form of partly processed products, and this will reduce their own grinding figures.

Tables giving the latest F.A.O. production and grinding figures are reproduced overleaf.

GRINDINGS IN PRODUCING COUNTRIES

	1965	Projected Capacity (1)
For Export:		
Ghana	51,000	94,000
Nigeria	—	80,000
Ivory Coast	10,000	12,000
Cameroon	14,000	30,000
Brazil	53,000	72,000 (2)
Dominican Republic	6,000	40,000 (2)
Mexico	—	14,000
Ecuador	—	15,000
Total	134,000	357,000
For Domestic Consumption:		
Colombia	29,000 (3)	
Mexico	13,000	
Philippines	9,000 (3)	
Other Countries	25,000	
Total	76,000	
Total Grindings ...	210,000	

(1) Not F.A.O. figures (principal source U.S. Dept. Agric.).
(2) Extra capacity already exists but not utilised.
(3) Net importing countries (i.e. Grindings > Production).

3. L'Institut Français du Café et du Cacao

R. Coste, Director General, I.F.C.C.

L'Institut Français du Café et du Cacao has, since 1959, started work in the Ivory Coast, the Central African Republic, Madagascar and the French Antilles, and extended its operations to the Federal Republic of Cameroon in 1964. Negotiations are in progress with a view to operating in Togo and the Comores, and contacts have been established with Congo (Brazzaville) so that the operations of the I.F.C.C. will, in the very near future, cover practically all the French-speaking countries that are cocoa producers.

The I.F.C.C. also works internationally, and quite recently gave assistance to Uganda, which had approached the French Government for technical help for the improvement of cocoa tree cultivation. In addition, there is a possibility of operations in Latin America in respect of cocoa and coffee.

Next to its office in Paris, which supervises and co-ordinates all the research programmes and work overseas, the I.F.C.C. has a set of laboratories specially equipped for studying the chemistry and technology of coffee and cocoa.

About half the work and resources of the Research Centres of I.F.C.C., both in France and overseas, is devoted to cocoa research.*

In the Ivory Coast, the I.F.C.C. Research Centre is based at Bingerville, near Abidjan, where a set of laboratories is devoted to the following fields: agronomy, genetics, plant pathology, entomology, physiology, pedology and chemical technology.

Field experiments are conducted at Bingerville and also at Abengourou and the Central Station at Divo. Other field trials are carried on over the whole of the cocoa-growing zone in collaboration with the Ministry of Agriculture. The area devoted to trials with cocoa trees at present covers approximately 100 hectares.

In Cameroon the I.F.C.C. administers the Centre of Agronomic Research at Nkolbisson and the Cocoa Station of Nkoemvone. The research programmes on cocoa and coffee in West Cameroon (formerly British Mandated Territory) have recently been entrusted to the Institute.

The I.F.C.C. Research Centre at Nkolbisson near Yaounde has a set of laboratories covering the following fields: agronomy, plant pathology, entomology, physiology and chemical technology.

The cocoa station at Nkoemvone, near Ebolowa, concentrates on selection and agronomic experiments with cocoa and has 75 hectares of trial plantings. In addition two centres dealing with the propagation of selected planting material which are attached to the station at Nkolbisson and Nkoemvone have been placed under the technical control of the I.F.C.C.

In the Central African Republic, I.F.C.C. is installed at the Agronomic Research Centre at Boukoko with the Institute for Research into Tropical

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*Apart from cocoa and coffee, the I.F.C.C. is responsible for research tea and cola — *Editor.*

Agronomy (I.R.A.T.). The work of this Centre is concerned mainly with Robusta and Excelsa coffee, but it deals also with cocoa. Various tests of an agronomic nature have been undertaken with selections from Cameroon.

In Madagascar the Research Centre of I.F.C.C. has its headquarters at Ilaka on the east coast, where the work is mainly devoted to coffee.

In the north-west of Madagascar, the I.F.C.C. has a cocoa station at Ambanja which is concerned with the selection of the Criollo types grown in the Sambirano area.

In the French Antilles, I.F.C.C. works in conjunction with the Institute for Tropical Fruits and Vegetables (I.F.A.C.). There is a station in Guadeloupe where research work on cocoa is conducted, and another in Martinique.

As a side activity to its research work, I.F.C.C. has been asked by the Governments of the Ivory Coast and Cameroon to carry out some extension work. In the Ivory Coast these operations are concerned with soil studies, the training of staff and the planning of cocoa production.

In Cameroon the Government has entrusted I.F.C.C. with the propagation of selected planting material which is delivered to planters as rooted cuttings. For the year 1965, I.F.C.C. had a sum of £465,000 at its disposal for its work on cocoa, of which £190,000 was provided by the French Government, the rest being subscribed by the countries in which the Institute works.

The scientific staff comprises some 40 scientists and experts who devote at least 50 per cent of their efforts to research work on cocoa.

Their work is concentrated mainly in the following four spheres: selection and breeding; cultural techniques; study of pests and diseases; and the quality of the product.

1. Improvement of planting material

In the Ivory Coast the programme of selection begun in 1960 is based on the hybridisation of cocoa trees of the Amazon type with local selections of Amelonado and foreign selections.

More than 500 hybrid progeny tested in trials at Divo revealed their great superiority over the local trees. The precocity and yield of certain hybrids are remarkable (three tons of marketable cocoa per hectare three years after planting). Several bi-clonal seed gardens have been laid out with the aid of this initial information.

In Cameroon the work of selection which began in 1949 has been directed to the selection of clones of Amelonado and Trinitario types as well as introductions of ICS and open-pollinated Amazons. This work led to large-scale multiplication and to the creation of two important centres for propagation by cuttings, which have supplied more than 500,000 plants to farmers in 1965.

In 1959 the selection work was directed towards the development of hybrid seeds and more than 100 hybrid families are being studied. Comparative trials have been undertaken and about 10 seed gardens have been planted since 1960. Cuttings of Amazon types have been introduced from West Cameroon in 1965, and this has enabled the list of hybrids to be extended considerably.

In Madagascar cocoa tree selection has been concentrated on the Criollo type, which enjoys an excellent reputation on the market. Hybridisation with Trinitarios whose cotyledons have a pale colour is the main task of the research work.

2. Improvement of cultural techniques

The mineral nutrition problems of the cocoa tree form the subject of studies undertaken both in the Ivory Coast and in Cameroon, and special attention is being paid to foliar diagnosis to determine the most favourable time for applying fertiliser.

Numerous trials with mineral fertilisers have been carried out on different types of soil, both on stations and outside, sometimes combined with several degrees of shade. Since most of these trials were started recently, they have not yet demonstrated the profitability of manuring under natural shade. The superiority of the PK formulas has, however, been established both in the Ivory Coast and in Cameroon.

Other experiments are concerned with rehabilitation of farms and the techniques of replanting old cocoa trees. An experiment aimed at developing a method of improvement by natural regrowth has been started at Divo.

Several spacing trials have been planted to study the rate at which the canopy closes, with a view to enquiring into the interactions between density and manuring.

3. Study of pests and diseases

Entomology

The main entomological problem, both in the Ivory Coast and in Cameroon, is that of capsids, and a common programme for these two countries has been worked out. In the Ivory Coast the main aim of the entomological laboratory is to provide a solution to the problems of replacing Lindane, should resistance to this insecticide develop. Field trials have compared the respective merits of various alternative insecticides. In Cameroon, the research work on capsids has been directed towards a study of the biology of this pest, both under natural conditions and in the laboratory, and also towards comparisons of the efficiency and profitability of the different forms of treatment: fogging and spraying.

Plant pathology

The study of black pod, due to *Phytophthora palmivora*, is virtually the only current work of the I.F.C.C. plant pathology laboratories in the Ivory Coast and in Cameroon.

In the Ivory Coast the work is concerned mainly with the biology of Phytophthora and its method of attack on pods; in Cameroon, where this disease is more severe, the work is control: methods of prophylaxis, different methods of spraying and the frequency of treatment.

4. Improvement of the quality of the product

The work in technology effected overseas is carried out under the direction of the I.F.C.C. Laboratory in Paris.

It mainly concerns the following points in the Ivory Coast and in Cameroon: study of the influence of the length of fermentation and of the number of mixings on the flavour characteristics of the beans, trials in microfermentation in the laboratory to assist selection—research into pesticide residues in beans—study of drying processes—research into storage in the ports; chemical studies of the evolution of the forms of nitrogen in the course of the fermentation and storage of beans.

In Madagascar, the fermentation of Criollo cocoa forms the object of special studies carried out through the development of a method adapted to this type of cocoa and local climate.

"The Natural History of Chocolate"

EDITOR'S NOTE:
The Natural History of Chocolate *is a small book on cocoa published in* 1724, *its sub-title being "A distinct and particular account of the COCAO-TREE, its growth and culture and the preparation, excellent properties and medicinal virtues of its fruit". Some of the descriptions and comments on cocoa-growing seem appropriate today so some extracts are being published. The book was originally written in French by de Chélus and was translated into English by R. Brookes. There were several editions.*

The word "nursery" is not used in its modern sense but means a plantation or farm.

Extract from Chapter II. Of the choice and disposition of the place to plant a nursery.

When one would raise a nursery, it is necessary, above all things, to choose a proper place, in respect of situation, and a soil agreeable to the nature of it.

The place should be level, moist and not exposed to winds; a fresh, and (if one may be allowed the expression) a virgin soil, indifferently fat, light and deep. For this reason, ground newly cleared, whose soil is black and sandy, which is kept moist by a river, and its borders so high as to shelter it from the winds, especially towards the sea coast, is preferable to any other; and they never fail putting it to this use, when they are so happy as to find any of this sort.

I have said, "ground newly cleared", that is to say, whose wood is cut down purposely for it; for it is necessary to observe that they at present plant their nurseries in the middle of woods, which have been so time out of mind, and this for two weighty reasons: the first, because the wood that is left standing round it may serve as a shelter; and the second, because there is less trouble in weeding or grubbing it. The ground that has never produced any weeds will send forth but few, for want of seed.

As for nurseries planted in high ground, the earth is neither moist nor deep enough, and commonly the chief root which grows directly downwards cannot pierce the hard earth which it soon meets with. Besides, the winds are more boisterous, and cause the blossoms to fall off as soon as blown, and when a little high, overturn the tree, whose roots are almost all superficial.

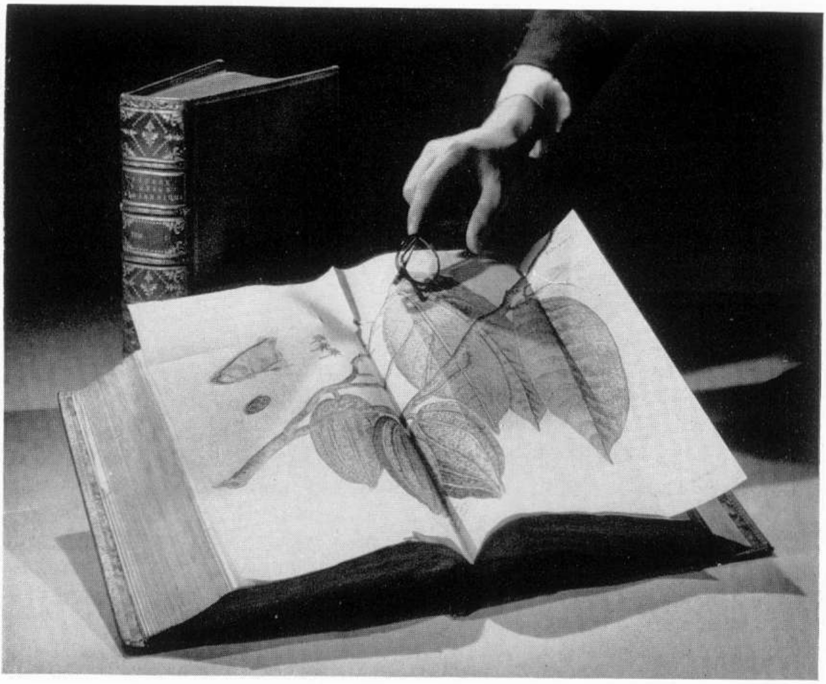
This is yet worse on the hills, whose descent is too steep; for besides the same inconveniences, the falling down of the earth draws with it the good soil, and insensibly lays the roots bare.

One may therefore conclude that all these nurseries are a long time before they bear, that they are never fruitful, and that they are destroyed in a little time.

It is also proper that a nursery, as much as may be, should be surrounded with standing wood; but if it is open on any side, it should be remedied as soon as possible by a border of several ranks of trees called Bananes.

Besides this, the nurseries should be moderate in respect of magnitude, for the small have not air enough, and are, as it were, stifled; and the very large are too liable to dryness, and to the great winds, which, in America, they call Ouragans.*

*These violent and outrageous winds blow from all points of the compass in twenty-four hours. And this is one material thing to distinguish them from the regular and common winds of this climate.



This picture is from the famous 18th-century book by Sir Hans Sloane and shows a fine colour print of cocoa pods. A copy of this rare book is in the Bournville archives.

The place of the nursery being chosen, and the bigness determined, they apply themselves to clear it of the wood. They begin with plucking up the little plants, and by cutting the shrubs, and small kinds of trees, and felling the trunks and larger branches of others; they then make piles, and set them on fire in all parts, and so burn down the largest trees of all, to save themselves the trouble of cutting them.

When all is burnt, and there remains nothing upon the earth, but the trunks of the great trees which they don't trouble themselves to consume, and when the space is well cleaned, they make alleys by the help of a line, straight and at equal distances from each other, and thrust sticks into the ground of two or three foot long, and 5, 6, 7, 8, 9 or 10 feet distant, or at such a distance that they design to plant the cocao trees, which they represent. Afterwards they plant Manioc in the empty spaces, taking care not to come too near the sticks.

One may observe that the nurseries planted at the great distances of eight or ten feet are a great deal more troublesome to keep clean in the first years, as we shall observe hereafter; but then they prosper a great deal better, bear more, and last longer.

It must be observed:

1. Not to plant in a dry season. One may indeed plant in any month of the year, or any moon, new or old, when the season is cool, and the place ready; but it is commonly believed that planting from September to Christmas, the trees bear more than in some months.

2. Not to plant any but the largest kernels, and such as are plump; for since in the finest shells there are sometimes withered kernels, it would be very imprudent to make use of them.
3. To plant the great ends of the kernels lowermost: this is that which is held by a little thread to the centre of the shell, when one takes the kernel out. If the little end was placed downward, the foot of the tree would become crooked, neither would it prosper; and if it was placed sideways, the foot would not succeed very well.
4. To put two or three kernels at every stick, that if by any mischance the tender shoots of one or two are broken by insects, or otherwise, there may be one left to supply the defect. If no bad accident happen, you have the advantage of choosing the straightest and most likely shoot. But it is not best to cut up the supernumerary ones till that which is chosen is grown up and, according to all appearance, out of danger.

Extract from Chapter III. Of the method of planting a nursery, and of its cultivation, till the fruit comes to maturity.

The whole cultivation of the cocoa tree may then be reduced to the practice of two things.

First, to overlook them during the first fifteen days; that is to say, to plant new kernels in the room of those that do not come up, or whose shoots have been destroyed by insects, which very often make dreadful havoc among these plants, even when one would think they are out of danger. Some inhabitants make nurseries apart and transplant them to the places where they are wanting: but as they do not all grow, especially when they are a little too big, or the season not favourable, and because the greatest part of those that do grow languish a long time, it always seemed to me more proper to set fresh kernels; and I am persuaded, if the consequences are duly weighed, it will be practised for the future.

Secondly, not to let any weeds grow in the nursery, but to cleanse it carefully from one end to the other, and taking care, above all things, not to let any herb or weed grow up to seed; for if it should happen so but once, it will be very difficult thenceforwards to root those troublesome guests out, and to keep the nursery clean, because the cold in this country never interrupts vegetation.

This weeding should be continued till the trees are become large, and their branches spreading, cast such a shade as to hinder the weeds from coming up; and afterwards, the leaves falling from the trees, and covering the earth, will contribute to stifle them entirely. When this troublesome business of weeding is ended, it will be sufficient to overlook them once a month, and pluck up here and there those few weeds that remain, and to carry them far into the woods for fear of seeds.

Factors affecting Flowering of the Cocoa Tree

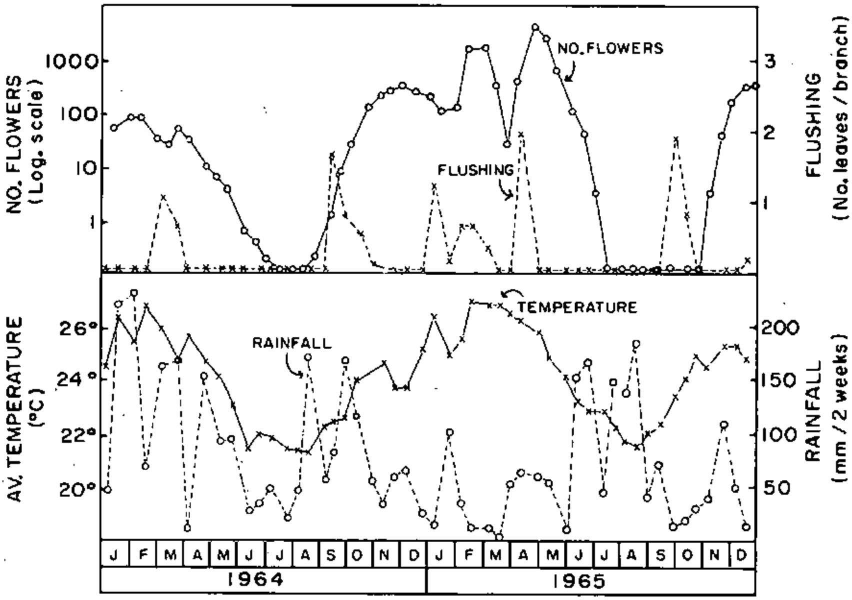
Paulo de T. Alvim,
Centro de Pesquisas do Cacau, Itabuna, Bahia, Brazil

Our knowledge of the environmental factors affecting flowering of the cocoa tree is still rather limited. It is known that in regions with well distributed rainfall and little seasonal change in temperature, such as in Costa Rica (1), the cocoa tree usually flowers throughout the year, therefore behaving as a typical ever-flowering plant. However, even in such regions the intensity of flowering is never uniform throughout the year, but shows variations which are certainly associated with some environmental factors. In areas with well defined seasonal changes in temperature or rainfall, flowering is known to become markedly seasonal, and periods completely without flowers often occur. This is observed, for instance, in the cocoa region of the States of Bahia and Espírito Santo, Brazil, where the flowering season lasts from October to June, and practically no flower is seen on mature plants during the months of July, August and September. In West Africa, flowering is usually abundant from March to August and is drastically reduced from September to February (5).

Seasonal periodicity of flowering in Bahia

Preliminary observations in Bahia indicated that the seasonal periodicity of flowering is affected by the age of the cocoa tree and apparently bears some relationship to the growth rhythm of the plant as a whole. In relatively young trees, which are known to flush almost continuously, some flowers are always present on the plant. After the plant passes the age of about three or four years, flowering and flushing become apparently synchronized, the non-flowering period usually starting one or two months after the non-flushing period begins. This apparent relationship between flushing and flowering seems to suggest that the stimulus for flowering, probably of hormone nature, originates in relatively young or recently hardened leaves.

The cocoa region of Bahia is located at a latitude of about 15° S, where day-length varies from 11 hours 15 minutes in June to 12 hours 55 minutes in December. Since the non-flowering period occurs when the days are shorter, an experiment was made to check the possibility of inducing flowering by extending the day-length by means of artificial illumination. Trees about 20 years old under normal field conditions were used for the experiment. Eight 150-watt photo-flood lamps were placed at a distance of about one meter above the tree canopy so as to give a light intensity of approximately 1,000 lux (100 ft-c) at the site where the upper leaves were located. Three treatments were compared, namely, 16-hour day-length (artificial light from 5 p.m. to 9 p.m.), 24-hour day-length (artificial light from 5 p.m. to 6 a.m.), and control without artificial illumination. The treatments were applied from 1 May to 31 August, 1963 and repeated in the following year during the same period. The results showed that flowering and flushing in cocoa, contrary to what has been previously suspected (2), do not seem to be affected by photoperiodism. In both years the artificially illuminated plants behaved exactly like the control, flowering stopping in July and starting again in October.



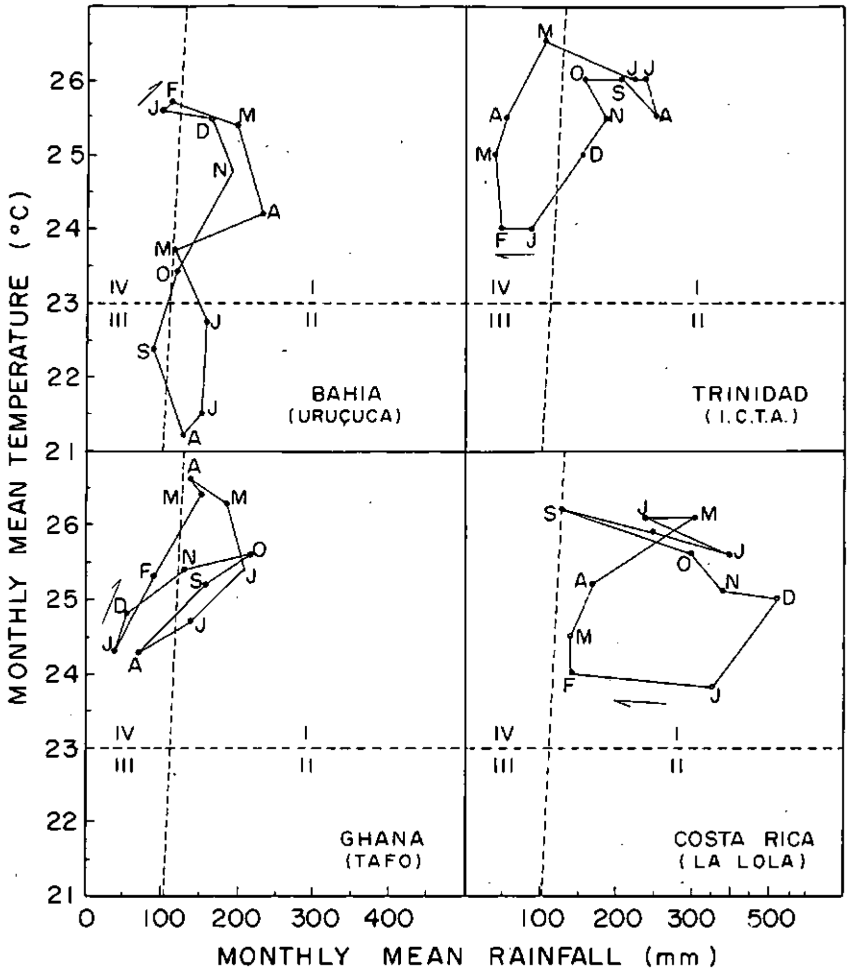
Bi-weekly data on flowering and flushing of cocoa trees in Bahia, together with temperature and rainfall data.

Fig. 1 summarises the results of another study carried out at the Cocoa Experimental Station of Uruçuca, Bahia to determine possible causal relationships between temperature and/or rainfall and flowering intensity. Data on flowering was obtained at weekly intervals, from January 1964 to December 1965, by counting the number of recently opened flowers on trunk portions (previously marked by painting) of 100 trees. Data on flushing were also obtained by counting the number of the newly-formed leaves (above 2 cm long) on 100 branches of 10 plants (10 branches per tree).

These results show clearly that the main climatic factor associated with the decrease or complete absence of flowering from July to September appears to be the relatively low temperature during this period. Apparently, flowering in Bahia is completely inhibited whenever the average temperature is lower than about 23°C.

It should be pointed out that the actual number of flowers recorded at each count (total 100 trunk portions) varied from zero during the low temperature months to 2,000-4,000 during the periods of very heavy flowering, such as observed in February and April 1965. Because of the wide variation in flower counts, the relative flowering intensity, as expressed by the bi-weekly averages of the total number of flowers at each counting, had to be graphically represented in a logarithm scale.

Fig. 1 also shows that, during the warmer months, flowering was strongly affected by rainfall. The decrease in flowering observed in December 1964, January 1965, and again in March 1965, was obviously a result of reduced rainfall in November-December 1964 and February-March 1965.



Hythergraphs of the four typical cocoa regions; (I) months with adequate conditions for flowering; (II) months with reduced temperature; (III) months with reduced temperature and rainfall; and (IV) months with reduced rainfall.

Attention should be called to the remarkable increase in flowering observed in January and April 1965, following the first heavy rains after the periods of reduced rainfall. In April, the intensity of flowering increased more than one-hundred fold within a period of less than two weeks after the onset of rains. This spectacular increase in flowering seems to indicate that a period of moisture stress does not actually stop flower-bud differentiation, as one might think, but just holds the buds in a state of rest or depressed growth. As soon as the first heavy rain comes, all the buds formed during the dry spell grow simultaneously;

this accounts for the observed profusion of flowers. It may therefore be concluded that it is not so much the amount of rain that controls flowering intensity of the cocoa tree during the warmer months, but chiefly the distribution of rains. As suggested in a previous paper (2) the abrupt transition from a dry to a wet period appears to be an important factor controlling flowering intensity in many tropical species. The term "hydroperiodism" has been proposed to refer to this stimulating effect of a dry-wet transition on flowering of plants (2).

As shown in Fig. 1, two main peaks of flushing occur in Bahia, one in September-October and another in February-March or March-April. One or two minor flushes may occur from November to January, but no flushing has ever been recorded from April to August. In other words, flushing stops about two months before the non-flowering season starts and is usually resumed simultaneously or just before the reappearance of the flowers in October. This seems to corroborate the hypothesis concerning the production of a flowering hormone in newly formed or recently hardened leaves.

Seasonal periodicity of flowering in other cocoa regions

It is well known that in many cocoa regions rainfall distribution is the most important controlling factor for flowering. On the Pacific coast of Costa Rica, for instance, where there is practically no rain from December to March (1), flowering gradually reduces, and usually becomes completely arrested by the end of the dry season only to be initiated after the onset of the rains in April or May. A similar situation occurs in Trinidad, Ghana and Nigeria.

The amplitude of seasonal changes in four different cocoa regions is shown by the hythergraphs in Fig 2, in which monthly mean temperatures are plotted against monthly mean totals of rainfall. Because both temperature and rainfall are important factors for flowering, these graphs have been found to be of great help to explain the relationship between seasonal periodicity of flowering and the annual climatic cycle. On the assumption that flowering requires a monthly mean temperature above 23°C., as suggested by the results in Fig. 1, and a monthly mean rainfall higher than the potential evapotranspiration, the theoretical limits of temperature and rainfall for unimpeded flowering are represented by the two dotted lines which divide the hythergraphs in four zones: (1) zone of adequate conditions for flowering; (2) zone of reduced flowering because of low temperature; (3) zone of reduced flowering because of limited rainfall and low temperature; and (4) zone of reduced flowering because of limited rainfall.

The limited-rainfall line was traced in accordance with a simplified formula for the estimation of potential evapotranspiration on the basis of temperature (3):

$$\text{EP monthly} = \frac{T \times 58{\cdot}93}{12} = T \times 4{\cdot}91 \text{ mm.}$$

where T=average monthly mean temperature in centigrade.

Soil moisture becomes deficient to plants when rainfall is smaller than the potential evapotranspiration. However, because the soil usually retains sufficient moisture to meet the plant requirements for some time, the first month of reduced rainfall, as indicated by Fig. 2, should not be considered as deficient in soil moisture for flowering. Obviously, moisture deficiency becomes more severe as the number of months below the potential evapotranspiration line increases. Also, because temperature appears to affect first vegetative growth, which in turn would affect flowering, a time lag of one month is allowed before flowering is depressed when the mean temperature is below 23°C.

For Bahia, Trinidad, and Costa Rica, data on flowering and monthly crop are in very good agreement with the theoretical deductions from the hythergraphs represented in Fig. 2. As mentioned before, the relatively low temperature in June, July, August and September appears to be the limiting factor for flowering in Bahia from July to September, this accounting for the absence of harvest in January, February and March. The reduced harvest often observed in Bahia during the month of August is apparently a result of moisture stress in February. In Trinidad, the absence of crop from July to October (4) is clearly a result of moisture deficiency from February to May. The continuous flowering in the lowlands of the Atlantic coast of Costa Rica (1) is also in accordance with the hythergraph for La Lola.

The main flowering season in Ghana goes from March to August and the low flowering period from September to February (5). No obvious explanation can be found from the hythergraph for Tafo for the reduced flowering in October and November. It appears that in this country a third factor overshadows the influence of rainfall and temperature during that part of the year. It seems possible that in this country, because of the heavy concentration of the crop in September-December, flowering intensity is reduced, notwithstanding the adequate climatic conditions in October and November, because of internal food competition between the growing pods and flowers. This type of competition is known to occur in other tropical species, such as papaya (2). It is recognised, however, that further research is needed to properly explain the seasonal periodicity of cocoa-flowering in Ghana.

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Pruning Cocoa

V. A. Cook, Anglican Mission, Jegarata, Papua

EDITOR'S NOTE:
This article was submitted by Mr. Cook and is a useful account of pruning. It is not an account of experiments, but is written from a practical planter's point of view. Some readers may hold other views; if so their letters or brief articles would be welcome.

Cocoa planters are faced with the question: first, to prune, or not to prune, and then how much and when. The planter may simply remove suckers, or he may prune severely to produce an open-centred tree. Within this range one of the important considerations is that the method be easily taught to labourers. The method in use at the Anglican Mission farm at Jegarata near Popondetta is described here, together with some of the advantages noted.

Aim of pruning

The aim of pruning is to make all parts of the mature tree accessible and visible to labourers standing erect on the ground under the tree, and to a labourer climbing into the tree. The benefits which result from a plantation in this condition are numerous and, it is believed, economical.

(*a*) The general hygiene of the plantation is improved. The progressive elimination of the *low-level* branches as the tree matures allows weeding to be done more cheaply and effectively and improves the ventilation through the plantation, thus reducing the incidence of fungus diseases. It also aids spraying and other pest-control work, not only making it easier but probably more effective.

(*b*) The *interior* of the tree is made more accessible, and this greatly facilitates harvesting, not only saving labour costs but lessening losses caused by the leaving of ripe pods on the trees. The removal of the low-level branches also aids harvesting by enabling labourers on the ground to circle the tree while standing erect and looking up. There is no doubt that a surprisingly high percentage of ripe pods is missed in plantations where the lower branches of the trees cause the labourer to bend forward in order to pass, or even deter him from approaching the trunk.

From the following brief notes on methods of pruning used at Jegarata it will be seen that no great expense is involved. Accurate man/hour records have not been kept, but it has been found that one man is not fully occupied in pruning fifty acres in all stages of growth.

1. From planting until the tree reaches a height of 6 to 8 feet

(*a*) Leave a single strong chupon, removing side shoots. Should the growing point be destroyed by insects, the stem is cut back to a point above a healthy bud, the lower the better, providing that there are at least two or three healthy leaves remaining on the stem. It has been observed that satisfactory recovery from complete defoliation is very rare.

(*b*) Four to twelve months after jorquetting takes place, the number of main branches is reduced to four. When choosing which branch or branches to remove, it is best to take those which are nearest the horizontal position.

A young cocoa tree after pruning.

Cocoa trees after pruning, showing the ease of harvesting.

A perfectly good tree can be built on two main branches, but the idea should be to keep pruning to the minimum, within the aims prescribed.

2. From a tree height of 6 to 8 feet until maturity

(*a*) Continue to remove all suckers from the main stem and the main branches for a distance of one to three feet, according to the height at which the tree has ramified, that is, just above the head of the labourer standing on the ground.

(*b*) Remove progressively during this period all secondary branches arising from the main ones from one to three feet above the jorquette, according to the height at which the tree has ramified, leaving sufficient head-room for the labourer to stand erect and to give him access to the interior of the tree.

(*c*) The aim is to keep a complete canopy of leaves over the crown of the tree, but not so dense as to exclude sufficient light for good visibility even on dull days. This plan inhibits suckering.

3. From maturity to old age

Most cocoa trees in this locality throw out fanwood suckers and an occasional chupon above the jorquette throughout the life of the tree. Choice of those to remain should not be made indiscriminately.

(*a*) All chupons appearing above the jorquette should be removed.

(*b*) Fanwood suckers appearing above a height of two to three feet above the jorquette can generally be ignored, unless they fall across the centre of the tree and interfere with accessibility to the interior of the frame. In this case they should be removed.

(*c*) Fanwood suckers appearing below this level should all be removed except for one, or perhaps two, strong ones per tree on separate main branches chosen specially for their position. For instance, where the original main arms have begun to sag at the outer ends, a strong fanwood sucker can be left, preferably at about one foot above the jorquette and at the side of the main branch. This enables the harvesting on the old branch to be carried out while the new leader is being formed at a slight outward angle from the vertical. In this way the entire frame can be continually renewed.

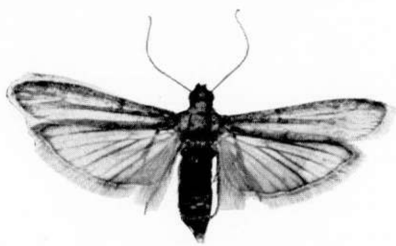
4. All cuts should be made as flush as possible with the face of the parent branch. At Jegarata a pruning saw is used almost exclusively. Although on the smaller branches this produces a rather rough cut, it is found that this is much preferable to the uneven protruding stumps left by a bush knife. This last type of cut delays healing of the wound and allows deeper penetration of the rot-causing organisms.

Insect Infestation in Cocoa Beans

C. Smedley, Cadbury Brothers Limited

Infestation of cocoa beans and the danger this presents to the factory and the finished goods is a problem that manufacturers have to tackle. Freshly fermented beans are free of insects and the manufacturer's problems arise from the presence of those insects which get into the beans after fermentation; these are quite different species to those causing trouble to cocoa growers.

The insects which give most concern in Britain are small moths and beetles. The main offender is a small grey moth, *Cadra cautella*, commonly called the tropical warehouse moth. The female may lay up to 250 eggs during its lifetime of about a week. It does not feed but will drink if water is available in a suitable form, such as condensation or wet patches on a floor. The moths drown quite



Cadra Cautella, *or the tropical wharehouse moth.*

easily in a liquid surface, and often the first indication of their presence in a room will be to find them spread on the surface of some liquid, such as water in a bucket or a tray. If the moth is able to get water the majority of the eggs it lays will hatch; otherwise only the first 60 or 70 will hatch. Dry storage, in the sense that no wet spots are visible, is therefore desirable.

The only Safe Package

We cannot find any evidence that female moths are able to detect foodstuffs suitable for their progeny, and our experience is that they lay their eggs quite indiscriminately, preferring only a rough surface to a smooth one. The viable eggs hatch in a few days in the tropics, and a tiny, active grub emerges which can crawl three feet before it needs to feed, and can get through a hole 7/1000 in. wide. This means that the grubs can get into a tin with an ordinary push-on lid quite easily by crawling up the seam. They can still get in even when the lid is taped. In fact, the only package guaranteed to keep them out is a completely soldered tin or its equivalent.

Again, we can find no evidence that these freshly-hatched grubs are able to detect foodstuffs which will nourish them. We took 100 eggs and placed each one on a nut, which is excellent food for them. The nuts were then suspended in mid-air on the tops of needles. Only two of the 100 grubs that hatched out survived; the rest crawled off the nuts and starved. It seems, therefore, that, for the first 24 of the 56 hours that a freshly-hatched grub can survive without food it is anxious to find protection and instinctively starts to crawl to some crevice where it can hide. If the crevice happens to contain food which it can chew with its tiny jaws it survives; if there is no such food it dies. Grubs which find food continue to wander within the area where it is available, leaving behind them a silken thread. These threads often become woven into a mass in which the excrement of the feeding grub becomes entangled. This is known as "frass" and is the characteristic damage first noticeable on food. The frass from grubs fed on fatty foods, like cocoa beans or nuts, has a very high fatty acid content. In cases of heavy infestation the inclusion of such material may affect the flavour of the finished product.

The grub feeds for between three and eight weeks in cocoa beans, depending on the temperature, and in the tropics the shorter period applies. By the time it is mature it has consumed about 0·3 grammes of nib and has grown to about $\frac{3}{8}''$ long, whitish in colour, and with four rows of black spots down the length of its back. All can be seen with a magnifying glass, but the two centre ones are usually visible with the naked eye. In its early stages its jaws are not strong enough to chew the shell of a properly dried cocoa bean, and the grubs are dependent for their survival on finding broken, cut or germinated beans. Care in gathering, pod opening and subsequent handling is therefore a help in reducing the chances of grub survival. At its fully-fed stage the grub gets restive again and starts wandering. We do not know why, but there seems to be a tendency for it to climb. They do this until they find a suitable crevice in which to spin themselves a silken cocoon and turn into a chrysalis. Such crevices are often the junction between the top bags and the second layer in a stack of beans, but not infrequently the grubs will crawl away from the cocoa and find a crevice, usually at the top of the wall or in the roof of the building housing the beans. This is one reason why we suggest that stacks should be free-standing; another advantage of a gangway all round a stack is that it gives access for examination and treatment of a variety of pests.

The Life Cycle

From the chrysalis the next generation of moths hatches. The proportion of males and females is roughly 50-50; mating takes place within a few hours, and the cycle starts all over again. The total life cycle in the tropics will be of the order of six weeks, but in the temperate zone it will be double that time, in heated premises during the winter or during the summer months in unheated ones. In northern Britain these moths do not survive, in any stage of development, a winter in unheated premises.

Where does the infestation start? At the fermenting stage the beans are free of insect life and there is little doubt that the moths which are present in the local grain and other food supplies are the source of damage in cocoa beans. If the beans could be segregated from other foodstuffs while being stored or transported, moth damage could be eliminated. Probably the nearest we shall ever get to this ideal is the rapid movement of beans from the fermentation stage to cool conditions where the few insects that do get in have their development slowed down so that they cease to do any harm before the beans are used.

How does all this affect the manufacturer? To him the cocoa beans take the place of the local foodstuffs in the tropical countries. The beans are shipped to the temperate countries where they may be put into store with other goods. Suppose a consignment of beans arrives in London in September and is put into a store alongside a stack of canned peaches cased in fiberite cartons. The moth grub in the beans, when fully fed, would wander and might find a suitable resting place in the joints of the fiberite cases. These might then be carried into a grocer's shop, which would be warm enough for the moths to hatch out from the chrysalis in the fiberite. Eggs could then be laid in the near vicinity of bars of chocolate, or other wrapped foods on sale to the public, where wrappings would almost certainly contain holes larger than 7/1000″. If that chocolate bar is sold two or three weeks later the grub will have grown big enough to be seen, and the purchaser would get a shock on opening the wrapping—such a shock, indeed, that he might exercise his right to complain to the local Public Health Department.

"The Greatest Danger"

An inspector would then be sent to investigate. He would visit the shop from which the block was purchased and probably be unable to find any further evidence of infestation because this would involve unwrapping more foodstuffs, thus making them unsaleable. He would then refer the matter to the manufacturer and make his report to the local Health Committee. If the Committee thought there was any negligence on the part of either the shopkeeper or the manufacturer a summons would be issued under the Sale of Food and Drugs Act on one of the following counts: selling goods unfit for human consumption, selling goods not of the substance demanded, or selling goods not of the quality demanded. Conviction in any of these counts carries a maximum fine of £100 or six months' imprisonment.

The greatest danger, however, might be that a report of the court proceedings could appear in the National Press, and the effect on goodwill could be disastrous.

The risk of this happening is small—one complaint in 10 to 12 tons of goods sold—but the whole question of infestation causes deep concern and the risk will be eliminated only when everyone, from the primary producer to the consumer, is aware of the causes and takes care that the insects are given the least possible chance of getting into the goods in his care.

Cocoa Abstracts

These abstracts are reprinted from "Tropical Abstracts", published by The Royal Tropical Institute, Amsterdam.

November, 1965

Wessel, M. A brief outline of the climate of the main cocoa growing area of Western Nigeria. In: Proc. Conf. on mirids and other pests of cacao at the W. Afr. Cocoa Res. Inst. (Nigeria), 24th to 27th March, 1964, p. 90-6.

Fairly detailed data are presented of the climate of the cocoa belt extending from Ilaro to Ikare in W. Nigeria. Cocoa growing areas within this belt total 450,000 ha; the average yield is 400 kg of commercial cocoa per ha. The climate is characterized by an annual rainfall of 1,100-1,500 mm, of which only 9% falls in Nov.-Feb.; during the severe dry season the harmattan penetrates deeply into the cocoa belt. A comparison with other cocoa producing countries of W. Africa indicates that this climate is similar to that of Abengourou in the Ivory Coast, and is much more extreme than that of the cocoa growing regions of Ghana. Tables. Graphs. Map. 9 refs. Discussion p. 97.

Correa Velásquez, J. Efecto del hierro en el desarrollo de las raíces de las plantas. (Effect of iron on the development of plant roots). Rev. Fac. Nac. Agron., Colombia 24, 61, p. 27-52 (1964).

In Colombia cocoa seedlings were grown in a Fe-free nutrient solution; Fe chelate was added to the solution or sprayed on the leaves when the plants had become chlorotic. Root growth was stimulated by chelate in the solution at up to 6 p.p.m. Fe and by foliar spraying at 10 p.p.m., depressed by foliar spraying at 20 p.p.m. Stem growth was depressed by 6 p.p.m. Fe in the solution and by foliar application at 20 p.p.m., not affected by lower concentrations. Fe 59-labelled $FeCl_3$ sprayed on the leaves was readily absorbed and translocated to the roots; $FeCl_3$ added to the solution was readily absorbed by the roots but translocation to the aerial parts was rather slow. A similar trial with coffee seedlings indicated a stimulating effect of the chelate on root and stem growth when it was applied either to the roots or to the leaves. Tables. Graphs. 36 refs.

Tarjot, M. Étude de la résistance des cacaoyers à la pourriture brune des cabosses due au Phytophthora palmivora (Butl.) Butl. en Côte d'Ivoire. Première partie: Inoculations expérimentales par blessure et fragments de culture. (A study of the resistance of cocoa trees to pod rot caused by *Phytophthora palmivora* in the Ivory Coast. Part 1: Experimental inoculation of wounds with culture fragments). Café, Cacao, Thé 9, 2, p. 126-33 (1965).

Susceptibility to pod rot of cocoa trees in the Ivory Coast was assessed by filling a hole punched in the pericarp of detached fruits with a culture of *Phytophthora palmivora*, and measuring the diseased patch after 5 days. All trees of the local Amelonado type and of the Upper Amazon type, and all crosses of Upper Amazon trees with Amelonado, Trinitario and Criollo trees included in the tests proved to be equally susceptible. Among 9 Trinitario trees tested, 1 tree (received from the United Fruit Company) showed some resistance; crosses with 2 Upper Amazon trees were as susceptible as the Upper Amazon parents. English, German and Spanish summaries. Tables.

Pereira, R. J. Càravalho. Emprêgo de herbicidas na eliminação do "canoão". (The use of herbicides to eliminate *Setaria sulcata*). Cacau Atualidades 1, 11-12, p. 3-7 (1964).

The grass *Setaria sulcata* (*Panicum sulcatum*), introduced as an ornamental or forage crop from Trinidad, has become a highly noxious weed of cocoa fields in the Brazilian State of Bahia. Herbicide trials showed that it can be successfully controlled by spraying twice, at an interval of 15-30 days, with dalapon at a rate of 2.5 kg acid equivalent per ha or with TCA at a rate of 10 kg active ingredient per ha, whereas monuron at 7.5 kg/ha and 2,4-D at 7.5 kg/ha were but little effective. Two sprayings with paraquat at a 30-day interval, using 1 and 0.5 kg active substance per ha, respectively, killed the aerial parts so rapidly that the herbicide was not translocated to the roots; consequently, the grass recovered within a short time after the treatment. Tables. Photos.

Everard, C. O. R. Some aspects of vertebrate damage to cocoa in West Africa. In: Proc. Conf. on mirids and other pests of cacao at the W. Afr. Cocoa Res. Inst. (Nigeria), 24th to 27th Mch., 1964, p. 114-9.

Vertebrate damage to cocoa was found in W. Nigeria to be mainly caused by rodents. Seeds and young seedlings are dug up, older seedlings are gnawed through at the base. Rodent damage to pods may be fairly serious but has been exaggerated because it was confused with damage caused by the caterpillars of *Characoma stictograpta*. Fermenting beans may be contaminated with faeces because the mucilage attracts several animals; stored cocoa is consumed by rodents and contaminated with faeces of rodents and lizards. Nurseries should be enclosed by wire netting or corrugated iron sheeting; stores should be made rodent-proof. Protection of plants in the field against porcupines and rats may be attained by treating the plants with a formulation containing nicotine, or by spraying the ground with endrin. Tables. 12 refs. Discussion p. 119.

(Rat control in cacao fields). Cacau Atualidades 1, 6, p. 8-9 (1964).

Cocoa planters in the Brazilian State of Bahia are advised to control rats by the destruction of nests, the protection of snakes, and birds of prey, and the use of poisoned baits. Baits can be prepared from maize meal, rice plus 2% groundnut oil, or fruits, poisoned with one of the common rodenticides such as warfarin. About 20 bamboo joints provided with 200 g of bait, or 20-30 poisoned fruits are required per ha. A simple, effective bait may be prepared by sticking matches into bananas; after 24 hours the matches and a slice of the peel are removed, and the banana is tied in the fork of a cocoa tree.

Gerard, B. M. Insects associated with unshaded Theobroma cacao L. in Ghana. In: Proc. Conf. on mirids and other pests of cacao at the W. Afr. Cocoa Res. Inst. (Nigeria), 24th to 27th Mch., 1964, p. 101-11.

Actual and potential side-effects of shade removal in cocoa fields are discussed with special reference to insect pests. Among the species attacking shaded fields as well, mirids become less easy to control because of the changed growth habit of the cocoa; thrips tend to cause more serious defoliation in unshaded fields. In general the insect fauna shows a shift from species naturally occurring in forests to savanna types. In Ghana a pentatomid bug, *Bathycoelia thalassina*, threatens to become a serious pest of unshaded cocoa;

it pierces the pericarp of young pods to feed on the developing seeds. For the time being, successful growing of cocoa without shade appears to depend on effective chemical control of the most important pests. Tables. Map. 22 refs. Discussion p. 111.

Entwistle, P. F., and Youdeowei, A. A preliminary world review of cacao mirids. In: Proc. Conf. on mirids and other pests of cacao at the W. Afr. Cocoa Res. Inst. (Nigeria), 24th to 27th Mch., 1964, p. 71-8.

A review is presented of the distribution of mirid species associated with cocoa in all countries growing this crop, and of their host plants, biology, and ecology. The 35 species mentioned pertain to 9 genera, of which *Monalonion* is restricted to the New World and is the only genus found there; *Sahlbergella, Distantiella* and *Bryocoropsis* are restricted to W. Africa, *Odoniella* to the Congo, and *Boxiopsis* to Madagascar; *Helopeltis* occurs from New Guinea to W. Africa, *Pseudodoniella* in the Philippines and eastern New Guinea; *Platyngomiriodes* has been found in Sabah. Tables. Map. Discussion p. 79. Bibliography by T. W. Cochrane and P. F. Entwistle, p. 123-31.

Ingram, W. R. A note on the control of Toxoptera aurantii B. de Fon, in cocoa nurseries in Uganda. In: Proc. Conf. on mirids and other pests of cacao at the W. Afr. Cocoa Res. Inst. (Nigeria), 24th to 27th Mch., 1964, p. 112-3.

In Uganda the aphid *Toxoptera aurantii* may cause severe malformation of cocoa seedlings in the nursery; its high incidence may be the result of regular spraying with DDT against leaf-eating caterpillars. Good control of the aphid on potted plants was attained by spraying with the systemic insecticide menazon at a concentration of 0.25% active ingredient, applying 3.5 l of fluid per 1,000 plants. Caterpillars, which are not controlled by the aphicide, have still to be sprayed with DDT; it is advisable not to apply this treatment when aphids are still present. Table. 6 refs.

Conway, G. R. A note on mirid bugs (Hemiptera: Miridae) and some other insect pests of cocoa in Sabah, Malaysia. In: Proc. Conf. on mirids and other pests of cacao at the W. Afr. Cocoa Res. Inst. (Nigeria), 24th to 27th Mch., 1964, p. 80-4.

Major cocoa pests in Sabah all appear to occur naturally in adjacent forests; they include the ring-bark borer *Phassus hosei*, a branch-boring *Zeuzera* sp., a few other lepidopterous species attacking the leaves, mealybugs, the flatid *Colobesthes falcata*, and 2 mirids. One mirid, *Helopeltis clavifer*, prefers the pods, feeding on young shoots only when no pods are present. The other mirid, *Platyngomiriodes apiformis*, causes serious damage to pods by its gregarious feeding on the tips and bases; it does not feed on young shoots but was found to feed on partially lignified chupons and in a few trees on branches and stems. The mirids can be controlled with lindane; other pests are kept in check by their natural enemies since chemical control was discontinued in 1961. Map. 11 refs.

Krug, C. A., and Quartey-Papafio, E. World cocoa survey. FAO Agr. Stud. 63, p. I-XI, 1-242 (1964).

A survey based on questionnaires and visits to cocoa producing countries, presenting concise information on the cocoa industry in each of these countries: climate and soils, types cultivated, cultural practices, extension and training, and research. Maps show the extent of actual and/or potential cocoa growing regions. The final chapter contains a summary of the information arranged according to subjects, and indicates problems to be solved. The appendices present sources of information, a summary of replies to questionnaires sent in 1958 and 1963, a list of stations and centres working on cocoa research, a list of scientific names of plants, pests and pathogens connected with cocoa, and conversion tables. Tables. Maps. Bibliography of 74 titles.

Zwanhuizen, M. Th. Report to the government of Nigeria on agricultural industries for the processing of raw materials in the Eastern Region. Expanded Techn. Assistance Progr., FAO Rep. 1741, p. 1-94 (1963; received 1965).

This report, the result of a study made in 1962-63, describes the proper procedures for the harvesting and processing of coffee, cocoa, rubber, oil palm fruits, and rice, and discusses the possibility of introducing improved methods that are within the reach of individual farmers or farmers' co-operatives in E. Nigeria. Improvements in processing methods, resulting in better quality products, would provide a necessary stimulus for the improvement of agriculture in the country. In particular, improvements in coffee processing would probably create a good local market for coffee produced in E. Nigeria. Tables. 21 refs.

Ferrão, J. E. M. Cacaus de S. Tome é Príncipe; dos polifenois durante a fermentação. (Cocoa of São Tomé and Príncipe; on the polyphenols during fermentation). Anais Inst. Superior Agron. 25, p. 17-222 (1963: received 1965).

The bulk of this paper (p. 21-150) reviews literature on: (1) the history of cocoa cultivation; (2) the taxonomy of cultivated cocoa; (3) the history and development of the cocoa industry in São Tomé and Príncipe, and cultivation and processing methods in these islands; (4) the structure and reactions of polyphenolic compounds in the cocoa bean; (5) the chemistry of cocoa processing with special reference to the transformations of polyphenols during fermentation and drying. The author's investigations on polyphenol transformation during the processing of cocoa (p. 151-89), which yielded results similar to those of other authors working with the same type of cocoa, are discussed in relation to the desirability of shortening the period of fermentation usual in São Tomé. Tables. Graphs. Photos. 500 refs.

December, 1965

Are, L. Observations on the effects of gibberellic acid on the growth of cocoa seedlings. Nigerian Agr. J. 1, 1, p. 26-9 (1964).

In Nigeria 20-day-old seedlings of Upper Amazon cocoa were sprayed with gibberellic acid at concentrations of 250, 500 and 1,000 p.p.m. During 4 weeks after treatment the chemical increased the rate of elongation of the stem and the rate of maturation of new leaves, the effect increasing with the concentration. After that time the effect of gibberellic acid gradually decreased. No differences in the number or size of leaves were observed between treated and untreated plants. Tables. Graph. Photo. 15 refs.

Gordon, J. Problems of forecasting the cocoa crop in Ghana. World Crops 17, 3, p. 64-5 (1965).

Forecasting the cocoa crop involves 2 problems; that of seasonal forecasts of main- and midcrops and the much more difficult problem of forecasting long-range trends in production. Seasonal forecasts depend mainly on climate but the amount of crop actually harvested depends upon farmers' decisions. Sampling is the greatest difficulty in accurately estimating the crop because of the large number of small farms. Seasonal forecasting is not so much a statistical problem as an economic one. Long-term forecasts of production trends can be determined provided that government wage rates are not further inflated, that farm wages move in sympathy with town labour rates, and that cocoa prices are not further depressed. In the author's opinion Ghana has already reached and passed its peak of production, and the increase of 100,000 tons of cocoa envisaged in the 7-year plan is considered too optimistic. The future production aspects are critically commented upon. French and Spanish summaries, p. 13-4.

Creencia, R. P. Dwarf cacao. Coffee Cacao J. 8, 4. p. 74 (1965).

Plants of a dwarf type of Criollo cocoa are grown on a farm in the Philippines. The dwarf character is heritable; seeds obtained in 1955 for an experimental plot at Los Baños yielded dwarf trees that have been bearing pods for 5 years. The trees grow to a height of no more than 2 m and form few chupons; pod and bean size are normal. Since they can be planted close together, normal yields per ha can be obtained. Photo.

Simandjuntak, S. B. Peneduh ditanaman tjoklat muda. (Shade in young cocoa plantations). Bull. Res. Inst. S.P.A. 52, p. 1-18 (1964).

This literature review on the role of shade in young cocoa includes information on the use of shade and the planting of cocoa under other perennial crops such as coconut palm and oil palm. Whereas the yields of cocoa under rubber in various countries have been disappointing, preliminary results of cocoa under oil palm in Indonesia are promising. The practice of planting cocoa under oil palm on 2 estates on Sumatra is briefly described. It is concluded that further information is needed in order to assess the merits of mixed planting of cocoa and oil palm. English summary. 11 refs.

Opuku, A. A. Cover crops (for cacao). Mem. Agr. Res. Stat. Kade, Univ. Ghana 3, p. 16-21 (1963-64).

Results are presented of 3 field trials conducted at Kade, Ghana, to compare soil covers for young cocoa. In experiment CC2 the cocoa grew better with hedges of *Flemingia congesta* or *Pennisetum purpureum* than with natural regeneration, *Cajanus cajan*, *Leucaena glauca* or *Tithonia Diversifolia;* application of P. fertilizer to the covers had no effect on the growth of the cocoa. Experiment CC.6 showed cocoa yields, in the 2nd year of bearing, of 1,194 kg/ha under mulch, 901 kg/ha with *Calopogonium*, 826 kg/ha with *Pueraria*, 770 kg/ha with *Mimosa invisa*, 725 kg/ha with *Centrosema*, and 332 kg/ha with natural regeneration. Among 9 cover plants compared in experiment CC.7, *Flemingia congesta* gave the best overall development of cocoa seedlings in their 1st year. This species tolerates poor drainage, but its cost of establishment is rather high. Hedges could best be established from seedlings; sowing was satisfactory, cuttings were a failure. Tables.

Gonçalves, J. R. C. Theobroma grandiflorum (Spreng.) Schum. as source of inoculum of witch-broom disease of Theobroma cacao L. Trop. Agr., Trinidad 42, 3, p. 261-3 (1965).

Inoculation experiments conducted at Belém do Pará, Brazil, demonstrated that witchbroom disease in *Theobroma cacao* and *Th. grandiflorum* is caused by the same strain or strains of the fungus *Marasmius perniciosus*, as was presumed by several authors. Consequently, *Th. grandiflorum*, which in the State of Pará is used in the refreshment and canned fruit industries, should not be allowed near cocoa fields. 5 refs.

Kasasian, L., and Donelan, A. F. The effect of herbicides on cocoa (Theobroma cacao L.). Trop. Agr., Trinidad 42, 3, p. 217-21 (1965).

In Trinidad the effect of 21 herbicides applied to young cocoa stands was studied in 12 field trials, supplemented by pot experiments. The results indicated that good long-term weed control without appreciable harm to the crop can be attained by applying simazine or linuron at a rate of 3.3 kg active ingredient per ha. Paraquat at 0.56-1.12 kg/ha, 2,4-D, 2,4,5-T or MCPA at 2.25 kg/ha, and dalapon at 5.6 kg/ha may be used for short-term control. The post-emergence effect of simazine and linuron is enhanced by addition of paraquat or 2,4-D. Sodium chlorate, TCA, ametryne, prometryne, neburon and amiben had little effect on the cocoa but gave unsatisfactory weed control. The cocoa was injured by atrazine, atraton, prometone, diuron, fenac, amitrole and 2,3,6-TBA, and especially by bromacil and isocil. Tables. 4 refs.

Gerard, B. M. Bathycoelia thalassina (Herrich-Schaeffer), (Hemiptera: Pentatomidae); a pest of Theobroma cacao L. Nature 207, 4999, p. 881 (1965).

The pentatomid bug *Bathycoelia thalassina* has been known for many years as a minor cocoa pest in Cameroon and Congo (Léopoldville), causing small pods to shrivel and fall but having no serious effect on older pods. Large nymphs and adults were recently found to inflict rather serious damage on developing cocoa pods in Ghana and Nigeria, penetrating the pod wall with their long stylets and sucking sap from the beans. Feeding results in inconspicuous black spots on the exterior of the pod wall; pods damaged at an early stage stop growing and show a constriction in the middle; when they ripen they are found to contain brown, malformed beans without mucilage. Young nymphs feed mainly on the leaves and do little damage. Photos. 2 refs.

A review of the cocoa processing industry in producing countries. Foreign Agr. Circ., U.S. Dep. Agr., FCB 2-65, p. 1-8 (1965).

In their efforts to industrialize, a great many cocoa producing nations are opening or expanding cocoa processing and storage facilities. A review is given of the cocoa processing industry in Brazil, the Dominican Rep., Mexico, Ecuador, Venezuela and other Latin American countries as well as in the following African countries: Ghana, Nigeria, Cameroon, Ivory Coast, Angola, Congo (Léopoldville), and the Malagasy Rep. Lists of processing industries include (where known) number of factories, operating capacity, location and other relevant information pertaining to the industry. Table.

Fontanilla-Barroga, S. A progress report on the study of insects associated with pollination of Theobroma cacao with special emphasis on midges. Philippine J. Agr. 27, 3-4, p. 147-59 (1962; publ. 1965).

Midges observed to alight on flowers and other parts of cocoa in the Philippines were identified as *Forcipomyia fuliginosa*, *Proforcipomyia* spp., *Atrichopogon* sp., and *Dasyhelia* sp. Since members of the first 2 genera are known to be the chief pollinators of cocoa in several other countries, they are presumably responsible for cocoa pollination in the Philippines as well. Pollination was found to occur throughout the day, with a pronounced peak between noon and 3 p.m. in the dry season, and a broad maximum between 9 a.m. and 2 p.m. in the rainy season. Of the 1,950 flowers examined, 45% had pollen masses characteristic of midge pollination on their styles. Tables. Graphs. 11 refs.

Swarbrick, J. T. Storage of cocoa seeds. Exp. Agr. 1, 3, p. 201-8 (1965). Experiments on cocoa seed storage were conducted at Ibadan, W. Nigeria; beans treated with a fungicide were stored in plastic bags containing a storage medium. Pre-storage in the pod for 2 weeks had little effect; washing before storage was beneficial; draining washed beans for 15 minutes and drying in the shade for 3 hours were equally good; sterilized sawdust and charcoal were better storage media than sand; pre-drying reduced germination; a storage temperature of 22°C. was near the optimum; the number of beans in the bag had no effect on germination; soaking stored seeds before planting had no appreciable effect. Among several fungicides tested at a rate of 3 g/250 beans, captan, ziram and dimethyl-dithiocarbamate copper chelate were the most effective, followed by triphenyl tin acetate and cuprous oxide; thiram and maneb were but little effective. A mixture of 2 antibiotics was completely ineffective. Tables. Graphs. Photo. 13 refs.

Zink, E., and Rochelle, L. A. Estudos sôbre a conservação de sementes. XI — Cacau. (Investigations on seed storage. XI — Cocoa). Bragantia 23, 11, p. 111-6 (1964).

At Campinas, Brazil, cocoa seeds were stored at room temperature in the pod, in cloth bags, in hermetically sealed glass jars, and in jars with a perforated cork. Seeds not stored in the pod were treated with lime, washed, dried in the shade for 24 hours, and mixed with 0.2% of a phenyl-mercury acetate formulation containing 1.5% Hg. Storage in a jar with a perforated cork resulted in 72% germination after 90 days; germination of seeds stored in sealed jars was 80% after 45 days but only 2% after 60 days; seeds stored in bags lost their ability to germinate within 30 days; seeds stored in the pods showed 26% germination after 30 days but only 2% after 45 days. Seeds stored at 5°C. completely lost their ability to germinate within 15 days. English summary. Table. Graph. 4 refs.

Cardoso, M. Influência da posição das sementes no fruto do cacaueiro sôbre a germinacão e desenvolvimento das mudas. (Influence of seed location in the cocoa fruit on germination and seedling growth). Bragantia 22, 36, p. 461-4 (1963: received 1965).

Seed samples from the top, centre and bottom portions of the pods of 2 cocoa varieties, one with purple and the other with white beans, were planted separately at Ubatuba, Brazil. No differences in germination or in development of the seedlings were observed between the different samples. English summary. Table. Photo. 1 ref.

Jabagun, J. A. A mechanical cocoa pod sheller. Nigerian Agr. J. 2, 1, p. 44-5 (1965).

A mechanical cocoa pod breaker, constructed in Nigeria, costs about £400 and is capable of breaking 100 pods in 3 minutes, so that it will do the work of 32 men. Pods are fed into a vertical steel cylinder with internal ribs; a ribbed wooden cone revolves in the cylinder. Shell fragments and beans flow through a chute into a horizontally rotating cylinder made of woven steel wire with a mesh width of 2.5 cm; beans are delivered through the meshes while shell fragments are collected at the open end. The drum and sifter are coated with plastic to prevent corrosion. The apparatus is driven by a petrol engine consuming 4.5 l of fuel per day. Photo.

Longworth, J. F., et al. Problems in assessment of the response of cacao progenies (Theobroma cacao L.) to infection with swollen shoot virus in Nigeria. Nigerian Agr. J. 2, 1, p. 1-6 (1965).

In W. Nigeria 5 field trials were conducted to assess the degree of tolerance of virulent strains of the swollen shoot virus in 46 hybrid cocoa progenies, all of which had an Upper Amazon clone for at least 1 of their parents. Part of the seedlings were infected by grafting a patch of bark from a diseased tree onto them; the controls were grafted with a patch from a healthy tree. The most satisfactory measure for the degree of tolerance was found to be the percentage reduction in stem girth increment after infection, comparing infected and control trees within each progeny. The condition of the canopy and, to a smaller extent, symptom severity were useful supplementary criteria. Some further improvements of the technique are suggested. Tables. Graph. 5 refs.

Nederlandse Cacao en Cacaoproducten Vereniging, 30ste verenigingsjaar 1964; jaarversiag en jaarcijfers. (The Netherlands Cocoa and Cocoa Products' Association, 30th year of the association 1964; annual report and annual figures). Jaarversl. en Jaarcijfers Ned. Cacao en Cacaoprod. Ver. 1964, p. 1-51 (1965).

More than 15% of the world output of cocoa beans is handled by the Netherlands trade and supplied to consumers in Europe and elsewhere. The Netherlands cocoa industry is the third largest user of cocoa beans in the world. The Netherlands are the largest exporter of cocoa butter and powder and the second largest exporter of chocolate. This annual report provides detailed data on imports and exports as well as information on post-war developments including the year under review. The consequences of the establishment of the European Common Market for the Netherlands cocoa industry are discussed. Tables. Graphs.

Kleinert, J. Kakaobohnen und Schokolade. (Cocoa beans and chocolate). Gordian 65, 1551/52, p. 628-38 (1965).

The influence of cocoa bean fermentation on the quality of chocolate was investigated in Switzerland. A sample of Venezuelan cocoa was separated into well-fermented (brown), violet and slaty beans; unroasted and roasted beans of each group were analysed. The largest differences were found in the pigment contents and the pH of the unroasted beans, which both increased with the degree of under-fermentation. Organoleptic tests of sweetened chocolate made from unroasted and roasted beans showed a distinct preference for brown over violet beans, and for violet over slaty beans. However, chocolate from roasted beans containing 70% brown and 30% violet beans was preferred to chocolate made from brown beans only, indicating that over-fermentation reduces quality more than does a moderate degree of under-fermentation. A revised system for the evaluation of commercial cocoa is proposed. Tables. Graphs. Coloured Fig. 19 refs.

February, 1966

Lavabre, E. M. Les insectes des stocks de cacao et de café. (Insects in stored cocoa and coffee). Café Cacao Thé 9, 3, p. 193-205 (1965).

This paper contains: (1) a list of the main insects attacking stored cocoa and coffee beans, indicating their relative importance; (2) brief descriptions of the most frequently encountered species, with notes on their biology; (3) directions for the protection of stocks by fumigation. The only species constituting a serious threat to stored coffee is *Araecerus fasciculatus; Stephanoderes hampei* is often found but cannot survive under storage conditions. Cocoa beans, on the other hand, are frequently attacked by several insects, among which *Cadra cautella*, *Lasioderma serricorne* and *Araecerus fasciculatus* are the main primary species and *Tribolium*, *Carpophilus* and *Ahasverus* spp. are the most important secondary invaders. A description of *Trogoderma granarium* is included because it may infest cocoa stored in proximity to groundnuts or cereals. English, German and Spanish summaries. Table. Figs. Photos. 25 refs.

March, 1966

Turner, P. D. Comparative sporulation as an indication of resistance by cacao to Phytophthora pod rot. Trop. Agr., Trinidad 42, 4, p. 305-9 (1965).

Investigations conducted in Ghana showed that the fungus *Phytophthora palmivora*, inoculated into detached immature cocoa pods, generally produced significantly fewer sporangia on pods of selections with high field resistance to pod rot than on pods of varieties less resistant or susceptible. These differences, the causes of which are unknown, did not extend to lesions in mature tissues. The results suggested a correlation between sporulation levels and periods of high disease incidence. Comparative sporulation may be, in conjunction with other criteria, a useful and rapid indicator of resistance in laboratory tests on existing and new cocoa selections. Author's summary. Table. 6 refs.

Leakey, C. L. A. Sudden death disease of cacao in Uganda associated with Verticillium dahliae Kleb. E. Afr. Agr. Forestry J. 31, 1, p. 21-4 (1965).

A type of die-back that may become a serious menace of the cocoa industry in Uganda is a vascular wilt disease probably caused by the fungus *Verticillium dahliae*. The same disease may have caused the decline of the cocoa industry by 1925. The first symptoms are wilting and browning of the leaves of a single fan branch, progressing towards the jorquette. After a prolonged dry season or very heavy rainfall resulting in waterlogging of the soil, trees may be killed within a week. In less severe cases death may be slower or only a part of the crown is killed. The wood in the affected areas in longitudinal sections shows black streaks consisting of sclerotoid aggregations of dark mycelium. The worst affected field so far known is on land previously planted to *Cinchona*, where 4% of the cocoa trees were killed. Breeding for resistant varieties is considered to be the most satisfactory method of control. Photos. 16 refs.

Smith, M. R. A list of Lepidoptera associated with cocoa in West Africa with notes on identification and biology of species in Ghana. Techn. Bull. Cocoa Res. Inst. (Ghana Acad. Sci.) 9, p. 1-68 (1965).

A list of 173 lepidopterous species encountered on cocoa trees in W. Africa is followed by brief descriptions of the 147 species that have been recorded more often than once or twice. This part also contains notes on the occurrence of each species, its life-history, alternate hosts, and types of damage inflicted on cocoa. Keys are provided for the identification of all caterpillars as far as the family, and as far as the species within the 6 most important families. Identification is facilitated by 14 text figures, 100 black-and-white photographs of adults and 8 larvae, and 46 coloured photographs of larval stages. A list of 24 references and a glossary of technical terms conclude the publication.

Glendinning, D. R. Experiences in flavour evaluation of cocoa varieties. Trop. Agr., Trinidad 42, 4, p. 297-304 (1965).

Because bean quality of new selections to be planted in Ghana should closely resemble that of W. African cocoa as it is at present, a number of samples from selections were submitted for evaluation to manufacturers in the U.S.A., the U K., Switzerland and Germany. Differences between the judgments of the different firms, partly resulting from individual preferences with respect to certain flavour components and partly due to a confused terminology, were so great that, with one exception, no valuable information was obtained concerning the quality of the selections. Cocoa breeders are warned not to rely on the opinion of only one or a few manufacturers for quality assessment of their selections. Abnormal flavours were more often reported from small samples than from bulk samples; this may partly be explained by the fact that microbial infection of fermenting cocoa is an uncontrolled process. Table. 4 refs.

April, 1966

Ibañez, M. L., and Casas, I. A. The effect of pH on cacao seed germination inhibition by mucilage of the cacao pod. Turrialba 15, 4, p. 353-4 (1965).

Studies conducted in Costa Rica indicated that cocoa pulp contains a heat-stable substance inhibiting the germination of the seeds. Its effect was equally strong whether the pH was 4 or 7; it appeared to stimulate germination at low concentrations. Spanish summary. Table. 3 refs.

Lems, G. Cacao plantmateriaal advies 1965-1967. (Cacao planting material recommendations 1965-67). Surinaamse Landbouw 13, 5, p. 177-82 (1965).

Cocoa plantation managers in Surinam are advised to use only clone ICS 95 for large-scale planting; prope-legitimate (open-pollinated) SCA 6 and legitimate SCA 6×ICS 6 seedlings may be used for planting on a limited scale, clones TSH 565, TSA 644 and TSH 792 for planting on a small scale. Smallholders are recommended to plant seedlings only. SCA 6×ICS 6 seed will shortly become available from local seed-gardens. Recommended densities are 1,000 clonal trees per ha or 1,250 seedlings preselected for witchbroom resistance in the nurseries; seedling fields may then be subsequently thinned for susceptibility to certain diseases. Data from the literature and from locally made observations are presented concerning the degree of resistance of the recommended material and some other clones to several diseases and pests. English summary. 30 refs.

Bonaparte, E. E. N. A. Pruning studies on Amazon and amelonado cocoa in Ghana. Trop. Agr. 43, 1, p. 25-34 (1966).

Three trials conducted in Ghana showed that regularly removing all chupons from the 1st jorquette of cocoa seedlings resulted in yields higher than those of unpruned trees during the initial years and in lower yields from the 10th year onwards. The initial effect was somewhat greater in the 2 trials with Amelonado cocoa than in the trial with Upper Amazon cocoa. In 2 other trials, 1 with Amelonado and 1 with Upper Amazon cocoa, chupons were removed, either from the 1st jorquette or from the 2nd jorquette if the 1st one was at a height of less than 1.5 m; in these cases yields were consistently higher in the pruned plots. Unpruned trees usually formed 4 jorquettes. The reduction of harvesting costs resulting from pruning was negligible. The trials indicate that Upper Amazon cocoa does not require a pruning system different from that for Amelonado. Tables. 14 refs.

Delgado, J. C., and Echandi, E. Evaluación de la resistencia de especies y clones de cacao al mal del machete provocado por Ceratocystis fimbriata. (Assessment of the resistance of cacao species and clones to the disease caused by *Ceratocystis fimbriata*). Turrialba 15, 4, p. 286-9 (1965).

At Turrialba, Costa Rica, pieces of wood and bark of several *Theobroma* and *Herrania* spp. were inoculated with a spore suspension of *Ceratocystis fimbriata* and incubated at 23°C. for 3-4 days; when little or no mycelium developed, branches of the trees were inoculated in the field and mycelial development was assessed after 15 and 30 days. A high degree of resistance to the fungus was found in 3 out of 50 *Th. cacao* clones, viz. IMC 67, Pound 12 and SPA 9 (all Amazon forastero types) as well as in *Th. mammosum*, *Th. angustifolium*, and the reciprocal hybrids of *Th. mammosum* and *Th. simiarum*. Six other *Theobroma* spp. and the 7 *Herrania* spp. investigated proved to be susceptible. English summary. Tables. 12 refs.

Soria, V. J., and Salazar, G. Pruebas preliminares de resistencia a Ceratocystis fimbriata en clones e híbridos de cacao. (Preliminary tests of resistance to *Ceratocystis fimbriata* in cacao clones and hybrids). Turrialba 15, 4, p. 290-5 (1965).

Resistance to *Ceratocystis fimbriata* of cocoa types in the collection at Turrialba, Costa Rica, was tested in Aug.-Nov. 1964, using a modification of the method of Delgado and Echandi (see above). Among 143 clones, the Amazon clones SPA 9, Pound 12, IMC 67 and PA 121 were found to be highly resistant: the white-seeded clones Catongo (Brazil-Amelonado) and DR 38 (Java-Trinitario) were moderately resistant. Among 175 seedlings tested, 12 were highly resistant and 77 were moderately resistant; resistant trees were found in all of the 8 progenies tested including a hybrid progeny of 2 susceptible parents, indicating that resistance is due to recessive genes. Repetition of the tests in clone IMC 67 and in the progeny ICS 1 × IMC 67 in May-June 1965 showed a lower degree of resistance than that observed in Aug.-Nov. English summary. Tables. 9 refs.

Silva, P., and Bastos, G. A. C. Polvilhadeira-injetora PG para combater formiga-de-enxêrto. (The PG dust injector for the control of *Azteca* ants). Cacau Atualidades 2, 2, p. 20-3 (1965).

A simple instrument was designed to inject insecticidal dust into the arboreal nests of the ant *Azteca paraensis* var. *bondari*, an important pest of cocoa in the State of Bahia (Brazil). A cylinder provided with a piston holds the powder, which is forced through a narrow tube attached to one side of the cylinder and protruding in a forward direction for some 50 cm. The tube ends in a sharp point which pierces the nest wall, and has openings behind the point which blow the dust into the nest. Trials showed that BHC dust containing only 1% gamma isomer is sufficiently effective, and that control by means of the instrument is much cheaper than the traditional method of dusting the outside of the nest, pulling the nest down, and cutting it apart while dusting the fragments. Table. Figs.

Torto, J. O. Report to the government of Tanganyika on cocoa production. Expanded Techn. Assistance Progr. FAO Rep. 1869, p. 1-26, I-VII (1964; received 1966).

A survey of problems of cocoa cultivation in Tanganyika revealed that the area suitable and available for growing the crop is not large. In the Kilombero district irrigation must be provided to make cultivation possible. In most of the prospective growing areas the patchy occurrence of suitable soils restricts cultivation to smallholdings. The farmers show a growing interest in cocoa; suggestions are offered concerning training and extension. It is recommended to plant Upper Amazon varieties; seed of these varieties should be given free to co-operatives who make their own nursery. Appendices. Table. Map. 9 refs.

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