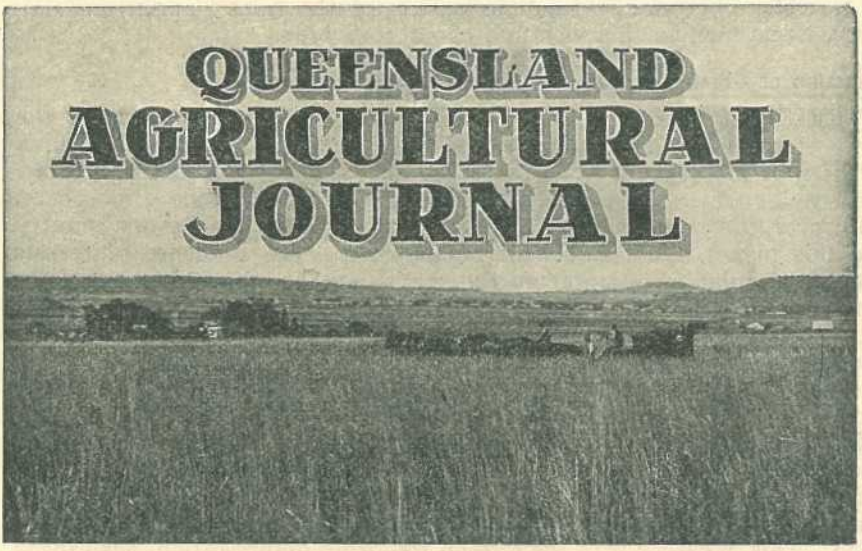
ANNUAL RATES OF SUBSCRIPTION.

Farmers, Graziers, Horticulturists, and Schools of Arts, **One Shilling.** members of Agricultural Societies, **Five Shillings,** including postage. General Public, **Ten shillings,** including postage.



VOL. XLVI. 1 OCTOBER, 1936. PART 4

Event and Comment

A Plea for the Tree.

SHELTER belts around a farm homestead serve a dual purpose. They increase the comfort of the dwelling, making it a much more pleasant place to live in, and also provide an attractive setting or background for the buildings. Such belts should not be planted too close to the house, as the trees would unduly shade the buildings during the winter months, possibly increase fire risks, and block tanks and drains with leaf litter.

Dealing with the subject on broad national grounds, to any plea for the tree may be added a plea for the development of a real forest conscience. Australians are often accused of a lack of that quality, and when the inevitable argument starts one is invited immediately to gaze on the landscape from a railway carriage window between any of our capital cities, without going further afield, where enormous tracts of country have been denuded ruthlessly by indiscriminate ring-barking and otherwise, of valuable indigenous forests. We once heard a lecturer advance the interesting theory that many Australian farmers and others have inherited a conscious or sub-conscious hatred of trees from their pioneer ancestors, who when they "invaded" Australia were faced with vast armies of trees. To prepare the ground for use they had to attack this enemy with a ruthlessness born of necessity, and now, when it is not only unnecessary but extremely harmful to the country, the same pitiless destruction goes on. "Farms," he said, "are seen standing naked, without a stick of timber to clothe them, and valuable forests are wiped out so as to provide relatively worthless

paddocks—that reference is, of course, to poor country where one blade of grass grows where two trees grew before." The lecturer hinted at a terrible vengeance which "the spirits of the trees" might one day exact from man for his violation of nature's laws.

Relation of Green Vegetation to Water Supply.

GREEN vegetation, we are told, is necessary to the composition of the very air we breathe and to the continuance of our water supplies. That idea might seem to us fantastic, but certainly without proper air and water we would perish quickly in a dry and choking atmosphere. However, the importance of tree life to the well-being of every country on this planet is not sufficiently understood. The influence of forests on the circulation of water on the earth's surface is also not yet fully understood. It is now claimed that land covered with grass or crops contributes through direct evaporation and through transpiration more vapour to the air than bare moist soils. Of all the vegetative coverings, a dense forest contributes most vapour. The French aptly call the forests the "oceans of the continent," and compare the vapour given off by them to clouds of exhaust steam thrown into the atmosphere. Lowdermilk, in his recent investigations of the influence of the forest on rainfall, found that the increasing dryness of the interior of China is brought about by the decreased humidity of the air due to deforestation. This, together with the erosion following deforestation, has caused serious disturbance to the entire circulation of water in China. Whether forests actually increase rainfall may be still a question, but their influence on the distribution of rainfall over the land has a good foundation of scientific fact.

Trees and Soil Erosion.

THE preservation or replenishment of our forests has a definite bearing on one of the greatest problems that farmers, not only of Queensland or Australia but of every country, have to face—the problem of soil erosion. Every hill slope growing trees that hold back the soil, that blocks erosion, should be treasured and improved. Every timber reserve that holds back the bank of a winding stream should be maintained on sound forestry principles. The day may come when the streams may have to be straightened out, but always and for ever every bank should be protected from the action of flood waters by a fringe of good timber trees. Every pound of soil that goes down creek or river is so much loss. Facts may be stubborn, but they are a much more lasting foundation for success than individual fads. It has taken the Americans over 260 years to bring their vast forests to the verge of destruction, but Australians with the experience of the world before them have taken less than a century to bring their forests to the same condition of partial ruin.

Necessity of Forestry Reserves.

CONSTANT demands are being made to throw open forest reservations for settlement. Bearing in mind the small area of good land now available, and the keen competition for such good land for occupation, it is fairly certain that many of the existing reservations as they are denuded of timber supplies will have to be utilised for settlement. The proposal to make it compulsory that a certain area of all land under settlement must be reserved for forestry purposes is, therefore, wise and justifiable.

Parks, playgrounds, and recreational areas are a part of modern life. They could, in many instances, be improved and extended as national parks, and in time become a source of income, and at the same time furnish material for industry.

Every country town should consider seriously the possibilities and potentialities of a municipal timber reserve. It is not sufficient to confine activities to State school plantations. The need of wood for industrial purposes is already apparent, and the co-operation of all factors—town, country, State and nation—will only be effective when all realise to the full the urgent need for systematic forestry development and reafforestation. Facts concerning what to plant, when to plant, where to plant, and how to plant are obtainable. Accurate information is the basis of successful effort. That information is definitely available to every farmer interested, and on that information is based this plea for the tree.

The Problem of Prices.

A REASONABLE degree of stability in the prices of primary products is essential to national economic health. How is that stability to be attained and maintained? That is the question. It is not altogether unanswerable, and one obvious aspect of the answer is to improve our system of marketing. Effective marketing and distribution are twin problems facing the farmer to-day, not only confronting the farmer, but also the nation for a healthy and permanent argiculture is a fundamental condition of our survival as a nation.

Marketing is viewed, ordinarily, in the very narrow sense of selling what has been produced for sale. We have, however, to broaden that view to take in all the activities and organisation of handling, transporting, storing, processing, and manufacturing—the finding of ways and means of improving present marketing systems, the ultimate sale of products to the consumer.

The home market remains the farmer's best market, and between producer and consumer there is still too wide a gap, and that gap can only be reduced by better knowledge and stronger action by farmers organised along right lines and fortified with, at least, some understanding of the cold economic facts and extremely difficult problems with which their industry is beset. Intelligent and vigorous leadership —and this point cannot be stressed too strongly—is essential, and through it much loss of time, money, and misdirected energy can be avoided. The old slogan that competition is the life of trade contains a half-truth than which there is nothing more dangerous. Recent developments in the world commodity situation indicate that unrestrained competition might lead to the destruction of society as we know it, and have opened the eyes of the business world to the necessity of tempering a time-worn statement by the addition of one word and making it read "enlightened competition is the life of trade."

Stabilised prices and stabilised currency would give the farmer a fairer market deal. The fluctuations of both are among the chief causes of the farmer's economic difficulties.

Modern agriculture is very largely commercial. Farmers produce primarily for the market. The price basis on which they exchange their products is therefore a problem of prime importance. This problem of adjustment of production and marketing mechanism to ensure fair and reasonable prices to the producer calls for earnest study by all associated with rural industry.

White Grub Damage to Pastures on the Atherton Tableland.

J. HAROLD SMITH, M.Sc., Entomologist.

THE butter exported from the Atherton Tableland, an extensive tract of dairying country in North Queensland, is worth £300,000 to £400,000 per annum. This produce is derived from farms which have been established during the past thirty years; many of the most recently selected are only in partial use. Development on the individual property is comparatively slow for the indigenous rain forest has first to be felled and burned. Grass seeds are then sown in the residual ash, and the pasture is thus established contemporaneously with the disintegration of the logs and stumps which perforce litter the ground for some years. Permanent pastures supply almost all the feed requirements of the herd, though supplementary fodder crops are now receiving attention. Many of the older pastures show marked deterioration, and carrying capacities are generally declining. Under normal circumstances, improved farming practices should offset deterioration, and the industry would gradually evolve on mixed farming lines adequate to conserve the fertility of the soil at a suitably high level.

In the Malanda district pasture deterioration has taken place more rapidly than elsewhere. Climatic factors, important though these doubtless are in the tropics, do not completely explain the phenomenon in this district. Supplementary damage attributable to white grubs, the larvæ of a Scarabaeid beetle, *Lepidiota caudata* Blkb., makes the position of the farmer really critical. This pest has so weakened the pastures on numerous farms that during the dry winter and spring months the available feed is, in some years, below the normal maintenance requirements of the herd.

The species is indigenous to rain forest areas in North Queensland, and has previously attracted attention as an occasional pest of sugar cane in the Babinda district. The present investigations were centred on the Atherton Tableland, where the economic problem is quite distinct from that in the coastal sugar-cane areas.

Significance of the Pest.

The symptoms of white grub attacks in pasture lands are quite distinctive. The sward loses its normal green appearance during the late summer at focal points scattered here and there throughout the paddock. These areas gradually extend until larval development is completed, and by that time the bulk of the pasture may be worthless. A similar sward failure is also conspicuous along fence lines, and on the banks of the many gullies which cut through much of the land under consideration. The affected turf, when examined, can easily be removed to expose the numerous white grubs just beneath the surface. If the grub population is high, the turf may be completely destroyed.

Grub infested pastures quickly react to moisture deficiencies in the soil, and their appearance depends largely on the contemporary rainfall. If the rains are evenly distributed throughout the year, infested pastures may retain some vestige of life and recover rapidly when the pest ceases to feed at the end of larval development. Should continuous dry weather

coincide with the last few months of larval life, the grass may be almost entirely destroyed, and recovery is inevitably slow and is accompanied by a luxuriant weed growth.

Older paddocks usually suffer most severely. On many farms, the pastures range in age from five to 25 years, and the losses are confined to those which have been established more than 15 years. Paspalum, *P. dilatatum*, is the most important grass, but Kikuyu grass *Pennisetum clandestinum*, and Para grass, *Panicum muticum*, have also been introduced to the district. All three are subject to attack, though their recuperative powers differ somewhat when the larvæ have completed development, and weather conditions are favourable for recovery.

The destructive larval stages cover some eighteen to twenty months, but even the heaviest grub population makes little apparent impression in the pasture until the last of the three larval stages. The bulk of the root system is then destroyed, and the efficiency of the remainder seriously impaired by the soil disturbance inseparable from the activity of a grub population which moves freely in the soil. The failure of the turf to respond to good growing weather is the first sign of damage, and the symptoms become more and more acute until larval development is completed.

An incidental loss has frequently been noted. Farmers with grub-attacked paddocks may, when the damage has reached its peak, remove stock to facilitate natural recovery, renovate with implements, or crop the land with maize or some cereal for one or two years before regrassing. When the last-mentioned policy is adopted, the first year's crop is often valueless though yields in the second year are normal. The phenomenon will be discussed at a later stage in this paper.

The pest is also important from a health point of view. Many farmers and residents of small towns in the grub-infested areas procure their domestic water supplies from roof drainage collected and stored in tanks. During the flight season, countless numbers of the adult beetles are trapped in the spouting of the buildings and rot in situ. A contaminated water supply is thus a frequent cause of gastric troubles among the resident population.

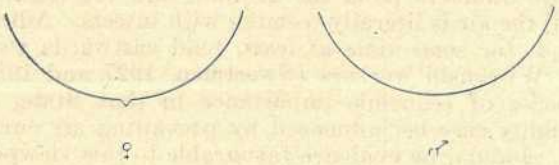


Plate 191.
Last abdominal segment in *Lepidiota caudata* Blkb. Female on left; male on right.

Life History.

The parent beetle of the white grub is a large, cumbersome, dark brown insect about an inch in length. The sexes are superficially similar, but may be separated by the shape of the last abdominal segment, which, in the female, has a posterior projection absent from the other sex (Plate 191). Flight occurs during the spring and early summer months. Eggs are laid in the soil at a depth of a few inches in rather fragile earthen cells. These eggs hatch into small white grubs of typical Scarabaeid shape within three weeks, and are very common in pastures

during January, particularly in the vicinity of fallen trees and residual stumps. Growth proceeds steadily through the three larval instars, the first two of which require some twelve months for their completion. The larvæ enters the third and final instar early in its second year. Larval development is completed between July and September, when the grubs construct pupal chambers, which are normally situated at soil depths between one and two feet. Here transformation into the heavy-bodied pupa takes place within the limits of the earthen cell, and the adult beetle emerges during the spring months.

Before flight is possible, the adult must burrow through a considerable depth of soil, and its ability to do so is controlled by the texture of the overlying earth. At the end of the comparatively dry winter and spring months the soil may be almost impenetrable, and until soaked by the spring rains the beetles are unable to escape. Should the storm rains be insufficient to soften the ground down to the pupal chambers, the beetle mortality is considerable. The duration of the flight period and the intensity of the flight are thus subject to marked fluctuations. Early and copious rains which gradually introduce the monsoons induce moderate flights which may cover a considerable period, viz., October to January, the beetles emerging as soon as transformation is completed in the pupal chamber. A dry spring, in which storms are omitted from the climatic sequence until late November, causes mass emergence at a comparatively late date. The beetle population then on the wing includes vast numbers which have been cooped up in the soil unable to escape earlier together with recently transformed adults. Frequently the precipitation prior to late December is insufficient to penetrate the soil to pupation depths, and the pre-emergence mortality is then considerable.

Observations over a number of years indicate that the importance of the pest in any one season can be correlated with the intensity of the flight two years previously, a logical sequence of a two year life cycle, in which the larval injury to pastures is at a maximum in the second year of development.

Beetle Flight.

The beetle flight has several distinctive features. At dusk, adults emerge in vast numbers from the ground, and the flight increases in intensity until the air is literally teeming with insects. Adult movements are rapid, and, for some time at least, tend eastwards away from the setting sun. Wisconsin workers (Sweetmen, 1927 and 1931) studying an allied species of economic importance in that State, suggest that directional flights may be influenced by prevailing air currents, but in the case of L. caudata, no evidence favourable to this viewpoint has been obtained. The beetles fly directly to buildings, trees, charred stumps, and fence posts, and cling to the western side of any such obstacles on which mating, the primary object of the evening flight, takes place.

As more and more individuals are paired, the hum associated with the evening flight gradually diminishes, and within half an hour of its commencement few, if any, adults remain on the wing. At the completion of mating some of the beetles fly back to the open and presumably burrow into the pasture; quite a number remain on the trees, but the majority fall to the ground, and shelter in the soil below or near the tree, stump, or building on which mating has occurred.

A flight, if such it can be called, of another kind has been observed in the early morning. Before daybreak, trees on which mating has

occurred are clustered with adults, resting in a more or less torpid state on twigs and leaves. They loosen their hold at daybreak, and the majority drop directly to the ground, while a few fly strongly to the open. All remain underground until dusk when flight is again resumed. The morning flight is brief, and the sound of heavy-bodied insects falling through the foliage of the trees is reminiscent of a heavy hail storm.

Both sexes are equally numerous in the early part of the flight season, but later on there may be a distinct preponderance of females. These late season insects include freshly emerged adults with the purplish, elytral bloom intact, and weathered females from which the bloom has long since disappeared. It appears, therefore, that both sexes make nightly flights over a considerable period, polyandry on the part of the female and polygamy on the part of the male being normal for the species.

Though partial defoliation of some trees on which mating occurs is common, the damage is by no means serious in even the heaviest flight years. It is, therefore, inferred that the adults do not normally consume any considerable amount of food. Partial defoliation has been observed in the following trees:—Bloodwood (*Eucalyptus corymbosa*), grey teak (*Gmelina fasciculiflora*), northern silky oak (*Cardwellia sublimis*), fig wood (*Ficus Watkinsiana*), red tulip oak (*Tarrietia peralata*), Davidsonia plum (*Davidsonia pruriens*), Poinciana (*Poinciana regia*).

After the mating flight, most of the males and some of the females drop to the ground, and burrow under the surface, hence females are much more common than males in beetle series collected from trees at the conclusion of the evening flight. Yet, when the beetles are counted on the same trees before daybreak the following morning, both sexes are more or less equally represented. Again it is curious that while adults are numerous on stumps, fence posts, etc., during the mating flight, they have all disappeared before daybreak, when the insects are still quiescent on adjacent trees. Both observations suggest that there is some adult movement after the main business of mating. When or how this takes place is quite conjectural, but it is tentatively assumed that there is some slight post-mating migration to suitable host trees for feeding purposes.

White Grub Distribution on the Farm.

The flight as thus described sheds some light on the incidence of the pest on the farm. Pasture destruction frequently assumes its most acute phase near tree stumps and along fence lines. As these and similar obstacles are used by the adults to facilitate mating, vast numbers must burrow into the adjacent soil during the flight season. At least some of these will be sexually satiated, and lay eggs which will yield a considerable larval population. This inference can be confirmed in the field during January for first stage larvæ can then be collected in such situations with comparative ease. Infestation of this kind can thus be attributed to the place which stumps, fences, etc., occupy in the adult economy during the flight season.

Quite a considerable amount of damage occurs, however, in pastures which are quite free from stumps or trees which could be used by adults during mating. Such pastures typically show dead and dying areas unevenly scattered through the field, the intervening grass being quite green. These areas of damaged turf gradually extend owing to the lateral migration of the larvæ until each may cover an acre or more, and several may merge before larval development is completed.

The few reports of injury to crops cultivated on the Atherton Tableland all possess some special features worth recording. Cow cane, a common form of roughage grown in the district for winter and spring use, persists for a number of years. During the flight period, the crop may be five or six feet in height. Adults may be attracted to the crop when mating, and subsequently lay their eggs in the soil. The larvæ later attack the roots. A cropping system in which annuals are used would, of course, eliminate losses of this type, for eggs are not normally laid in land which is fallowed at the time of flight.

Frequently pastures harbouring second stage larvæ are ploughed and planted to maize. The pest, deprived of the grass roots on which it has hitherto fed, inevitably attacks the planted crop, and all the maize failures directly attributable to white grubs are of this type. Subsequent crops grown after the grub population has matured escape infestation.

The available data on the flight of the beetle readily explain pasture injury along fence lines and near trees or tree stumps, but cannot be linked up with injury in timber-free pastures, or the freedom from attack of cultivated land used for annual crops.

Pastures which have been grossly overstocked for some years often suffer most acutely from the pest, and it is sometimes inferred that turf characters influence oviposition. This view is held by workers on similar pests in Wisconsin, in the United States (Graber et al., 1931), where the inter-relationships of pasture composition and white grub infestation are receiving attention. Most of the pastures on the Atherton Tableland are pure stands of paspalum, but the quality of the sward varies with both the age of the pasture and the usage to which it has been subjected. Differences in the sward of a single paddock are thus due simply to the vagaries of stock feeding, an insufficient basis on which to postulate selective oviposition.

Yet the almost complete absence of white grub losses in land which is cropped annually implies selective oviposition. When gravid females are confined over bare soil in the laboratory, eggs are laid freely, and subsequent development is normal. The most reasonable explanation of the freedom of annually cropped lands from attack would thus be the assumption that gravid females prefer a vegetative cover when egg-laying. The relative attraction of the several different tyes of vegetative cover available in any one district are irrelevant to the freedom of cultivated annuals from attack though, perhaps, of interest as a possible explanation of localised grub development in a pasture.

If selective oviposition is omitted from consideration, it may be supposed that while oviposition is randomised, the turf type may modify both egglaying habits and the subsequent development of the larvæ. Both eggs and larvæ of some Scarabaeids are very susceptible to variations in soil temperatures and humidity, hence the natural mortality may be high (Pemberton, 1935). Randomised oviposition in the pasture may not, therefore, be followed by randomised larval development and coincident pasture destruction.

On purely observational data, it has been suggested (Buzacott, 1935) that the mass oviposition implied by the characteristic white grub injury to pastures may be due to an aggregation of adults in response to sound stimuli operating during flight. This thesis still lacks experimental warrant.

Spring Rainfall and the Seasonal Importance of the Pest.

The agricultural importance of the white grub pest varies from year to year though the area subject to infestation grows steadily larger—25,000 acres in 1935. The possible causes of this extension will be discussed later, but it is necessary to distinguish between soil and pasture characteristics, which control susceptibility to attack and the seasonal fluctuations in the numbers of the pest attributable to climatic and other causes. Of these climatic inhibitions, the most important concerns the effect of spring rains on adult emergence from the ground.

The life cycle of the pest covers some two years. Flights of variable intensity occur every spring, and the grub population in the soil comprises larvæ in all stages of development. Some of these larvæ are the progeny of females on the wing during the previous spring, but the larger forms are twelve months older and date back to an earlier flight. The year 1932 was, however, exceptionally dry during the spring months, and the beetles which should have emerged were almost completely killed below ground. As a consequence, flights in both 1932 and 1934 were negligible, and it will be some time before the pest will be of importance in even numbered years.

This striking demonstration of the beetle mortality attributable to a dry spring has prompted an analysis of the Malanda rainfall records for the past twenty years, in the hope that the available data on the spring rainfall would shed some light on the present position of the pest. The data is graphically displayed in Plate 2 to which reference should be made in the further discussion of the subject.

In North Queensland, spring is agriculturally an indefinite term, but for the present purpose may be defined from a consideration of the rainfall during the last six months of the year 1932, in which the most complete check to the pest so far recorded took place. These monthly rainfalls are as follows:—

July.	August.	September.	October.	November.	December.
1.70	3.17	0.48	0.65	0.34	10.17

Beetle emergence depends entirely on a prior soaking of the soil to pupation levels by rain and flight normally begins in October. In spite of fair winter rains, three months comparatively dry weather between September and early December were sufficient to almost completely inhibit beetle emergence. Hence when flight failure is attributed to insufficient rainfall during the spring months, the period, September to early December, is usually referred to. In 1932, the precipitation during this period was only 1.47 inches, and the beetle extermination was almost complete. The actual significance of spring rains to the pest will, of course, depend on their soaking properties, and the prior moisture content of the soil, one heavy fall being more advantageous to the pest than occasional light showers. Generalisations only are permissible at present, but for analytical purposes it may be assumed that when the spring rainfall, as defined above, falls below four inches, adult emergence will be inhibited to a greater or less extent.

Considering first the beetle series which normally flies in the spring of years with an even number (Plate 192), it will be noted that climatic checks to beetle flight occurred in the years 1918, 1922, and 1932. Prior to 1926 of the period under review, the grub population could scarcely

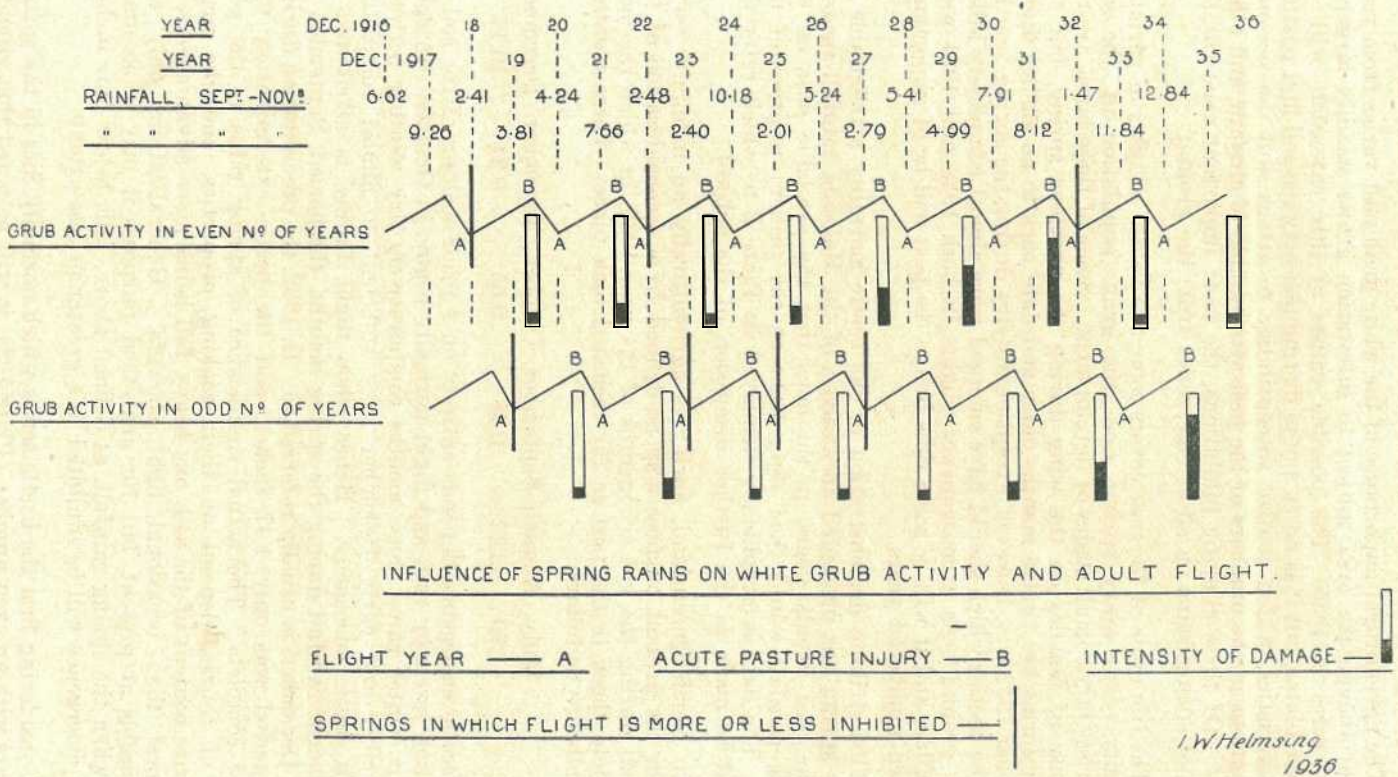

YEAR
YEAR
RAINFALL, SEPT.-NOV.
" " " "
DEC. 1916
DEC. 1917
6·02
9·26
2·41
3·81
4·24
7·66
2·48
2·40
10·18
2·01
5·24
2·79
5·41
4·99
7·91
8·12
1·47
11·84
12·84
18 20 22 24 26 28 30 32 34 36
19 21 23 25 27 29 31 33 35
GRUB ACTIVITY IN EVEN Nº OF YEARS
GRUB ACTIVITY IN ODD Nº OF YEARS
A
B
INFLUENCE OF SPRING RAINS ON WHITE GRUB ACTIVITY AND ADULT FLIGHT.
FLIGHT YEAR — A
ACUTE PASTURE INJURY — B
INTENSITY OF DAMAGE —
SPRINGS IN WHICH FLIGHT IS MORE OR LESS INHIBITED —
I.W.Helmsing
1936

Plate 192.

rise to pest proportions, but after that year, the status of the pest would steadily increase until the dry spring of 1932 practically exterminated the adult population. As would be expected, the available records indicate that, between 1926 and 1932, serious pasture injury occurred in the even numbered years.

In beetle flight years with an odd number (Plate 192) the position is rather different. Climatic checks were effective in 1919, 1923, 1925, and 1927. As a result, white grubs in this series had little agricultural significance until 1931. Heavy beetle flights in 1933 were studied for various reasons in connection with mating and other habits of the pest. The progeny of these beetles caused large scale pasture damage in 1935.

A number of important points can be deduced from the available data. These are:—

(*a*) Prior to 1928, the relative freedom of the Malanda district from white grub losses can be attributed, in part, at least, to the influence of dry springs in the years 1918, 1919, 1922, 1923, 1925, and 1927 on beetle emergence.

(*b*) Since 1928, the even year series, which had increased to alarming proportions, has since been checked by the dry spring of 1932, and should cause little trouble for some time.

(*c*) Since 1928, the odd year series has developed unhindered, and these insects are now a very serious worry.

(*d*) After a severe spring check, insects in either series require at least six years, i.e., three generations, to reach pest proportions once again. In the case of the even year series, the exceptional mortality in 1932 may possibly lengthen this period for no observed recovery took place in 1934.

It is interesting to notice that seasons which the farmer would consider favourable to dairying, i.e., seasons characterised by good spring rains, are equally favourable to the pest. Actually a dry spring serves dairying interests in the grub-susceptible belt much better by keeping the beetle population within manageable limits.

Natural Control.

As with most species, various natural enemies attack the several stages of the beetle now under consideration. Various Scoliid wasps attack Scarabaeid larvæ in the coastal districts, and probably show similar habits on the Atherton Tableland. The commonest species is *Campsomeris tasmaniensis* Sauss. These insects have not as yet proved an efficient check on Scarabaeid activity in Queensland, and *Bombylid* hyperparasites are probably the limiting factor to their utility.

Tachnid larvæ have often been dissected from moribund adults handled in the laboratory, and from them flies, as yet unnamed, have been reared. This parasite is quite unable to keep the pest in check, and it seems that effective parasitism is at present negligible.

The grub-infested parts of a paddock are often pitted with holes excavated by bandicoots (*Parameles spp.*). These usually attract attention during the later phases of larval life, and, though indicating carnivorous habits in the animal, hardly permit the inference that bandicoots materially assist in the control of the pest.

Two birds, the straw necked ibis (*Threskiornis spinicollis*) and the native companion (*Megalornis rubicundis*) are particularly fond of white grubs, and conspicuously forage through pastures in search of them. The former is perhaps the more important, chiefly because it is the more numerous species. Both birds are of value only towards the end of the larval period, but their numbers are quite insufficient to appreciably affect the pest position. They usually appear in pastures when the damage has almost reached its peak, for the birds can then easily penetrate the turf when searching for white grubs.

The Significance of Soil Characters to the Pest.

The grub-infested district forms part of the much larger Atherton Tableland, situated some 2,500 feet above sea level. The soils are grouped as tropical red earths, representatives of which are by no means common in Australia. The source rock is basaltic for the most part, though schistose outcrops are common towards the coastal range. Volcanic activity was apparently widespread in the locality during Tertiary times (David, 1932), and several explosion craters occur in the white grub-infested country. Though superficially similar, the red earths fall into two distinct types, confined to specific districts, and separable on acidity values, one being neutral or alkaline, while the other is very acid. It may be noted here that the most acid soils on the Tableland are located in the grub-infested districts.

The contour of the country varies a great deal. Towards Atherton, farms are located on undulating country, much of which can be conveniently ploughed. Towards the coastal range, the rainfall is heavier, and prolonged erosion has produced quite a rugged contour, which is greatest towards Millaa Millaa. Similar features characterise many farms on the outskirts of the present settled area adjacent to the forest reserves, which clothe the main coastal range. Farms in the grub-infested zone are of an intermediate type, and much of the country could be ploughed without serious risk of erosion, though many of the paddocks are unsuitable for permanent cultivation.

The dominent basaltic soils are red to chocolate in colour, and usually lack any distinctive profile. In spite of a high clay content, 40 per cent. to 60 per cent., they are permeable loams, the friability of which may be due to the flocculating effect of free ferric hydroxide (Prescott, 1931). In the wetter parts of the Tableland, the soil depth is very variable. Colour values grade from red, through brown to yellow, and even grey. The significance of erosion and leaching in creating the present facies is amply demonstrated by the sequence of soil colours down the length of a hill, the darker shades capping the summit, and grading into lighter shades towards the gullies. The shallower soils may possess a profile. Deposits of greyish podsolic types of soil may be built up at creek bends by material derived from the coastal range.

The whole of the Tableland, apart from sclerophyllous forest areas of limited extent, was originally clothed with luxuriant rain forest. The destruction of the timber as a preliminary to closer settlement has destroyed a most powerful brake on erosion, the harmful effects of which are better appreciated now than hitherto. Gullies are widening to claim a greater part of the original paddock, and sheet erosion in cultivated areas is a constant danger during the wet season.

Grub Distribution in Relation to Acidity and Humus Values in the Soil.

Various entomologists interested in Scarabaeids have previously suggested a correlation between pH values of the soil and white grub distribution (Christensen, 1933). No uniformly applicable conclusion has yet been reached on the subject, and, indeed, generalisations would be difficult to establish with such a wide range of species, many of which show distinct ecological requirements. On the Atherton Tableland, two species, *L. caudata* and *L. lævis* Arrow, infest separate localities, which are superficially similar, the former near Malanda, the latter at Atherton. Though *L. caudata* is slowly extending its domain, *L. lævis* has persisted on four or five farms for many years, and shows no signs of spreading. Clearly some factor or factors capable of elucidation must determine their distribution. Soil differences are the most promising field for investigation, and preliminary studies of Tableland soils have shed some light on the distribution of *L. caudata,* the species with which this paper is chiefly concerned.

Soil samples have been collected, both within and outside the grub-infested area, for the determination of humus content and pH values. When rain forest is first cleared, preparatory to grassing, vast reserves of organic matter have accumulated in the soil, and these are primarily responsible for the lush growth and consequent high carrying capacities of pastures when first established in the tropics. High temperatures, however, rapidly mineralise the organic matter, and pasture deterioration takes place. The humus content of the soil in grub-infested districts is generally good, being approximately 3 per cent. in soil dried at 100 degrees C., but the activity of the pest shows no parallelism with the several available humus determinations. It would appear, therefore, that the humus content can scarcely be a controlling factor in the distribution of white grubs, though it doubtless plays an important part in maintaining growth in infested pastures, and in stimulating regrowth once infestation has come to an end.

The implications of acidity values in the soil yield more suggestive results. Soil samples have been collected over the whole of the Tableland, and the trend of acidity values in and near the grub-infested areas is shown on the accompanying sketch (Plate 193), which also indicates the area attacked in 1935. The available data suggests conclusions which, though tentative only, are accepted for purposes of discussion.

In the first place, it should be noted that grub susceptible soils are usually more acid than those not subject to infestation. Typical pH values may be set out for comparison as follows:—

Within the grub-infested area:—

5.29; 5.4; 5.57; 5.95; 5.25; 5.94; 5.3; 5.51; 5.17; 5.36.

Outside the grub-infested area:—

7.49; 7.2; 7.09; 5.74 (*a*); 6.15; 6.1; 5.7 (*b*); 5.83 (*b*); 5.73 (*b*); 6.03; 6.3.

(*a*) The farm from which this sample was taken is unique in the locality as white grubs have, on one occasion, caused some loss during the past decade.

(*b*) These properties lie close to the present southern boundary of the area infested in 1935. A recent spread in that direction has to be recorded.

The acidity of soils in the grub-infested area is uniformly high, and it may be inferred from the available data that soils with a pH value in the vicinity of 5.5 or under are liable to infestation.

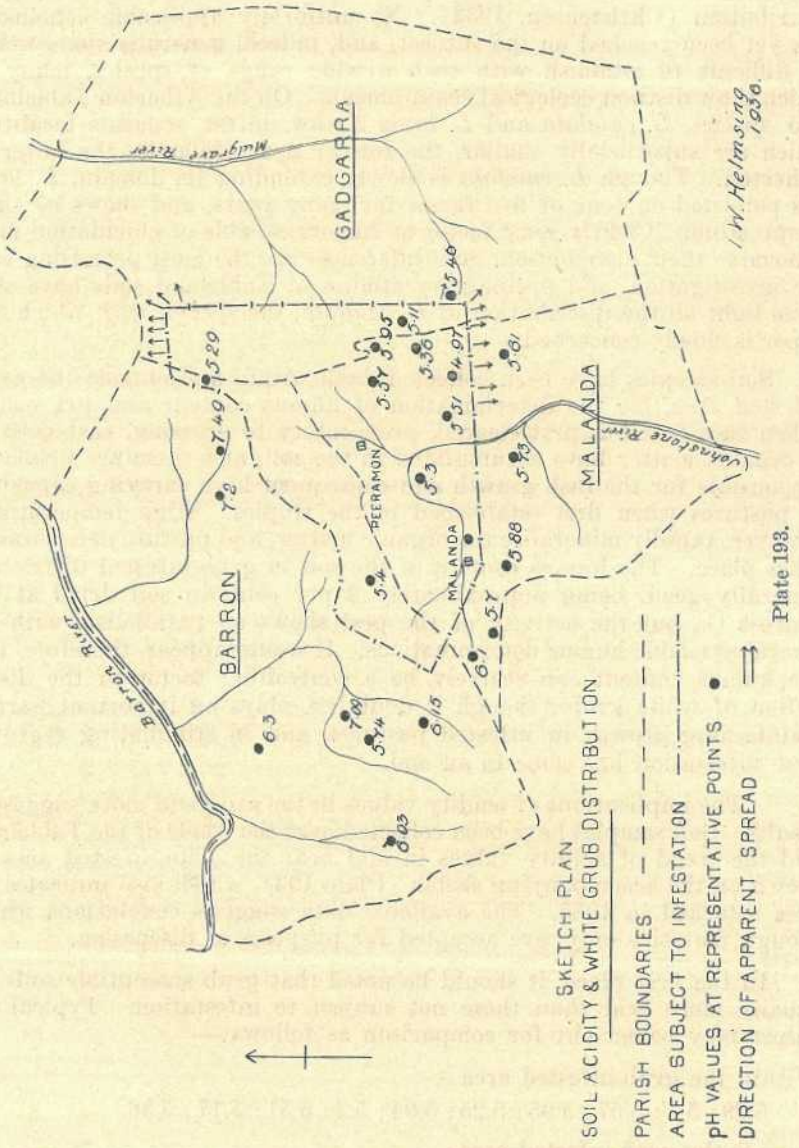


Plate 193.

The western and north-western boundaries of the infested area have been more or less stable since observations commenced some years ago. These boundaries front the Barron watershed, soils in which are more or less neutral. The difference in acidity determinations between soils from the Barron watershed on the one hand, and the Johnstone and Mulgrave watersheds on the other, though perhaps partly attributable to disparate rainfalls, probably reflects the rock type from which each is derived. The contrast between the two soils can be illustrated by reference to a purely agricultural point. Lucerne thrives best in an

alkaline soil, both the duration of the stand and the yield diminishing under acid soil conditions. The crop can be successfully grown on most of the country watered by the river Barron, but attempts to use the crop in the grub-infested districts have been uniformly unsuccessful. One may thus legitimately infer from the data that the relatively alkaline soils of the Barron watershed may be responsible for the stability of the western and north-western boundaries of the grub-infested area.

Soils just outside the grub-infested area on the southern and northerly boundaries are rather less acid than those within its limits, but the difference in acidity levels is less marked than on the western and north-western grub-free soils. It is interesting to note that some extension of the infested area to the north and south in the vicinity of the coastal range has taken place during recent years. These areas are in a heavy rainfall belt, and soils would tend to become more and more acid through the leaching processes to which they are subject, soil bases being removed in considerable quantities during the wet summer months. At present, these soils possess acidity values approaching the critical pH 5·5 level, below which possible grub infestation is inferred. A further extension of the grub susceptible area can therefore be expected if the acidity thesis is correct. In the absence of authentic data on the annual depletion of available bases from the soil, estimates of the rate of spread can scarcely be offered, and they would, in any case, by subject to marked fluctuations with the seasonal numbers of the pest.

Acidity is a measure of the base un-saturation of the soil, and, as calcium accounts for some 80 per cent. of the reaction value of these bases, deficiencies in this element can be correlated with acidity for ordinary purposes. Aluminium compounds may also influence acidity, but an excess of these is usually indicated by toxic effects in the vegetative cover. The significance of lime deficiencies alone are considered here.

Soils are often grouped into crumb structure and single grain structure types, individual soil particles being held together in the former by soil colloids, which are deficient in the latter. Crumb structure soils are best suited for general agricultural purposes, as they facilitate cultural operations and conserve the moisture necessary for plant requirements. A steady loss of lime through leaching and other causes may degrade a crumb structure soil to inferior types, but the desired texture may often be restored by the addition of supplementary supplies of quicklime, rock lime, &c. The soils in the grub-infested area are by no means physically poor at present, but there is some evidence to suggest that physical characters are deteriorating.

Again, as the clay content of these soils is exceptionally high, alterations in the clay complex may follow lime attrition. Changes of this type will inevitably show up in an altered soil texture, and may have some bearing on the suitability of acid soils for the development of white grubs.

In some parts of the world, definite correlations have been established between soil texture and the susceptibility of a soil to white grub infestation. These correlations may be, as in Hawaii, not only susceptible to chemical analysis, but can, in some instances, be detected in the field by direct observation. Such clear-cut distinctions between susceptible and non-susceptible soils cannot, as yet, be formulated for the Atherton Tableland. But the existence of such correlations in some Scarabaeids suggest that the localisation of the Malanda species to the more acid soils

may not be due to acidity *per se*, but to alterations in soil texture associated with the drift in lime values. The significance of such changes should be a profitable field for further study.

Soil Capillarity in Relation to White Grub Infestation.

Temporary changes of another type are frequently detected in land which has been infested with white grubs. When damaged paddocks are ploughed, they may be allowed to revert immediately to grass or a crop of maize may be harvested before pasture re-establishment is attempted. In those parts of the paddock where grub injury has been most pronounced, the initial maize crop may be a failure, or alternatively pasture recovery is surprisingly slow. Analyses of representative soils indicate that capillary values have been seriously disturbed in these areas.

In a paddock allowed to revert to grass after a single ploughing in 1932, capillary values in normal and sub-normal recovered areas were:—

	3 hours.	6 hours.	24 hours.	48 hours.
Sub-normal recovery ..	2½in.	3½in.	4¾in.	6in.
Normal recovery	5¾in.	7in.	9½in.	10¾in.

On a second farm, the samples were taken from an existing grub attacked paddock, and an adjacent one, in which an initial crop failure was recorded two years previously:—

	3 hours.	6 hours.	24 hours.	48 hours.
Grub attack pasture ..	6½in.	7½in.	8½in	9in.
Cropped paddock	8½in.	9½in.	10¼in.	11½in.

From both sets of figures, it would appear that the capillarity of soils which have been infested with white grubs has been depressed.

Owing to the high permeability of soils on the Atherton Tableland, plant growth is almost entirely dependant on the precipitation moisture retained by the upper layers of the soil. Even the small amount of the total rainfall held by the soil is subject to rapid depletion, for surface temperatures may be high and evaporation considerable. An ideal cropping season thus presupposes intermittent rains at fairly short intervals during the growing period. Alterations in soil capillarity induced by the white grub population indicate a marked disturbance in the moisture holding capacity of the soil, a defect which may be responsible for the adverse showing of either pasture or crops grown on recently ploughed grub-infested soils during a difficult season.

The mechanism by which white grubs influence soil capillarity is uncertain. Normally the larvæ move freely in the soil in sympathy with changes in the moisture levels during the year. In saturated soils, the grubs are close to the surface, but during persistent dry weather, they pass to greater depths. The mechanical disturbance of the soil caused through the movements of the comparatively large-bodied larvæ may be sufficient to upset normal capillary values, but another factor probably comes into play. The larvæ habitually ingest considerable quantities of soil and, when heavily infested, the soil may show "pellet" characters. Alterations in capillary values may well be associated with the phenomenon.

A single wet season is usually sufficient to restore the capillarity to more or less customary levels.

Control Measures for White Grubs.

White grubs are well-known pests in Queensland, and cause considerable damage to some of the sugar-cane crops grown in the coastal areas of the State (Illingworth and Dodd, 1921). Fumigation has frequently been recommended for the control of these pests (E. Jarvis, 1925).

In pasture land fumigation for white grubs is quite impracticable, for, no matter whether carbon bisulphide, paradichlorobenzene, or a mixture of these is used, the expense entailed would be prohibitive to the dairy farmer. Even were suitable methods of applying the fumigants to pastures available, the outlay would only be justified if the treatment endured immunity from further attacks for a number of years. The habits of the insect preclude this, and the utility of fumigation and similar methods of control can, therefore, be omitted from further discussion.

Trapping Measures.

During the flight season, vast numbers of adults cluster round houses in the grub-infested districts. In view of this obvious attraction to buildings, it is not surprising that suitably designed lights have been proposed as a means of trapping the adults. The suggestion is, however, based on a misinterpretation of a distinctive habit. Lights in the home are not the primary attraction to the beetle. Comparable numbers may be found in and around outbuildings, or at trees and stumps. Homes attract the beetles in precisely the same way as any other upright structure, i.e., because they provide adequate support for mating purposes. The common belief that lights do attract the insect was, however, checked during the flight of 1933.

Acetylene lamps were placed in the middle of trays some three feet square, each of which held water to which a little kerosene had been added. Beetles attracted to the lights ultimately fall into the water, and are held there until the following morning. All lights were lit just before dusk, and allowed to burn for a period of three or four hours. At one station, lights were placed in a grub-infested pasture near a clump of trees to which beetles were obviously attracted during the mating flight. From the two trays in use, 136 beetles were collected, the catch including more males than females. On a second occasion, the lights were placed near a deserted homestead. Three hundred and forty-four adults were taken in the two trays, again with a preponderance of males.

When related to the intensity of the flight, the numbers caught were quite negligible. Far more beetles were obtained from both trees and stumps by hand collection of the mating groups in a very short time. Hence, were trapping seriously considered as a control measure, methods more efficient than light traps could easily be devised.

Houses, unfortunately for the residents, form excellent traps, for many adults strike the galvanised iron roof during the mating flight and gravitate to the spouting from which they are unable to escape. In a heavy flight year, the spouting must be cleaned every two or three days, and literally thousands of dead and dying insects are removed on each occasion. The frequent contamination of tank water used for drinking purposes is positively dangerous, and gastric ailments are apt to be very common in the Malanda district. The collection and destruction of insects in and around houses is therefore a necessary trapping measure, which must be carried out as a reasonable health precaution.

The method could, perhaps, be extended by collecting adults under the principal feeding and mating trees. At the conclusion of the evening flight, and again at daybreak, vast numbers simply drop to the ground and burrow under cover. These may be conveniently collected and subsequently destroyed. On most farms in the grub-infested districts, the large number of stumps and logs scattered through the pastures lessens the value of systematic trapping, for, no matter how conscientiously carried out, it is almost impossible to concentrate on all the focal points at which the beetles congregate in the short time at the operators' disposal.

Better results should be obtained by running pigs in adequate numbers through the paddocks during the flight season. Pigs depastured at that time of the year quickly locate beetles sheltering in the soil, and destroy vast numbers of the pest. The beetles are relished by the pigs, and their accessibility diminishes the tendency of the animals to wander. Fencing difficulties are consequently less acute than usual. The further extension of the practice is therefore to be commended.

The Utility of Renovation.

When a grass paddock has been severely infested with white grubs, the stock must be removed and grazed elsewhere. If the pasture is left undisturbed, sufficient roots may survive to re-establish the sward when the spring and summer rains once again stimulate growth. The response is often surprisingly good, and it appears that the pest removes the root-bound condition which hampers growth in so many old paspalum pastures. In prolonged dry weather, root destruction may be carried too far, and the naturally re-established sward is by no means complete. As paspalum does not spread by means of runners, supplementary seed must be sown to regrass the bare patches or alternatively, the pasture may be managed to facilitate natural seeding. In the latter case, the paddock is closed to stock until seeding takes place, usually in March or April. Light harrows then provide the necessary cover for the seed and stocking may be restocked, though the pasture should only be lightly grazed until the sward is completely re-established.

Incidental renovation without the use of implements is effected when "hogging off" is practised. Most farmers keep a few pigs as a profitable outlet for skimmed milk and other by-products of the farm, and the pigs are often allowed access to infested paddocks where they root up the damaged turf in the search for larvæ. If sufficient pigs are available, almost the whole of the infested pasture will be broken up and, should growing weather supervene, the grass grows vigorously owing to the joint effects of renovation and white grub destruction. Not infrequently, however, pigs have been depastured during the relatively dry winter and spring months with definitely harmful results. It would thus appear that while pigs may be very useful during the spring flight as a means of exterminating the beetles and during the summer months when the grub population is high, some risk is inseparable from "hogging off" unless normal seasonal conditions guarantee rapid re-establishment of the pasture—i.e., "hogging off" can be safely adopted only during late spring and summer.

Renovation in either of the above ways is perhaps the simplest method of handling pastures attacked by white grubs. The resultant improved quality of the sward indicates that renovation on more systematic lines would be profitable. Many Tableland pastures do not

yield an adequate body of feed, growth being depressed by a matted root system which interferes with the aeration and water relationships of the soil in the root occupied zone.

Ordinary renovation presumes the use of implements capable of remedying the root-bound condition in a pasture. Ploughing adequately serves the purpose, and pastures treated in good growing weather subsequently carry an excellent body of healthy grass. The operation must, however, be accurately timed to give the best results, for there are cases on record in which indiscriminate ploughing has been definitely injurious. Ploughing exposes both dead and living roots, and the re-establishment of the pasture depends on the latter striking root again. If the land is turned over in dry weather and adverse conditions persist for any length of time, many of the living roots are destroyed and pasture recovery is incomplete. Ordinarily the consequences of ill-timed ploughing may be serious enough, but in grub-infested areas the few roots which in good weather would be sufficient to re-establish a new pasture may be almost completely destroyed. Reseeding will then be necessary. Grub infestation is rarely severe enough to hinder pasture re-establishment in good growing weather though the appearance of the sward may be spoiled for a time by a prolific weed growth. These are of little direct importance for vigorously-growing paspalum quickly smothers incidental growth of this kind. Ploughing should, therefore, be restricted to the late spring and early summer months when adequate rains are assured.

Pastures growing under the stimulus of cultural operations are more resistant to the ravages of the pest than others which have been untreated in any way. If the land harbours a considerable population of second-stage grubs, cultural disturbance of the soil interferes very little with their development and the larvæ subsequently attack the renovated pasture. This difficulty can be largely overcome by restricting cultural renovation in the grub susceptible belt to the late spring or early summer in which flight is anticipated. The grub population has then completed its destructive phase, the treated paddocks are more or less in a fallow condition during the flight and the beetles should lay their eggs elsewhere. The reinfestation of pastures renovated in this way is thus obviated for some time, though still possible in a subsequent flight.

Disc ploughs are in common use on the Atherton Tableland, and admirable though their work may be in permanent cultivation their value for pasture renovation is a very moot point. The matted turf is thrown in all directions, the discs are very liable to "ride" parts of the pasture and the whole paddock is left in a very rough state. On slopes, this may be a serious disadvantage for erosion after heavy rain is facilitated. Better results should follow the systematic use of the mouldboard plough even though the draught is heavier and the work somewhat slower. Mouldboard ploughing shows the following advantages:—

(*a*) The turf is completely turned over and finally produces an even pasture free from the irregularities inseparable from disc ploughing in grass land;

(*b*) The harrowing which should normally follow the ploughing is more thoroughly carried out;

(*c*) The combined effect of (*a*) and (*b*) is such that, during the flight season, the surface has a cultivated fallow appearance and oviposition should not normally occur.

Another possible procedure requires the insertion of a cropping system between ploughing and pasture re-establishment. So far, this method of attacking the problem has not received any considerable attention. This may be due to the limited range of crops which can be profitably grown on the Atherton Tableland, the common failure of a first crop planted in previously grub-infested paddocks, and finally to the widespread reluctance of farmers to embark on a mixed farming project involving the feeding of stock during the winter months.

Grassland farming in which farmers rely almost wholly on either native or introduced grasses for the feed requirements of their stock is a more or less elementary method of managing a property. Intermittent rains are necessary to ensure a continuous supply of fodder, and without them the farm merely passes from one shortage to another with intervening surpluses. In North Queensland the pastures are invariably parched during the winter and spring months, and a fodder crisis is an almost annually recurring event on many properties. For ordinary purposes, complete dependence on permanent pastures can only be justified in the early stages of development and must sooner or later give way to farming systems which incorporate both permanent pastures and a certain amount of tillage.

In the grub-infested areas the need for some such alteration is perhaps more urgent than elsewhere in North Queensland, for a cultivation unit attached to the farm ensures a supply of feed when grub activity has played havoc with the pastures. Improvements in pasture management involving the subdivision of paddocks to permit rotational grazing and the elimination of overstocking, a common evil, will doubtless improve matters, but in themselves are insufficient to make farming profitable.

Cultivation in the wetter parts of the tropics introduces a number of problems, the chief of which is the susceptibility of the soil to erosion. In rugged country this difficulty is almost insuperable, but in most areas where cultivation now requires attention, the surface is more or less undulating with moderate gradients. The risk of soil erosion could, in this type of country, be minimised by the systematic adoption of contour drains, the value of which is, as yet, insufficiently appreciated.

In any mixed farming project suitable for the Atherton Tableland, certain fundamental features will require attention. Some of these are:—

(*a*) The subdivision of existing pastures to acreages not exceeding 15, though smaller paddocks could advantageously be used in many instances. Relatively small pastures both permit rotational grazing and facilitate the insertion of a cultivated crop into the programme when renovation becomes necessary.

(*b*) The movement of tillage operations round the property so that most of the paddocks would periodically be brought under the plough. Thus in any one paddock systematic cropping would precede the establishment of a pasture which would, in turn, revert to the plough as soon as deterioration became apparent.

(*c*) The provision of storage facilities on the farm in the form of silos, &c., to ensure that crop wastage due to the deterioration of any surplus over immediate feed requirements would be eliminated. Climatic conditions are generally unfavourable for fodder conservation as hay.

(*d*) The introduction of a variety of crops suitable for compounding rations which can be balanced at all times of the year.

Immediate improvements can be suggested on most farms, but the best method of utilising areas under cultivation is still in doubt. Normally the summer rains are assured on the Atherton Tableland, and there is consequently little difficulty in procuring adequate feed for the herd during the summer months from permanent pastures. The provision of winter feeds is more difficult for the late summer and winter rains needed for the seeding and establishment of suitable cereals are often problematical. Present farming systems assume a fodder shortage during the winter and spring months and cows are brought to the bale in spring and summer to ensure the maximum flow of milk when food supplies are adequate. Under existing methods, this is perhaps the only way to manage a herd, but it can hardly be considered a desirable permanent agricultural practice. In short, dairying methods are dictated at present by the availability of fodder supplies in a grazing system. Further progress presupposes some cultivation, and the provision of sufficient fodder reserves to keep the herd in profitable production for the whole twelve months.

Pasture Management in Relation to White Grub Activity.

Various observations during recent years suggest that the condition of the pasture has much to do with white grub infestation in the susceptible area. The relative immunity of young pastures from attack has already been mentioned and the turf in these is invariably much better than that in older pastures where attacks are normally expected. Pastures within the grub-infested areas which, for various reasons, have not been intensively grazed also appear to escape severe attacks while hillsides usually suffer more acutely than flats favoured with seepage water. The position thus shows some slight similarity to that recorded for the white grub, *Phyllophaga sp.* in Wisconsin, where intensive studies of agricultural methods of control have been carried out for some years (Christensen, 1934).

At Wisconsin suitable methods of pasture management and improvement are tolerably well understood as a result of long term experimental work. Mixed pastures of grasses and legumes can be established and maintained without any great difficulty, while both organic and mineral fertilizers appreciably affect both the quality of the turf and the fodder yield from it.

On the Atherton Tableland methods of pasture management and the response of pastures to manures have not yet received detailed attention. Nevertheless it is commonly supposed that tropical red earths of the Tableland type do not respond adequately to fertilizers unless they are applied in uneconomic quantities. This supposition can scarcely be accepted as final when pastures show obvious signs of deterioration and the subject merits further study in both the field and the laboratory. The relationship of sward types to white grub susceptibility should be better understood when results of recently initiated pasture improvement work are available.

Modifications in pasture types also require consideration. Clovers cannot be successfully grown except in the wetter parts of the Tableland and in particularly favoured seepage soils. Other legumes have similarly proved unsatisfactory. Grasses of various types are in use. Paspalum, *P. dilatatum,* a summer-growing perennial, is the most important, but many of the older paddocks are being invaded by the much inferior species *Axonopus compressus* and *Paspalum conjugatum.* Kikuyu grass, *Pennisetum clandestinum,* grows more vigorously than paspalum but appears to exhaust the soil much more quickly than other grasses of value to the farmer. Its dominant habit, moreover, is such that other species are smothered out in a comparatively short time. Rhodes grass *Chloris gayana,* and Para grass, *Panicum muticum,* play minor roles in Tableland pastures and are best suited to restricted areas with soil and drainage characteristics which are not general to the district. At present it appears that permanent mixed pastures containing a number of selected grasses and legumes are scarcely attainable in the immediate future. It may, however, be practicable to control the turf type to some extent by various methods of stock management and the application of manures.

The difficulty of controlling pasture composition adds further point to the importance of the cultivated area on the farm. There alone can the cropping system be manipulated to supplement the available pasturage. Thus while pastures may contain pure stands of paspalum as summer feed, the cultivation area alone permits the discriminate use of the ground for the growth of crops which will both add to the limited winter pasturage and narrow down the ration balance to desirable levels.

How far the practicable control of herbage types may influence the susceptibility of pastures to white grub attacks is a moot point, but it would perhaps be unwise to expect results comparable to those secured at Wisconsin. This viewpoint is based solely on the greater difficulty of altering the constituent flora in the pasture by manurial and grazing methods.

Summary and Conclusions.

1. The Scarabaeid, *Lepidiota caudata* Blkb., has been a serious pest of pastures in the Malanda district for some years. The pasture deterioration due to this and other causes is now so pronounced in that area that dairying under present methods is scarcely profitable.

2. Flight takes place during the spring when the storms which usher in the monsoonal rains have penetrated to pupal depths in the soil. Flight habits are described in some detail, especially in so far as they concern oviposition and the subsequent incidence of white grub damage. Development requires two years and pasture destruction usually becomes acute during the second year of larval life. It is thus possible to forecast more or less accurately the probable damage in any year by referring to the intensity of previous flights.

3. The only known natural check on the pest is a climatic one—viz., a dry spring which prevents the beetles emerging from the ground at the completion of their development. A dry spring may, as in 1932, almost completely exterminate the generation which is due to fly. The present importance of the pest can be attributed to a succession of wet springs in odd numbered years—1929-31-33—in which conditions have been entirely favourable to the pest. Prior to 1927 dry springs were a common phenomenon on the Atherton Tableland and the pest was thus kept within reasonable limits.

4. White grub activity, due to *L. caudata,* is confined to the most acid soils on the Atherton Tableland. Acidity probably reflects the magma types from which these soils were derived, but will become intensified by the leaching to which they are subject. On these premises it is inferred that the area subject to attack will gradually extend, particularly in the vicinity of the coastal range where the rainfall is heaviest.

5. The common failure of previously grub-infested land to crop well during its first year under the plough is invariably due to prior grub interference with soil moisture relationship. An interval of twelve months or so elapses before the return to normal.

6. Measures which prove useful for the control of white grubs in the sugar-cane growing areas of the State are far too expensive for Tableland purposes. In any case, they cannot give permanent relief to the farmer. Better results should accrue from alterations in current agricultural practices which will lessen the risk of the farmer being completely at the mercy of the pest, as is inevitable under purely grazing methods of maintaining a herd. Suggested alterations include fodder conservation for use when grazing reserves are depleted, better pasture management with the aid of rotational grazing and lighter stocking with grade cattle.

7. In any mixed farming system suitable for general adoption in the white grub-infested areas, entomological considerations must influence its major features. The more important of these are:—

(*a*) The practicability of forecasting white grub losses permits the farmer in normal seasons to accumulate reserves for any anticipated fodder shortage. Such reserves would include carry-over roughage, cow cane, winter cereals of approved varieties, and ensilage. The area necessary for the cultivated crops under the proposed scheme requires more tillage than is at present usual and farmers should aim at an allowance of 20 acres per farm. The cultivation areas should, if contours permit, move round the farm so that any given paddock comes under the plough at least once in every ten or fifteen years.

(*b*) Eggs are rarely laid in fallow ground, hence grass paddocks should be broken up early in the flight season—i.e., during the spring storms. If the paddock is ploughed in late summer or autumn, the grub population is already established and will attack any crops subsequently planted so matter how well the land may be worked. Hence should the beetle flight in any year presage heavy pasture damage eighteen months later, a suitable area on which fodder reserves can be grown should be brought under cultivation as soon as the intensity of the flight can be estimated.

(*c*) Normally disc ploughs are used for breaking up pastures, no matter whether renovation or tillage is the aim of the farmer. It should be noted that the mouldboard plough is much more suitable for pasture renovation than the ubiquitous disc type, particularly in grub-infested districts, for the more complete soil cover obtained acts as a deterrent to egg-laying. The heavier draught of the mouldboard plough is more than compensated for by the better work done.

(*d*) "Hogging off" should be confined to the late spring and summer months when good growing conditions are assured. Pigs can be very useful during the beetle flight period when they consume immense numbers concealed in the soil between successive flights. During the summer grubs are consumed. The incidental rooting up of the turf is quite beneficial to the pasture during the wetter months of the year, the effect being comparable to renovation with implements. "Hogging off" during the dry winter months may be harmful for, in the absence of rain the disturbed roots fail to strike root and pasture recovery is consequently delayed.

8. Most of the pastures consist of pure stands of either paspalum or kikuyu grass. The control of pasture types presents singular difficulties and it is improbable that white grub infestation can be influenced by such means in the near future.

Acknowledgments.

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ADDENDUM.

White Grub Injury in Pastures Elsewhere in Queensland.

Though *Lepidiota caudata* Blkb., the subject of this article, is beyond question the most destructive pasture species in the State, sporadic outbreaks of other Scarabaeids are quite common. One of these, *Lepidiota laevis* Arrow, has been mentioned already, for it has a restricted range on the Atherton Tableland and causes a great deal of confusion to the farmer who is invariably more familiar with the tolerably similar larvæ than with the quite distinct adult beetles.

All the economically important pasture species are found in friable red or chocolate loams which originally carried a typical rain forest flora, the constituent elements in which varied with latitude, rainfall, and other relevant factors. The Scarabaeid species involved in the recorded outbreaks show a like diversity and the identity of some is still uncertain.

The more significant features of recent outbreaks may be noted.

A light-brown species, *Lepidiota laevis* Arrow, is restricted to a small area of alkaline soil in the vicinity of Atherton and is as destructive within its limits as the more important *L. caudata*. Unlike the latter species the adults are strongly phototropic and immense numbers can be trapped at lights. Apparently the insect has rather specialised ecological requirements for, though known some twenty years, there has been no spread of the pest other than minor seasonal fluctuations associated with the climatically controlled ebb and flow in adult emergence. As in *L. caudata* the life cycle covers two years.

The Childers sugar-cane beetle, *Pseudoholophylla furfuracea* Burm., has been recorded as attacking pastures. Childers is essentially a sugar-cane producing area and *P. furfuracea* is the most important of the Scarabaeids attacking the crop. Pasture injury in the vicinity of sugar-cane is unusual but can be understood by reference to the rather peculiar flight habits of the species. Mating takes place near the ground soon after adult emergence in the spring, and the flight lacks any distinct attraction to either trees or standing crops. Herbage types are thus relatively unimportant in determining the whereabouts of oviposition and subsequent white grub injury. The life cycle covers two years.

Several species of the genus *Rhopæa* are relatively common in the southern parts of the State. Outbreaks have been recently investigated at Nanango and near Killarney in pastures located on volcanic rain forest soils. The affected farms are located at the extreme ends of a basaltic outcrop which extends from the Queensland-New South Wales border to the north of Kingaroy, and it is probable that the intermediate areas are also susceptible to attack. In both outbreaks the pasture injury was similar to that already described as typical for *L. caudata* and cultivated crops—e.g., peanuts and maize—planted in newly ploughed up pastures may suffer from attacks by the carry-over larval population. The life cycle of the insects implicated in these outbreaks has not yet been elaborated but the control problem is much the same in all instances.

Studies on the Biology and Control of the Large Roundworm of Fowls, Ascaridia galli (Schrank 1788) Freeborn 1923.

[*Continued from p. 356, Part III., Vol. XLVI.—September,* 1936.]

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PART IV.

5. RESISTANCE OF THE CHICKEN TO INFESTATION WITH ASCARDIA GALLI.

AS evidence that chickens may display a resistance to infestation with this roundworm, the following observations are recorded:—

1. It has been noted that in naturally infested cases young birds are in general affected to a much greater extent than old birds.

2. An examination of 352 birds three years of age and over, and of 153 birds two to six months old, gave the information expressed in the following table:—

TABLE XIV.

Number of Birds Examined.	Age.	Percentage Infested.	Mean Number Worms per Bird.
352	3 years and over	27·5	6·71
153	2 to 6 months	60·8	16·93

Thus the information secured by this survey denotes that not only is the incidence of infestation much greater in young birds than in old birds, but the infestation in young birds is also heavier.

3. Under the section "Pathogenicity of Infestation," a series of experiments is outlined in which three groups of birds, namely, Group VII., Group IX., and Group XI., were fed a number of eggs per day from the ages of thirty days, fifty-eight days, and seventy-nine days respectively.

The effects of these infestations on the respective groups were interpreted by an analysis of the differences in amount of mean weekly gain between each group and its uninfested control.

Group VII.—This group was fed 100 eggs per day from the age of thirty days, the dose being increased to 300 eggs per day from the age of eighty-five days.

No curve could be fitted to the points representing the differences in amount of mean weekly gain between this group and its control, as the infested group did not at any time gain in weight to a greater extent than the controls (Graph No. 4 (B)). The plotted points indicate, however, that the infested group commenced to recover somewhere about the end of the fourth week, that is, at about this time

the group's resistance to infestation became evident. Following the increase in dosage to 300 eggs per day, it appears that this resistance was broken down, and the birds became reinfested to such an extent that the gains in weight were again affected.

Group IX.—This group was fed 300 eggs per day from the age of fifty-eight days, the dosage being increased to 1,000 eggs per day from the age of 118 days.

Graph No. 5 (B) shows that this group's resistance to infestation first became evident during the fifth week, and continued to increase to such purpose that by the ninth week the infested birds overtook the control birds in amount of weekly gain. The increase in dosage caused a marked and rapid lowering of this resistance, but the experiment was not continued long enough to ascertain whether a further resistance to this increased dosage was eventually developed.

Group XI.—This group received 500 eggs per day from the seventy-ninth day of age, and 1,000 eggs per day from the 119th day.

Graph No. 6 (B) denotes the development of a resistance as early as the third week, as a result of which the birds made such a rapid recovery that by the fifth week they were gaining in weight to a greater extent than the controls. The increase in the dosage appears to have been followed by a very rapid decrease in resistance and an equally rapid recovery.

Post mortems on these three groups at the termination of the respective trials showed in general that despite the large number of eggs fed, very few worms had survived, and that the majority of these were very small in size. In Group VII., worms reached maturity in three birds only, after forty-eight, fifty-two, and sixty-eight days respectively, which periods are very much longer than that obtained when a single dose of 100 eggs is given to birds of the same age, namely twenty-seven days. In the two other groups, an examination of the fæces showed that of the ten birds employed, worms reached maturity in only one, namely No. 63 of Group IX., eggs appearing in the fæces for the first time on the sixty-eighth day.

The three most affected birds, Nos. 68, 72, and 80, yielded very few large worms on autopsy, the infestation in each case consisting of extremely large numbers of small worms, the majority of which were under 20 millimetres in length.

From the weight curves and the autopsy findings, it is evident that a resistance to infestation was acquired by each of these groups. The period during which the birds were affected appears to have been dependent upon either the age of the group or upon the number of eggs fed. For example, in Group XI., a resistance was developed after three weeks, the birds being seventy-nine days old when first infested, and the number of eggs per day being 500, whereas in Group VII., fed only 100 eggs per day from the age of thirty days, no definite point of recovery is denoted by the graph, though it appears to have occurred some time about the fifth week. It is also to be noted that a resistance which is developed under conditions involving the administration of a number of eggs per day, may be readily broken down when the dose is increased.

A review of the observations recorded by previous investigators on the development of a resistance by the chicken to infestation with this roundworm shows that a resistance has been demonstrated under conditions involving (i.) age, (ii.) pre-infestation, (iii.) deficient diet, (iv.) loss of blood, and (v.) the breed of host.

I. AGE RESISTANCE.

(i.) Previous Investigations.

That chickens develop with increasing age a marked resistance to infestation with *Ascaridia galli* is regarded as one of the classical examples of the development of an age resistance by a host to an helminth parasite.

Herrick[64] was the first investigator to draw attention to this phenomenon, when he demonstated under controlled conditions that the growth and chance of survival of Ascaridia was inversely proportionate to the age of the host. He infested chickens varying in age from five days to 240 days, and found that, aften a ten-day infestation period, larvæ in chickens five days old showed an average gain in length of 5·3 millimetres. In chickens sixty days old the average gain in length was 2.6 millimetres; in chickens ninety days old, ·4 millimetre; and in chickens 103 days old only ·1 millimetre. In chickens older than 103 days, this gain was still ·1 millimetre, showing that birds, say 240 days old, were no more resistant to the growth of the worms than at 103 days old. The variation in the size of the worms increased from 10 per cent. in chickens five days old to a maximum of 25 per cent. at sixty days. In the older birds the growth of the worms appeared more constant, a variation of not more than 1 per cent. being noted. Moreover, the number of birds containing worms decreased from 87 per cent. among chicks five days to one month old, to 29 per cent. at twenty-one weeks and older. As the age of the birds increased, Herrick also noticed that they became more resistant to the effects of infestation.

In 1930, Ackert[7] reported an experiment in which chicks of various sizes were given a single dose of 1,000 eggs. Using birds two months old, he found that the uninfested controls made a greater gain in weight, and that on autopsy all infested chicks, except one, contained worms. With chickens ten to twelve weeks old, there was no such difference in weight, and in each age group only one bird contained worms when examined. In a further experiment, twenty-four chickens were reared under worm-free conditions till three months old, and were then placed with infested birds on contaminated soil. At the end of six weeks, all birds were thrifty in appearance, and on examination only four were infested, the maximum number of worms present in any one bird being eight. Ackert concluded from these experiments that if chickens are kept worm free for the first three months of life they may then be run on infested ground with little danger of subsequent ill effects.

Three further reports were published by Ackert et. al., in 1932 and 1935[16, 19, 20, 21], on experiments concerned with age resistance. The first detailed report appeared in 1935[21], in the compilation of which Ackert collaborated with Porter and Beach. In this experiment, chickens varied in age from thirty-seven to ninety-three days, and the results were secured after feeding single doses of 50 and 300 eggs

respectively. When the mean lengths and numbers of the worms surviving after a 21-day period of infestation in each age group were compared, it was shown that as chickens increased in age there was developed a resistance, which inhibited the growth and survival of the infestation.

In the same year, Ackert, with Eisenbrandt, et. al. [19, 20], was able to demonstrate that an age resistance was developed not only in single-comb White Leghorns, which breed had been employed in all his previous work, but also in Rhode Island Reds, Buff Orpingtons, White Plymouth Rocks, Barred Plymouth Rocks, and White Minorcas.

In an attempt to transfer this resistance by means of serum from old birds, Herrick[64] secured promising results. Using the serum from a cock 123 days old, and injecting it into a 22-day old chick, which had been infested for ten days, the autopsy findings led him to believe that such serum in this case possessed marked vermicidal properties. Serum from the same cock was also given to three other chicks in doses of 1 millilitre, 2 millilitres, and 3 millilitres, respectively. On subsequent examination, the chick into which the 3-millilitre dose had been injected was found to be free from worms, whilst each of the controls harboured over 2,000 larvæ. A third test gave evidence of a strong protective action, though the growth rate of the worms was not affected. No clear cut results, however, were secured from the use of the serum of other aged cocks, and Herrick concluded that such serum, in general, made chickens more resistant to the effects of the worms than to the worms themselves.

(ii.) Personal Observations.

In order to obtain some conceptions of the behaviour of *Ascaridia galli* in chickens of various ages, the following experiment was planned. Four groups of chickens, each of ten birds, were maintained under worm-free conditions up to the respective times of infestation. With each group three controls were allowed to run, and immediately prior to the infestation of each group were killed and examined carefully for worms. In every case the control birds were found to be worm free. Each group was given approximately 100 infectious eggs, all of which were from the one culture, and deposited by female worms secured from a single bird. The groups were infested at the ages of thirty, fifty-eight, eighty-one, and 112 days respectively. After a 21-day period of infestation the birds were autopsied, the worms present carefully collected, counted, and measured. The worms were killed by hot water, and measurements were made with the aid of a camera lucida. Two further controls accompanied the autopsy of each group, and on no occasion were these infested.

The results secured from this experiment are shown in table.

TABLE XV.

Number of Group.	Age when Infested.	Per cent Birds Positive.	Total Worms Recovered.	Mean No. Worms per Bird.	Range of Measurements of Worms.	Mean Length of Worms.
XIII. ..	30 days	100	92	9·2	18·6 mm–34·3 mm	26·72 mm
XIV. ..	58 days	100	78	7·8	12·9 mm–30·6 mm	20·84 mm
XV. ..	81 days	60	40	4·0	8·2 mm–17·8 mm	12·2 mm
XVI. ..	112 days	10	2	0·2	3·0 mm– 5·6 mm	4·33 mm

In Groups XIII., thirty days old, and XIV., fifty-eight days old, all birds were infested, but when the age of the birds was increased to eighty-one days, Group XV., and 112 days, Group XVI., the incidence of infestation decreased to 60 per cent. and 10 per cent respectively, the difference between the percentage infestation of Group XIV. and Group XV. approaching significance, and that between Group XVI. and Group XIV. being significant. The average number of worms per group, and the respective mean lengths of the worms in each group, also showed a very marked decrease as the groups became older.

When the average numbers of worms in each of these age groups were plotted against the age of the groups, a regression line was obtained, the slope of which is regarded as approaching significance (Graph No. 7 (A)). A similar method of interpretation in regard to the mean lengths of the worms in each age group also gave a straight line, the slope of which in this case is significant (Graph No. 7 (B)).

GRAPH No. 7.

AGE RESISTANCE.

(A)—Regression of Average Number of Worms in Each Age Group on Age of Group.

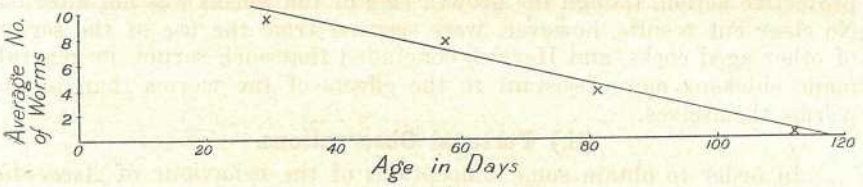


Plate 194.

$y = -1.14\ (x - 30) + 9.9.$

Slope Approaching Significance.

(B)—Regression of Average Length of Worms in Each Age Group on Age of Group.

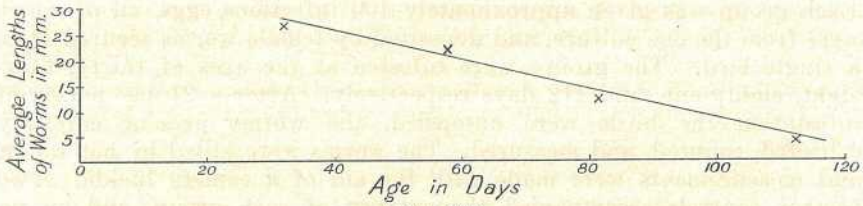


Plate 195.

$y = -0.3\ (x - 30) + 28.08.$

Slope Significant.

These results are in agreement with those recorded by Ackert, and indicate that as chickens increase in age fewer birds become infested, fewer worms survive, and the growth rate of these becomes significantly retarded. Finally, at the age of about 112 days, the experiment indicates that the age resistance which is responsible for the decreasing percentage of larval survival, and the increasing influence of the growth inhibiting factor, has become developed to such an extent, that very few larvæ would succeed in establishing themselves in birds maintained under worm-free conditions till about four months old.

As an age resistance may be regarded simply as a type of natural resistance whose influence increases with age, some idea of the underlying factors may, it is considered, be obtained by examining any evidence which may indicate the existence of a natural resistance by the young bird to infestation.

Table VII., compiled in connection with larval survival in birds employed for life history studies, shows that there is a gradual decrease in the number of larvæ during the first nine days after infestation. As the larvæ occur freely in the lumen of the intestine throughout this period, their gradual elimination is most probably due to the existence of a natural resistance, the mechanism of which is not understood.

That the influences concerned with this explusion of the larvæ may become more potent with increasing age is indicated by an experiment in which five birds reared under worm-free conditions were given a single dose of 1,000 eggs when 125 days old. Autopsies of these birds, after varying periods of infestation, gave the following information:—

TABLE XVI.

Number of Bird.	Egg Fed.	Period of Infestation.	Number Larvae Present.
90	1,000	6 hours	471
91	1,000	1 day	388
92	1,000	3 days	150
93	1,000	5 days	7
94	1,000	9 days	16

Owing to the small number of birds used in this experiment, the information secured cannot be regarded as conclusive evidence that in aged birds in good health large numbers of larvæ are eliminated within nine days after hatching, but it is at least indicative of the presence of a resistance which acts in this manner. Such a resistance could also be concerned in a retardation of growth, which would naturally be correlated with the struggle of the larvæ for survival.

II. ACQUIRED RESISTANCE.

(i.) Previous Investigations.

This type of resistance is developed by the host as a result of infestation, and its influence tends to become more marked under the stimulus of repeated infestations.

Herrick[64] noted that, in the case of *Ascaridia galli*, if chickens of approximately the same age were given a single feeding of eggs, there appeared to be a definite relationship between the numbers of worms harboured and their size, the greater the number of worms present, the smaller the size of the worms. Ackert, Graham, Nolf, and Porter[14] have also drawn attention to this phenomenon, and have

noted that a single feeding of twenty-five to fifty eggs was more conducive to the growth of an infestation than single doses of larger numbers of eggs. The percentage worm survival was also shown to be inversely proportionate to the number of eggs fed. These results were considered to be due to a "serological" factor operating during the period when the larvæ were attacking the intestine wall.

Graham, Ackert, and Jones[55] infested eighty-four chickens at five weeks, and again at ten weeks, and found that the lengths and numbers of the worms surviving from the second infestation were indicative of the development of a slight immunity. In a second experiment, the chickens were given carbontetrachloride to eliminate the worms resulting from the first feeding, and were then infested the second time. The evidence from this second feeding was again suggestive of a slight immunity, though in only one case were the differences in lengths and numbers of worms statistically sound. They suggest that this immunity is due to the formation of antibodies at the time when the young worms burrow into the intestinal wall.

Rebrassier and McCrory[81] endeavoured to ascertain the effect of Ascaridia extract towards establishing an immunity (passive acquired immunity). Three groups of chickens were used, and were infested when forty-six, ninety-seven, and 131 days old, respectively. Each group was then divided into three subgroups. Subgroup 1 was given infectious eggs only; subgroup 2 infectious eggs plus injections of Ascaridia extract, whilst subgroup 3 was retained as uninfested controls.

In the 46-day old group, the lot given ova plus extract made a greater gain in weight than that given ova only. Similar results were secured with the 97-day old birds, though the differences were not so marked. It was also noted that in the younger birds, the addition of the extract had some protective action against the enteritis accompanying the infestation. The extract, however, had no effect upon the number or growth of the worms.

(ii.) Personal Observations.

Referring once again to the series of experiments in which three groups of birds were fed a number of eggs per day, the autopsy findings as regards the numbers of worms surviving, and also the interpretation given to the differences in amount of mean weekly gain in weight between each of these groups and its control, indicate, it is considered, that these birds eventually acquired a resistance to infestation. The possibility that the recoveries observed may have been associated with age has not been overlooked, but it is considered, that as the resistance developed in each group appeared to be broken down by an increase in the dose of eggs, the recoveries, irrespective of the age of the group, were due mainly to the development of an acquired resistance.

It was also observed that as the groups increased in age, recovery was more rapid. Whether this was due to age, or to the fact that the older groups were given much larger daily doses of eggs than the younger group, thereby enabling the more rapid acquisition of a resistance, is not understood, though possibly both factors are implicated.

As regards the mechanism of this acquired resistance, attention is directed to the work of Bachman and Molina,[25] with *Trichinella spiralis* in pigs; and that of Roberts,[88] with *Ascaris lumbricoides* in pigs, where it has been shown that the association of an eosinophilia with an helminth infestation may be indicative of the development of a resistance by the host. Bachman's and Molina's observations in particular, are also suggestive that this resistance is concerned with the blood leucocytes and cells of the reticulo-endothelial system.

When young chickens are infested with a single dose of the eggs of *Ascaridia galli*, an examination of blood smears has shown that during the course of the infestation a marked eosinophilia may be evident. This is shown in the following table, in which the weekly eosinophile percentages of five chickens (Group III.) given a single dose of 1,000 eggs are recorded.

TABLE XVII.

No. of Chickens.	Per Cent. Eosinophiles.					
	At Infestation.	1st Week.	2nd Week.	3rd Week.	4th Week.	5th Week.
48	1·5	1·5	4·0	2·5	2·0	1·0
49	1·5	2·0	7·5	5·5	2·5	4·0
50	0	1·5	6·0	3·5	1·5	0
51	1·5	1·0	11·5	7·5	0·5	0
52	2·5	0	6·5	1·5	1·0	1·5

The eosinophile percentages from five uninfested controls during the same period varied between 0 and 2·5. In the case of each bird in the infested group, the maximum eosinophile count was recorded at the end of the second week. Prior to this the percentage was normal, and except in No. 49 returned to normal after the third week. During the fourth and fifth week, no eosinophilia was evident in any bird, except in No. 49, in which the percentage again increased to 4 at the end of the fifth week. The occurrence of an eosinophilia during the eighth to the twenty-first day after infestation is significant, as it is during this period that the larvæ attack the intestinal tissues.

An examination of Table VII. shows that after the tenth day the numbers of larvæ collected from the chickens tabulated therein decreased markedly. That this decrease is coincident with an eosinophilia suggests very strongly, it is considered, that it is due to the development of a resistance by the host, which resistance, in the light of the interpretations already made with reference to the occurrence of an eosinophilia in helminth infestations, is possibly due to a localisation of those cellular forces concerned in body defence in the tissues of the small intestine.

The degree of resistance developed would depend upon the number of larvæ present and attacking the wall of the intestine, that is, upon the numbers of eggs fed. Thus, if the experiment in which three groups of chickens, each aged thirty days and given a single dose of 100,

500, and 1,000 eggs respectively, is again considered (Groups I., II., and III.), it will be noticed, as shown in the following table, that as the dose is increased the growth of the worms is retarded and the percentage survival becomes smaller.

TABLE XVIII.

No. of Group.	No. Eggs Fed.	No. of Birds with Worms.	Total No. Worms in Group.	Per Cent. Survival of Worms.	Min. Maturity Period of Worms.
I.	100	5	112	22·4	28 days
II.	500	4	91	3·64	34 days
III.	1,000	5	119	2·38	39 days

III. DEFICIENT DIET.

The influence of nutrition on Ascaridia infestation has been the subject of a good deal of investigation by Ackert and his co-workers. In seeking for an explanation as to the reason chickens on farms appeared more susceptible to infestation than chickens on a well-regulated diet, Ackert suspected that diet may be a factor on which the susceptibility of the host depended to a large extent. Experiments were thereupon undertaken to ascertain what effect the vitamins A and B would have on this susceptibility. The first experiment to be reported in detail was conducted by Ackert, McIlvaine, and Crawford[12] in 1931, and concerned vitamin A. Four experiments were carried out using semi-synthetic diets deficient and adequate in vitamin A, and a normal full diet and also involving a variation in the age of the host and the dosage of eggs employed. The results from the first three experiments showed, as indicated by the numbers of worms surviving and their size, that the vitamin A deficient groups on the semi-synthetic diet were least resistant and the groups on the normal full diet most resistant. The results secured from the fourth experiment were somewhat confused by an increase of vitamin B and the supplementary protein allowance to the groups on the semi-synthetic diets, and although the group on the normal diet contained more worms than the group fed the vitamin A deficient diet, the worms in the normal diet group were much smaller in size. The authors concluded that the resistance of growing chickens four to seven weeks old to *A. galli* is lowered when they are maintained on a vitamin A deficient diet. They suggest that as a weakened peristalsis is one of the effects of this deficiency, such may be an explanation of the results obtained.

In 1931 Ackert and Nolf published an account of the principal results obtained in a further series of experiments concerning the effect of a vitamin B deficient diet[13]. These experiments were conducted on practically the same lines as those concerned with vitamin A. At the age of seven weeks one group of chickens was given a semi-synthetic diet deficient in vitamin B, a second group the same diet plus yeast and a third group a normal full diet. After two weeks on these diets all chickens were infested with 500 eggs of *A. galli*, and autopsied after three weeks infestation. The first group carried an average of 13.43 worms per chick, with a mean length of 13.38 mm.;

Group 2 an average of 5.28 worms, with a mean length of 18.28 mm.; and Group 3 an average of 4.41 worms, with an average length of 13·80 mm. Many of the chicks on the vitamin B deficient diet suffered from a partial paralysis of the digestive tract, and the authors consider that the larger number of worms in that group may be explained by the fact that this condition assisted the worms to remain in their natural habitat. The larger size of the worms in the chicks receiving yeast was suggested to be due to some factor present in the yeast which was favourable to the growth of the worms. Further work by Ackert and Beach[11, 15] on yeast as a factor in the growth of the worms showed, however, that in the presence of an adequate amount of vitamin B yeast does not furnish a special growth factor.

The effect of these two vitamins A and B on the resistance of chickens to infestation with *A. galli* may therefore be summarised as follows:—

The absence of vitamin A in the diet so lowers the resistance of chickens to infestation with this parasite that more worms are able to survive and also to grow more rapidly than in chickens receiving an adequate quantity of this vitamin. A deficiency of vitamin B, on the other hand, while indicating that more worms may survive appears to result in worms of smaller size than in the case of a diet adequate in vitamin B. Vitamin D, on the other hand, was considered by Ackert and Spindler to have no effect either on the growth rate or numbers of *Ascaridia galli.*

Further work by Ackert and Beach[18] on the effect of dietary supplements upon resistance to *A. galli* has shown that the type of amino-acid may influence the course of an infestation as the inclusion of skim milk and meat meal increased the growth ratio and resistance of chickens, whilst a plant diet produced slowest growth rate and least potent resistance.

IV. LOSS OF BLOOD.

Herrick[64] found that thyrectomy and alteration of the flow of bile did not in any way interfere with the development of the worms, but that the removal of large amounts of blood by cardiac puncture made the chicken less able to cope with the growth of the worms. The effect of bleeding on the growth and survival of this roundworm has also been investigated by Ackert and Porter[10]. Three hundred young chickens were used, and were divided into two groups of 150 each. Group A was bled at weekly intervals, the amount of blood taken being gradually increased from .5 ml. at four weeks old to 5 ml. at nine weeks. Group B was not bled at any time. When six weeks old each group was subdivided and each subgroup was given a single dose of eggs varying from 25 to 500 in number. Those subgroups given 300 and 500 eggs and bled contained, after a three-week infestation period, larger worms than those given a similar number of eggs and not bled. Whilst the differences between the remaining subgroups were not significant, the worms from the bled birds were larger than those secured from the birds which did not suffer any blood loss. The results were interpreted as indicating that bleeding affects the growth inhibiting mechanism, lowering the resistance of the chicken to the parasite.

V. COMPARATIVE RESISTANCE BY DIFFERENT BREEDS OF FOWLS.

In 1933 a brief note was published by Ackert, Eisenbrandt, Glading, and Wilmoth[17] concerning experiments involving the comparative resistance of six breeds of fowls to infestation with *Ascaridia galli*. These experiments were continued, and a complete report was made available in 1935[19]. A total of 1,351 chickens were used, including six breeds, namely, White Leghorns, Buff Orpingtons, White Plymouth Rocks, Barred Plymouth Rocks, Rhode Island Reds, and White Minorcas. Of this latter breed two varieties were employed. Groups of birds belonging to these various breeds were fed a single dose of 50 $\pm$ 5 embryonated eggs at the ages of twelve, twenty-one, thirty, thirty-three, and forty-four days respectively. The results as interpreted from the numbers and mean lengths of the worms present in each group after a twenty-one-day period of infestation showed that the heavier breeds, Rhode Island Reds, White Plymouth Rocks, and Barred Plymouth Rocks, were significantly more resistant than the lighter breeds, White Leghorns, Buff Orpingtons, and White Minorcas. Of the two strains of White Minorcas infested a heavy strain proved to be more resistant than a lighter strain of the same breed with a different genetic constitution. The greater susceptibility of the lighter breeds is considered to be possibly due to the fact that these breeds are markedly more active and nervous than the heavier breeds, and this greater utilisation of energy might be unfavourable to the development of inhibiting factors.

CONCLUSIONS.

From these observations the phenomenon of resistance by the fowl to infestation with *A. galli* may be summarised as follows:—

1. As birds grow old there is developed a marked resistance both to the infestation itself and its effects. This type of resistance, as recorded by Herrick and Ackert and confirmed by the writer, is denoted by the difficulty the worms experience in establishing themselves and developing in old birds. Experimental results secured by Ackert and the writer indicate that at about three to four months of age this age resistance has become developed to such a high degree that birds reared under worm-free conditions for this period could then be turned on to infested soil with slight subsequent ill effects.

In attempting an explanation of the factors underlying this age resistance, Ackert, Porter, and Beach[21] point out that their results do not confirm Sandground's view that the chicken is an abnormal host. *Ascaridia galli* was originally described from a specimen taken from a turkey, which host is inferred by Sandground to be the normal and less resistant host of this roundworm. Work by Ackert and Eisenbrandt[20], however, showed that if chickens and turkeys of the same age are fed the same dose of eggs, the chicken is less resistant to infestation, as their birds harboured more and longer worms than the turkeys. These authors are inclined to the view that the resistance is not associated with the intestinal mucosa itself, but is concerned with growth inhibiting factors in the serum of the chicken the nature of which is unknown. This hypothesis is supported by the periodic bleeding experiments of Porter and Ackert, and also to some extent by the results secured by Herrick using the serum from aged worm-free

birds. The writer's work, on the other hand, has indicated that the mechanism concerned in this age resistance may possibly be identical with that of a natural resistance which is considered to be responsible for the elimination of larvæ during the first nine days after infestation, and whose influence increases with age. There is, however, also some slight evdience that the resistance acquired as a result of infestation and developed as a result of the larvæ attacking the intestine wall,, assists the age resistance, becoming more potent with increasing age. As the factors concerned with this acquired resistance are considered to be associated with the blood serum, this evidence would favour Ackert's hypothesis of serum borne growth-inhibiting factors and age resistance, though in the light of these observations such a resistance would not be, strictly speaking, an age resistance but an acquired resistance.

2. During the period in their life cycle when the larvæ attack the intestine wall, a marked eosinophilia may be demonstrated in the peripheral blood of the host. This phenomen, together with the conspicuous diminution in the numbers of larvæ which occur at this time, is considered to indicate the development of an acquired resistance. The mechanism of this acquired resistance may possibly be associated with a concentration of the blood leucocytes and cells of the reticulo-endothelial system in the tissues of the intestine wall. Under conditions of repeated infestation this resistance may be acquired to a high degree, so that, despite the continuous ingestion of large numbers of eggs over a long period, very few worms may survive to the adult stage.

3. Theoretically, therefore, old birds should remain practically unaffected by *A. galli,* both by virtue of their age and by the fact that they may have been continuously exposed to infestation over a long period. Such, however, is not the case, and serious infestations may be frequently encountered in such birds. This can be explained only by the fact that their age resistance and acquired resistance has in some way or other been broken down. Foster[50] concluded from his long experience with the resistance developed by the dog to the hookworm, *Ancylostoma caninum,* that such an immunity is conditioned upon the general wellbeing of the host, and that any factor which in any way affects this wellbeing may result in a breaking-down of the immunity. Ackert has shown that a diet deficient in vitamins A and B and in animal protein may affect the resistance of the fowl to *A. galli.* A similar lowering of resistance to this roundworm was recorded under conditions of repeated bleeding. It seems, therefore, that any other such factor which affects the health of the fowl, such as the presence of disease due to bacteria, protozoa, other helminths, or the strain upon the bird's vitality by production, &c., may also make the fowl more susceptible to infestation.

[TO BE CONTINUED.]

OPHTHALMIA OF DOMESTIC ANIMALS.

The disease known as ophthamia, which is an inflammation of the eye, and is often referred to as "blight" or "pink eye," affects all the domestic animals, although it is probably most frequently encountered in cattle and sheep.

The disease is contagious and is brought about by the entrance of a special germ into the eyes. Injury to the eyes such as is caused by grass seed is sometimes considered to be the sole cause of blight; this, however, is incorrect, for the true contagious form of the disease cannot be produced unless the specific germ is present. It must not be overlooked, however, that any foreign material which becomes lodged in the eyes will set up irritation and give rise to a non-contagious form of ophthalmia, and, secondly, eyes in such a condition are more susceptible to the contagious form.

The infective material which is responsible for setting up new cases is present in the discharges from the affected eyes, and it is frequently carried from one animal to another by means of flies. Another method of spread, particularly with sheep, is by long grass, &c., becoming contaminated with eye discharges, which are later transferred to the eyes of healthy animals grazing over the same area.

The first change noticed following infection is a watery discharge issuing from the inner corners of affected eyes. If the eyes are examined at this stage evidence of inflammation will be noticed in the form of a general reddening and enlargement of the minute blood vessels. As the disease progresses the discharge becomes more copious and full of pus, and the general appearance of the eye becomes dull. If no treatment is carried out a film appears over the eye and the animal becomes temporarily or in some cases permanently blind. The film is due to an inflammation of the surface layer of cells. Frequently the case does not extend beyond this stage, and even without treatment the eyes begin to recover gradually and return to normal. In other cases the inflammation may extend to the deeper structures, leading to permanent blindness in one or both eyes. In those cases which recover without treatment the animals may be partially or totally blind for up to a week, and during this period they are difficult to drive and usually lose condition. Losses are also experienced on account of the animals becoming separated from the rest of the herd and not being able to find water.

If animals are treated in an early stage of the disease, they soon recover. Several mixtures may be used in the form of drops into eyes, and very good results have been obtained with a 2 per cent. solution of zinc sulphate. To make this solution ½ oz. of zinc sulphate is dissolved in 1 pint of clean water, which has been boiled and allowed to cool. A 5-10 per cent. solution of argyrol is also effective. For treatment, about 10 drops of one of the above mixtures are dropped into each affected eye at least once, and, when possible, twice or more often daily. The treatment should be continued until the eyes have returned to normal.

In the case of valuable animals the discharge should be cleaned away from the eyes with a boracic acid solution, and yellow oxide of mercury ointment (1-50) should be applied to the lids to prevent them from sticking.

As the disease is contagious and rapidly spreads from animal to animal, the affected cases, particularly when only few in number, should be isolated until they have completely recovered. Particular care should be taken when new animals are introduced to see that they are not infected, as the disease is often introduced into and spread through a flock by such means.

In the case of sheep it is wise, when facilities are available, to treat all the animals and to draft off those showing evidence of the disease for more intensive treatment in a small hospital paddock.

Principles of Botany for Queensland Farmers.

C. T. WHITE, Government Botanist.

[*Continued from p.* 391, *September*, 1936.]

Part II.—ANATOMY.

THE STUDY OF THE INTERNAL STRUCTURE OF PLANTS.

CHAPTER X.

Cells.

THE previous chapters having dealt with the external features of the different plant members, root, stem, leaves, &c., attention will now be drawn to their internal structure, a knowledge of which will be found necessary before we can fully understand the work which these organs perform and the part they play in the life of the plant.

So far, for the most part, the features described can be seen with the naked eye or with the aid of a low-power hand lens, but in the study of their anatomy the use of a higher power becomes necessary. Thin slices or sections of the part to be studied are cut and examined under the microscope, and, in order that a full knowledge of their nature and relationship be gained, it is necessary that sections be made, not only in one, but in several directions. Sections are usually cut (1) at right-angles to the main axis, when they are termed transverse sections; (2) parallel to the main axis, when they are termed longitudinal sections; in the latter case the terms "radial" and "tangential" are added respectively to distinguish whether the section passes through the centre of the axis or not. (See Plate 196.)

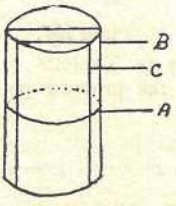


Plate 196.

Diagram to Illustrate Relative Positions for Different Sections.
A.—Transverse. B.—Longitudinal and Radial. C.—Longitudinal and tangential.

To separate the finer internal parts in the living plants is extremely difficult. On this account, the part to be sectioned is generally killed or "fixed"—i.e., it is put into a solution such as weak formalin, spirit, or other chemical solution which quickly penetrates to the finest interior parts so that they remain in the same, or practically the same, position as when alive. The sections are stained with various stains to bring out the details, and then mounted on glass slips, after which they are ready for microscopic examination. The accounts of cell division and such minute processes as are described in the following pages are not made from living cells, but from a number of such sections of an extreme thinness cut in series by mechanical aid.

The Cell.—The bodies of all living creatures, whether animals or plants, are built up of minute elementary organs called cells. In plants the individual cells are surrounded by a cell wall composed of a substance known as cellulose.

In the lowest forms of life—among animals, bacteria, and plants—the individual consists only of one minute cell and is invisible to the naked eye.

All living bodies consist primarily of protoplasm—a substance varying in consistency, but usually of a slimy, granular, or jelly-like nature; it is the basis of life, and without it the ordinary life processes of either animals or plants become impossible, death implying its destruction or decomposition.

The youngest cells are always found where growth is most actively going on—viz., at the growing points—and are called embryonic or meristematic cells, and the tissue in which they occur is known as the meristem or growing tissue. (Plate 197, A). If a thin section through a growing apex be made and examined under the microscope, the cells will be found to be more or less cubical in shape, with delicate cell-walls and filled with protoplasm. Each cell contains a central body—the nucleus (Plate 197)—clearly differentiated from the main mass of protoplasm. The general mass of protoplasm in the cell outside the nucleus is distinguished under the name of cytoplasm (Plate 197, A).

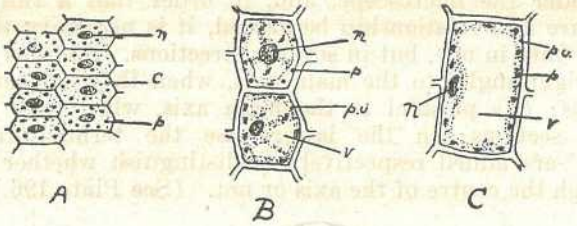


Plate 197.

Cells in Various Stages.

A.—Very young cells from near the growing point (meristematic cells).
B.—Two older cells.
C.—Single full-grown cell.
c, Cytoplasm; *n*, nucleus; *p*, plastids; *p.u.*, primordial utricle; *v*, vacuole.

In animals the older cells, like the younger, are, as a general rule, completely filled with protoplasm, but this is not the case in plants. As the plant cell increases in size the protoplasm can no longer completely fill the cell cavity, and spaces—termed vacuoles (Plate 197, B, C)—arise in the cell, the cytoplasm being reduced to a layer lining the cell wall, with perhaps a number of connecting threads across the cell cavity; this continuous layer of cytoplasm is often referred to as the primordial utricle (Plate 197, B, C). The vacuoles are filled with a fluid—termed the cell-sap—consisting mainly of water with a number of substances in solution, some intended as food for the protoplasm, others excreted from it.

Generally speaking, the cell-sap, is colourless, but often it contains a colouring matter—called anthocyanin—to which the bright colours of many flowers, fruits, and young leaves are due; also, the particular flavour of most common fruits and vegetables is due to substances dissolved in the cell-sap.

In addition to the nucleus, there occur several smaller bodies, like it, of a denser character than the surrounding cytoplasm; these are the plastids (Plate 197), three kinds being recognised:—

1. In very young cells, in underground parts, such as roots and tubers, and in deep-seated tissues the plastids are colourless, and are known as leucoplasts.

2. In parts of plants exposed to light, such as leaves, the plastids develop the green colouring matter typical of plants and known as chlorophyll; they are then referred to as chloroplasts, and practically all green parts of plants owe their colour to their presence. These minute chloroplasts are of extreme importance, as the chlorophyll they contain is essential in the manufacture of organic food substances in the living plant.

3. Chromoplasts is the name applied to plastids containing various colouring matters, generally yellowish or red; they are found in the cells of floral members of fruits, and, generally speaking, are confined to yellow and red flowers and fruits, the colours of most blue, purple, and many red flowers, &c., being due to the colouring matter anthocyanin, previously referred to.

The three kinds of plastids detailed are convertible one into another; the leucoplasts of underground parts—Potato tubers, for instance—develop chlorophyll when the particular parts are exposed to the light; similarly, chloroplasts of such plants as the Endive and Celery are artificially converted into leucoplasts by the gardener; the chloroplasts in green unripe fruits develop into chromoplasts as the fruit ripens, and those of the cells of young leaves may change into chromoplasts, producing the well-known autumn tints.

The protoplasm or living contents of the cell thus comprises: (1) the nucleus; (2) the cytoplasm; and (3) the plastids. In addition, there are a number of non-living substances found in cells; if soluble, they are dissolved in the cell sap; if insoluble, they appear in solid form. The most important of these substances are starch and proteid grains.

Starch is found as large grains most abundantly in parts which service as store places of reserve food material, as in tubers and enlarged roots, in the albumen of seeds, &c. They stain blue or violet when treated with a solution of iodine, and generaly present a characteristic stratified appearance under the microscope.

Aleurone or Proteid Grains.—These are solid grains of proteid substances found as reserve food material in different parts of the plant —mainly in seeds. They stain yellowish-brown when treated with a solution of iodine. They occur usually as minute granules, except in oily seeds, such as the Castor Oil and Candle Nut, when they are comparatively large.

Other substances are fats and oils, resins, ethereal or essential oils, caoutchouc, tannins, and mineral crystals, which will be dealt with later on when dealing with the chemical composition of plants.

Cell Formation (Plate 198).—As all plants are built of cells, a great multiplication in the number of cells must take place with the increased growth of the plant and the formation of new members. So far as we know at present, all new cells originate from pre-existing cells, and this is usually brought about by normal cell division; this only takes place in young cells, each cell as it attains full size dividing into two.

This is rather a complicated process. The whole cell about to divide enlarges; the granular substance of the nucleus changes and becomes a long thread coiled on itself, and finally breaks up into a number of V

or U-shaped pieces called chromosomes. The nuclear membrane disappears, and there arises in the surrounding protoplasm what is known as the nuclear spindle, while the chromosomes now arrange themselves round the equator of the spindle, and then gradually move apart in masses of an equal number to the opposite ends of the cell; here the chromosomes intertwine and form a spiral similar to their original form, eventually reverting to the granular condition of the original nucleus, and, like it, enclosed in a nuclear membrane. As the chromosomes move towards the two poles of the spindle, the spindle threads gradually disappear, and a thickening appears along the equator, which eventually develops into a cell wall, thus completing the division into two cells. In this way an accurate division of the nuclear contents of the cell is insured.

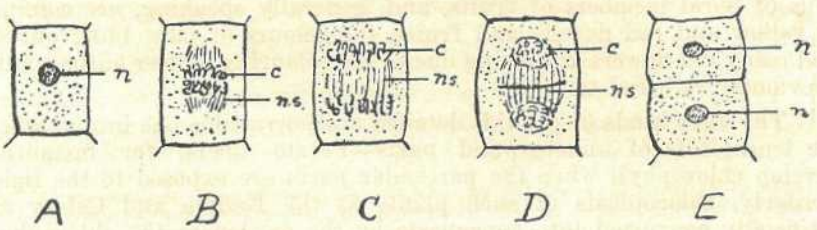


Plate 198.

Cell Division.

A, B, C, D, E.—Diagrams to illustrate various stages in ordinary cell division. *c*, Chromosomes; *n*, nucleus; *n.s.*, nuclear spindle.

This is the common type of cell division in the vegetative growing points of the higher plants; it is usually referred to as the ordinary method of cell division, and the process itself its known as mitosis or karyokinesis.

A noteworthy feature is that the number of chromosomes is constant in any given species.

It is as well to get a grasp of the general features of mitotic or karyokinetic division of the members, as the process is often referred to, not only in advanced works, but in popular ones dealing either with zoological or botanical matters, while it is the common type of cell division in animals as well as plants; in fact, in their fundamental features plants and animals approach each other very closely, even in the highest types.

Thickening of the Cell-Wall (Plate 199).—The young cell found in the meristematic or juvenile tissue are all more or less alike in size and shape; as they increase in size, however, they become variously altered in shape or structure, according to the functions they have to perform in the fully developed parts of the plant.

In the young cells the cell-wall is very thin, but as the cell attains full size the wall usually becomes thickened, the thickening substance being applied in layers on the inner surface of the original membrane; the thickened walls give firmness and strength to the structures of which they are a part.

It is rarely that the thickening takes place uniformly over the whole interior surface of the cell-wall, and parts of the original wall usually remain unthickened. Sometimes very small areas are thus left, forming narrow channels through the thickened tissues, and appearing as dots on

the surface of the cell-wall; these small unthickened areas are appropriately termed pits. What is termed a bordered pit is a modification of the simple pits, in that, as in that form, a small unthickened area arches over to form a dome instead of being closely appressed to the primary walls, as is the case with a simple pit. The apex of the dome, however, is open, and forms the entrance to the bordered pit; opposite this opening the original cell membrane is thickened, forming the so-called torus. Since the thickening substance is laid on the inner surface of the cell-wall as viewed from the outside, the bordered pits take the form of lenticular hollows, and each presents the appearance of two circles or ellipses, one within the other.

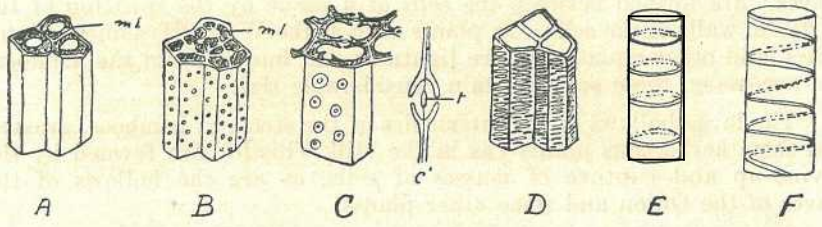


Plate 199.

Diagrams to Illustrate Thickening of Walls of Cells and Vessels.
A.—Uniformly thickened. B.—Simple pits. C.—Bordered pit. D.—Scalariform. E.—Annular. F.—Spiral.
m.l., middle lamella; *t*, torus; *c'*, side view.
[A, B, and C adapted from illustrations by Percival.]

If the pits are long and narrow, appearing as transverse slits with straight bars of thickening between them, the marking is said to be scalariform. The pits of one cell-wall are placed exactly opposite the pits of the wall of an adjoining cell, serving as a means of communication from one cell to another. In the cases where more of the cell-wall remains unthickened, the thickened portions may take the form of narrow annular or spiral ring-like bands which sometimes anastomose to form a network when the thickening is spoken of as reticulate.

Alteration of the Cell-Wall.—With the growth of the cell the cell-wall not only increases in thickness, but is usually more or less changed by the addition of various chemical substances:—(1) It may by impregnation with a waxy substance called cutin become converted into cuticle—a substance very elastic, almost impermeable to water, and thus of great value to those parts of plants which require to be protected from excessive evaporation; (2) it may be converted into cork; (3) it may become impregnated with lignin—that is, lignified or converted into wood; or (4) it may be altered into mucilage, when it becomes capable of absorbing great quantities of water; mucilaginous cells are hard and horny when dry, but when moistened swell up considerably and become soft and gelatinous or sticky.

In other cases mineral matters are deposited in the substance of the cell-wall; the commonest of these is silica. Silica is present, especially in the cell-wall of the external parts of the stems and leaves of grasses, and sometimes so competely impregnates the cell-wall that when the tissue is burnt the silica remains in the form of a skeleton retaining the form of the cell.

CHAPTER XI.

Tissues and Tissue Systems.

Tissues.

The continued process of cell-division results in the formation of vast numbers of cells, and if a thin section of part of a plant be examined under the microscope it will be observed that the cells are of varying forms and sizes and that the different kinds are grouped together in various ways, according to the particular plant or part of the plant that is examined; such groups of cells associated together are spoken of as tissues.

Intercellular Spaces.—Sometimes what are known as "intercellular spaces" are formed between the cells of a tissue by the splitting of the partition walls of the cells. In plants such as the Water Hyacinth, Water Lilies, and other aquatics where lightness and buoyancy in the members are necessary, these spaces attain considerable size.

The large hollows in the internodes of the stems of bamboos, grasses, and some herbaceous plants (as in the Milk Thistle) are formed by the drying-up and rupture of masses of cells, as are the hollows of the leaves of the Onion and some other plants.

Intercellular spaces may contain various substances, such as gum, resin, or ethereal oil. The cavities usually spoken of as "oil-dots" that occur in the leaves of the Orange, Lemon, Eucalypts, and some other plants furnish a familiar example. These dots are very clearly discernible, sometimes with the naked eye and always with the aid of a lens when looked at through transmitted light. An oil gland in transverse section and much enlarged is shown in Plate 200.

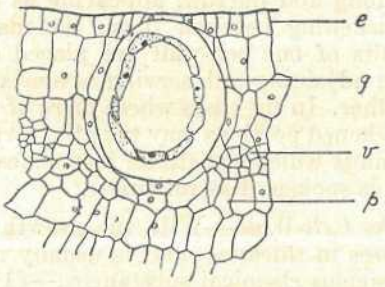


Plate 200.

Transverse Section, Highly Magnified (after Welch, in "Journal and Proceedings of the Royal Society, New South Wales"), of Portion of a Leaf of a Eucalypt, Showing Large Oil-gland.

e, epidermis; *g*, oil-gland; *p*, general ground tissue; *v*, small vascular bundle.

The so-called resin-canals, resin-passages, or resin-ducts of Conifers are really intercellular spaces into which resin is excreted by the surrounding cells.

Types of Tissue.—The tissues of plants may be classified under two headings:—

(*a*) Meristematic tissue, consisting of cells capable of growing and dividing, and thus providing new cells; it is found in those parts of plants where growth is actively taking place such as at the growing apex of stems and roots.

(*b*) Permanent tissue, consisting of cells which have reached their full development and have ceased to divide. The cells of permanent tissues vary greatly in shape, size, and other particulars, and different distinguishing terms are applied to tissues, according to the types of cells they consist of.

The cells may remain more or less rectangular or cubical in shape, forming the tissue known as parenchyma. The cell-wall may be thin, as in the soft fleshy parts of plants, when it is spoken of as thin-walled parenchyma.

In other cases the cells may become thickened, when the tissue is spoken of as thick-walled parenchyma; of this there are two principal forms: (1) Collenchyma (Plate 201–A), in which the thickening matter consists of cellulose laid down at the corners of the cells, and which is found just below the surface in many young stems, petioles, and midribs of leaves, &c., giving them the necessary firmness; (2) wood parenchyma, in which the cell-walls are lignified; this is referred to as soft tissue in descriptions of timbers.

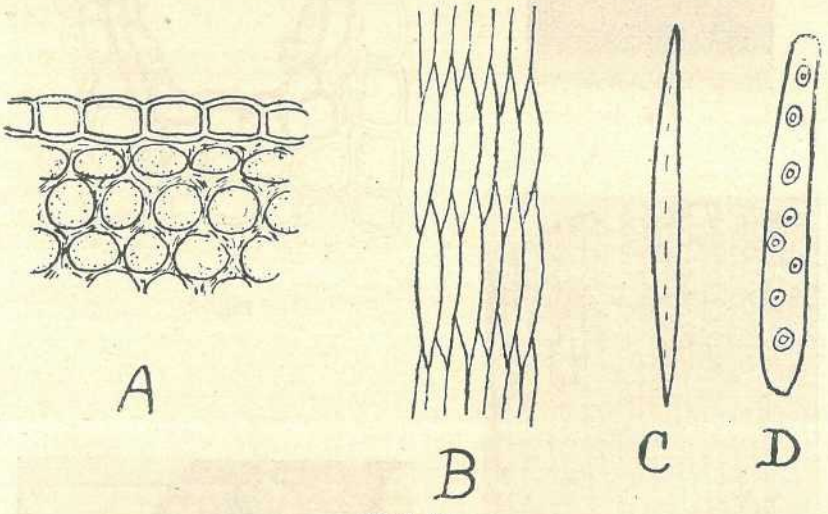


Plate 201.

A.—Collenchyma. B.—Prosenchyma. C.—Woody fibre. D.—Tracheid.

The cells may become long and pointed at both ends, the ends dovetailing in between those of other cells without intercellular spaces, and forming the tissue known as prosenchyma (Plate 201–B). Prosenchymatous cells, which early lose their protoplasmic contents, and in which the cell-walls are more or less thickened, are called fibres (Plate 201–C). When the walls become lignified they are termed wood fibres.

Tissues in which the walls of the cells are very much thickened and hard are distinguished under the name of sclerenchyma; the small gritty masses that occur in the fruit of the pear provide a familiar example. In the section of a tree-fern stem, the bands of hard strengthening tissue shown in Plate 88 are formed of sclerenchyma.

Tracheids (Plate 201–D) is the name applied to cells of a somewhat elongated shape and with thickened, usually lignified walls; they are similar to fibres, but the ends are blunt. By the absorption of the

transverse partitions (coincident with the disappearance of the protoplasmic contents) longitudinal rows of such cells may become converted into what are termed vessels.

Fig. 1.

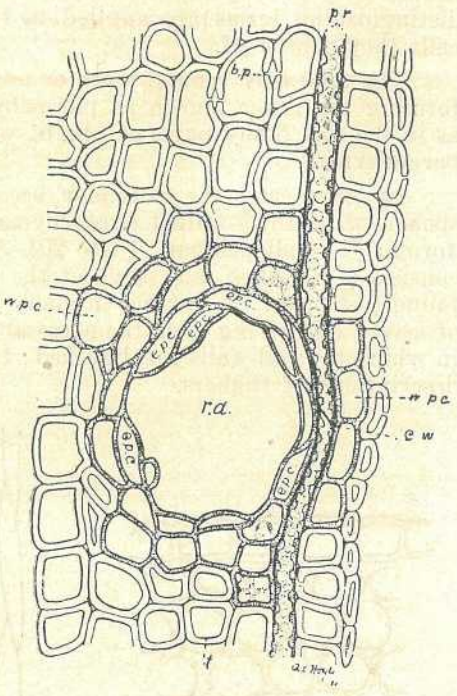


Fig. 2.

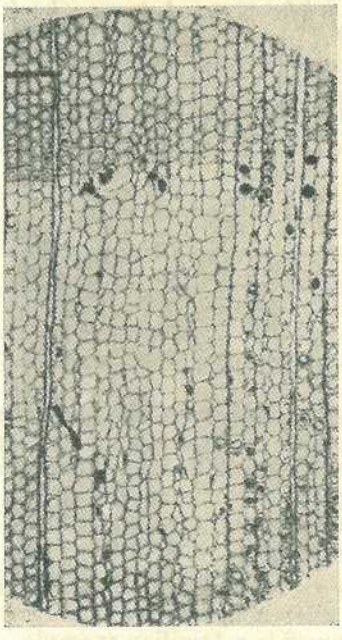


Fig. 3.

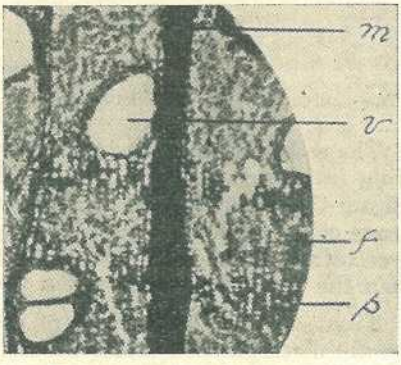


Fig. 4.

Plate 202.

In the Angiosperms (Plate 202, Fig. 4) the vessels are characteristic structures of the wood; they may attain a considerable size, and on transverse section often show up plainly under a low-power lens as pores. In Gymnosperms (Pines, &c.) tracheids only occur (Plate 202, Fig. 3).

The essential difference between a tracheid and a vessel lies in the fact that the former is developed from a single cell, whereas the latter is a long, tubular structure derived by cell fusion from a longitudinal

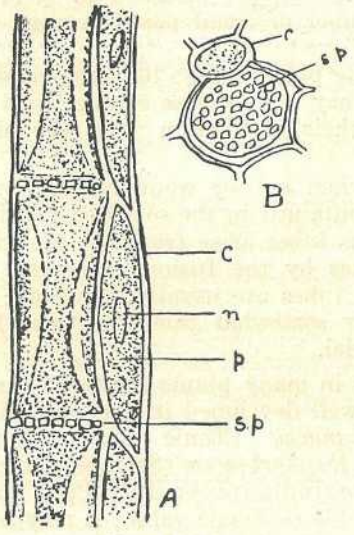


Plate 203.
Sieve Tubes and Companion Cells.

A.—Longitudinal section. B.—Transverse section. C.—Companion cell. *n*, nucleus of companion cell; *p*, protoplasm (cytoplasm); *s.p.*, sieve plate.

row of cells. The tracheid, as it were, corresponds to a single joint of a vessel. Tracheal tissue is particularly important as a conductor of watery solutions from the root to the foliage leaves and other parts of the plant.

DESCRIPTION OF PLATE 202.

Vessels, Tracheids, and Resin Ducts as seen in Transverse Sections of Timbers.

1. Transverse section through the wood of an American Pine (*Pinus ponderosa*); the section is cut through a single annual ring; the wood, with the exception of the pith rays (*p.r.*) is composed almost entirely of tracheids (*t*). The late wood of the ring is easily distinguished from the early wood by its dense character and much thicker walls of the tracheids; the late wood of one and the early wood of another ring can be clearly seen in the lower and upper edges of the section respectively. Two resin ducts can be seen, one towards the left-hand bottom corner, and the other towards the right-hand top corner of the section. The section is magnified 20 diameters.
2. Transverse section of a resin duct of *Pinus ponderosa* with its surrounding tissue, magnified 250 diameters; *b.p.*, bordered pits; *e.p.*, epithelial cells; *p.r.*, pith ray; *r.d.*, resin duct; *t*, tracheids; *w.p.c*, wood parenchyma cells.
3. Transverse section through an Australian Pine (*Araucaria Cunninghamii*). The wood of the Australian conifers does not possess any resin ducts and is composed almost entirely of tracheids. Two medullary rays are shown in the picture; their cells are mostly empty. The black particles represent deposits of manganese compound. The areas of early and late wood are not particularly well defined. Section magnified about 80 diameters.
4. Wood of a Dicotyledonous or Broad-leaved tree (*Tarrietia argyrodendron*), Booyong or Crows-foot Elm. The wood is composed of vessels, fibres, and wood parenchyma; the vessels or pores (*v*) are large and often septate; the wood-parenchyma or soft tissue (*p*) alternate with bands of fibres (*f*); the medullary rays (*m*) has its cells filled with a brown deposit. The section is magnified about 45 diameters.

[Figs. 1 and 2.—Taken from illustrations by Sudworth and Mell in "Forest Service Bulletins" 101, U.S. Dept. Agriculture; Fig. 3, from Baker and Smith's "Pines of Australia"; and Fig. 4, R. T. Baker's "Hardwoods of Australia."]

What are termed sieve tubes (Plate 203) are, like vessels, formed from longitudinal rows of cells. The walls are thin, and there is a lining of cytoplasm, but no nucleus. The transverse partitions, instead of being completely absorbed, are modified to form sieve plates, and are perforated by a number of small pores through which the contents of the cells can pass. Sieve tubes are conductors of organic food substances from the leaves to the places where they are required. A peculiar fact about them is that they are in close contact with elongated thin-walled cells, which, from their association with the sieve tubes, are called companion cells.

Many plants, when cut or wounded, freely exude a milky fluid termed latex; it is contained in the so-called lactiferous tubes or vessels. Sometimes lactiferous tubes arise from the continued development of a single cell; sometimes by the fusion of several cells, as in ordinary vessels. Lactiferous tubes are usually branched; their walls consist of cellulose, are usually somewhat thickened, and have a thin lining of protoplasm with nuclei.

Latex is present in many plants scattered through several families, and is particularly well developed in the *Asclepiadaceæ* (Hoya, Wild Cotton, &c.), *Apocynaceæ* (Tonic Bark, Milk Wood, &c.), *Caricaceæ* (Papaw, &c.), *Euphorbiaceæ* (Spurges), and *Moraceæ* (Figs, &c.). Sometimes, as in the India-rubber Fig, Para Rubber, Opium Poppy, &c., it is of considerable economic value; it may be acrid and poisonous, as in the Milky Mangrove and Mistletoe Tree (*Euphorbia Tirucalli*).

Tissue Systems.

The different forms of tissue described are grouped together in various ways in the plant members to form tissue systems. On broad lines three main systems are recognised—(1) epidermal system; (2) vascular system; (3) fundamental or ground tissue system.

1. *Epidermal Tissue.*—This comprises the epidermis or the entire outer skin of the plant. The epidermis may consist of a single continuous layer of cells, or may be several cells in thickness. In stems and leaves the external walls of the cells are more or less thickened and hardened, and form a thin closely applied skin known as the cuticle; it is particularly well developed in leathery leaves, and very strongly in succulent plants adapted for desert conditions, as the Prickly-pears, &c., in which it can more or less easily be detached as a thin, tough, more or less transparent skin from the other layers.

The epidermis is also often provided with an additional covering in the shape of deposits of wax or various kinds of hairs.

2. *Vascular Tissue System.*—A typical vascular system is only developed in the higher *Cryptogams* (Ferns and their allies) and the *Phanerogams* (flowering plants), and together these two groups constitute the vascular plants. The vascular bundles or strands consist of strong, tough tissue running longitudinally through stem and root and passing out into the leaves in string-like cords.

It is continuous through all parts of the plant, giving strength and flexibility to the members, and serving for the conduction of nutritive substances. The intricate vascular systems of the leaves can easily be seen in "skeleton" leaves which are either produced artificially by macerating the leaf in water and carefully washing away the softer tissues, or simply by natural decay.

A vascular bundle (Plate 204), as in stems and leaves, may consist of two distinct parts—the xylem or wood and the phloem or bast—or, as in roots, may consist of wood or bast only. The wood consists chiefly of vessels and tracheids, or, as in conifers, of tracheids alone; associated with the tracheal tissue are some parenchymatous cells—the wood parenchyma or soft tissue, and some long, narrow cells with thickened walls—the wood fibres. The bast consists of sieve tubes with parenchyma and fibres.

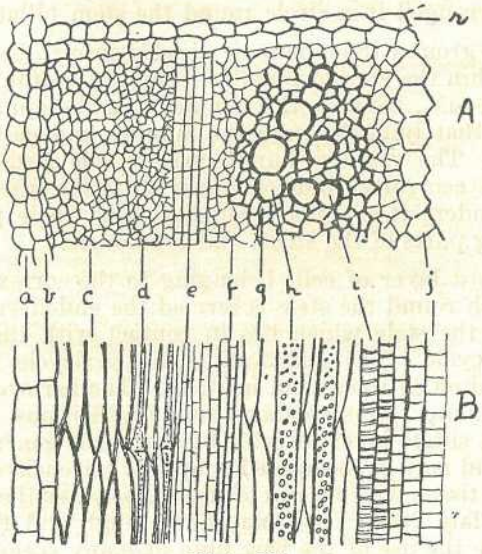


Plate 204.

A.—Transverse and B Longitudinal (Radial) Section through a Typical Vascular Bundle (Diagrammatic).

a, cortex; *b*, endodermis; *c*, pericycle fibres (hard bast); *d*, sieve-tube tissue (soft bast); *e*, cambium; *f*, wood parenchyma; *g*, wood fibres; *h*, pitted vessels; *i*, annular vessels; *j*, pith; *r*, medullary ray; *c-d*, constitute the phlœm or bast, and *f-j*, the wood or xylem.

Origin and Development of the Vascular Bundles.—The vascular bundles and the various other forms of permanent tissue described do not, of course, suddenly arise in their perfected state, but are formed by the gradual alteration of some of the cells of the young tissue. At some little distance behind the growing point certain groups of cells become elongated, forming strands known as the procambial strands; these are really the young or rudimentary bundles which, further back in the older plants, can be seen in their fully developed form.

3. *Fundamental or Ground Tissue System.*—All tissue which does not belong either to the tegumentary or to the vascular system is classed as the fundamental or ground tissue, and under such a broad heading it is natural that a great variety of cell forms will be found. It comprises the succulent parts of leaves, fruits, young stems, &c., and consists mainly of thin-walled, usually large-celled parenchyma, but may contain also sclerenchyma, collenchyma, lactiferous, and glandular tissue, &c. Intercellular spaces are frequent. Sometimes it is marked off into distinct regions such as the pith and medullary rays of stems, the palisade tissue of leaves, &c., as will be found detailed in the following chapter when dealing with the structure of the different members.

CHAPTER XII.

Anatomy and Development of Plant Members.

A Stem.

A.—(1) STEMS OF DICOTYLEDONS AND GYMNOSPERMS.

Primary Structure.—If a thin transvere section be made of the stem of some herbaceous plant, or of a young stem or branchlet of a tree, and examined under a powerful hand lens or microscope, the vascular bundles will be found arranged in a circle round the stem (Plate 205).

The general ground tissue may be divided into three definite regions —that lying within the ring of bundles forming the pith, that lying outside the bundles—i.e., between the bundles and the epidermis—forming the cortex, and that lying between the bundles and called the primary medullary rays. The vascular bundle system, the medullary rays, and the pith form a central cylindrical mass of tissue known as the stele or vascular cylinder; it extends throughout the whole plant from root tips to the young parts of the stems and branchlets.

The innermost layer of cells belonging to the cortex and forming a continuous sheath round the stele is termed the endodermis. The outermost portion of the stele which lies in contact with the endodermis is termed the pericycle. The endodermis and pericycle are much more distinctly marked off in roots than in stems. The pericycle is important, as from it originates all secondary and adventitious roots. It may consist of only a single layer of cells, but in stems generally consists of several layers, and may be composed simply of parenchymatous tissue or parenchymatous tissue with masses of fibres known as the pericycle fibres or hard bast (Plate 204); these may have tough and flexible walls, to which fact is due the use of the bast fibre of many species in the manufacture of ropes and cordage. Bast fibres are well developed in the three closely allied families *Malvaceæ* (Mallows), *Sterculiaceæ*, and *Tiliaceæ*, and in the *Linaceæ* (Flax), *Urticaceæ* (Figs, &c.), *Thymelaeaceæ* (Tie Bushes), and other plants.

Longitudinal Course of the Bundles.—The bundles run parallel to the stem and are continued into the leaves. If a bundle be traced upwards, it is found to pass through one or more internodes, and then to bend outwards and pass into a leaf; at the point where this bending takes place another bundles arises, and it likewise continues through one or more internodes and passes out into a leaf, and so on through the whole length of the stem. The course of a bundle can, perhaps, be more clearly followed downwards—e.g., tracing it out through a leaf it is found to pass down into the stem through one or more internodes, and then to divide into two branches, each of which coalesces with other bundles entering the stem from older leaves further down.

Secondary Growth (Plate 206).—In trees and shrubs a further process sets in, termed secondary growth in thickness. The steady increase in thickness from year to year of the stems and branches is due to the activity of the cambium of the bundles, and when secondary growth is about to begin certain cells in the medullary rays also become meristematic; these lie between the cambium of the bundles and cross from one to the other so that a complete cambium ring is formed in the stem.

From the cambium ring new cells are continually being formed, both on the inside and outside of the ring, those formed on the outside being

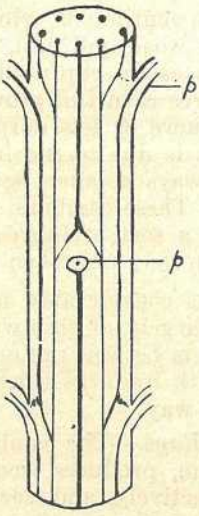


Plate 205.

Diagram to Illustrate Longitudinal Course of Bundles in a Dicotyledon. *p*, base of petiole.

developed into additional bast or phloem elements, and those on the inside into xylem or wood elements, the amount of wood produced being considerably greater than the bast.

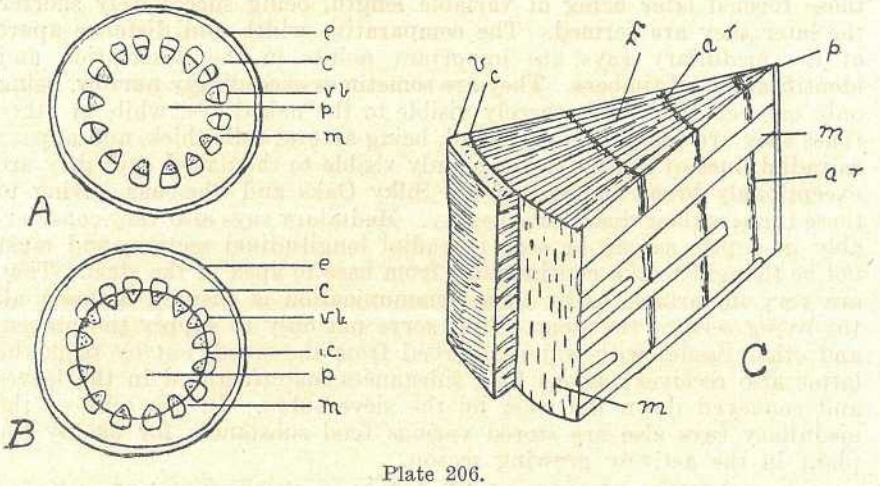


Plate 206.

Diagrams to Illustrate Secondary Thickening of Stems.

A.—Transverse section of a young stem before formation of the interfascicular cambium.

B.—Transverse section of a young stem after formation of the interfascicular cambium.

c. cortex; *e*, epidermis; *i.c.*, interfascicular cambium; *m*, primary medullary ray; *p*, pith; *v.b.*, vascular bundle, consisting of an outer portion, the phloem or bast, a central narrow band of tissue, the cambium, and an inner portion, the xylem or wood.

C.—Portion of a four-year-old stem.

a.r., annual ring; *b*, bark, consisting of the cortical and bast tissues; *c*, cambium; *m*, medullary ray; *p*, pith.

The cambium forms a continuous ring of thin-walled, actively dividing tissue between the wood and bast, and as it consists of living, very thin-walled cells, it is easily ruptured when the bark is stripped from the tree. When the tree is in full growth the bark is more readily detachable than during a more or less dormant period, such as during cold or dry weather. This is due to the fact that during the actively growing season there is always a layer, several cells in width, of still undifferentiated cambium. These cambium cells are rich in protoplasm, and when ruptured act as a sort of lubricant, by means of which the bark is easily stripped off in long unbroken lengths.

The cambium produces considerably more wood than bast; moreover, as the bast consists largely of thin-walled tissue, it soon becomes crushed into very thin sheets betwen the outer dead resistant bark and expending wood, which, with its large thick-walled vessels and lignified tissue, suffers little in this way.

Secondary Medullary Rays.—The cambium between the bundles, as well as the bundle cambium, produces wood and bast elements on the inner and outer sides respectively, and, seeing that this is the case, the primary medullary rays are thus broken up; certain cells, however, instead of producing xylem and phloem, produce totally new, very narrow medullary rays consisting of parenchymatous cells extending radially through both the secondary wood and bast elements. As the stem increases in thickness new medullary rays arise between those already formed.

The secondary rays first formed extend from the pith to the cortex, those formed later being of variable length, being successively shorter the later they are formed. The comparative width and distance apart of the medullary rays are important points in the description and identification of timbers. They are sometimes exceedingly narrow, being only one cell thick and scarcely visible to the naked eye, while at other times they are comparatively broad, being several cells thick, and appear as radial lines of lighter tissue plainly visible to the naked eye; they are exceptionaly broad in most of the Silky Oaks and She-oaks, giving to those timbers their distinctive beauty. Medullary rays also vary considerably in depth, as can be seen in radial longitudinal section, and must not be thought to run continuously from base to apex of the stem. They are very important, as by them communication is ensured between all the living cells of the stem. They serve not only to supply the phloem and other tissues with water absorbed from the wood, but by them the latter also receives various food substances manufactured in the leaves and conveyed down the stem by the sieve tubes. In the cells of the medullary rays also are stored various food substances for use by the plant in the actively growing season.

Annual Rings.—In plants with definite resting and actively growing periods, such as deciduous trees, the wood in cross-section is seen to exhibit a number of more or less easily discernible concentric rings. This is due to the wood formed by the cambium at the beginning of the growing season—usually the spring—being of a softer nature and provided with larger and more numerous vessels than the wood formed at the end of the season—usually the autumn—which is of a denser nature. As naturally follows, the next spring-wood is formed just outside the last layer of autumn-wood, so that the contrast between the two is very marked, producing the so-called annual rings. In the wood of many trees of tropical and sub-tropical countries marked annual rings

are absent, except in the case of deciduous or semi-deciduous species, such as the Red Cedar (*Cedrela*), White Cedar (*Melia*), &c.

In Queensland native trees, both Eucalypts and rain-forest species, annual rings which are fairly distinct may be formed. Experience has shown, however, that they cannot be absolutely relied on to give the age of the tree, though they are approximately correct. Probably in all seasons an annual ring is formed, but in some cases the rings are indistinct and more than one seems to be formed in a season. Climatic changes, particularly periods of rain alternating with long seasons of drought, would be responsible for this.

Heart-wood.—The marked distinction in colour that is sometimes seen between the sap-wood and the heart-wood has already been referred to. The heart-wood generally consists of dead tissues and acts as a fairly strong support for the tree; the cells of the wood parenchyma have lost their living contents, and the vessels no longer act for the conduction of water, and become impregnated with tannin and other substances, to which the dark colour and also largely the durability of the heart-wood are due. In some soft woods there is no marked distinction in appearance between sap-wood and heart-wood, and the latter may contain living tissue.

In many old trees the heart-wood rots away, leaving the lower part of the trunk and sometimes the main branches hollow; but, as, however, the heart-wood consisted only of dead tissue, this does not directly cause the death of the tree, the newer wood and the bast elements acting as conductors of water and food materials. This "pipiness" in the trunk is very marked in Australian hardwood trees, particularly Eucalypts.

Formation of the Bark.—In herbaceous plants the epidermis continues to increase so as to accommodate itself to the increasing development of wood and bast elements within; but in woody plants, as a rule, the epidermis becomes ruptured and falls off after the first year of development, in older plants an epidermis only being found on the young shoots and the leaves.

New protective tissues, however, arise, due to the formation of a secondary meristematic tissue known as the cork-cambium. This is commonly produced just below the epidermis; it may, however, arise in the cortical tissues, as in the Eucalypts, or even in the pericycle, as in some Tea Trees. It divides in the same way as does the ordinary cambium, but, unlike that, does not give rise to wood and bast; instead, the cells produced by it on the outside eventually lose their protoplasmic contents and become converted into cork, while those formed on the inside retain their protoplasm and often contain chlorophyll, and constitute the tissue known as phelloderm. Quite commonly cork cells are alone formed. The cork effectively takes the place of the epidermis as a protecting tissue to the interior parts of the stem, shielding them from mechanical injuries; being almost impermeable to air and water, it further acts as a preventive of excessive exaporation, and, as it is a bad conductor of heat, it protects the delicate inner tissues underlying it from excessive degrees of temperature, whether of heat or cold. When the cork-cambium, instead of being produced just below the epidermis, originates deeper the living cells outside are prevented by the impermeable cork produced from obtaining their necessary supplies of food and water, and in consequence

dry up and die, forming a rough outer layer of dead bark, part of all of which sooner or later is shed in various ways or becomes very much cracked and fissured.

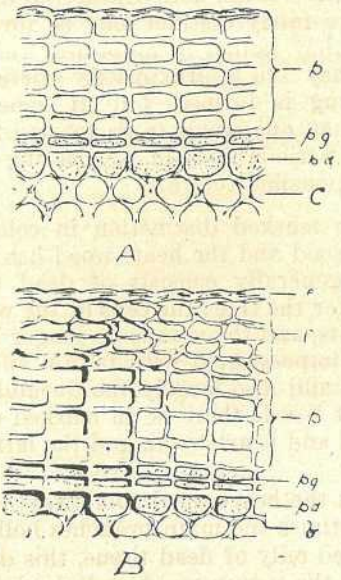


Plate 207.

Diagrams to Illustrate Cork Formation.

A.—Phellogen arising just below the epidermis; and B deeper in the cortical tissues. C.—Cortex (withered in the case of B).

b, bast tissues; *e*, epidermis; *p*, phellem or cork; *pd*, phelloderm; *pg*, phellogen.

In some cases the first-formed cork-cambium persists throughout the life of the tree, new cork cells being formed below as the older ones fall off or die. In most cases, however, the first cork-cambium ceases to be active, and a secondary one is formed deeper in the tissues; this again in its turn ceases to give rise to new cells, and a further one is formed still deeper in the tissues, and so on in this way until a number of successive periderms may be formed. As the successive cambiums are formed deeper and deeper in the cortical tissues, they eventually come to lie very close to the vascular bundles, and in some cases may even arise in the bast itself.

In this again, as where the primary cork-cambium arises in the deeper tissues, the outer living cells are cut off in the same way from supplies of food water, and in consequence die and are added to the outer layers of dead bark.

In trees such as the Plane Trees, Bolly Gum, Crow's Ash, Kauri Pines, &c., where the outer bark is shed in scales, the cork-tissue bordering on the scale consists of thin-walled, brittle cells, which are easily crushed or broken between the expanding trunk and non-growing scale, with the consequence that the scale is shed.

In some cases the bark is shed in tough, thin sheets somewhat the thickness of ordinary paper; this is due to the fact that the thin sheets of bark consist of hardened tissue lying between a few-layered stratum of thin-walled cells, which are easily torn through, the bark then peeling off in papery layers. Sometimes, as in the Paper-barked Tea Trees, the

numerous thin layers are held together and hindered from falling off by numerous strands of bast-fibres which belong to the withered cortical system cut off by the deeply-seated phellogen or cork-cambium.

When the original phellogen persists throughout the life of the tree, or when a phellogen remains active for a number of years, it may produce very thick layers of cork, which reach their maximum in such trees as the Cork Oak (*Quercus Suber*), the various trees known in Australia as Corkwoods (e.g., species of *Erythrina, Duboisia, Alstonia*, &c.). Sometimes the cork is produced in the form of narrow wings, as in the Cork Vine (*Mezoneurum brachycarpum*).

Young trees often have a smooth bark, while older trees of the same species possess rough, fissured, or scaly barks. This is due to the fact that in the young tree the bark is alive and the cells composing it divide and keep pace with the increasing trunk. As the tree gets older the bark is unable to do this, with the result that, unless the outer dead layers are thrown off, it becomes more or less deeply cracked and fissured.

Some trees periodically cast off the older layers of bark and present a new coat of smooth, clean, often glossy bark. Among Australian trees the various smooth-barked gums or eucalypts are familiar examples—e.g., Blue Gum, Grey Gum, Scribbly Gum, &c. Some others have two distinct bark systems, the bark on the basal parts or lower half of the tree remaining persistent, that on the upper part of the barrel and branches being periodically shed in various ways, as in the Moreton Bay Ash, Gum-topped Box, Flooded Gum, Blackbutt, &c. This form of bark system is probably a result of adaptation to local conditions, the lower rough, persistent bark being a bad conductor of heat, acting as a protecting cover to the delicate inner tissues of the tree when the ground in which they live is more or less regularly swept by bush fires.

Lenticels.—Scattered over the branchlets, and even the stems in some cases, may often be seen pale-coloured spots, usually of an oval shape and well differentiated from the rest of the bark: these are termed lenticels, and are much more abundantly produced in some species than in others, their relative abundance being usually referred to in descriptions. They may be seen well developed in the Red Cedar, the White Cedar, &c. Sometimes in branches with a whitish or pale-coloured bark they may be differentiated as darker spots than the surrounding bark, as may be seen on young shoots of Cudgerie (*Flindersia Schottiana*), Tulip-wood (*Harpullia pendula*), &c. At these points the cork-cambium, instead of producing cells packed closely together in the usual manner produces cells arranged in loose, granular, powdery masses. These allow the necessary interchanges of gases between the outer air and the intercellular spaces in the interior of the stem and branches.

Healing of Wounds.—Injuries made into the soft parts of plants such as herbaceous stems, leaves, and fruits, usually become covered over by a greyish-brown corky tissue developed by the outermost layer of cells which remains uninjured.

In woody stems which have been injured, cork is not immediately formed, but the cambium and the very young cells of the wood and bast bordering on the wound become active and give rise to a cushion of thin-walled cells termed a callus. In the outer layers of the cells of the callus a cork-cambium or phellogen is developed, while the layers of cells continuous with the old cambium like it give rise to wood on the inside and bast on the outside. The tissue thus formed is usually spoken of as

wound-tissue, and, owing to the abnormal conditions under which it is formed, it often differs considerably from the normal tissues. This wound-tissue continues to grow rapidly until the wound may be eventually completely covered over. The wounded area now becomes covered over by new layers of growth in the ordinary way until no external sign of its existence is visible.

The wood cells exposed by the wound die and turn a dark colour, and no close union or growing together is possible between them and the new wood formed by the cambium of the callus, so that a distinct line of demarcation between the tissues always exists. Thus it is that old marks made on growing trees, such as surveyor's marks, &c., can be traced quite plainly in the wood, though they may have been covered over by many annual layers of new wood and no external sign of their presence is visible.

When branches are cut off above one or more living buds, the buds, by sending out leafy shoots, may keep the branch alive until a callus has been formed and the deal cells at the end covered over by a wound-tissue.

If, on the other hand, the cut stump carries no buds, the tissues shrivel up and die, and a ring of callus is formed at the base of the stump, but as the new tissue formed by it has to push its way up under the old dead cortical tissues adhering to the stump, healing is slow and decay may set in before the wound becomes covered; hence the necessity, in pruning and cutting off branchs, to cut them as close to the parent stem as possible, so that the callus tissue may meet with no obstacle in growing over the wounded area. Clean-cut wounds heal much more quickly than rough, jagged ones, and it is hence advisable, when large branches are cut off with a saw, to trim the exposed cambium edges with a sharp knife or chisel. It is also a good plan to assist nature in preventing the decay of the dead wood by painting the exposed surface over with Stockholm tar or other antiseptic dressing.

A.—(2) Stems of Monocotyledons.

General Structure.—In a transverse section of a typical monocotyledonous stem, such as that of a palm, the vascular bundles, instead of being arranged in a ring, are found to be irregularly scattered through the general ground tissue. (Plate 208.) Usually the cortex is very narrow, a marked pith is rarely present, and, owing to the scattered nature of the bundles, medullary rays are absent. There is a gradual transition, however, from the dicotyledonous to the monocotyledonous type, and in some cases, as in many grasses or sedges where there is a large central hollow or pith, the bundles may be confined to a narrow outer ring of ground tissue, and in some cases may even be arranged in a single ring round a central pith.

The wood usually lies in the form of a V, the annular and spiral vessels lying at the apex of the V, and one or more larger pitted vessels lying on either arm, the whole accompanied by more or less wood parenchyma. The phloem tissue consists of sieve tubes and companion cells, and lies more or less between but a little above the large pitted vessels.

As previously stated, the bundles are closed—i.e., they contain no meristematic tissue or cambium, and hence secondary growth in thickness does not occur, no further change taking place after the complete development of the primary vascular cylinder. On this account the stem may

be not only of much the same thickness throughout, but the upper part may be larger than the lower, as may be seen in many large grasses, such as Maize, Sugar-cane, &c. This is due to the fact that such stems soon reach their maximum development in thickness at the base, and the portions formed later may receive more food and attain a greater thickness. This style of growth produces a rather unstable structure, but one firmly anchored in the soil by oblique roots, which often, as in the Maize, Screw Pine (*Pandanus*), &c., take the form of props or stilts. In many large Palms the base of the stem is often more or less expanded; this is due to distention of the ground tissue.

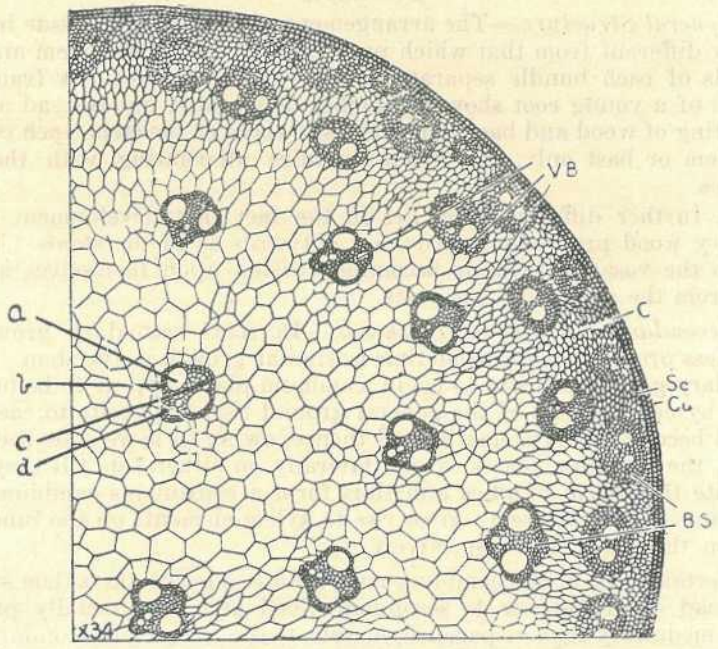


Plate 208.

Transverse section through stem of Johnson Grass (*Sorghum halepense*). Much enlarged.

B.S., bundle sheath; *C.*, ground parenchyma; *Cu.*, cuticle; *Sc.*, strengthening zone of sclerenchyma; *V.B.*, vascular bundle.

Lettering on left for the parts of a single vascular bundle: *a*, pitted vessel of xylem; *b*, sheath of sclerenchymatous fibres (bundle sheath); *c*, phlœm; *d*, spiral and annular vessels (protoxylem); lying between the bundles is a certain amount of xylem parenchyma.

[After Breakwell in "Agricultural Gazette of New South Wales."]

Special Strengthening Tissue.—Though no true bark is formed by most Monocotyledons, just below the epidermis the ground tissue is strengthened; the individual bundles are also usually surrounded by a sheath of hard tissue or sclerenchyma which considerably strengthens the stem. When especially well developed, as in Palms, these hardened masses show up on transverse section as a number of small, hard, black areas, and give to their wood the distinctive strength and beauty that make them in demand for walking-sticks, &c. To the same tissue is also due the strength of such well-known fibres as Sisal Hemp, New Zealand Flax, and Manila Hemp—all obtained from monocotyledonous plants.

Longitudinal Course of the Bundles.—In the Monocotyledons the bundles do not run parallel to the surface of the stem. From the base of the leaves a number of bundles can usually be traced into the stem, first passing obliquely towards the centre, and then curving outwards again towards the surface, passing through one or more internodes and eventually coalescing with older bundles in the lower part of the stem. As the numerous vascular bundles or leaf traces penetrate the stem to varying depths, transverse sections show the scattered arrangement characteristic of the Monocotyledons.

B.—ROOTS.

General Structure.—The arrangement of the vascular tissue in roots is very different from that which prevails in stems. The xylem and bast strands of each bundle separate as they enter the root. A transverse section of a young root shows a number of bundles, but instead of each consisting of wood and bast elements, as in those of the stem, each consists of xylem or bast only, the xylem bundles alternating with the bast bundles.

A further differentiation lies in the fact that development of the primary wood proceeds inwards, not outwards as in the stems. This is due to the vascular strands becoming twisted upon themselves as they pass from the stems into the roots.

Secondary Growth in Thickness.—In roots secondary growth in thickness proceeds at the same time as similar growth in the stem. When secondary growth is about to begin, cambium plates appear to be brought about by certain cells of the general ground tissue opposite to each bast strand becoming meristematic, and thence, owing to more cells becoming active, the cambium plates extend laterally on either side till they meet opposite the xylem bundles and thus form a continuous cambium ring. This ring—as in the stem—gives rise to xylem elements on the inner and bast on the outer side respectively.

Certain cells of the cambium ring—those opposite the xylem strands—instead of giving rise to secondary wood and bast, usually produce broad medullary rays of parenchymatous tissue. Smaller secondary rays are also formed. The wood in old roots is, as a rule, more porous than that formed in stems, but otherwise root-wood and stem-wood resemble each other very closely.

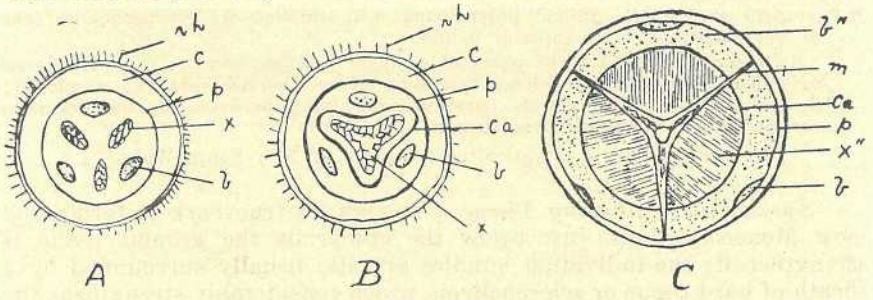


Plate 209.

DIAGRAM TO ILLUSTRATE SECONDARY THICKENING IN ROOTS.

A.—Transverse section of a very young root.

B.—The same when cambium has formed a continuous band.

C.—After secondary thickening has been in progress some time.

b, primary bast; b^{II}, secondary bast; *c*, primary cortex; *ca*, cambium; *m*, primary medullary ray; *p*, pericycle; *r.h*, root-hairs; *x*, primary xylem; x^{II}, secondary xylem.

Growing Point.—In the stem the tender growing point is protected by rudimentary leaves; roots, of course, produce no leaves, but the growing point as it pushes downwards through the earth is protected by a mass of tissue known as the root-cap.

The outermost cells of the root-cap are continuously dying away, but as quickly as they do so other cells are added by actively dividing meristematic tissue in the lower part of the cap. A little distance behind the growing point are found the root-hairs; as previously explained, these are elongations of some of the epidermal cells, and they adhere very closely to the particles of the soil, absorbing water and food substances held in solution in it. As a rule, they live for a very short time, being quite absent from the older parts of the root, but as new hairs are continuously being formed behind the growing point as the root grows downwards, a large absorbing surface is always maintained.

C.—Leaves.

The leaf is composed of general ground tissue traversed by vascular bundles, and the whole is covered by an epidermis, all of which are continuous with the corresponding tissues in the stem. The vascular bundles pass into the leaves from the stem without twisting, so that we find the xylem lying towards the upper and the bast towards the lower face of the leaf respectively. On entering the leaf, the vascular bundles, instead of running along definite lines as in roots and stems, branch and rebranch in various ways, traversing the general ground tissue as veins; as they pass into the smaller veins or veinlets, however, they lose all the xylem and bast elements of a typical bundle with the exception of one or two small spiral vessels or tracheids. The bast elements also undergo reduction as the end of the bundle is approached, the sieve tubes and companion cells being replaced by single long cells which extend as far as the xylem elements.

The bundles are closed, there being no need, in members of such limited growth as leaves, for a cambium actively producing wood and bast.

Epidermis.—The epidermis, with few exceptions, consists of a single layer of cells which fit closely together without any intercellular spaces, except that here and there special openings occur. These are the stomata (Plate 210), and if the epidermis be removed and examined

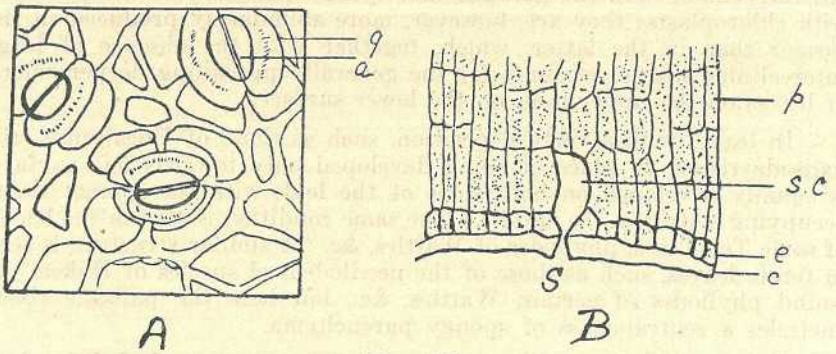


Plate 210.

Stomata on Leaves of Eucalyptus.

A.—Surface view. B.—In longitudinal section.

a, aperture; *c*, cuticle; *e*, epidermis; *g*, guard cells; *p*, palisade parenchyma; *s.* stoma; *s.c.*, substomatal cavity.

[Adapted from illustrations in F. V. Mueller's "Eucalyptographia."]

under the microscope each stoma will be seen to consist of two sausage-shaped cells—termed guard-cells—lying lengthwise alongside one another, with a narrow slit or small opening—the aperture—between them.

The guard-cells can alter their form so as to increase or decrease the size of the opening, closure of the aperture acting as a means of preventing excessive evaporation; thus the stomata play a most important part in regulating the amount of water-vapour given off by the plant, and naturally indirectly, if not directly, act in response to varying conditions of the atmosphere. They also act as a means of communication between the internal tissues and the external air, each opening into a substomatal cavity or air-chamber which is in communication with the intercellular spaces in the ground tissue.

The stomata, though they may occur on the softer parts of stems, are, practically speaking, confined to the leaves and principally to the under surface, the upper surface of the leaf in most plants possessing none or very few stomata. In leaves placed vertically, however, as in many Australian trees—e.g., adult leaves of Eucalyptus, phyllodes of Wattles, &c.—the stomata are equally distributed on both surfaces.

In the leaves of plants which naturally grow in dry country, the stomata—evidently with the object of conserving the water moisture within the plant—are protected in various ways. This may be effected either by the natural clothing of the plant, by being sunken in little cavities or crypts, as in some Honeysuckles (*Banksia*), or they may be protected by the rolling back of the edge of the leaf, leaving only the midrib exposed on the under surface, as in the Wedding Bush (*Ricinocarpus*), &c.

Ground Tissue.—The general ground tissue of the leaf is termed the mesophyll, and in the ordinary type of leaf is usually marked off into two distinct regions—(*a*) the palisade tissue in the upper part, and (*b*) the spongy tissue in the lower.

The palisade tissue is composed of one or more layers of elongated, somewhat columnar cells lying closely packed together, with none or few intercellular spaces between them; the spongy tissue, on the other hand, is composed of loosely-packed cells of very irregular form, and with numerous comparatively large intercellular spaces between them. All the cells of both the palisade and spongy parenchyma are provided with chloroplasts; they are, however, more abundantly produced in the former than in the latter, which, together with the absence of large intercellular spaces, accounts for the generally prevailing deeper colour of leaves on the upper than on the lower surface.

In leaves with a vertical position, such as those of Eucalyptus, the palisade tissue, in place of being developed only towards one surface, is equally developed on both sides of the leaf, with the spongy tissue occupying a strip in the middle. The same condition is seen in the leaves of some Tea Trees, phyllodes of Wattles, &c. A similar structure is seen in terete leaves, such as those of the needle-leaved species of Hakea, the round phyllodes of certain Wattles, &c., but here the palisade tissue encircles a central mass of spongy parenchyma.

Leaves of Conifers.—The leaves of Conifers show marked differences in structure from those of other trees (Angiosperms). The leaf of any common pine (*Pinus*) may be taken as a type, and, though other genera show considerable diversity from this, the same general characters are

more or less retained through the whole family. The epidermis consists of a single layer of thick-walled cells interrupted here and there by the stomata; the guard-cells are sunk slightly below the level of the epidermal ones and open into a cavity. Immediately below the epidermis is the hypodermis, consisting of a layer or layers of strong cells particularly well developed at the corners of the leaf and interrupted at the stomata. The general ground tissue is not differentiated into palisade and spongy parenchyma, and the cells, which are rich in chloroplasts, as in the leaves of other plants are packed closely together without large air spaces. Situated in the mesophyll are a number of resin-passages. Situated approximately in the centre of the leaf are two vascular bundles embedded in a mass of parenchymatous tissue containing no chlorophyll; this is the many-layered pericycle, and the whole is surrounded by a more or less conspicuous endodermis, or bundle-sheath.

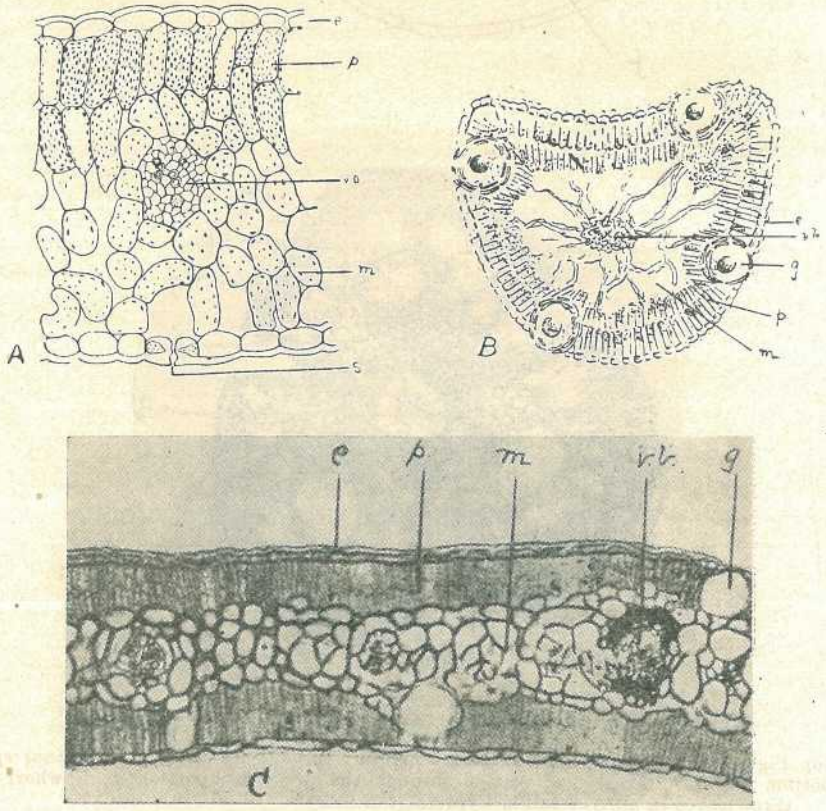


Plate 211.

Leaves in Transverse Section.

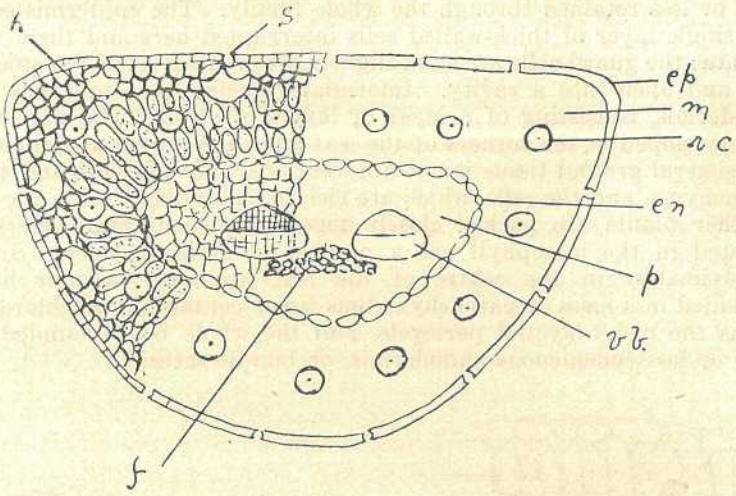
A.—Ordinary bifacial or broad-leaved type (after Smith and Smith in Bulletin No. 218, College of Agriculture, University of California, U.S.A.).

B.—*Darwinia fascicularis*, round or centric type.

C.—*Melaleuca genistifolia*, isobilateral type. (*B.* and *C.* after Baker and Smith in the "Journal and Proceedings of the Royal Society of New South Wales.")

e, epidermis; *g*, oil-glands; *m*, mesophyll or spongy tissue; *p*, palisade cells; *s*, stoma; *v.b.*, vascular bundle.

[All figures enlarged to a considerable extent]



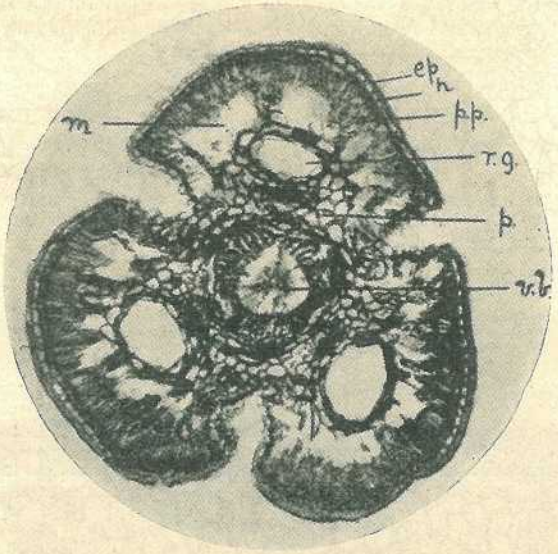


Plate 212.

Leaves of Conifers.

Top Figure: Transverse section (diagrammatic) through leaf of a Pine (*Pinus sp.*)
Bottom Figure: Transverse section through the decurrent portion of a whorl of three leaves in an Australian Cypress (*Callitris*).

en, endodermis; *ep*, epidermis; *f*, pericycle fibres; *h*, hypodermis; *m*, mesophyll; *p*, pericycle; *r.c.*, resin canal; *s*, stoma; *v.b.*, vascular bundle.

[Both figures enlarged to a considerable extent. Bottom figure after Baker and Smith.]

As previously stated, other Conifers show considerable diversity from this type. The anatomy of the Australian Conifers has been closely investigated and described by Messrs. Baker and Smith, who give detailed accounts of the different genera in their work—"A Research on the Pines of Australia" (Sydney, 1910).

In *Callitris* (Australian Cypress Pines), the commonest and most widely spread genus, these authors have shown that the leaves—which occur in whorls of three—are for the greater part of their length decurrent on the branchlets; the stomata are confined to the ventral surfaces, being found in the grooves formed by the decurrent leaves, the epidermis consists of one or rarely more rows of epidermal cells, and immediately below the epidermis is a one or two layered hypodermis. The cuticle changes in character on different parts, on the back or outer edge of the leaf it being of the ordinary type, but on the vertical surfaces—i.e., where the stomata are situated—it becomes broken or changes into little papillose projections, whose function is probably to act as secondary guard-cells to the stomata. The mesophyll is differentiated into palisade and spongy parenchyma, and in the centre of the latter occurs in each leaf one usually large oil-cavity. The leaves themselves contain no vascular bundles, but in the centre of the branchlet on which they are decurrent are three wedge-shaped bundles surrounded by an endodermis and accompanied by more or less transfusion tissue.

Fall of Leaves.—When leaves are about to be shed, a layer of cork is formed at the base of the leaf-stalk and continuous with the periderm of the stem. The fall of the leaf is due to a layer of cells situated at the base of the leaf-stalk and immediately above the recently formed cork-layer becoming disorganised owing to the stoppage by the cork-layer of supplies of moisture from the stem. When the leaf falls, the cork layer that was formed protects the internal parts of the stem from injury, and, further, the cavities of the sieve tubes and vessels may become sealed with gum or cork.

On the scar left on the branch by the fall of the leaf may be seen the closed ends of the vascular bundles which originally ran from the stem to the leaf. The shape of the scar and the distribution of the bundles vary with the different species, and the leaf scars on a twig are often useful guides in helping to determine the species to which the twig belongs.

D.—Development of Secondary Members.

Young shoots first make their appearance on the growing points as minute humps, due to the growth and division of actively dividing cells. As these grow, the young epidermis increases in area, but as its cells divide in one direction only—viz., at right angles to the surface—it does not increase in thickness.

Young secondary roots do not arise in the superficial tissues, but originate in the fundamental tissue of the parent root.

When a young root is about to be formed, certain cells become meristematic and a growing point is produced. The young root has to bore its way through the tissues lying between it and the exterior of the parent root; this is accomplished, not by purely mechanical means, but by chemical action. Certain cells of the epidermis and sometimes one or two layers of the cortex form a sort of cap over the growing point; the cap so formed is known as the digestive sac, because its cells secrete a ferment which breaks down or digests the walls of the overlying cells so that the young root is able to reach the surface.

[to be continued.]

Some Peculiar Feeding Habits of Stock and What They Indicate.

W. R. WINKS, B.Sc., A.A.C.I., Analyst, Agricultural Chemist's Laboratory.*

IN order to study peculiar feeding habits of stock, it is necessary to have some idea of what has been going on in our pastures since man first introduced sheep and cattle into areas previously supporting only native animals.

The original pastures grew, died, and decayed, and on decaying returned to the soil the mineral matter taken from it during their period of growth. Along with the mineral matter, which is derived entirely from the soil, nitrogenous matter derived partly from the soil and partly from the air also found its way back to the soil to supply later pastures with their necessary food. The virgin grass lands thus became increasingly fertile, as practically nothing was being removed from them, and extra nitrogen from the air was being added to them. Long years of grazing have brought about many changes. Instead of the vegetation decaying and being returned to the soil, it is consumed by the stock, the non-digestible portion being returned with the excreta, but much of the mineral matter goes to form the skeleton of the animal and the other organic matter to build the body.

It may be explained here that the ash of the grass consists of the mineral matter, while that portion which burns away is the organic portion. When the animal is sold the elements derived from the soil are removed with it, and no corresponding replacement takes place. With the death of the animal the nitrogenous matter is quickly returned to the soil, but the mineral of the bones only becomes available over a fairly long period.

Add to these factors the cutting up of the ground surface by the hooves of the stock and the consequent surface erosion, and it will be evident that our soils are gradually being depleted of their available mineral plant food, and this depletion must be reflected in the pastures themselves.

We now find the animals which depend on these depleted pastures for their existence eating substances altogether foreign to their natural diet, and it is these peculiar feeding habits that form the subject of this article.

The first peculiarity that we will notice is the bone-chewing habit.

This habit is quite common on many of our Australian stations and dairy farms, but for a long time did not cause any serious concern to the stockowner, although it seems to have been early recognised that it indicated some deficiency in the natural pastures. It does not seem to have been recognised until recently in Queensland that bone-chewing, or rather its causes, could have anything to do with the unthrifty condition of stock.

Bones consist for the most part of calcium phosphate or, popularly "phosphate of lime," and bone chewing would naturally lead one to suspect that a deficiency of either lime or phosphorus in the pastures is indicated. Phosphorus is an element which is not very abundant in most of our Queensland soils, and the factors indicated in the opening paragraphs of this paper would tend to bring about an actual deficiency

* In a broadcast talk from Radio Station 4QG, Brisbane, through the courtesy of the Australian Broadcasting Commission.

of this element after years of grazing and removal of stock, even where phosphorus deficiency did not originally exist.

By chewing bones the animal attempts to obtain that supply of phosphatic material so necessary for the building of the skeleton, and if the bones have been thoroughly weathered some benefits may even result from the habit, but if the bones are not cleaned by the weather, but have scraps of decayed flesh adhering, sickness and death may result.

A disease known in South Africa as Lamsiekte, which results from the chewing of bones with adhering carcase debris, was the cause of serious stock losses until Sir Arnold Theiler in 1920 demonstrated that the disease was indirectly caused by phosphorus deficiency, and the feeding of phosphatic licks was found, not only a preventive of the disease, but also resulted, to quote Sir Arnold Theiler, in "Increase of milk yield of cows, better calves at birth, more rapid growth of young stock, and superior fattening of adult cattle."

"Indeed, by focusing attention upon specific nutritional deficiencies of South African veld, the disease (Lamsiekte) can almost be said to be a 'blessing in disguise.'"

The habit of bone chewing thus indicates phosphorus deficiency, and it can be cured by feeding phosphatic licks.

That phosphate feeding is a payable proposition can best be indicated by quoting again from Sir Arnold Theiler in "Phosphorus in the Live Stock Industry," when he concludes: "In all areas where the soil and pastures are known to be deficient in phosphorus, it is profitable to feed bone-meal to practically all stock for the sake of improving condition and facilitating rapid growth. For cattle it is particularly advisable since two important diseases, lamsiekte and styfsiekte, can be prevented by liberal bone-meal feeding. When insurance against disease, increased beef production, increased milk yield, and more rapid growth of young cattle are all taken into consideration, it will be found that any expenditure on bone-meal is repaid many times over."

The next peculiar habit to claim our attention is that of flesh or carrion eating.

This habit has been mentioned as incidental to the bone chewing habit, when adhering carcase debris was found to be eaten along with the bones. In the "Journal of the Council of Scientific and Industrial Research, 1933," we find the statement that, "Botulism, i.e., 'Ptomaine Poisoning' in sheep is now being regarded as being a source of greater economic loss than all other diseases affecting sheep in Western Australia. It is due to the ingestion of toxic rabbit carrion." Later we have in the same journal the statement by Mr. D. Murnane that "both cattle and sheep have been observed to eat raw flesh," and also that "in parts of South Australia cows have been seen eating unskinned rabbits in traps, and sheep eating dead sheep and 'goannas.'"

The habit of carrion-chewing leads to loss from what is popularly known as "ptomaine poisoning," and, if only for this reason, an endeavour should be made to overcome the depravity.

It has been proved that any long-continued deficiency can cause almost any peculiar habit, but an investigation of the cause of carrion eating by Mr. Murnane led to the conclusion that "sheep kept on a diet low in protein will eventually resort to flesh eating to correct the

deficiency," and that "the return to a ration containing an adequate supply of protein soon overcame the depravity."

Flesh or carrion eating has not been reported as a serious disorder in Queensland, but what resembles this depravity occurs in the Maranoa district. This is what is known in the district as caterpillar eating, but is really the eating of the larvae of the sawfly. The sawfly larvae feed on the leaves of the silver-leaf ironbarks, and come to the earth to pupate. In times when the larvæ are plentiful the trees are stripped of their leaves, and the starving larvæ fall to the ground and perish. They are eaten both in the live and dead state by cattle, and cause death in less than twenty-four hours.

The cause of this habit is being investigated, but there are many apparently contradictory aspects of the problem which render a positive diagnosis of the cause, at the present time, a matter of difficulty.

There are indications, however, that this habit may be due to phosphorus or protein deficiency, and if so the use of phosphatic licks and a protein concentrate such as linseed, or cottonseed meal, should help to overcome the trouble. This could be tried with advantage during the outbreak that is threatening at the present time.

The dirt-eating habit is the next to come before us in this paper, and this habit is probably more prevalent amongst stock than is generally recognised.

Dirt or soil is a very complex mineral substance, and may contain practically all the known elements, so that the lack of any element may be responsible for this habit.

When the fact that animals did eat dirt was first recognised, it was generally thought that salt was the substance lacking. This was probably due to the fact that salt is often present in sandstones licked by stock, but in parts of Queensland stock have been observed to leave salt troughs and eat mud from creek banks, indicating that in some cases at least salt is not the mineral that is deficient. In this same district the ashes of burnt logs are eaten with evident relish.

The dirt-eating habit may, however, be the result of phosphorus deficiency, or of a deficiency of iron, lime, or other mineral matter.

The foregoing will serve to show that peculiar feeding habits of stock generally indicate a deficiency in their feed, which may lead to actual death or at least retard the growth of the animal.

STAGGER WEED AND MINT WEED.

At the present time stagger weed is beginning to evidence itself as a weed of cultivation in southern Queensland, and every winter and spring large numbers of specimens are received from farmers who are under the impression it may be the mint weed that has been proved by feeding tests to be poisonous to stock, and in consequence areas of winter feed badly infested with this weed are often withheld from feeding off.

Though frequently called mint weed, and wild mint as well as stagger weed, it can be distinguished from the poisonous variety in being of a more or less yellow-green rather than sage-green colour, and having short, round, not narrow leaves.

Stagger weed is only harmful when fed to working horses or travelling stock, animals having to be excited in some way before any effects are noted. As indicated by the local name the symptoms of disorder are a marked twitching, shivering, and staggering. Ordinarily resting stock, such as dairy cows and calves, are unaffected by the weed.

Dairy Winter Fodder Trials, Mackay District.

Mr. C. S. Clydesdale, Senior Instructor in Agriculture, reports (21*st August*, 1936):—

THE experiments were established with the view of demonstrating to the dairy farmers throughout the Mackay district that the growing of these crops during the winter months can be carried out successfully, thereby supplementing pastures to tide their dairy herds over the leaner periods of the year.

At this season of the year feeding becomes necessary, due to the fact that the natural pastures become dry and of little value to cows in full profit.

Again, values for cream usually rise, and to receive the full benefit of these high prices it is necessary that some class of succulent feed be supplemented to gain the full advantage of this increase. Further, if this practice is followed, the cows will be kept in good condition during the cold months, and it may be expected normally that an increase in supplies will be forthcoming immediately when fresh growth is made by the natural grasses.

Under ordinary conditions, where no provision is made for winter feeding, the cows become low and weak, and some months elapse before they are back to normal.

The experiments conducted were designed to ascertain the most suitable crops or crop mixtures for the district, and to demonstrate that the methods, as practised, were within the reach of all dairy farmers.

The plots were arranged for on the property of Mr. E. S. Abell, Blue Mountain. The land selected was forest, and is a deep alluvial type of light-brown loam, which has been under crop for the last two years. As there is no official rain-gauge in this district, the nearest station, Sarina, is quoted. The approximate distance being twenty miles, some variation in the precipitations may be expected, due to the fact that Blue Mountain is approximately 1,000 feet above Sarina.

RAINFALL, SARINA.

Month.	Points.	Wet Days.
January	986	19
February	3,870	21
March	2,904	19
April	53	5
May	183	9
June	833	12
July	58	8

The heavy falls experienced during February and March, amounting to 67·74 points, caused considerable damage and delay in getting the land prepared for the experiment.

It was originally intended to plant out the plot during the latter end of March or early in April, but this work was not carried out until the first week in May, which, under the circumstances, was rather late to expect early supplies of winter feed.

The area comprising 2 acres with eight plots each ¼ acre was planted with the following varieties, viz.:—Florence wheat, skinless barley, belah oats, and canary seed, while in the remaining plots these cereals were planted with a mixture of Dun field peas.

The weight of the seed planted, in the order named above, was 45 lb., 40 lb., 40 lb., and 10 lb. per acre, while the four mixture plots contained the following weights per acre:—Florence wheat 30 lb., peas 20 lb.; skinless barley 30 lb., peas 20 lb.; belah oats 30 lb., peas 20 lb.; canary seed 7 lb., peas 20 lb. The total cost of the seed for the eight ¼-acre plots aggregating 2 acres was 11s. 9d., the seed for the four straight plots costing 5s. 2d., and that for the four mixture areas 6s. 7d., excluding freight from Brisbane.

Plate 213.

Crop of Florence wheat. Planted 7th May, 1936. Photographed 28th July, 1936. Green weight 13 tons 10 cwt. per acre.

Cultivation.—The land was prepared as soon as conditions became favourable for the work. Ploughed early in April with the single disc plough, and harrowed; towards the end of April cross-ploughed and harrowed, and prior to planting was reduced to a fine tilth by means of a spring tooth cultivator harrow and roller.

In the sowing of the seed the usual practice of broadcasting was followed, as no seed drill was available. When used in mixtures the pea was sown first and a spring tooth used so as to give a good covering, and the cereals then sown, harrowed, and rolled. This practice gave a good covering and compacted the soil, which resulted in a good germination.

All varieties made a quick, flush growth, and, with the exception of skinless barley, were particularly free from rust.

From the period of planting, viz., 7th May until the time when weights were taken on the 10th August—fourteen weeks—the wheat

Plate 214.

Crop of Belah oats and Dun field peas. Planted 7th May. Photographed 28th July, 1936. Green weight 16 tons 5 cwt. per acre.

Plate 215.

Crop of Belah oats and Dun field peas. Planted 7th May. Photographed 28th July, 1936. Green weight 16 tons 5 cwt. per acre.

proved to be the most advanced. It had attained a height of 5 feet, was perfectly healthy, and full of body in the foliage. It had just reached the stage when the grain was beginning the form in the glume, and within a week or two would reach its zenith as a green feed.

Remarkable growth was shown also by the plots containing oats alone and oats with peas, the last named giving a return of the highest tonnage on the acreage basis.

A description of the plots is as follows:—

Florence Wheat.—This crop made a very flush growth and attained a height of 5 feet, and was free from all traces of rust; the flag was broad and when inspected was just coming into flower.

Plate 216.

Canary seed and Dun field peas. Planted 7th May, 1936. Photographed 28th July, 1936. Green weight 11 tons 5 cwt. per acre.

Wheat and Peas.—This crop presented a wonderful appearance, as the peas grew to the full height of the wheat and were out in flower, indicating that this mixture would be a more balanced ration than the wheat sown alone.

Belah Oats.—This variety made rather quick growth, and when inspected was 4 feet in height, and only an odd plant appeared in the shot-blade stage. Dark green in colour, broad flag, rather fine in the stem, and exceptionally free from rust.

Oats and Peas.—Again the peas made a flush growth, and were noticeable throughout the whole area in flower.

Skinless Barley.—During the early stage rust appeared and the growth was stunted, with the result that from a feeding point of view this crop was of little value. When inspected it was only 18 inches high and commencing to die back.

Canary Seed.—This was much slower in growth than the other varieties, and when inspected was about 1 foot high. The stooling was very good, flag broad, and the stem inclined to be large but not coarse.

Canary Seed and Peas.—The peas were much quicker in growth, and practically had possession of the area. Showed good feeding qualities.

In calculating the weights, two portions each one square yard were taken from an average of the plot, and all vegetation on each area cut at mowing level and weighed. The average of these two weights were taken as a basis of the weights to the acre.

	Tons	cwt.
Florence wheat	13	10
Florence wheat and peas	13	0
Skinless barley	6	10
Skinless barley and peas	8	10
Belah oats	14	10
Belah oats and peas	16	5
Canary seed	11	0
Canary seed and peas	11	5

On 10th August a field day was arranged, and quite a number of farmers attended.

A GOOD LITTER OF PIGS.

The litter record shown here was checked officially at Mr. W. T. Tatnell's farm, Gympie, and is considered very satisfactory.

This was the first litter of the sow "Glenroy Viola"; ten pigs were born and nine reared to eight weeks old, one pig being accidentally killed when two weeks old.

LITTER RECORD.

Owner.—W. T. Tatnell, Greenbank Stud, Cedar Pocket, Gympie.

Dam of Litter.—Tamworth, Glenroy Viola.

Sire of Litter.—Tamworth, Wattledale Clinker.

Litter Born on.—10th June, 1936.

Tattoos .. / Sexes ..	1 B	2 B	3 B	4 B	5 B	1 S	2 S	3 S	4 S	5 S	Total.	Average.
Weight at— Birth ..	Lb. 3	Lb. 2	Lb. 3	Lb. 2	Lb. 2	Lb. 2½	Lb. 2½	Lb. 3½	Lb. 2½	Lb. 2½	Lb. 25½	Lb. 2·5
1 week ..	5	5	5	4½	3½	4½	4½	4½	4½	4	45	4·5
2 weeks..	7½	7	7	6½	6	7	7½	6½	7	5	67	6·7
3 weeks..	11	9½	10	9½	8	8½	10½		9	7½	83½	9·2
4 weeks..	13½	13	13½	13½	11½	12	14		12	10	113	12·5
5 weeks..	19	18	20	18	16½	17	19½	Accidently Killed.	18	16½	162½	18·0
6 weeks..	26	24½	25	25	23	23	28½		22½	19	216½	24·0
7 weeks..	31	25½	28	28	27	24½	31		28	24	247	27·4
8 weeks..	42	33	35	35	36	33	39		31	29	313	34·7

PIGS FOR PORK AND PIGS FOR BACON.

L. A. DOWNEY, H.D.A., Instructor in Pig Raising.*

THE question most frequently asked by pig breeders is "What is the best breed of pig to use?" and one might as well ask "What is the best make of motor truck to use?" for the answer depends on circumstances, including the purpose for which the pig or the motor truck is required; a two-ton tip truck is not suitable for light parcel delivery in the city, nor is a Large White pig suitable for a 60-lb. porker.

Having decided on the purpose for which his pigs are to be grown, it is possible for the breeder to select a breed or cross to suit his needs, but in Australia we are faced with a vast problem which must be attacked in a broadminded manner. Pig production in Australia has increased to such an extent in recent years that we have an exportable surplus over local requirements, and most of that surplus is being sold in Great Britain, and as we consider there is still room for expansion of our pig industry, we hope to sell more pork on the English markets, which are the most important importing markets in the world for pig products. Competition is keen on the markets of Great Britain, and so Australia is keen to export the highest quality pork.

Whilst there is a demand in England for pork and bacon pig carcasses weighing from 50 lb. to 200 lb., the greatest demand is for pigs weighing 60 to 80 lb. for pork and those weighing 130 to 160 lb. for bacon. In Australia, bacon factories prefer pigs for our local trade weighing 100 to 120 lb. dressed. Thus there are three optimum weight ranges for pig carcasses. Although weight is the primary consideration in the sale of pig carcasses, conformation and condition, which is influenced largely by the amount of fat the carcass carries, are very important considerations. For the light pork, light bacon, or heavy bacon trades, the same general conformation and proportions of fat to lean are required, the weights only being different.

A prime light porker should weigh between 60 and 80 lb. and have half an inch of back fat over the thinnest portion at the loin and not much more over the shoulder, it should have good length of middle in comparison to its weight, the hind legs should be well fleshed, and the forequarters, head, and neck should be comparatively light; briefly, the

* In a broadcast talk from Radio Stations 4QG, Brisbane, and 4RK, Rockhampton, by courtesy of the Australian Broadcasting Commission.

carcass should carry a large proportion of lean meat and a large proportion of the more valuable cuts, which are the middle piece and the hind legs. In this condition a pig is referred to as being finished, but not overfattened.

The light baconer should have the same degree of finish and similar conformation at 100 to 120 lb. dressed weight, its backfat measuring three-quarters of an inch over the loin. The heavier baconer, which is used in England for curing as Wiltshire sides, should also have the same relative conformation and proportion of fat to lean, but it should reach its finished condition at 130 to 160 lb. dressed weight, and have one inch to one and one-quarter inches of fat over the loin.

Now it should be realised that during its growth a pig increases in bone, muscle, and fat, but in the very early stage, about weaning time, the bony skeleton increases out of proportion to the muscle and fat; then a stage is reached during which the muscle increases at a greater rate than the bone and fat; and then, as the pig approaches maturity, it lays on fat very rapidly and the growth of bone and muscle is retarded. To secure that desirable balance between muscle, fat, and bone, which gives a prime carcass, it is necessary to slaughter the pig when it has covered its frame with muscle and before the fat has increased too much. These stages of development are called maturity, and maturity in pigs is not the rate of growth, but the development towards that stage when fat is deposited in the carcass at a very rapid rate. An animal may grow rapidly and yet be late in maturing, which means that it does not deposit much fat on its body until it is relatively old and of a heavy weight.

Different types of pigs mature at different weights, and so the pig raiser, who knows the class of carcass required by the particular trade for which he is catering, is able to select breeding stock of a type to give porkers or baconers maturing at the most desirable weights, or conversely to have his pigs in a finished condition when they reach marketing weights. The rate of maturing of pigs varies widely, but for convenience we may consider three classes or types:—

(1) That type which is "finished" at light porker weights;

(2) That which is "finished" at light baconer weights, and

(3) That which is "finished" at Wiltshire baconer weights.

While it is possible for a pig raiser to take any one of these three types of breeding stock and turn their progeny into prime finished pigs at light pork, light bacon, or heavy bacon weights, it is either uneconomical or impracticable for the average pig raiser to do so under average conditions, and therefore we must select a particular type of breeding stock to suit each particular market class.

Rate of maturity is usually indicated by size in mature breeding pigs, and thus we refer to small, medium, and large types, and we speak of particular breeds as being of one of these types, but it is important to realise that there is a big variation of type within breeds as there is between breeds, and in selecting stock the breeder must be able to recognise type irrespective of breed. By selection it is a comparatively simple matter to change the type of a breed; examples of this can be seen in the Berkshire breed, which may vary from a porker type in the average Australian Berkshire to a large bacon type in the Canadian Berkshire. The Tamworth breed until a few years ago was considered large bacon type, but the present Tamworth is of the medium type

suitable for the production of light baconers. These changes in type within a breed are due to the selection of types which occur from environmental influences and natural variation.

Feeding and environment will alter somewhat the rate of maturity in pigs, full feeding and limited exercise causing pigs to fatten at lighter weights, but inherited type has the greatest influence on the maturity, and therefore it is essential that pig raisers should use the correct type of breeding stock, for a typical porker is an overfat and chubby pig when he reaches bacon weights and a typical bacon pig is bony and unfinished when he is at pork weight, and the same differences apply between light and heavy baconers.

Considering the variations in type within breeds, it is difficult to classify breeds, but as a general guide to farmers, I would suggest that Berkshires and Middle Whites are mostly small porker type, Tamworths are mostly light baconer type, and Large Whites are typical English bacon type. Crosses between these breeds may be used; for example, the Large White crossed with the Berkshire or Middle White gives a medium type pig to suit the light bacon trade.

Mention should be made of the Tamworth-Berkshire cross which has been famous for producing a light bacon pig, but with the change in the Tamworth in recent years making it a smaller and quicker maturing pig, this cross is now finished at about 90 lb. dressed weight, and we find the Tamworth being used pure for light-weight baconers.

Pig raisers must visualise the classes of pigs required by various trades, they must then be capable of recognising type, irrespective of breed characteristics such as colour, and remember that there are pigs for pork and pigs for bacon, and unfortunately there is no such thing as an ideal dual purpose pig.

A BUSH CHAIR.

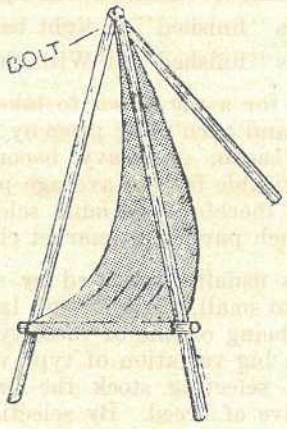


Plate 217.

Four lengths of wood, a bolt and a cornsack are all that is needed to make this comfortable bush chair. Bolt three pieces of wood together at the top to form a tripod. Fasten the fourth piece across two of the pieces at a suitable height from the floor and tack or sew one end of the sacking to this piece and the other to top of the chair.

UNSETTLED weather prevailed during the first week of September, resulting in some substantial falls on the far north coast, although elsewhere falls were of a light and scattered nature. On 8th September, welcome storm rains occurred in the South-East and Downs, many centres in the latter area receiving over an inch. At the time of writing (18th September), indications point to further storms which will be of great benefit to growing crops.

Wheat.

After an almost total absence of rain during August, available moisture resources were rapidily nearing exhaustion, so that the rains referred to above may be said to have saved the crop at a critical stage of its growth. Where the land was summer fallowed, and due attention paid to the subsequent cultivation, satisfactory growth has been in evidence, and growers are assured of satisfactory yields. Hurriedly prepared land has to depend entirely on seasonal rains, and as August and September are usually comparatively dry months fallowing is essential if high average returns are to be secured.

The estimated acreage sown, 335,000, is approximately 35,000 acres in excess of the previous season, and given favourable conditions during the present month and October, an over average crop can be confidently anticipated.

Lucerne for Grazing.

This plant is usually associated with rich alluvial flats, and districts possessing a high rainfall, where its response to such good conditions renders it the most profitable crop to grow. During recent years it has been found that lucerne will thrive under a much wider range of soil and climatic conditions in both New South Wales and Queensland, where the possibilities of utilising it as a grazing crop are now being explored.

Mr. C. H. Defries, Instructor in Agriculture, Roma, reports that Mr. Woodside, of Guluguba, now has 300 acres under lucerne on the box flat country adjacent to Jundah Creek, and that he has been fattening steers at a time when the district generally has been suffering from a severe dry spell. The oldest stand on this property is five years, and its growth is still vigorous. It is not surprising that in view of this

success Mr. Woodside intends to sow a further 100 acres of lucerne. The heavier clays and light pine lands of the Maranoa are naturally unsuitable for lucerne, but good stands have been established in brigalow and belah scrubs. Where soil conditions permit, lucerne will be found an excellent crop for old wheat lands. The chief difficulty lies in securing a good germination, which renders it necessary to make autumn sowings on thoroughly cultivated land. Heavy seeding is not required, as 3 to 4 lb. of sound seed per acre will be found sufficient for grazing purposes in the drier agricultural areas.

Tobacco.

In all districts tobacco growers are preparing their land for the coming season's operations, and indications are that, providing the season is a normal one, increased acreages will be placed under crop. In view of the fact that better quality leaf and yields are being obtained on virgin land, large areas are being cleared and ploughed.

Following the successful protection of tobacco seedlings from blue mould by use of volatile gases, such as benzol, toluol, &c., vapour treatment demonstrations are to be conducted in the principal growing centres during the next few months. It should be realised that gas treatment varies greatly from fungicidal spray treatment in that the former is much more likely to be influenced by the environment in which the work is carried out. The concentration of vapour, and hence its efficiency when a certain amount of liquid is exposed is influenced by the prevailing temperature as well as the size of the covering over the bed, and the gas-tightness of the material of which it is constructed. Hence one may expect varying degrees of success at first when this method is adopted on farms, depending on seasonal conditions, and care given to the construction of beds, and regularity of treatment.

Cotton.

The harvesting of the cotton crop has continued at a surprisingly good rate during the past month, bringing the total for the season to the 24th September, to 13,383 bales, 9,406 of which were ginned at Glenmore and 3,977 at Whinstanes. The grades obtained in the late crop have been particularly good, the continuance of the dry windy conditions having allowed the top bolls to be harvested in a very satisfactory condition for cleaning up efficiently in the ginnery operations, while the lack of rain has resulted in most of the cotton being of good colour.

Seed distribution for the coming crop has continued at a good rate, the total issued to the 18th September being sufficient to plant at least 40,000 acres. The greater proportion of this seed has been of the varieties producing the short to medium staple harder bodied cottons now in demand by the Australian spinners. Reports from most districts indicate that preparation of seed beds is well advanced, considering the dry conditions that have ruled. Good rains at an early date are desirable, however, not only to enable planting to be started in the Central district, but also to ensure of completion of seed bed preparation in all districts to enable the whole of the crop to get off to a timely start.

Sugar.

Rainfall in all cane areas was decidedly subnormal throughout September. In the far northern areas this was something of an advantage, for it brought about a substantial improvement in the sugar content of the mature crop, while not seriously handicapping the young cane.

In the Mackay district rain is urgently required to assist the growing crop, while the Southern districts are passing through a serious drought, which threatens the spring plant cane and young ratoons; unless early rains are received in these parts, the 1937 harvest prospects will be seriously jeopardised.

BEAN ANTHRACNOSE.

Some recent consignments of beans to the Brisbane markets have been badly affected with anthracnose. This disease produces dark-brown, sunken spots on the pods which, under moist conditions, develop a flesh-coloured area in the centre. This latter consists of a mass of fungus spores by means of which the disease is spread. These spots may be found in the field, or they may develop on an apparently healthy bean after it has been bagged.

In the field, in addition to the pod, other parts of the plant are affected. The veins on the lower surface of the leaves may be killed and blackened. On the stem the disease may appear as sunken spots very similar to those found on the pods. In wet weather spores are formed on these lesions, and it is by this means that the disease is spread through a young crop.

The fungus causing the disease may penetrate the pods and affect the seed. It may or may not produce obvious lesions on the seed, and thus diseased seed may be planted without a knowledge of its condition. When such affected seed is planted, the fungus forms the characteristic lesions on the young seedling leaves and on the base of the stems, and from these the disease spreads very quickly through the crop in wet weather.

As can be seen from the above description, the disease is carried from season to season on the seed, and affected seed may introduce the disease to a locality previously free from anthracnose. Thus, a first method of control is to obtain, if possible, seed from a source free from the disease. Failing this, a farmer may select healthy pods from the best areas in his own crop, and the seed can be retained from these. In making this selection care should be taken to eliminate also any plants affected with the bacterial disease, halo blight.

If the crop is diseased, it is well to remove and burn all refuse after the harvesting is completed, as the fungus can live over on the dead and decaying bean leaves in the soil. It is not advisable to plant in low, damp situations, nor to sow too thickly. If a crop in which there are only a few diseased plants is worked while wet with dew or rain, the disease is spread very quickly by means of the spores carried on the clothes and implements.

Spraying a bean crop to combat the disease is not considered to be an economic undertaking, but a small plot kept for the sole purpose of obtaining disease-free seed could be sprayed to some advantage with 4-4-40 Bordeaux mixture.

Whenever possible beans should be picked while the plants are dry. They should always be spread out in a clean place to dry thoroughly before packing or bagging. Any beans showing anthracnose development at the time should be rejected.

FRUITGROWING IN QUEENSLAND.

H. BARNES, Director of Fruit Culture.*

ALMOST every section of the fruitgrowing industry in Queensland offers opportunities for steady expansion, provided it is developed along modern lines.

The Banana.

Banana-growers are recognising that the old haphazard methods of husbandry have passed with the exhaustion of virgin rain forest lands, and are settling down to a system of more intensive cultivation and fertilizing.

Although banana-growing has always been the most important section of the fruit industry in Queensland, its position of prominence will be challenged seriously soon, if present anticipations in respect of pineapple-growing are realised. Pineapples possess advantages over bananas, not the least of which is that they can be canned and kept indefinitely, while bananas must be consumed as fresh fruit.

The Pineapple.

Recent investigations into pineapple matters in Queensland, carried out chiefly by Mr. Lewcock, of the Pathological Branch of the Department, have proved our cultural methods to be in need of a severe overhaul. In Hawaii, the average production per acre is about 500 cases; in Queensland, average production is about 200 cases per acre. The question which arises, naturally, is: Why is Hawaii able to produce such a higher average return—300 cases per acre more—than Queensland is doing? Our soils are quite as suitable for growing pineapples, and growers use large quantities of fertilizers, as is done in Hawaii. In the past, it has been the practice locally to plant pineapples in rows 9 feet apart, using from 5,000 to 8,000 plants to the acre; in Hawaii the rows are planted 6 feet and less apart, and from 12,000 to 16,000 plants are

* In a broadcast talk from Radio Station 4QG (Brisbane) and 4RK (Rockhampton), by courtesy of the Australian Broadcasting Commission.

set to the acre. Mr. Lewcock's experiments have shown that, by reducing the distance between the rows in Queensland and thus planting a greater number of plants per acre, not only is a greater yield of fruit obtained, but, in conjunction with the use of proper fertilizers, a much more vigorous plant growth is established for subsequent crops. The modern method of fertilizing pineapples is not to apply the fertilizer directly to the soil, but to scatter it in the basal leaves of the plants, whence it is washed down to the tiny roots present at the base of each leaf, and thus absorbed directly by the plant. Naturally, only water-soluble fertilizers are of value in this system.

It has also been determined that, contrary to previous belief, an acid soil is most beneficial to successful pineapple-growing, while iron in the soil is essential for healthy growth. The application of sulphur to the land prior to planting supplies both these requirements, in so far that it lowers the p.H. value to a point favourable to pineapple growth and wilt resistance, and makes insoluble iron in the soil available to the plants. Growers who have adopted Mr. Lewcock's recommendations along these lines have demonstrated that it is quite possible locally to at least equal average Hawaiian production.

So far as markets are concerned, Australia is absorbing almost the whole of Queensland's present production, and the demand for the fresh and canned fruit and the various by-products is increasing rapidly each year. The British market also is open to us for the canned product. The present rate of exchange is favourable, and the Sugar Industry Concession Committee has made certain financial contributions which have helped considerably the export of any small surplus in past years. There is no immediate indication that the rate of exchange will operate adversely in the near future, and, even if it did, with greater efficiency in production, the added advantage of at least 100 per cent. better returns per acre would go a long way towards making the industry still a profitable one. That there is a definite market in Great Britain is proved by the results of the efforts made last year by the Committee of Direction of Fruit Marketing. Negotiations were entered into with a large firm of distributors in England to handle Queensland canned pineapple, and within several days orders were placed for three or four times greater quantity than was available, and at a price favourable, under present conditions, to the industry.

Tropical Fruit Salad.

A popular by-product of the Queensland tropical fruit industry, which, during the past two or three years, has met with a big demand, is tropical fruit salad. The salad, which is put up in cans, comprises a blend of several well-known fruits, including pineapples, papaws, passion fruit, and bananas. The salad is delicious, and is certain of a far greater market as it becomes more generally known. The marketing of this product has naturally created a greater outlet for papaws and passion fruit.

The Papaw.

The quality of the fresh papaw is becoming recognised more widely in the Southern States, and the fact that improved transport facilities now enable it to be carried in perfect condition to Melbourne has created an increased demand at good prices.

Passion Fruit.

Passion fruit products are becoming popular in Britain, and are being used in many ways. Cocktail mixers and confectionery manufacturers are using considerably greater quantities of the juice each year, and it is important that Queensland growers should help meet the new demand.

Citrus Fruits.

Production of citrus fruits in this State does not equal local consumption, and considerable quantities are, of necessity, imported each year. Districts where irrigation is available are most suitable for the expansion of production of this fruit, which is very subject to the retarding effects of dry weather.

The Strawberry.

Strawberry-growing is a sound occupation for orchardists with only comparatively small farms. An excellent outlet exists for this berry, both in its fresh state and for factory purposes. Fresh berries are now being forwarded successfully to Victorian markets, where good returns are received.

Some newer branches of fruit production in Queensland which call for more attention by orchardists are macadamia nuts, avocados, mangoes, and dates.

The Australian Nut.

That the macadamia is the finest nut grown in the world has become a much-used phrase during the past few years among those closely associated with the development of this branch of horticulture. It is true, nevertheless. There are markets for macadamias in several parts of the world. The old argument that the hard thick shell would always have a detrimental effect on its popularity has been put on one side by the discovery of natural thin-shell types growing in coastal scrub lands. Several types of crackers have also been invented, the latest of which is claimed to crack a hundred nuts per second without damaging the kernels. With the existing demand, the two or three hundred acres which it is estimated are now being grown cannot hope to supply the market when they come into bearing, and there is room for many more trees.

The Avocado.

The avocado is a fruit still unfamiliar to most people, who, when they first taste it, are not keen on its flavour. Those, however, who know the avocado well will assure them that at the second and third tasting they will commence to like it, and then begin to demand it. The avocado is really something different in the fruit world. It has been described as "The Fruit Sensation of Modern Horticulture," and one of the greatest sources of food supply which the tropics have to offer. Up to the present only a few orchards have been planted in Queensland, and most of these are not yet in bearing. The limited supply of fruit now marketed is yielding exceptionally high prices to the growers. As production increases, the prices will come down, of course, when the public generally will have a better opportunity of becoming interested in the fruit, which in turn will naturally result in a bigger outlet.

The Mango.

The mango is a fruit which will grow in almost any part of Queensland. It grows freely from seed, but as the progeny very rarely, if ever, yield fruit of quality equal to the parent, the result is that many poor

varieties are now grown. Some enterprising orchardists of recent years have concentrated on the production of only the better types, and are able to export them successfully to the big cities of the South at good prices. There is room for a greater production of these choice varieties, which will soon oust the poorer sorts which at present dominate the market.

Dates.

It is interesting to note that 9,000,000 lb. of dates are imported into Australia each year. It has been demonstrated that in Western Queensland dates grow and ripen their fruit to perfection. The main requirement is plenty of water, and wherever bore water—which at present is flowing away in millions of gallons—is available, dates may be grown to excellent advantage.

SOME TROPICAL FRUITS.

No. 12.—THE COCHIN-GORAKA.

S. E. STEPHENS, Northern Instructor in Fruit Culture.

THIS fruit was introduced to North Queensland many years ago, and found conditions sufficiently congenial for its establishment without any great difficulty. It is a handsome tree of symmetrical appearance, and possesses value as a decorative foliage plant. As a fruit tree,

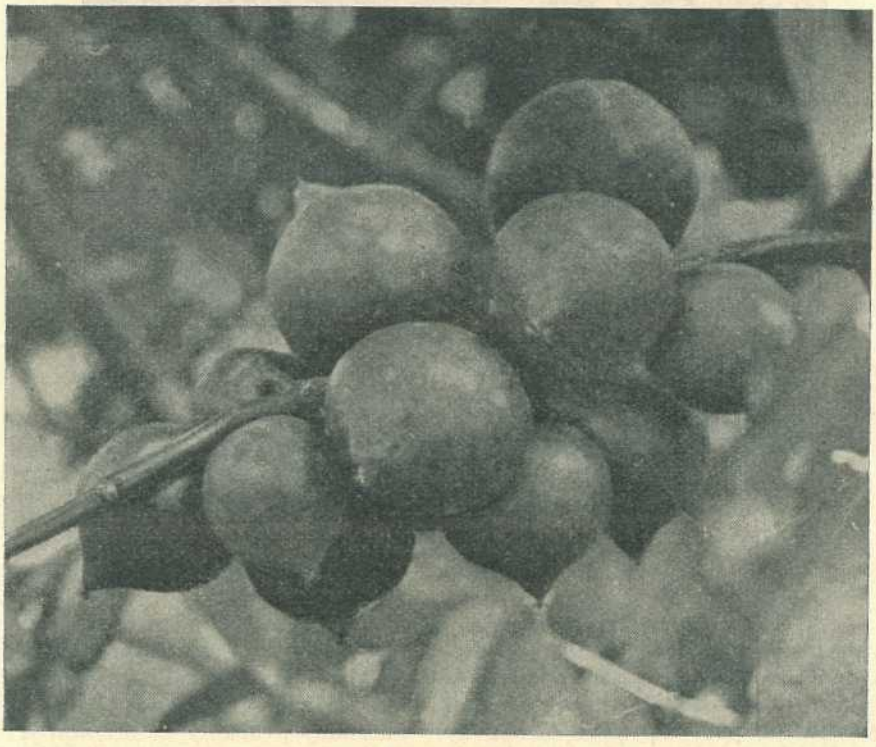


Plate 218.
Fruiting Habit of the Cochin-goraka.

however, it is not a great success, although it crops heavily under suitable conditions. It is known botanically as *Garcinia xanthochymus*, and is a native of Southern India and Malaya.

Plate 219.

The Cochin-goraka, *Garcinia xanthochymus*, approximately twenty years of age.

In North Queensland the tree thrives on various types of soil, but appears to give best results on low-lying alluvial soil which maintains a good moisture content but yet is well drained. On the deep red volcanic soils it also does well, but does not make quite as vigorous growth nor yet crop quite so heavily. This may probably be accounted for by the tendency of our volcanic soils to dry out owing to the low water table usually associated with them.

The tree is easily raised from the large fleshy seeds, which germinate most readily if sown in a bed of leaf mould kept well moistened and shaded. Root development is often somewhat sparse in the young plants, and growth for the first twelve months is rather slow.

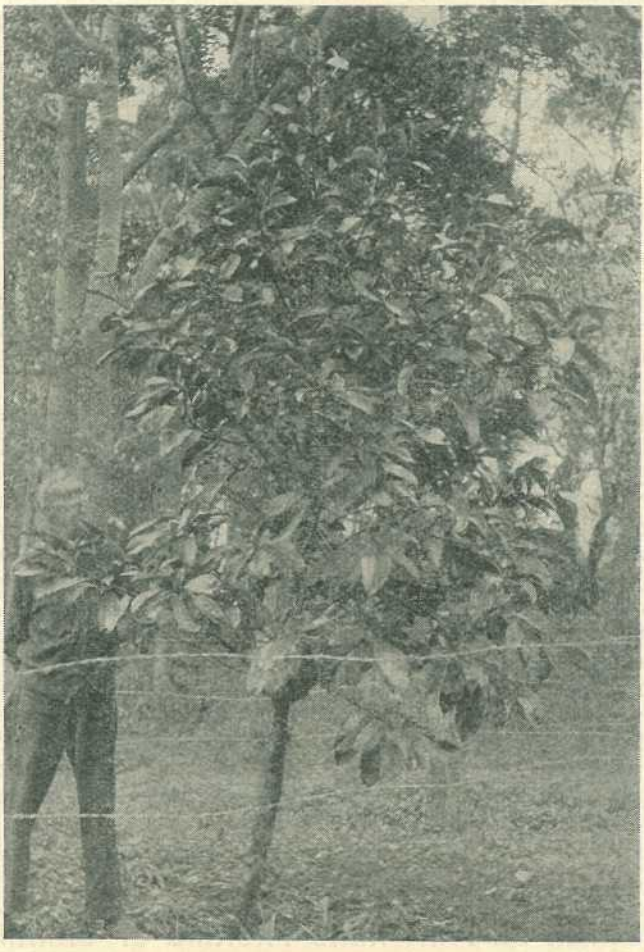


Plate 220.

The Mangosteen, *Garcinia mangostana*, approximately twenty years old.

The growth of the head is naturally symmetrical, and very little pruning is necessary to form a shapely tree. The leaves are large—up to about fifteen inches long by four inches wide—glossy, dark green, and leathery, and of pendulous habit. They are produced decussately on four-angled branches. The branches radiate from the central main stem almost parallel to the ground. Fruit is borne in clusters, laterally on the larger and smaller branches. It is smooth-skinned, and when mature up to three inches in diameter. The shape is unusual, the body of the fruit being almost spherical, and the apex prolonged into a slightly depressed point, whilst the stem is set below the central point on the other end. The axis of the fruit is thus offset towards the lower

side. The ripe fruit is of a bright orange yellow colour, and presents an attractive contrast to the deep green foliage. In North Queensland the fruiting season is from July to Christmas.

On running a knife transversely round the fruit, the apex end may be lifted off, and the peculiar construction may then be noted. Beneath a tissue-like outer skin is a fleshy and juicy rind of the same yellow colour. Within this a number of segments or "quarters" are disposed in similar fashion to the segments of a mandarin. These are also yellow in colour—sometimes just a shade lighter than the skin. These constitute the edible portion of the fruit, and when thoroughly ripened are of a refreshingly acid flavour. Before the fruit attains the bright yellow colour, however, the flesh is obnoxiously acid, whilst the fleshy rind at this stage is very astringent. Some segments of the fruit will be noticed to be larger than the remainder, and will be found to contain one large fleshy seed each.

According to H. F. Macmillan, the Cochin-goraka is used for the manufacture of a yellow dye. Both the bark of the tree and the skin of the fruit exude a bright yellow, sticky substance when injured, and in Assam particularly this is used in dyeing cloth.

In Queensland this tree has been and still is confused by many people with the mangosteen, by which name it is frequently called here, any many people have planted it under the mistaken impression or false information that it was the mangosteen. However, although it can claim relationship with the mangosteen, it is no more entitled to that name than a pear would be to the name of apple, for although the apple and pear belong to the one family they are distinct species. And so it is with the mangosteen and Cochin-goraka. While there may be some difficulty in distinguishing the two in young seedlings, the differences become more marked in the course of a year or two. The foliage of the Cochin-goraka is of a pendulous habit, giving the tree a drooping appearance, whereas the mangosteen has upright growing foliage, giving that tree an erect appearance. A reference to the two accompanying plates will best illustrate this difference in appearance. The fruit, too, are vastly different, both in colour and shape, as may be seen by the illustration.

CLUSTER OR PART-HAND PACKING OF BANANAS.

JAS. S. GREGORY, Instructor in Fruit Packing.

FOR some years past packing in singles has been the general method adopted for sending cased bananas to Southern markets. This method of packing was encouraged by wholesalers and retailers because it was thought that more fruit would be contained in the case. The ripeners also found it more convenient when ripening, as it enabled them to remove individual fruits which might ripen before the remainder in the case. With full-hand packs this would have been difficult to do. Whilst bearing this in mind one cannot help believing that the extra quantity in the case was really the main factor in the preference for packing in singles. This should now no longer be a serious consideration, as experiments with the same fruit have shown that a well-packed case of clusters contains the same amount of fruit as when packed in singles. As an example, a test case packed in full hands

contained two dozen less bananas than when packed in clusters. The clusters were then broken and packed in singles, and it was found there was a difference in content of only two bananas in favour of packing in singles.

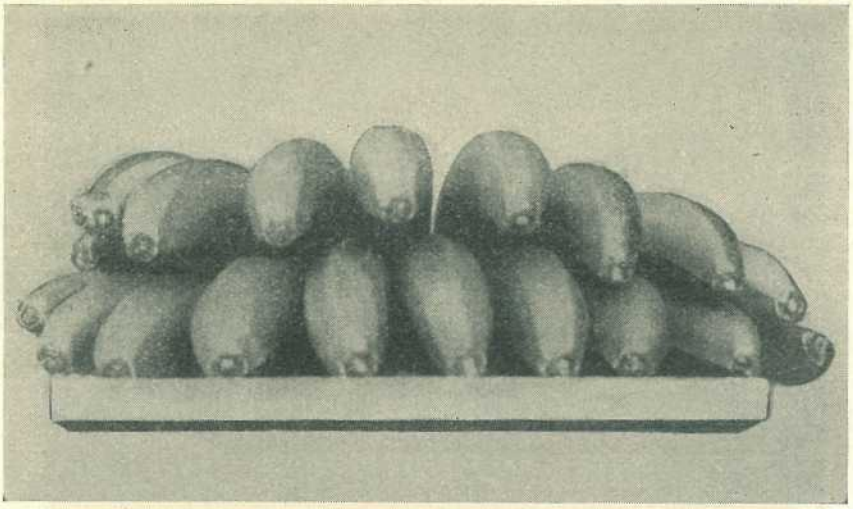


Plate 221.

A Hand of even Fruit which is very suitable for breaking into Clusters. See Plate 222 for Cluster Packing.

With the disposal of the argument with regard to shortage of fruit, the reasons in favour of the cluster pack by far outweigh those in favour of packing in singles. It must also be kept in mind when analysing the arguments for and against the various methods of packing that any extra work has to be done by the grower, and not

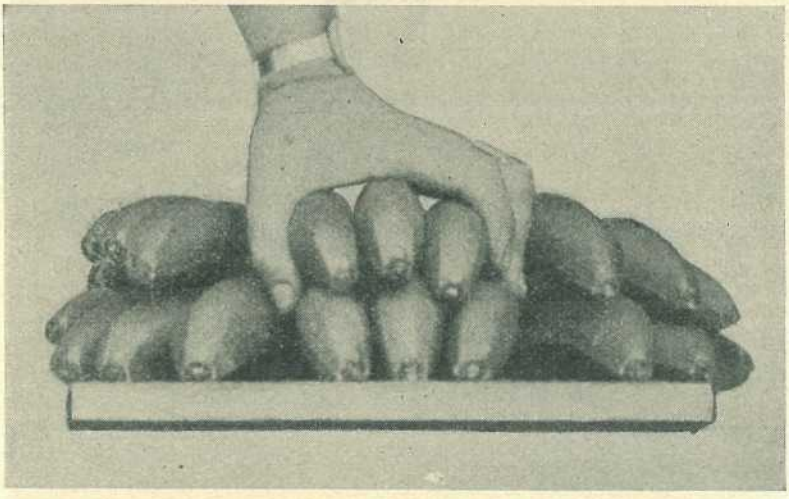


Plate 222.

The same Hand of Fruit as in Plate 221, showing how Fruit will fit together when pressure is applied.

by any others who handle the fruit after it leaves the plantation. The following arguments support the adoption of cluster packing:—

1. When packing in singles extra labour and time are required than when packing in clusters.

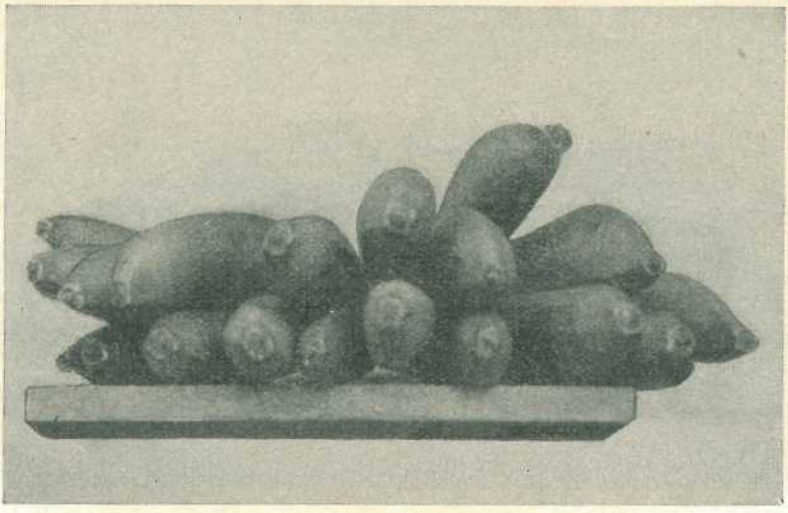


Plate 223.

An uneven Hand which would require breaking into smaller Clusters of three or four.

2. The risk of damage through bending the shanks of the bananas when breaking into singles is minimised. It is not necessary to break the shanks of any bananas, the small piece of the collar left on the hand after cutting from the stalk being the only thing that is broken.

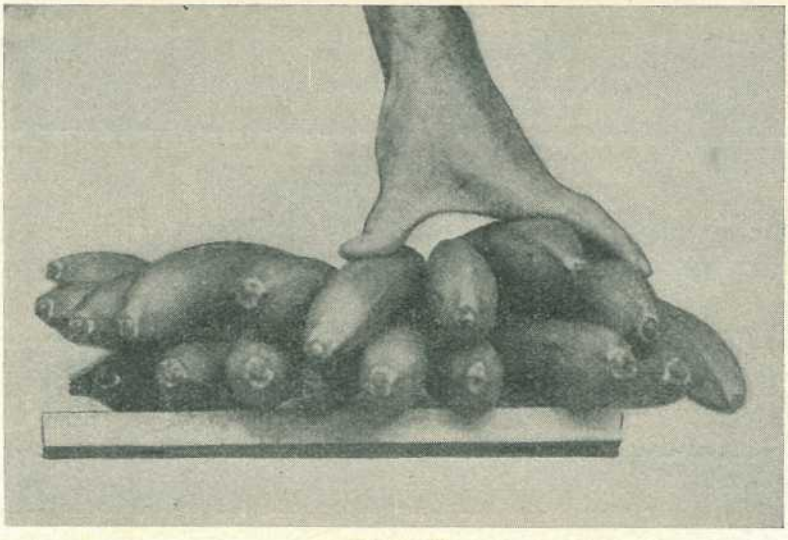


Plate 224.

The same Hand as Plate 223. Compare this Hand with Plate 222 to notice the difference in the way the Fruit fits when pressure is applied.

3. When packing in singles a high percentage of bananas that have been mutilated often happen to get placed in packed cases. This risk is almost completely obviated in cluster packing.

4. The early development of black-end, stem-end rot, and squirter because of stalk damage is prevented in the case of the cluster pack, thus enabling a much nicer-looking fruit to be retailed. Fruit badly affected with stalk collapse through black-end &c., does not sell as readily as fruit with solid stalks, top prices being much harder to obtain.

5. Single bananas do not ripen up with so fresh an appearance as bananas in clusters or hands, often having a wilted appearance. When retailers have to purchase fruit showing specimens with stem-end collapse or wilted in appearance, they naturally pay a lower price. This has a tendency to lower the trend of market prices.

6. As the clusters when packed are "pegged" or tightened by using twos or singles, no more difficulty should be experienced in packing all normal bunches of fruit in clusters than in singles, as awkward hands can be used for pegging.

Packing the Cluster or Part-hand Pack.

As the name shows, clusters comprise parts of the hand of bananas. These "clusters" contain three, four, five, or six bananas, depending upon the type of fruit available. A hand that contains an even type of fruit (Plate 221) can easily be broken into clusters containing up to six bananas which will fit together firmly (Plate 222). Plate 223 illustrates an uneven type of hand which would need to be broken into smaller clusters of three or four before they would fit snugly together without damage when pressure is applied. An examination of Plate 224 will point out the difficulties with hands of this description. It can be seen from these illustrations that it would not be altogether practicable to lay down a fixed number for each cluster. A packer must use discretion to obtain the best results, practice soon making perfect. Spaces between the clusters can be filled by using singles and twos to obtain a tight pack. Singles can also be used as key bananas for the centres. Packers should make it their aim to keep the clusters as large as possible, as this shortens the time taken for packing and also decreases the chances of black-end and squirter development.

Types of Cluster Packing.

As with single packs, there are different methods of placing the fruit. The clusters can be placed vertically with the concave side down (Plate 225) or placed on their sides (Plate 226). The vertical pack is recommended in preference to the side pack. The fruit fits together better with less chance of damage whilst in transit, although it must be observed that the heels of the fruit do not get case-marked as easily as when the concave pack is used. A better weight of fruit is placed in the case with the concave cluster pack. To do the side pack successfully greater care has to be exercised in the selection of suitable clusters.

Method of Starting Vertical Cluster Pack.

A layer of clusters of twos or fours is placed on their sides upon the bottom of the case in the same manner as the bottom row in the start of single packing (Plates 227 and 228). Both the straight and "S" types of bottom layer can be used to suit different types of fruit.

The next layers of clusters are then placed upon this fruit, concave side down. The case is finished by repeating the second layer until full.

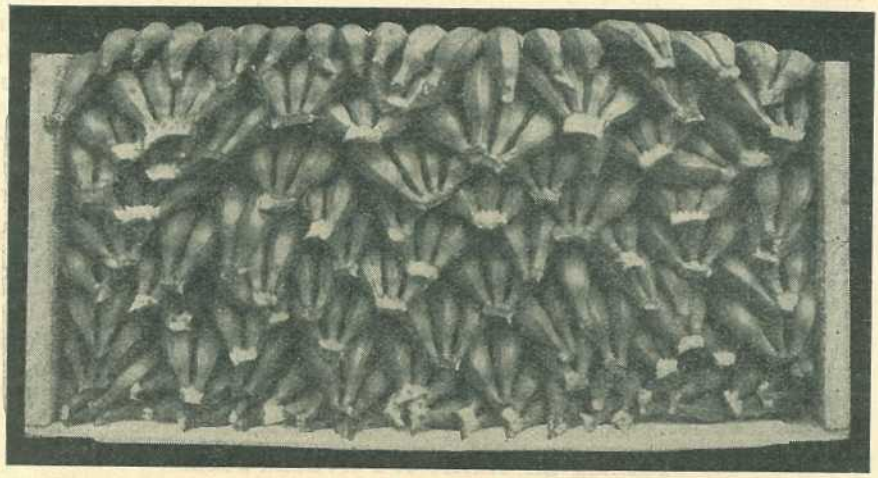


Plate 225.
Complete Part-hand Pack placed vertically; opened at side.

Where the straight type of pack is used in the first layer for starting the case, it is recommended to start one of the sides of the layer with a two and the other with a cluster of four. This will assist in overcoming the difficulty encountered through the top and bottom lines of fruit in each hand being of different lengths. By starting with a two the shorter bananas on the clusters placed on one side of the box are brought opposite the long bananas on the clusters on the other side. With the "S" type of first layer this automatically takes place when the clusters are turned.

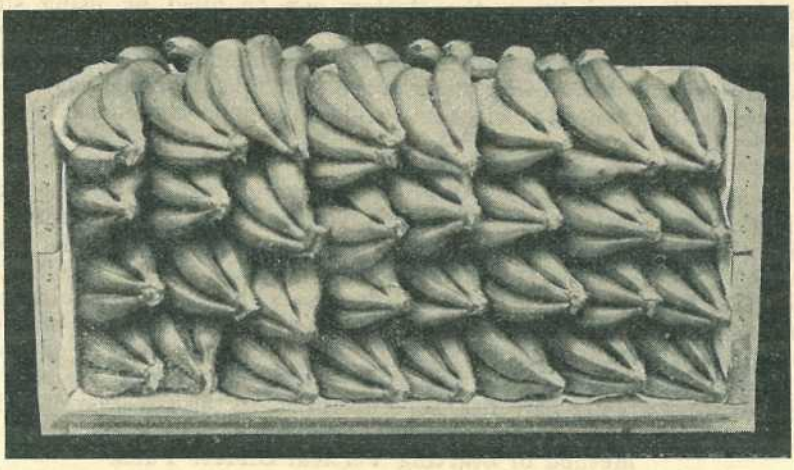


Plate 226.
Clusters placed on their side. This pack looks nice, but does not contain the weight of fruit. Clusters mainly all four bananas, and rowed in well. No case making on heels of fruit.

[*Photo. by courtesy New South Wales Department of Agriculture and Stock.*

A tighter pack is obtained if the clusters of a layer are placed on the spaces between the clusters of the layer beneath (Plate 225). Care must be taken to finish one layer before starting the next. Any spaces caused through the unevenness of the clusters should be filled by using singles or twos. Uneven clusters should be broken up into singles and twos for this purpose. Six-inch to 9-inch fruit can be packed in this manner.

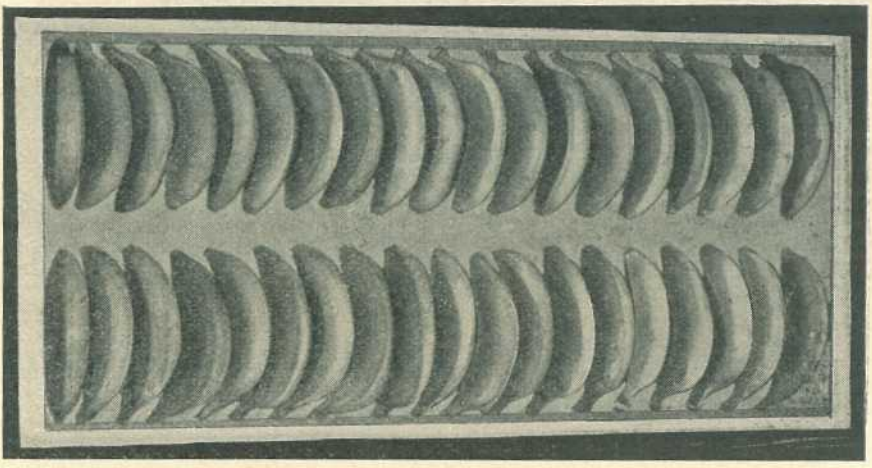


Plate 227.
Method of placing First Layer of "Sixes," "Sevens," and small "Eights."

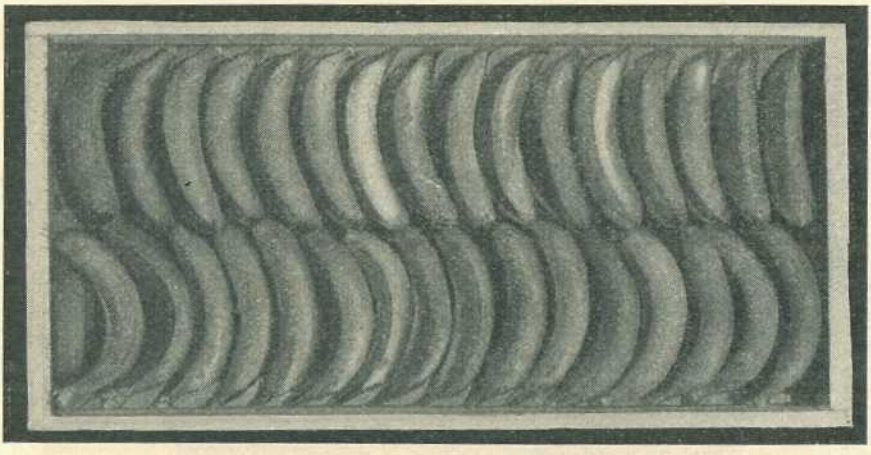


Plate 228.
Method of placing First Layer of Curved "Eights."

Side or Flat Packing.

To start this pack a full cluster of four is used, the bottom layer fruit being placed on its side. The case is finished by repeating this layer by layer until the case is finished (Plate 226). The shortcomings of this pack have already been pointed out. Six-inch to 9-inch fruit can be packed in this manner.

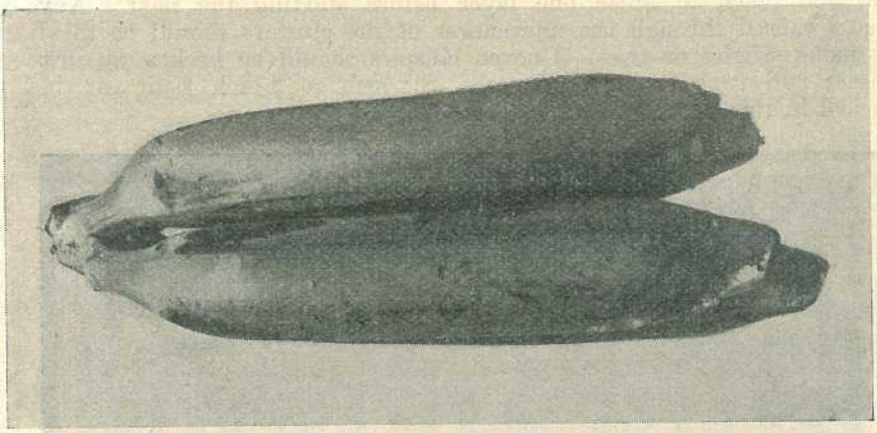


Plate 230.
Large, Long Fruit Type.

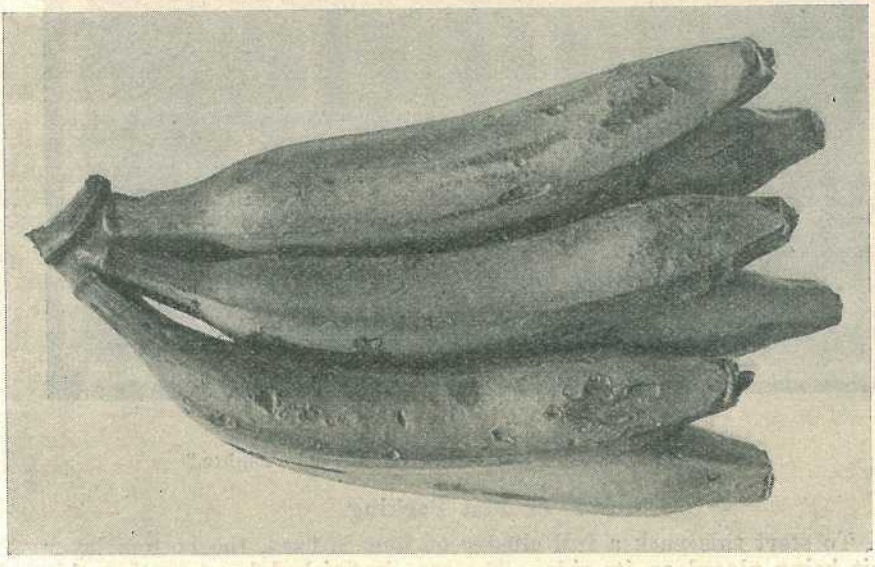


Plate 229.
Large 10½-inch Bananas.

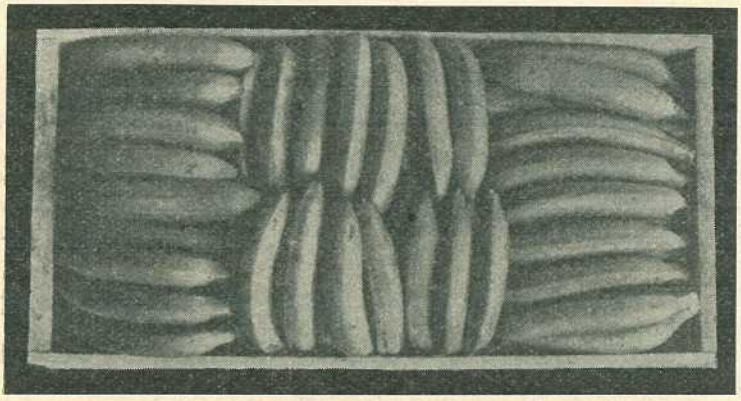


Plate 231.
Packing Long Fruit. Case with Top Removed.

Cluster Packs for Straight and Oversized Fruit.

Large long and straight long fruit (Plates 229 and 230) present difficulties in packing which the two packs mentioned do not easily overcome. Experiment proved that the easiest method was to pack the long clusters lengthwise in the case and fill in the middle (Plates 231 and 232). Use, as far as possible, the better-shaped curved fruit for the centre, keeping the straight for the two ends. Fruit of this type constitutes only a small percentage of the banana output during January and February, and no grower should experience much trouble in overcoming the difficulties encountered.

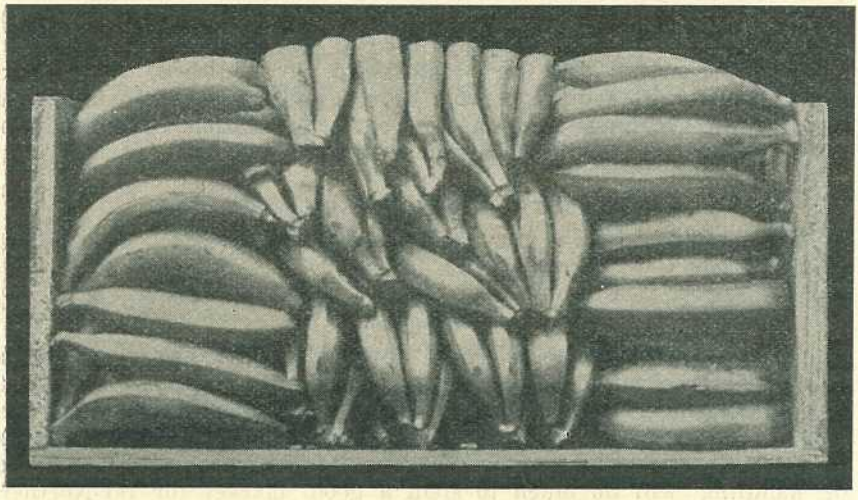


Plate 232.
Packing Long Fruit. Case with Side Removed.

FRUIT MARKETING NOTES.

JAS. H. GREGORY, Instructor in Fruit Packing.

THE prolonged spell of dry weather is causing much worry to growers Much small citrus fruit has still to be disposed of, especially as the Valencia Lates this season have generally been on the small side. As the trees are at present carrying fruit as well as being in bloom, the indications are that the prolonged dry spell will mean either a normal setting with small fruit or a light setting.

The problem of small oranges has still to be overcome and greater efforts should be made to increase their use for juice, &c. The larger sizes are easy to sell to the retail trade, the grower's chief difficulty being to dispose of the small fruit. Unfortunately this does not apply only with citrus fruits, as all fruits suffer the disadvantage of lack of means for the disposal of small fruit.

The markets generally have retained values, with the exception of bananas, which on the interstate markets have declined considerably in price.

Prices on the various markets during the last week of September were as follows:—

Papaws.

In Brisbane local fruit brought 2s. to 3s per bushel case, Gunalda fruit 3s. to 4s 6d. per bushel case, and Yarwun 5s. 6d. to 7s. per tropical case. Melbourne prices were from 7s. to 10s. per tropical case, and Sydney from 6s. to 11s.

Poorly coloured lines were hard to sell. From now on when sending to Southern markets growers should select fruit with a little less colour than was their practice during the winter months.

Granadillas.

The season for this fruit appears to have finished. The writer experimented with fruit sent from Cairns, and succeeded in keeping it for three weeks when it ripened in perfect condition. A description of the methods adopted will be published at a later date.

Custard Apples and Avocados.

These two fruits are now practically off the market. Fair quality Custards sold well at from 4s. 6d. to 5s. per case.

Mangoes.

The first consignments from Townsville have appeared on the Brisbane market and sold at 10s. per bushel case. Suppliers sending to Brisbane would do well to wrap their fruit. The impression was gained from some consignments that the fruit had been hammered from the trees with a stick, and growers should note that such careless methods of handling will do much to spoil a good market for far-Northern mangoes.

Pineapples.

The factories have been operating freely during the month, and have thus assisted to maintain values on a sound level.

Brisbane prices for smoothleafs ranged from 3s. to 6s. 6d. per case, and 2s. to 6s. 6d. per dozen loose. Ripleys returned 6s. to 9s. a case, and 2s. to 5s. 6d. a dozen. Melbourne prices ranged from 8s. to 10s. per case, and Sydney prices from 7s. to 9s. Green lines are not wanted.

Bananas.

The writer has inspected many bunches of bagged fruit. The practice of bagging bunches on the plant, even apart from any other reasons for its adoption, is well worth while, merely for the way in which the fruit at the back of the bunch is brought up to size, instead of the front of the bunch filling while the back fruit remains thin and angled.

In Brisbane Cavendish bananas realised the following prices—Sixes, 8s. 6d. to 12s. per case; Sevens, 9s. to 13s.; Eights and Nines, 10s. 6d. to 14s 6d. Lady's Fingers at 3½d. to 7d. a dozen, and Sugars at 4d. to 5¾d., were rather slow of sale.

Melbourne prices for Cavendish were—Sixes, 12s. to 13s.; Sevens, 14s. to 15s.; Eights and Nines, 16s. to 17s.; a few special lines higher.

Sydney prices: Sixes, 14s. to 16s.; Sevens, 16s. to 18s.; Eights and Nines, 18s. to 21s.

Passion Fruit.

There was an excellent demand for this fruit, Brisbane prices ranging from 5s. to 12s. per half-bushel case, Sydney prices from 6s. to 12s., and Melbourne from 12s. to 14s., with special lines higher.

Strawberries.

The season is now nearing its finish, and supplies are lighter. In Brisbane 5s. to 9s. a dozen boxes were obtained, and 10s. to 13s. for choice lines; in Sydney trays brought from 4s. to 7s. each, and boxes from 6s. to 17s. a dozen.

Citrus Fruits.

Oranges and mandarins of good quality are selling well, but small sizes below 2½ inches are not popular and are hard to shift.

Brisbane prices: Oranges, choice 5s. to 7s., small 3s. to 4s.; Gayndah 7s. to 8s., Redland Bay 4s. to 7s., Benyenda 7s. 6d. to 8s. 6d., New South Wales Navels, 6s. to 8s. 6d. per case. Mandarins, of which the general quality is rapidly falling off, King of Siam 5s. to 7s., Waratah 8s. to 11s., and Glens to 10s., if in good condition. Lemons, 3s. to 5s. ,with Gayndah and Benyenda from 8s. to 12s.

Sydney prices: Oranges, Navels, 4s. to 7s., Joppa 4s. to 5s., Valencia 4s. to 6s. Mandarins, local Emperors, 3s. to 10s.

Melbourne prices: Oranges, Navels 4s. to 11s., Commons, 4s. to 8s. Mandarins, 5s. to 10s. Grapefruit, 4s. to 10s. Lemons, 4s. to 6s.

Tomatoes.

The prolonged dry spell has brought on a shortage of supplies, and consequently prices are higher. In Brisbane local ripe fruit realised 3s. to 8s., green 4s. to 8s., and coloured to 9s. for good quality. In Sydney local fruit brought 10s. to 13s., and Queensland fruit 10s. to 12s. In Melbourne 13s. to 14s. was obtained for Adelaide hothouse fruit, and 7s. to 10s. for West Australian fruit.

Apples.

Apples are selling well in Brisbane, supplies of Queensland apples now being finished. Victorian Jonathans (2½ and 2¾ inch) brought 12s. to 13s., and Rome Beauty 8s. to 11s. Tasmanian Sturmers realised 8s. to 11s., and French Crab 9s. to 13s. New South Wales Kentucky Granny Smiths sold at 14s. 6d. to 15s. 6d.

Cucumbers.

Prices in Brisbane were 6s. to 9s., Sydney 10s. to 12s., and Melbourne 6s. to 9s.

Lettuce.

Lettuce on the Brisbane market realised from 6d. to 1s. 3d. per dozen.

Beans.

Brisbane prices were from 6s. to 11s. per sugar-bag, and Sydney prices from 2s. to 9s. per bushel case.

Assistance and advice in the packing and marketing of all fruit will be gladly furnished upon application to the Under Secretary, Department of Agriculture and Stock, William Street, Brisbane, B.7.

BRANDING CATTLE—A QUICK HITCH.

Here is the handiest method of securing cattle for branding. Speaking as one who has had quite a lot of experience in this work in the east and west of the continent, I think that the method here advocated has many advantages. I have done large numbers of stock with only one helper, and where big mobs are being handled and more hands are available, the method can be used at several parts of the yard simultaneously.

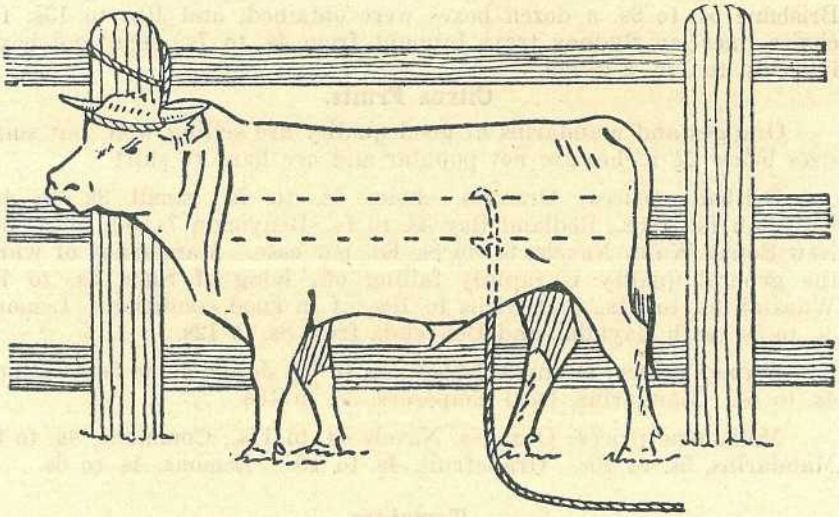
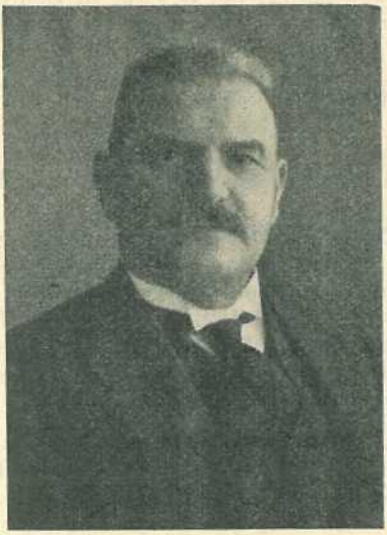


Plate 233.

The beast is roped over the horns or neck and pulled up to the rails of the fence. Another rope is tied to the fence at about the height of the beast's hip and allowed to lie on the ground, and as the beast is brought up to the fence the rope is thrown over the top rail and hauled tight. I know of many fittings which can be added to stockyards to simplify branding, but this is the simplest as it can be used in any stockyard and only the two ropes are necessary.—A correspondent in the "Western Mail." (W.A.).

The Passing of a Great Veterinary Scientist.

THE recent death of Sir Arnold Theiler in London marked the passing of a great scientist and a world-famous veterinarian. This great South African was well known in Australia, having spent six months here in 1928 in an advisory capacity to the Commonwealth Government. In the course of that time he visited Queensland, and the stockowners of this State benefited largely from the advice he was able to give on many of our important veterinary problems. In South Africa in his long career he had achieved a triumph in veterinary science and had been an inspiration to veterinarians the world over.



The Late Sir Arnold Theiler.

In "The Veterinary Record"* for August a very moving tribute is paid to his memory, and from which the following abridged account of a great career is taken:

The reputation of Sir Arnold Theiler was made in South Africa, and from the date of his entry into the Transvaal as veterinary pioneer in 1891 his life was an arduous but triumphant struggle against the many diseases which had thwarted the agricultural development of that country since the days of the Great Trek.

To few men is it given to see in their own lifetime so much of the practical economic results of their researches, and to receive such world-wide recognition before their death. As Sir John Russell expressed it in his address on "The Changing Outlook in Agriculture" at the Centenary Meeting of the British Association in 1931: "It is difficult to overrate the value of the service he has rendered to South Africa as a country and to farm animals the world over. He began at the time of the rinderpest plague in 1895, a virus disease which killed almost the entire cattle population of South Africa; the country was devastated by horse sickness, blue tongue of sheep, heartwater of cattle, sheep, and goats, and other terrible diseases. With almost uncanny precision he diagnosed the causes of these diseases and discovered curative measures; he founded the Veterinary Research Laboratories at Onderstepoort, of which not only South Africa but the whole Empire is proud, and he trained up a body of veterinary research workers who are extending the good work."

Theiler was honoured in every country in the world. He received seven honorary degrees from universities in three continents, the highest honours from scientific societies, a C.M.G. from Edward VII.,

* Official Journal of the National Veterinary Medical Association of Great Britain and Ireland.

a knighthood from George V., and a royal decoration from Belgium. He was the first recipient of the Gold Medal and Grant of the South African Association for the Advancement of Science and of the Captain Scott Memorial Medal from the South African Biological Society, the first recipient of the Laveran Medal from France, the second recipient of the Budapest Prize from the International Veterinary Congress and of the Medal of the Royal Agricultural Society of England. Amongst his earlier honours was election as Associate of the Royal College of Veterinary Surgeons of Great Britain and Ireland in 1907; amongst the latest was his election to the French Academy of Sciences in 1933, and to the Fellowship of the Royal Society of Medicine in 1934. His honorary degrees included the D.Sc. of the Universities of South Africa, of the Cape of Good Hope, and of Johannesburg, the D.V.Sc. of South Africa, Dr. Phil. of Berne, Sc.D. of Syracuse, U.S.A., and the D.Sc. of the University of Utrecht.

Born on 26th March, 1867, at Frick in the Swiss canton of Aargau, he was the son of a schoolmaster and received his early education at the hands of his father and at the gymnasium of Aargau before proceeding to the study of veterinary science at the Universities of Zürich and Berne.

In South Africa his inborn genius for investigation and his untiring energy now found their natural outlet and it was not long before his published work was attracting attention throughout the whole world. His ability to apply scientific research to the solution of problems of pressing economic importance and produce practical results of immediate benefit to the live stock industry, rapidly gained the confidence of the administration—above all, the confidence of the farming community.

Theiler was a man free from financial timidity in experimental work. He vindicated scientific research as a straight business proposition and pressed for increasing grants as fast as he produced results.

His own early research work was mainly in bacteriology, protozoology, and virus diseases—the name *Theileria* for a genus of intracellular protozoan parasites, commemorates this phase of his career, *Theileria* parva being the casual species of East fever. His work on the tick transmission of the piroplasmoses became classical. His early method of immunisation against horse sickness, more efficient with the mule than with the horse itself, rendered transport possible in areas formerly fatal to equines. His production of a vaccine for "blue tongue," a fatal catarrhal fever of sheep, stimulated the wool industry of the country. His net, however, was flung so wide that it would take a monograph on Theilerian research to do justice even to his "first reputation"—the reputation for which he was knighted in 1914.

It is given to few men to build four almost distinct reputations; Theiler did this and some scientists who recognised his eminence in their own field may hardly have heard of his reputation in the others.

Of economically important work done by Arnold Theiler may be mentioned the control of haemonchosis in sheep, research into diseases caused by poisonous plants, improvements in vaccine production and in immunisation against horse sickness, but above all the elucidation of the cause of "Lamsiekte" in 1917, a cattle disease which threatened

South African farmers with ruin over vast tracts of the country. Out of this last work sprang the long series of researches on aphosphorosis of ruminants and diseases associated with mineral deficiency—work which continues to this day and which provided Theiler with material for the histological studies into the skeletal diseases of the domesticated animals, to which he devoted the years of his retirement.

Some of the younger staff of his pioneer days may have felt roughly handled by the driving force of their tireless chief, and were certainly worked to the limit of their capacity by a man who made his own first round of inspection of his institute at 6.30 in the morning, observed all his experimental animals before breakfast, gathered his professional staff together at 8.30 a.m. with the blast of a siren from the clock tower, and brought them into conference every Wednesday night to discuss the scientific literature they had been reading during the week. But he lived to see them all grateful for his paternal discipline and few men have been more honoured by their disciples in their later years.

From 1921 onwards he occupied the positions of Dean of the Veterinary Faculty and Professor of Tropical Diseases in the University, in addition to his Directorship of Veterinary Research under the South African Department of Agriculture, until his retirement in 1927.

It was characteristic of the man that when he relinquished control of the largest institute in the world specially devoted to veterinary science, and of 100 white workers of whom about thirty were professional graduates, he at once cast about for an individual line of private research to occupy his retiring years—a line with which his own two hands could cope despite the handicap that one of these was wooden from the wrist.

In public life Sir Arnold Theiler was a compelling personality and great driving force. In private life he was modest, humorous and kindly, of simple habits and tastes, and revealed to his intimate friends the man of deep sentiment behind the man of action. He had faith in his star of destiny but was entirely free from lesser vanities. His ability as a leader arose from his enthusiasm for the "thing in itself," and his capacity for inspiring enthusiasm in receptive minds. As a director he was a rigorous disciplinarian and demanded unswerving loyalty from subordinates, but he strongly supported all who gave him service. He was a born teacher and although intolerant of indolence he showed infinite patience with the "man who tried his best."

The high standing of the veterinary profession in South Africa, and adequate financial recognition in Government service, is largely the result of his efforts, but his influence on the status of veterinary science is wider than that—he has done much to convince the administrative mind all the world over, that expenditure on veterinary research is a profitable investment for any country.

Genius has been defined by one sage as "intuition which has the warrant of ultimate certainty," and by another as "infinite capacity for taking pains." Theiler fitted both definitions. Few man have displayed more doggedness in arriving at the truth by patient elimination of possible hypotheses, but periodic flashes of insight has often provided the clue to his baffling problems.

The 1936 Brisbane Exhibition.

Departmental Displays.

Entomology and Plant Pathology.

A SERIES of island stands in the court of the Department of Agriculture and Stock provided a display of wide interest in respect of pest and disease incidence. The varied nature of the research activities of the Division of Entomology and Plant Pathology was evidenced by material showing the characteristic symptoms of injury by insects, fungi and bacteria to tomatoes, tobacco, bananas, papaw,

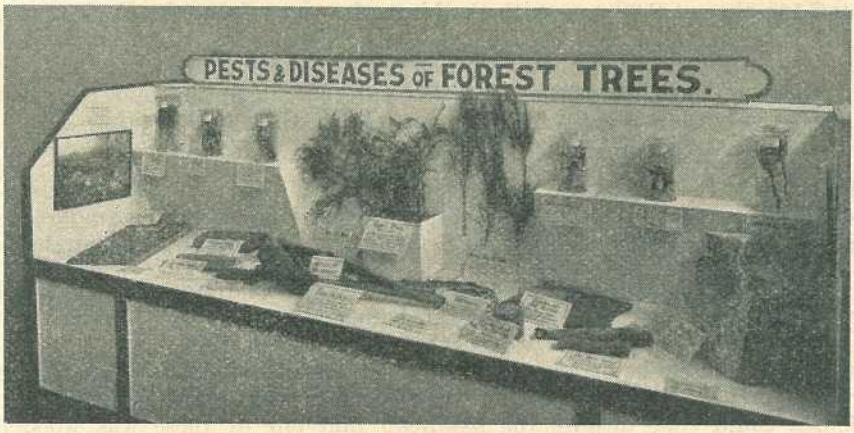


Plate 234.

passion fruit, citrus, vegetables, cereals, forest trees and timber, the several organisms being the subject of investigational work. Preserved specimens were included in the display, supplemented to a large extent by living plant material on which the blemises, malformations and decay were clearly recognisable, and also by cultures indicating the method of handling the organisms in the laboratory. Similarly, insect

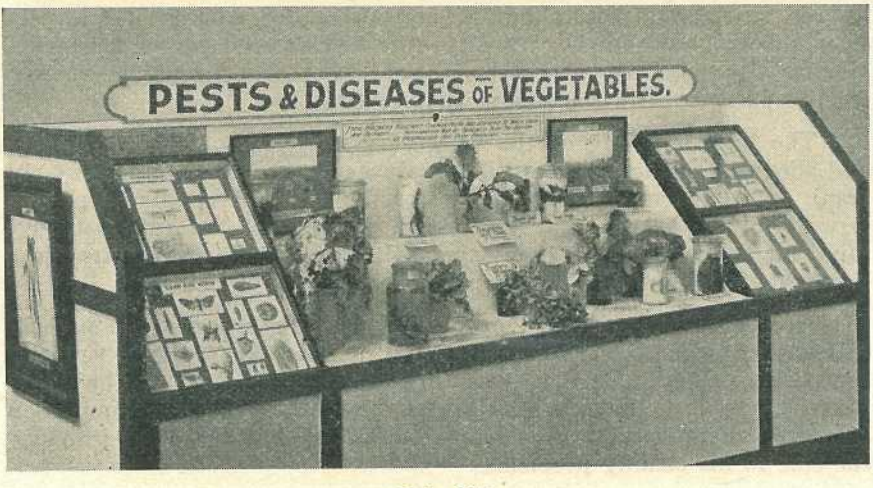


Plate 235.

specimens and detailed enlargements enabled those most interested—the primary producers—to familiarise themselves with the appearance of the more important pests.

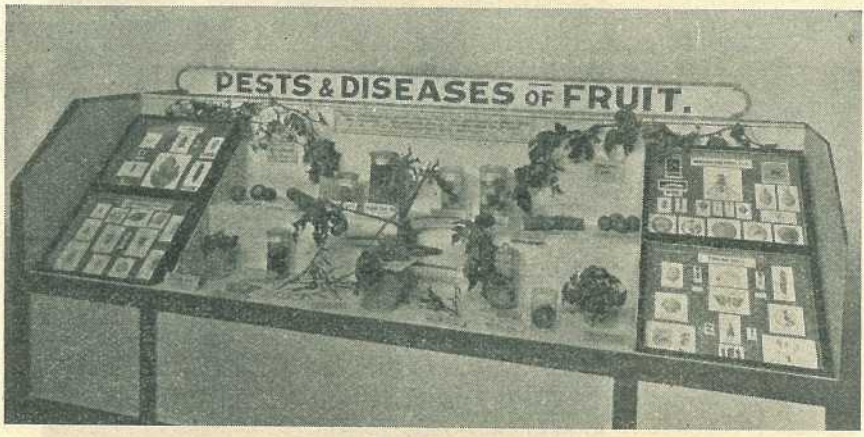


Plate 236.

Ability to recognise an insect pest in each of its transformation stages, or the symptoms of a fungal or bacterial trouble in the early stages of attack are matters of first importance to the grower. The application of an appropriate remedy, or the eradication of a dangerous breeding centre can then be carried out sufficiently early to minimise the extent of injury. For this reason primary producers were repaid amply for any time they spent in viewing this exhibit.

An important addition was a display of insectivorous birds, accompanied by specimen cases, demonstrating the value of most of our Queensland birds as allies in the destruction of insect pests. Country and city dwellers alike can accomplish much by discouraging the indiscriminate and thoughtless destruction of valuable birds, and the display provided a lesson that should stimulate the public conscience in this important matter.

Plate 237.

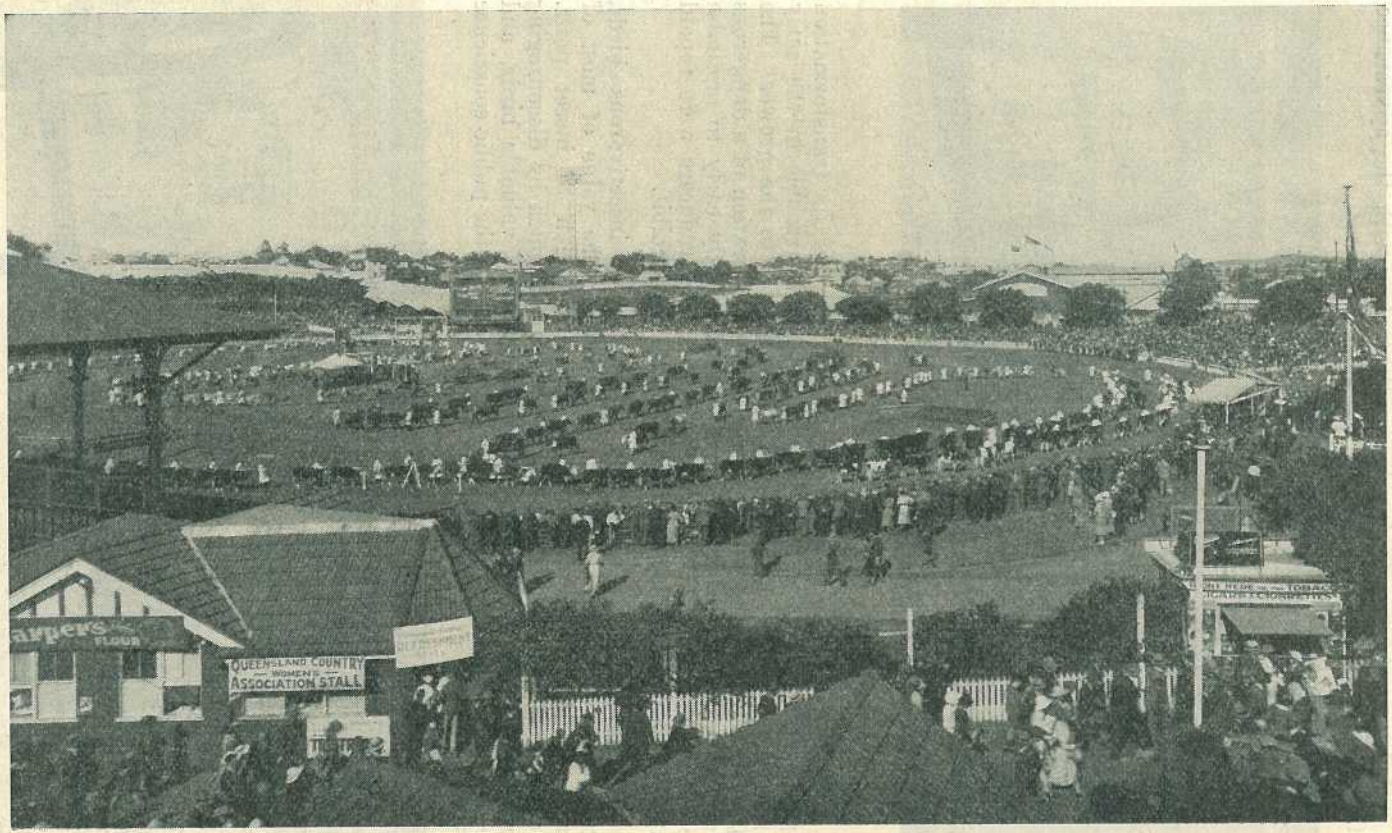


Plate 238.

1936 Brisbane Exhibition.—The Grand Parade of Beef and Dairy Cattle.

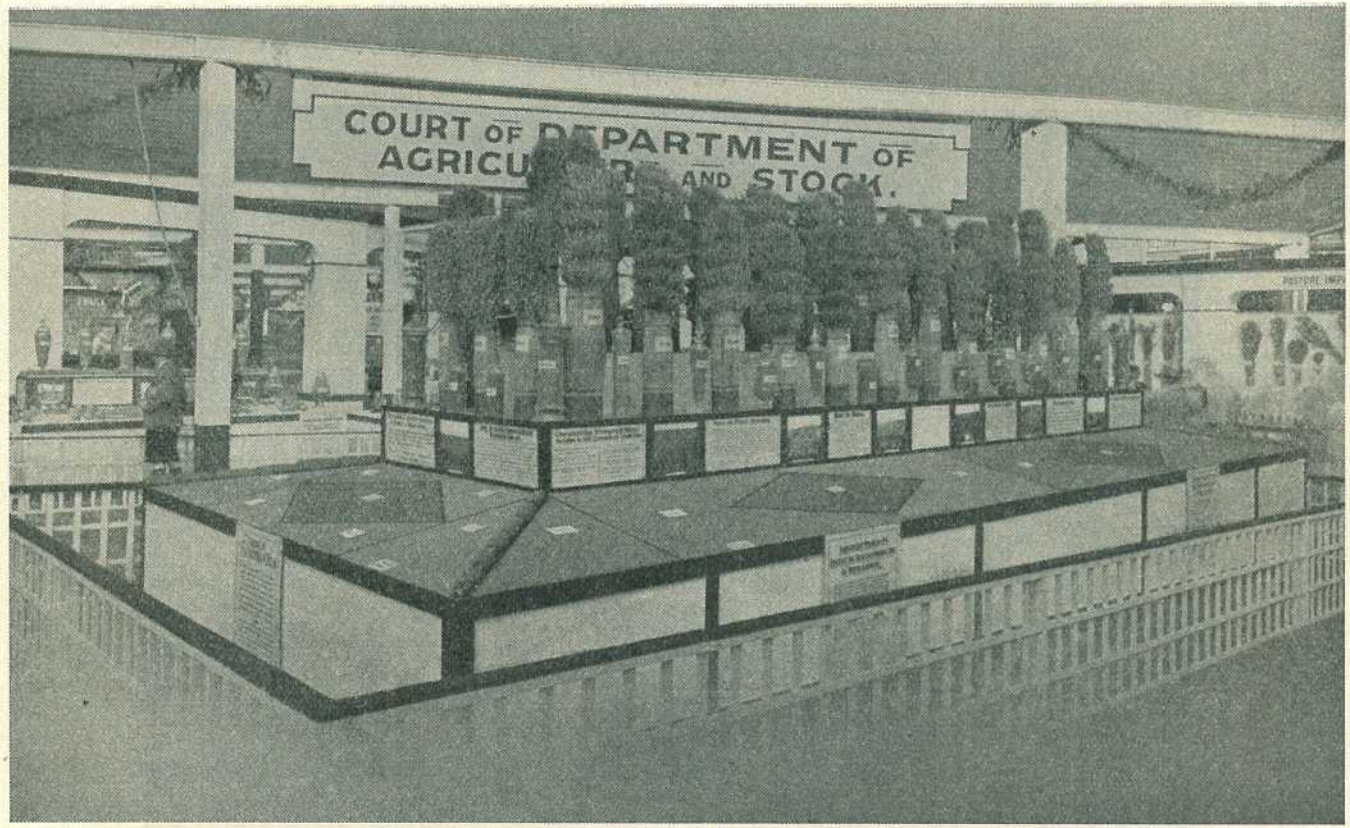


Plate 239.

The central trophy in the Agricultural Court illustrated the "cereal story" of the development of grain growing in Queensland. Wheat in sheaf and grain and corn in cob made a most effective display. The breeding and selection work carried out over a series of years has given excellent results, and the farmer has now a wide choice of high quality varieties. The cultural side was also featured, as the advantage of improved varieties is nullified unless sound methods of farming are regularly practised.

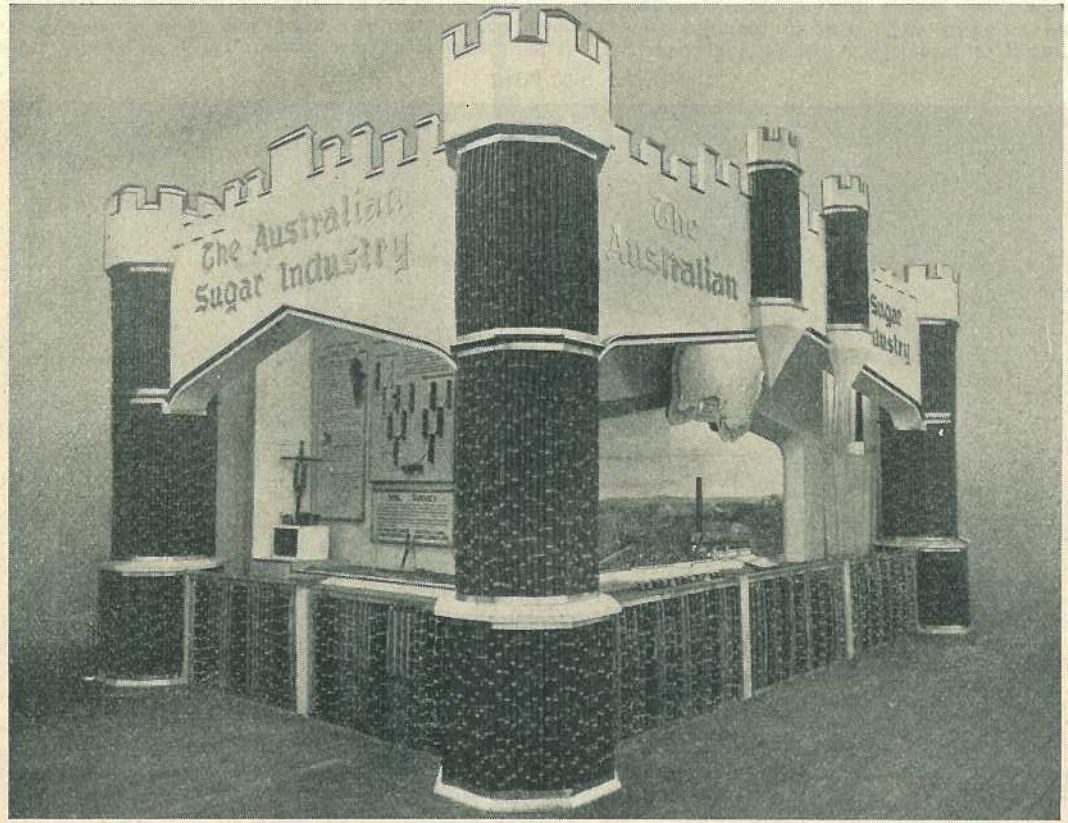


Plate 240.
Every phase of the sugar industry was represented in this impressive trophy.

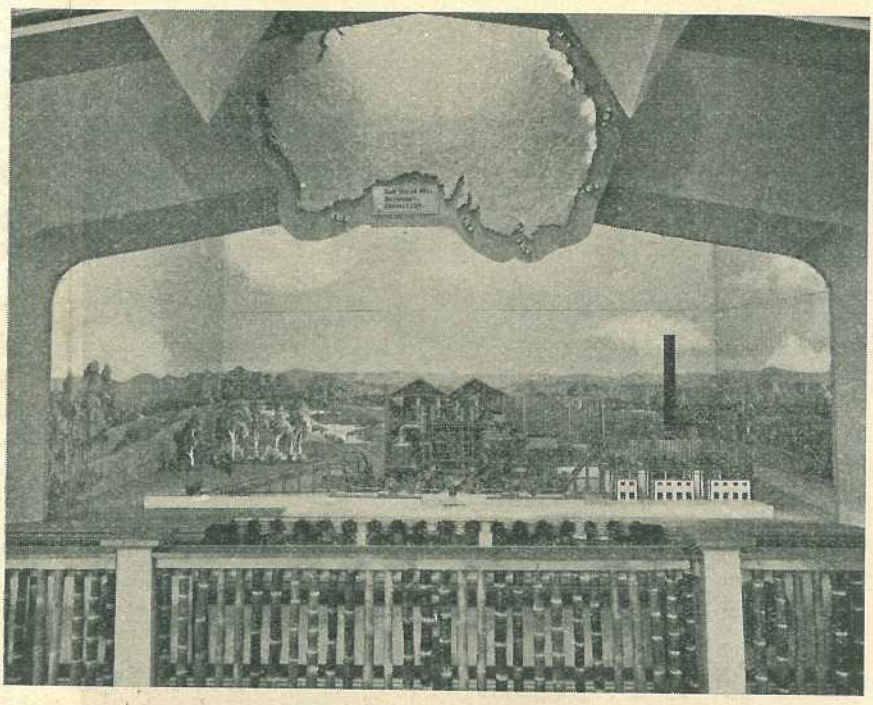


Plate 241.

This working model of a Queensland sugar mill with a background of typical Far North coastal scenery attracted great public interest at the Brisbane Show.

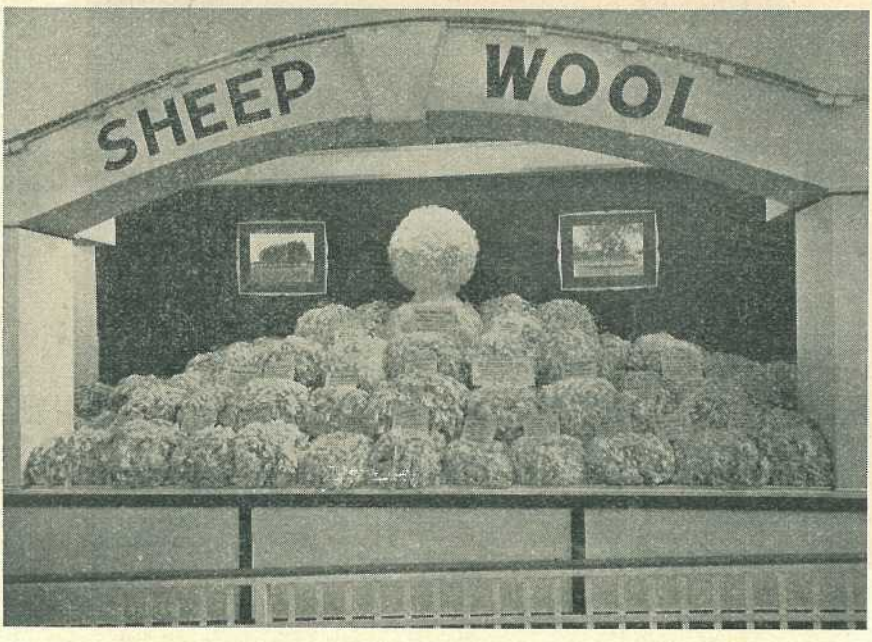


Plate 242.

An excellent show of fine Merino wools up to 90s.

Plate 243.

This bay in the Court of the Department of Agriculture and Stock contained excellent specimens of temperate and tropical fruits grown commercially in Queensland. Grading mechanism and a model of a "flying fox," illustrating the method of transporting bananas in hilly country, were among the principal features of a very fine exhibit.

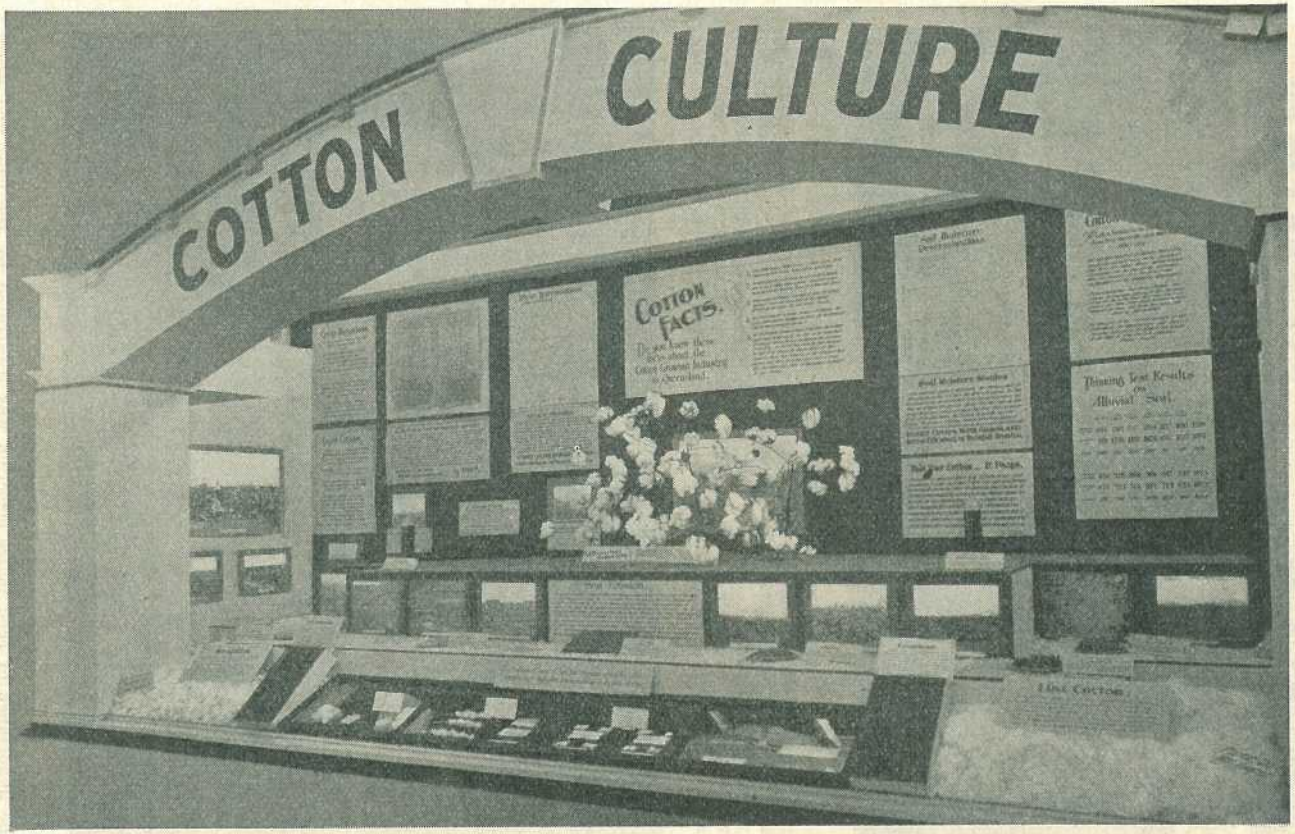


Plate 244.
Cotton facts and concrete evidence of the wealth of Queensland's cotton lands.

Plate 245.

In this exhibit leaf from the Mareeba, Dimbulah, Townsville, Bowen, Mackay, Miriam Vale, and Texas districts was shown, and was graded to show the typical quality, colour, and size of leaf. Of the varieties in cultivation, Hickory Pryor, Yellow Pryor, Cash, Warne, and Gold Leaf are the most popular at present, while leaf of Bonanza, Jamaica, Conqueror, Gold Dollar, and Yellow Orinoco was also on view.

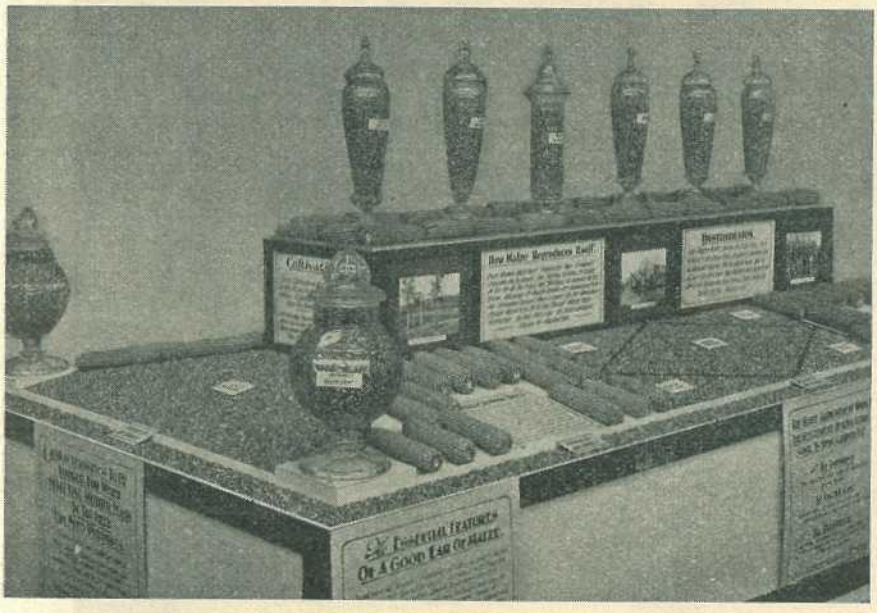


Plate 246.

The importance of seed maize selection was illustrated by the cobs and grain of the four chief varieties featured in this exhibit—Improved Yellow Dent, Reid's Yellow Dent, Funk's 90-Day, and Star Leaming.

Seed maize selection is an important activity of the Department, and its popularity is indicated by the fact that the demand for selected seed invariably exceeds the supply. A high standard has been reached, and efforts are directed continuously towards its maintenance and improvement.

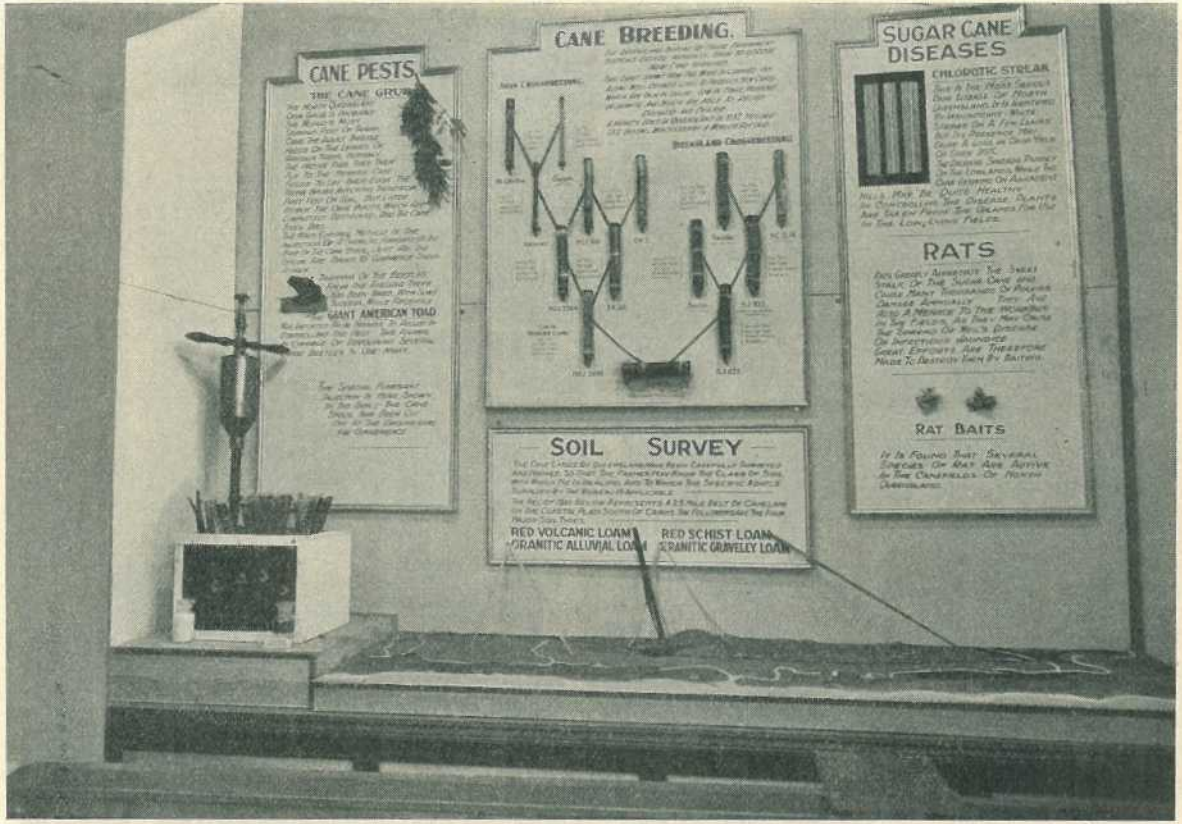


Plate 247.
This informative panel of the sugar exhibit illustrated the extent and value of the work of the Bureau of Sugar Experiment Stations.

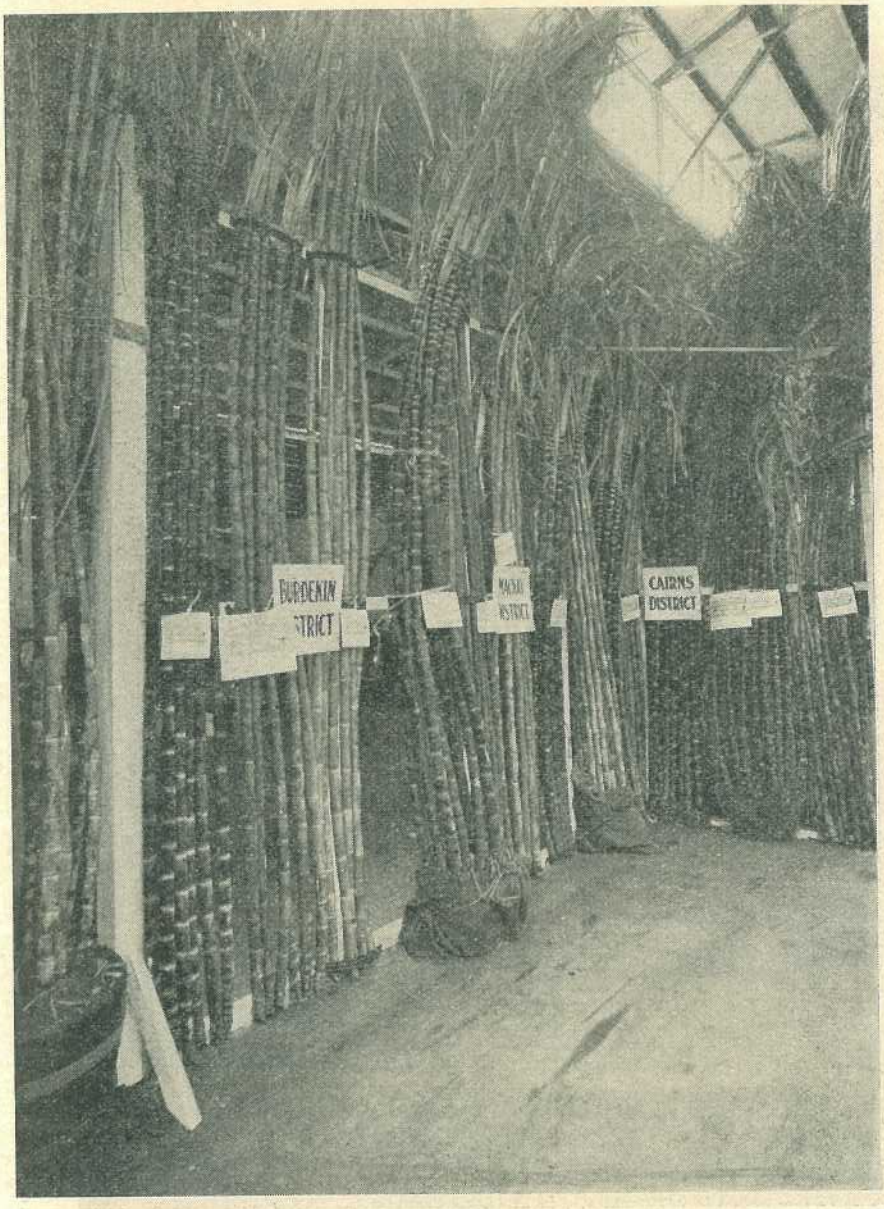


Plate 248.
Outstanding sugar-cane exhibits.

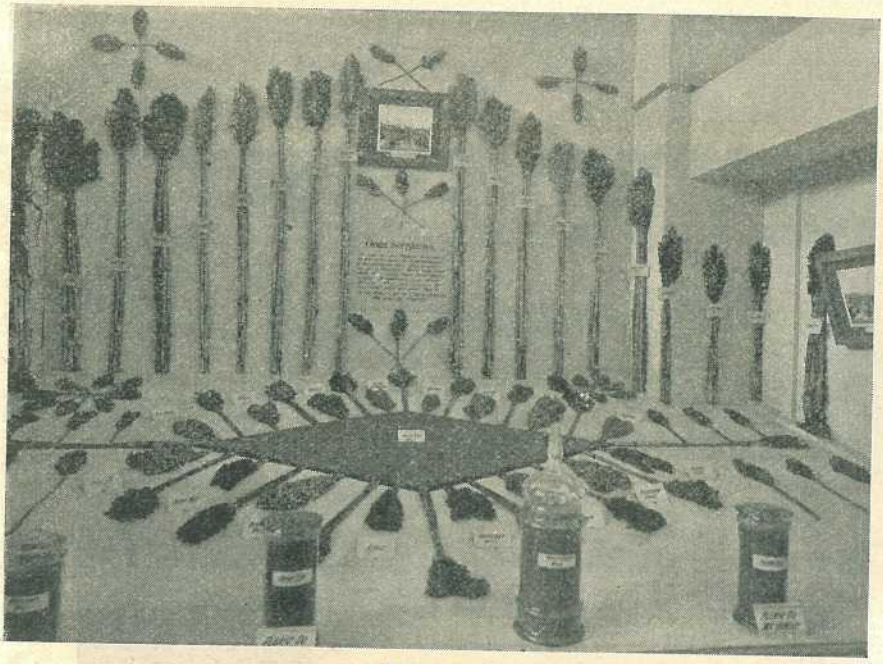


Plate 249.

Sorghums.—This year a section of the Departmental Court was devoted to sorghums, both grain and feed types. At present, a considerable area is sown to the sweet or feed types, which are valued as fodder and silage—suitable varieties being Saccaline, White African, and Imphee. The grain types are not grown to a similar extent, but in view of their ability to yield heavy crops of nutritious grain under climatic conditions which would be fatal to successful maize production, it is considered that a large area could be devoted to their cultivation. An alternative feed grain produced economically would be welcomed by the pig and poultry industries.

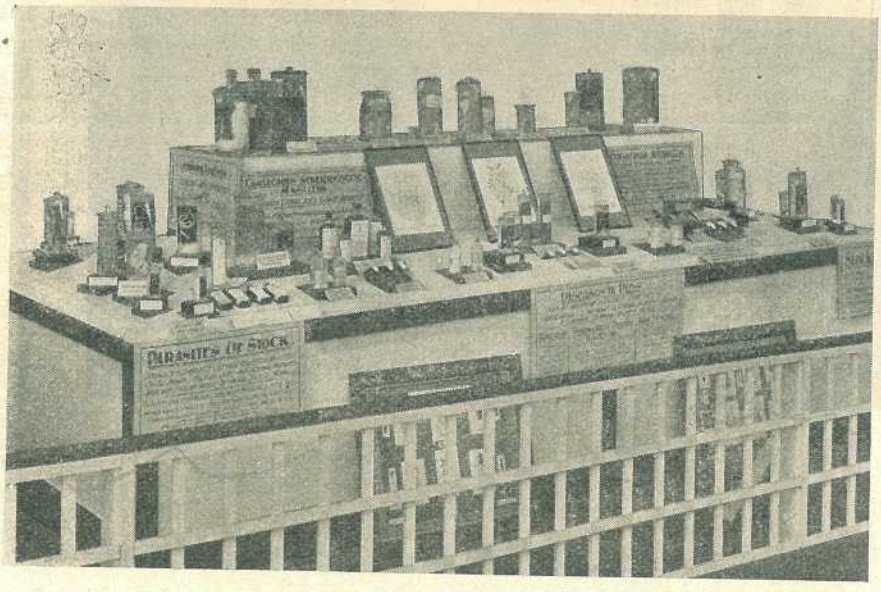


Plate 250.

Some branches of the work of the Animal Health Station at Yeerongpilly were illustrated impressively and effectively by this exhibit.

Plate 251.

AN ARRAY OF GRASSES AND EDIBLE SHRUBS ILLUSTRATED THE IMPORTANCE OF PASTURE IMPROVEMENT.—This year's exhibit comprised sheaves of the more important native grasses from which the pastoral wealth of the State is derived. Living specimens of summer grasses, winter grasses, legumes, and pasture weeds, were also shown, together with a sample of artificially-dried grass.

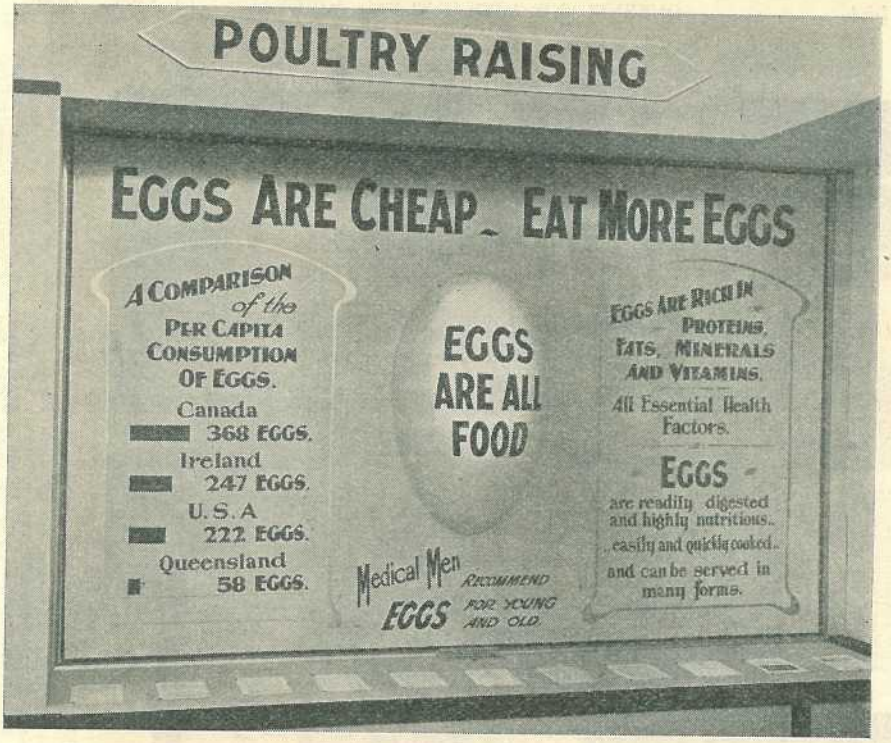


Plate 252.
A striking panel in the Departmental Court.

Plate 253.
The "Journal" Corner in the Departmental Court was a rendevous for farmers from the agricultural districts of the State, both far and near. Mr. Arthur F. Crees, of the Agricultural Branch, is the young officer in charge. Other officers associated with the several divisions of the Department of Agriculture and Stock were in attendance to advise show visitors on matters connected with the exhibits and the laboratory and field work of the Department generally.

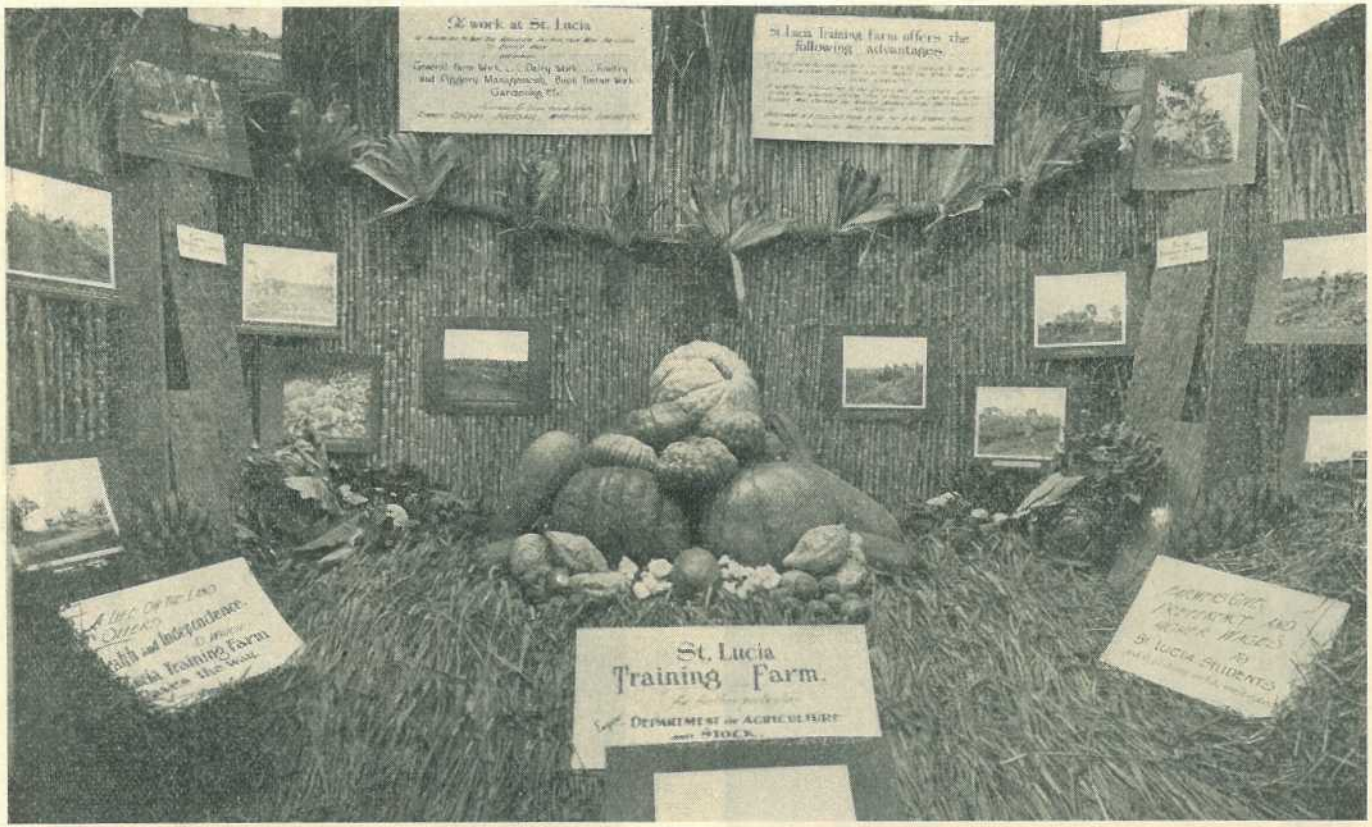


Plate 254.

ST. LUCIA FARM TRAINING SCHOOL FOR BOYS PROVIDED AN EXCELLENT EXHIBIT OF FARM AND GARDEN CROPS.—A free six months' practical farming course for youths and young men is available at St. Lucia. A thorough grounding in the rudiments of every branch of farm work is given amid beautiful rural surroundings on fertile land fronting a reach of the Brisbane River. At the end of the course a farm job for every trainee is guaranteed. Farmers' demand for St. Lucia trainees is far in excess of the number of boys available. This fact is a further demonstration of the practical value of the training that St. Lucia Farm Training School provides.

PRODUCTION RECORDING.

List of cows and heifers officially tested by officers of the Department of Agriculture and Stock which have qualified for entry into the Advance Register of the Herd Books of the Australian Illawarra Shorthorn Society and the Jersey Cattle Society, production charts for which were compiled during the month of August, 1936 (273 days unless otherwise stated).

Name of Cow.	Owner.	Milk Production.	Butter Fat.	Sire.
		Lb.	Lb.	
AUSTRALIAN ILLAWARRA SHORTHORN.				
SENIOR, 4 YEARS (OVER 4½ YEARS), STANDARD 330 LB.				
Cedar Grove Shannon 13th	Con. O'Sullivan, Ascot, *via* Greenmount	8536·5	359·22	Duke of Cedar Grove
Homelea Empress 2nd	J. Savage, Gleneden, Humphrey	9,195·33	345·014	Wonga's Commodore of Springdale
JUNIOR, 4 YEARS (UNDER 4½ YEARS), STANDARD 310 LB.				
Empress 32nd of Sunnyside	P. Moore, Wooroolin	8,592·55	361·378	Bruce of Avonel
SENIOR, 2 YEARS (OVER 2½ YEARS), STANDARD 250 LB.				
Headlands Ruby 5th	E. Althouse, Cloyna	7,266·45	295·889	Kalunga Bruce
H. V. Princess	R. Radel, Coalstoun Lakes	7,171·97	275·786	Burradale Emperor
JUNIOR, 2 YEARS(UNDER 2½ YEARS), STANDARD 230 LB.				
Headlands Rena	E. O. Althouse, Cloyna	7,267·75	256·721	Headlands Red Robin
Headlands Amy 10th	E. O. Althouse, Cloyna	6,356·15	250·977	The Valley Security
Rhodesview Queenie 18th (270 days)	W. Gierke and Sons, Rhodesview, Helidon	5,593·57	247·925	Rhodesview Red Knight
Rhodesview Backer 8th	W. Gierke and Sons, Helidon	6,449·12	247·265	Rhodesview Red Knight
Narvillus Maisie	Con. O'Sullivan, Ascot, *via* Greenmount	5,717·00	240·368	Parkview Mars
JERSEY.				
JUNIOR, 3 YEARS (UNDER 3½ YEARS), STANDARD 270 LB.				
Kensington Butter Queen	Miss. J. Nolan, Lindum	6,717·81	341·566	Banyull Lord Tiddlewinks
JUNIOR, 2 YEARS (UNDER 2½ YEARS), STANDARD 230 LB.				
Dawn Governess	A. L. Walker, Dawn	5,842·2	312·441	Retford Glory's Victor
Elspeth of Calton	A. Geritz, Goomeri	5,623·3	299·314	Retford Glory King II.
Dione of Calton	A. Geritz, Goomeri	5,046·00	292·896	Retford Meteor
Ashview Maureen	C. Huey, Sabine	4,681·4	259·154	Pamela's Armlet of Woodbine
Queen Rose of Romsey	J. Wilkin, junr., Raceview	4,182·68	234·152	Retford May's Victor

Answers to Correspondents

BOTANY.

Replies selected from the outgoing mail of the Government Botanist, Mr. C. T. White, F.L.S.

Notes on Grasses.

W.S. (Oxenford)—

Following are notes you require on the grasses mentioned in your letter:—

1. Perennial rye grass (*Lolium perenne*)—A native of Europe. Generally speaking, the most prized of all the rye grasses, but not particularly persistent under Queensland conditions.

2. Wimmera rye grass (*Lolium subulatem*)—a native of Central Europe and the Mediterranean regions. It first gained some reputation in Australia in the Wimmera districts of Victoria; hence the local name. There it is largely used as winter grass for sowing on worn out wheat lands.

3. Western Districts rye grass—A variety of this grass that we understand comes from the Western districts of Victoria. Hence the local name.

4. Commercial rye grass (*Lolium perenne*)—A form of No. 2, various strains of which are in cultivation.

5. White clover (*Trifolium repens*)—A native of Central Europe and temperate Asia, now widely spread over most warm temperate countries. It is a perennial species, and probably best of all the clovers grown in Queensland.

6. Bokhara clover (*Melilotus alba*)—A plant with a very wide distribution in the southern hemisphere. The typical form is a biennial, though annual strains are frequent. Like common melilotus it possesses rather a distinctive odour and flavour, and stock have to become accustomed to it before they take to it readily.

7. Subterranean clover (*Trofolium subterranean*)—A native of western and southern Europe. It plays no important part in agriculture in its native countries, nor in North America, where it has been introduced, but in the southern States of Australia this plant has proved itself one of the most useful and important factors ever introduced, especially for the improvement of the carrying capacity of second class country. It is of annual duration.

8. Burr clover (*Medicago denticulata*)—a native of southern Europe. An annual clover that does remarkably well under Queensland conditions. The only drawback to it is that the burrs cause some trouble in sheep country, particularly infesting the belly wool, but probably the plant's good points outweigh its bad.

9. Sheeps Burnett (*Proterium sanguisorba*)—Native of southern Europe and the Mediterranean region. A perennial plant of remarkable persistence under Queensland conditions.

Sandalwood.

R.H.F. (Bowenville)—

Santalum lanceolatum, Queensland sandalwood. This is quite different from the tree usually called sandalwood on the Darling Downs. It is identical, however, with the tree the timber of which is exported extensively from North Queensland. For many years we thought that the southern trees did not possess any scented timber, but the larger specimens when cut into are found to possess a heartwood with quite a strong sandalwood odour. Plum tree and damson are names sometimes given to this tree or shrub, and it is generally regarded as being quite useful as a stock fodder. Some of the fruits you mention are galled.

Prickly Supple Jack.

A.T.M. (Dayboro')—

The specimen is *Smilax australis*, sometimes called the prickly supple jack. It is a member of the family *Liliaceæ*, and is closely allied to the plant that produces the sarsaparilla of commerce.

Central District Plants Identified.

A.A. (Rockhampton)—

1. Leaves only, but we think they are of the white cedar *Melia dubia*. Would like to see later on in flower to make sure, as there are some imported trees with similar foliage. We presume, however, that this is a native.

2. *Chenopodium ambrosioides*—Worm Seed. A native of the warm parts of America now a very common naturalised weed in Queensland. The seed of this and allied species provide worm seed oil, which is extensively used in the hookworm campaign and generally as an anthelmentic.

3. *Eclipta alba*, a very common weed in parts of Queensland, not known to possess any poisonous or harmful properties.

4. *Solanum sp.* No flowers or fruit, therefore not possible to tell the species, but one of several prickly species of solanum known in Queensland as devil's needles. We have not heard of its being harmful to stock in any way.

5. *Solanum verbascifolium*—wild tobacco. A very common tropical weed in Queensland, particularly as second growth. The berries seem to be eaten freely by poultry as they fall from the bushes, and so far as we know have not caused any trouble.

6. *Acanthospermum hispidum*—star burr—a native of tropical America, now a naturalised weed in many warm countries. It is one of the worst weed pests of North Queensland.

Burnett Specimens Identified.

A.D. (Bundaberg)—

The specimens have been determined as follows:—

1. *Themeda australis*—kangaroo grass. One of the best-known grasses in coastal Queensland; it does not stand heavy stocking, although strains that stand heavier stocking than usual have been reported to us from time to time. This is one reason why the grass is so common along railway lines.

2. *Dicanthium sericeum*—blue grass. Various forms of this grass occur in Queensland, some coastal and some inland. It is generally regarded as an excellent fodder, but not particularly drought-resistant.

3. *Asclepias curassavica*—milky cotton bush. Also called red head or yellow oleander; a native of West Indies and tropical America, now a naturalised weed in Queensland. It has been proved by feeding tests to be poisonous to stock, although generally speaking they rarely eat it in sufficient quantities to cause trouble.

"Headache Vine."

M.E.H. (Murgon)—

The specimen is *Clematis glycinoides*, the headache vine. It is a native plant, and is fairly common in different parts of Queensland. The local name arises from the fact that if the green leaves are crushed in the hand and inhaled strongly, an irritation is set up somewhat similar to pepper being thrown at the nose. The eyes and nose start to run, and the headache is said to be cured. The plant has not been investigated chemically so far as we know.

Land Measurement.

B.G.—

With a width or frontage limit of 1½ chains the depth of ¾ of an acre would be 5 chains.

General Notes

The Late Mr. Dignan—A Fine Tribute.

In his annual report to Parliament, the Public Service Commissioner, Mr. J. D. Story, I.S.O., pays a moving tribute to the memory of his late Deputy. Mr. Story writes:—

By the death on 18th July, 1936, of the Deputy Public Service Commissioner, O. J. H. C. Dignan, B.A., after a brief illness, the country suffered a severe loss. As he was but fifty years of age, he had, in ordinary course, many years of usefulness in store. He was steeped in Public Service lore, mature in experience, and wise in judgment. With him, knowledge had come but wisdom had not lingered. The man has gone but his memory will live and be cherished. Mr. Dignan's career was an inspiration; though the State Service has lost by his death, his life has enriched its traditions.

Trans-Border Stock Restrictions.

In a recent statement made by the Minister for Agriculture and Stock (Mr. Frank W. Bulcock), he expressed the opinion that certain restrictions now placed on the entry of Queensland stock into New South Wales could, with advantage, be reviewed, and accordingly instructions were issued for the Chief Inspector of Stock (Colonel A. H. Cory) to confer with the Chief Veterinary Surgeon, New South Wales, on the matter.

As a result of representations made by this State, it is now probable that cattle from the tick-infested area in Queensland, known as Schedule "S," if travelled on the hoof, will be permitted entry into New South Wales on one dipping, under supervision, prior to departure from the centre where they are depastured, and another at the crossing place prior to entry into New South Wales, and the present restriction requiring their detention on the Darling Downs for a period of two months will be waived. The Minister pointed out that this concession should be of considerable advantage to stockowners consigning cattle to New South Wales. It is also understood that the New South Wales authorities will permit bona fide working horses and horses from Toowoomba and other tick-free centres to enter New South Wales at Tweed Heads, after spraying instead of dipping as is now insisted upon.

Confirmation of these modifications of the Regulations is now awaited from the New South Wales authorities.

Another Northern Wild Life Sanctuary.

Milray lagoon and swamp, on Milray Station, Pentland, has been declared a sanctuary under the Animals and Birds Acts.

Sugar Levy.

Regulations have been issued under the Primary Producers' Organisation and Marketing Acts, empowering the Queensland Cane Growers' Council to make a particular levy on all cane growers at the rate of one penny per ton of sugar cane harvested during the current season, the amounts raised by such levy to be expended on matters of an economic, legal, or compensatory nature, where such matters are of vital importance to the sugar industry generally.

Growers are given an opportunity of petitioning, on or before 5th October next, for a poll on the question of whether or not the above levy should be made.

Staff Changes and Appointments.

Mr. L. G. Walker, Inspector of Stock, Cunnamulla, has been appointed also an Honorary Ranger under the Animals and Birds Acts.

Mr. J. A. Mobbs (Ormeau) has been appointed an inspector under the Diseases in Plants Acts, Department of Agriculture and Stock.

Mr. M. Custance, Slaughtering Inspector, Coolangatta, has been transferred to Southport.

Mr. W. P. Hamon, Clifton Station, Ubobo, has been appointed an Honorary Ranger under the Animals and Birds Acts.

Mr. E. C. Dunn, Inspector of Stock, Boondooma, has been appointed also an Inspector of Dairies, and Messrs. F. T. Heers and J. V. Smith, Inspectors of Dairies at Bundaberg and Murgon, respectively, have been appointed also Inspectors of Stock.

Messrs. D. M. Corbett and H. J. Heidke have been appointed assistant cane testers for the balance of the sugar season at the Invicta and Farleigh sugar mills, respectively.

Messrs. E. M. Catherwood (Day Dream Island) and A. Shepherd (Milray Station, Pentland) have been appointed honorary rangers under the Animals and Birds Acts.

Mr. L. E. Nichols, Assistant to Dairy Bacteriologist, Department of Agriculture and Stock, has been transferred from Brisbane to Toowoomba.

Mr. E. F. Duffy, Inspector in Fruit Culture, has been transferred from Bowen to Manly; Mr. S. F. Kajewski, Inspector, Diseases in Plants Acts, from Brisbane to Bowen; and Mr. J. A. Mobbs, Inspector, Diseases in Plants Acts, will be attached to Brisbane.

Messrs. M. Buchanan, Gympie, and K. R. Hack, Nerang, have been appointed Growers' Representatives on the Banana Industry Protection Board until the 30th September, 1937.

Mr. K. M. Ward, M.Agr.Sc., of the Department of Agriculture, Victoria, has been appointed Assistant Horticultural Research Officer, Department of Agriculture and Stock, Brisbane.

Mr. C. R. Mulhearn, B.V.Sc., Government Veterinary Surgeon, Department of Agriculture and Stock, and Mr. G. D. Daly, Assistant Bacteriologist, Animal Health Station, Yeerongpilly, have been transferred to the Animal Health Station, Townsville.

Mr. A. McDowall, Stock, Slaughtering, and Dairy Inspector, has been transferred from Coolangatta to Gladstone.

Farmers' Assistance (Debts Adjustment) Act.

A Proclamation has been issued under "*The Farmers' Assistance (Debts Adjustment) Act of* 1935" appointing the 31st March, 1937, as the date within which any farmer who proposes to effect a composition or scheme of arrangement with his creditors in satisfaction of his debts, or part of them, may make application to the Rural Assistance Board for assistance to give effect thereto.

Honey Board Levy.

A Regulation has been issued under the Primary Producers' Organisation and Marketing Acts extending the Honey Board Levy Regulations published on 14th April, 1934, for the period from 1st April, 1936, to 8th March, 1939. The levy applies to all growers of honey and beeswax, and is at the rate of 1½ per cent. of the proceeds from sales.

Rural Topics

Worms in Sheep.

Within recent years, the problem of control of the parasitic worms in sheep has been given a good deal of attention in various parts of the world, more especially in South Africa, England, and Australia. Previously, treatment by means of drugs was successful only in the case of the stomach worm. Worms inhabiting the small intestine, e.g., the hair worms, and the large bowel, e.g., the nodule worm, were practically unaffected by drugs given in the ordinary way through the mouth.

The inefficiency of administration of drugs given through the mouth against hair worms and the nodule worm was found to be due to the fact that, under the conditions usually accompanying treatment, the drug passed into the first stomach or paunch and thus became diluted to such a degree that by the time it passed through the three remaining stomachs of the sheep it reached the intestine in too weak a concentration to be in any way effective against the worms situated there or lower down in the gut.

The process of swallowing in sheep is governed by a groove which passes from the gullet along the roof of the first and second stomachs and eventually into the fourth stomach, which then leads directly into the small intestine. When the sheep grazes, the food is passed directly into the paunch, to be later brought back into the mouth, chewed as a cud, and then swallowed again. This time, however, the groove closes and the thoroughly masticated food goes direct to the third stomach or bible and then is passed on with little delay into the fourth stomach or rennet. When the sheep drinks, the groove is again closed and the water passes almost directly into the fourth stomach. It was therefore considered that if some way could be found of getting this groove to close during treatment, the drug would pass directly into the fourth stomach and would reach the worms in the small intestine and large bowel in a sufficiently high concentration to kill most of them.

After a large number of experiments, copper sulphate was found to produce this effect. Various strengths from 1 per cent. to 10 per cent. were tried, and it was found that a very small quantity of a 5-10 per cent. solution gave very consistent results. This work was carried out simultaneously in Australia and South Africa. For the small hair worms, nicotine sulphate was then combined with the copper sulphate, and very excellent results were obtained. This drench was found to be effective against stomach worms and tape worms as well. Another point which was brought out by this work was that starvation before drenching was not desirable. It was previously considered that by a starvation period prior to drenching, the locality in which the worms were present would be rendered free of ingested food and thus allow better contact of the drug with the worms. Actually, it was subsequently found that this effect was more likely to be obtained without starvation, for with starvation the animals brought up the food from the first stomach, ruminated it, and then swallowed it into the fourth stomach, thus surrounding the worms therein and in the small intestine with the ingested material Details of this treatment may be obtained on application to the Animal Health Station.

In South Africa, work along these lines has been continued against nodule worm. It was found that by first placing in the mouth 2½ c.c. of a 10 per cent. copper sulphate solution the groove closed, and then by giving immediately afterwards a powder of copper tartrate, copper arsenate, and calcium hydroxide, a high efficiency against the nodule worm could be secured by two treatments on successive days. This treatment is now being tested in Australia, and is not yet available to the grazier.

Champion Large White Sow Farrows Large Litter.

The champion Large White sow, "Grinton Sunbeam," imported from New Zealand by Mr. J. A. Heading, of Murgon, and regarded as the best sow of her breed yet exhibited at a Queensland show, farrowed a litter of nineteen pigs soon after the Brisbane Exhibition. Some doubt was felt as to the wisdom of transporting this sow by rail to Murgon when it was known she was within a day or two of the due date for her litter, but Mr. Heading decided to take the risk, making special provision for the comfort of the sow in a railway waggon. Two of her first litter were also prize-winners at the Exhibition, indicating her capacity to reproduce her excellence.

Grow More Passion Fruit.

There is a very much greater demand for passion fruit, both locally and for export, than Queensland produces, and as this State grows a passion fruit of the very highest quality, it should be produced to a greater extent than it is. As an occupation on the orchard, it is one of the most pleasant. Previously, production of this fruit has been chiefly undertaken as a sideline only—a kind of secondary affair, which, if it yielded a return, so much to the good; if it didn't, well, it did not matter a great deal. With the ever-expanding demand, it warrants being made a principal crop, and being subjected to kind treatment.

Vines are prone to several diseases, which, with proper attention, can be controlled, but which, when the vines are allowed to grow uncared for, quickly destroy them. Due to these diseases and the haphazard method of cultivation frequently employed in the past, the idea has become current amongst the orcharding community that vines can only be grown for about two, or at most three years. That this is erroneous is being demonstrated at the present time by vignerons who have made passion fruit growing their main occupation, and who have vines bearing well at seven years of age. These growers, however, prune correctly, and spray at the correct times, as advised by the Department. They also grade and pack their product for market, and the result is they are reaping the benefit of an excellent monetary return.

It is stated by some that passion fruit growing entails too much work pruning and spraying, and the results are not worth it. A careful analysis of the position will refute such statements. Pruning the vine undoubtedly is a tedious and lengthy operation. Spraying also is objectionable, but remember that citrus growers, grape growers, and practically all other kind of fruitgrowers must also prune and spray their trees. So far as returns are concerned, good vines produce up to half a bushel of fruit per year. They are usually planted 15 feet by 8 feet apart, or 363 vines per acre. Prices vary from 22s. 6d. per half-bushel during the periods of scant supplies to 4s. 6d. per half-bushel paid by the local factories. From these figures orchardists can estimate for themselves the likely returns. On a conservative average of 3s. 6d. per half-bushel clear of marketing expenses the return would be £63 per acre per annum. Are there many other fruit crops netting orchardists this sum per acre?

A pamphlet giving full cultural details is available free on application to the Department of Agriculture.

Briefly, for the guidance of those who may be considering planting, it should be remembered that the passion vine is a climber, and thrives in warm, moist situations, preferably in the coastal districts. It grows well on the coastal highlands, like the Blackall Range and Tamborine Mountain, and also on the lowlands between these and the sea. The vine will resist light frosts, but heavy frosts will cause damage.

Reasonably fertile scrub and forest loams, provided they are well drained, are suitable soils, and if a hillside site is chosen, it should be well sheltered from heavy winds and preferably have an easterly or north-easterly aspect. It is important that the trellises be strongly made, and that they be at least 6 feet in height.

Two crops are borne each year—a summer and a winter crop—whilst occasionally intermediate crops are borne.

Spring is the best time to plant, though autumn planting is sometimes practised. Spring-planted vines sometimes return a small crop the following winter, but the first main crop can be looked for twelve to fifteen months after planting. With autumn-planted vines the first main crop is often not obtained until eighteen to twenty-one months after planting.

Cream Supplies—An Unwise Practice.

An unwise practice which has been indulged in by a few dairy farmers, has been reported during the week. This is the addition of water to cream, in the hope that it will be weighed and paid for as cream. If the practice were not so serious and full of potential danger to cream quality, it could be dismissed as ridiculous; but it is a serious matter and farmers should take heed of this note of advice.

The addition of water to cream is in no way beneficial, for the following sound reasons:—

(*a*) All cream arriving at a factory is tested by the Babcock Test, which indicates the total amount of fat that is in the can. The addition of water cannot possibly increase this amount of fat. What it does, in fact, is to lower the fat percentage or test of the cream.

(*b*) Addition of water means increased freight to the farmer.

(*c*) Water of doubtful purity, if added to cream, will seriously spoil its quality, and lower grades mean smaller cream cheques.

(*d*) Last but not least, there is a penalty attached to such malpractices.

There is nothing to gain and plenty to lose in the playing of such a game.

Sweet Potatoes.

The initial preparation of the areas intended for summer cropping should have been completed ere this, seeing that the rains essential for the carrying out of such work satisfactorily were experienced some time ago.

Planting of English potatoes will be in full swing in areas not subject to late frosts, and a prospective planting of sweet potatoes on those farms having suitable soils should now be commenced. Why this crop continues to be neglected to the extent it is is very difficult to understand. At the present time in the coastal areas it is not grown to anything like the extent its value as a stock food warrants, though it is not in this section alone of the State, but in the Western farming districts where its utter absence as a farm crop is more difficult to understand, more particularly when the suitability of the lighter soils found there and the ability of the crop to yield under droughty conditions are taken into consideration. In these localities, not only are the tubers capable of furnishing a first-class fattening food for pigs, but varieties can be grown which would with the proper storing of tubers, provide the farmer's table with at least one admirable vegetable over a goodly portion of the year. In addition to this, it is claimed in some quarters that the vines make excellent cattle food, though considerable care is recommended in respect of this, as cases of supposed stock poisoning have been reported from time to time as a result of eating the vines.

Although a sandy soil rich in organic matter is the most suitable type for this crop, any soils, other than clayey, which are wholly unsuitable, will give good returns.

As with other crops, success depends upon the preparation of the land for its reception. In this instance, the initial working should consist of ploughing as deeply as the nature of soil will admit. The secondary preparation should consist of its being worked to a depth of about four inches. Sometimes it is possible to defer the second working until planting is contemplated, enabling the two operations being carried out together, but this is controlled more or less by the condition of the land as to weeds, the period of the season, and the stage reached by the cuttings.

Work Among Bees.

In the Queensland coastal districts the bees are now commencing their activities outside the hive, but in more inland districts and on the Downs, the active season will not begin until this month.

With the opening of the earliest spring flowers and the accompanying rise in temperature, the bees venture forth to get the small amounts of nectar and pollen thus provided. As the weather becomes warmer the supplies rapidly increase, and the bees are greatly stimulated to build up the colony. Brood-rearing begins as soon as the new supplies come to the hive, and as the first bees emerge they in turn increase the capacity of the colony for brood-rearing, so that with a good queen and other favourable conditions, the amount of brood is rapidly increased.

The main object of the work in the spring is to ensure an abundance of bees in time for the coming honey flow, but during early breeding the bees should be disturbed as little as possible. In order to ascertain whether the bees have sufficient stores, the weight can be judged by tilting or lifting the hive, or the size of the cluster may be ascertained without breaking the propolis which seals the cover by looking at the combs from below.

On the first examination, which should take place when all danger of frosts is past, the beekeeper should look especially for queenless colonies. If any are found, it is best to unite these with normal colonies if queens are unobtainable. When uniting, two weak colonies should not be placed together, but a weak colony may be united with a strong one. If desired, the number can be restored later on, by subsequent division. The beekeeper should also examine the stores, for bees require large amounts of food during the spring, and, while they usually obtain considerable nectar outside, it is rarely enough to provide stores for the very rapid rate of breeding that is necessary at this time. If food is needed it may be given rapidly in the form of thick sugar syrup, or it is even better to provide combs of honey.

For those who are desirous of increasing their apiaries, this is a good time to purchase additional colonies, although the prices asked now are usually higher than those ruling in the autumn months. Bees purchased now are not only easier to transport while the weather is still cool, but they may also be expected, during normal seasons, to bring in an immediate return. If the hives are to be moved by motor truck, the combs should be placed parallel with the axle, but if it is intended to transport them by rail, the combs should be parallel with the rails.

Black Scurf or Rhizoctonia Disease of Potatoes.

Black scurf or Rhizoctonia disease of potatoes has been very prevalent in many consignments of seed potatoes arriving in Queensland during recent months, the presence of that disease resulting in numerous condemnations.

This disease receives its common name from the fact that the fungus causing it is present on the tubers as small black lumps very similar to small lumps of soil. They are easily distinguished from lumps of soil, however, by the fact that when wet they are deep black and are not easily washed off. These black lumps are the sclerotia or resting bodies of the fungus. The presence of these resting bodies on table potatoes would not cause an appreciable decrease in their market value.

If potatoe seed bearing these black lumps is planted, the resting bodies throw out cottony threads of fungus, which may grow up to the young potato shoots, attacking them at about ground level or even higher up, causing a rotting and dying away, or in the dry weather a wilting and shrivelling. The plant throws out more shoots which are usually small and stunted, giving it a bunched appearance. Aerial tubers may be borne on these shoots. The fungus may attack the plants in a very young stage, causing "misses" in germination. Affected plants produce few and small tubers, and yield is reduced very considerably if infection is severe.

As can be seen from this description, the disease is carried on the seed by the black resting bodies of the fungus. The fungus, however, once introduced into an area, is capable of attacking plants other than the potato and is able to remain alive in the soil for a number of years. By treating the potato seed before planting the black resting bodies of the fungus can be killed, but if the treated seed is planted in soil which already has the fungus in it some diseased plants must be expected.

In order to prevent losses from black scurf a rotation of crops should be practised, and seed selected which is free from this and other forms of scab. As an additional precaution the seed may be treated on the farm with either of two fungicides, namely, acidulated corrosive sublimate or hot formalin solution. Particulars regarding these treatments may be obtained on application to the Department of Agriculture and Stock.

A Substitute for Milk in Pig Feeding.

Once again at this time of the year most pig raisers are faced with the problem of feeding pigs with little or no milk. It is generally known that meatmeal is a good substitute for separated milk in the pig's diet, but unless it is used carefully, meatmeal may prove an expensive food.

Meatmeal, which is a by-product of abattoirs and meatworks, is sold under several trade names and some varieties contain a small percentage of bonemeal. It is a wholesome food, convenient to use, and costs from 9s. to 10s. 6d. per 100 lb. bag, Brisbane, the higher-priced brands containing a higher percentage of protein.

As meatmeal is so expensive in comparison with other pig foods, it should not be used more freely than is necessary.

Separated milk, which meatmeal replaces, is used according to its availability, pigs sometimes receiving milk as their sole diet, but actually pigs will thrive on very small quantities of milk used in combination with grain and other foods such as pumpkins and sweet potatoes; the milk supplies a large part of the protein necessary to balance the ration. Each pig from weaning until baconer stage and each dry sow should receive a minimum of three-quarters of a gallon of separated milk daily, and each sow with a litter double that quantity.

When these minima quantities of separated milk are not available, meatmeal may be substituted, using ½ lb. of meatmeal to replace each three-quarters of a gallon of separated milk.

Pigs thrive on a mixture of milk and meatmeal, or meatmeal alone as the protein-rich portion of the diet. The quantities used should not exceed from ¼ to ½ lb. daily per pig from weaning to baconer stage, according as to whether good lucerne is available or not; and ½ lb. for each dry sow and 1 lb. daily for each sow with litter.

By feeding a constant quantity of separated milk or meatmeal, and increasing the grain and other foods according to the pig's appetite, the nutritive ratio is automatically widened as the pig grows and satisfies its requirements.

In cases where pigs have access to good young pasture or green crops, the minimum quantity of separated milk or meatmeal stated above may be reduced by up to 50 per cent., depending on the quality of the green foods.

Meatmeal may be fed dry or mixed with milk or water

The Apiary.

Now that the days are becoming warmer, it is desirable that all the hives should be thoroughly cleaned. This is best effected by providing a clean spare hive, and transferring to it the frames, one by one, after scraping the wax and propolis from the top bars. The hive thus emptied is then thoroughly cleaned, all the burr-comb, propolis, wax, moth cocoons, and other debris removed, after which it is ready to accommodate the frames and bees from the second colony. This change into a fresh hive is continued throughout the entire apiary, taking care, however, that the original position occupied by each hive is not altered.

When the colonies are being overhauled, any hives that are leaning should be levelled up, as this will result in straighter combs being built. The queens should also be looked for, before the colonies become more populous. Note their age, and if, from the small size of the brood nest, their egg-laying capacity appears to be declining, their hive numbers may be entered in the notebook as being among those which require requeening.

At this time any faulty combs that do not contain brood may be removed. If brood be present, the faulty comb should be gradually moved outside the cluster to the side of the hive, and then removed after all the brood has matured. The spaces may be filled with frames containing full sheets of foundation, as the hives should never be left without their full complement of frames.

One of the chief aims in manipulating bees is to endeavour to have them at their maximum strength at the time of the chief nectar-flow. Observations of the local flora, with a careful note of the buds showing on the various eucalypts or other trees, together with a record of the rainfalls and climatic conditions generally, are good guides in this respect. If the chief flow occurs early in the season, preparations should have been made during the previous autumn to see that each colony possessed a young queen, and that they had sufficient stores. The ideal to strive for is two full-depth bodies filled with brood, and if this strength can be built up just before a nectar-flow, the bees will fill two or even three honey supers, as a young, high-grade queen will be able to keep two hive bodies filled with brood during an average season. As the consumption of stores by weaker colonies is just as great as by strong ones, and as they give less surplus honey, it is evident that a moderate number of strong colonies is a better business proposition than a larger number of weaker ones, besides requiring less work. Furthermore, an apiary containing colonies of even strength is an indication of the beekeeper's skill and good management.

Metallic Flavour in Butter.

The metallic flavour in butter may have several causes. Among them is the condition of or care bestowed on the various pieces of machinery used in neutralising, pasteurising, and holding cream. As a rule the metal surfaces of all cans, pasteurisers, and vats are kept in a first-class condition, but it sometimes happens that farmers, manager, buttermakers, and others are a little too eager to substitute some strong alkali washing powder for elbow grease. By sprinkling the dry powder on the metal surface of the vat, coil, or pasteuriser, they cause an undesirable chemical action, resulting in the solution of the tin coating, the exposure of the base metal, and the metallic flavouring of the butter. All persons responsible for this work are, therefore, advised strongly to always use only a very little diluted alkali washing powder in cleansing their machines and apparatus, and to rinse them thoroughly with clean, sterile water after washing them. It is a good plan to protect the tinware from strong alkali or metal brushes, or anything which scratches or corrodes the tinned surface. A rusty vat or can should not continue to be used, but should be replaced by one that is covered thoroughly with a good, clean, smooth coating of tin. Rusted and corroded tinware may be in use on a farm from which the cream is received, so that the butter factory management should not only investigate the condition of its own utensils, but insist on the cream being delivered to the factory in perfectly smooth, well tinned, seamless cans. This is a provision of the Dairy Produce Act.

Cream should be delivered before it becomes exceptionally sour, and not allowed to stand in either tin cans or vats for too long. Otherwise, the action of the high acid of the cream on the metal of the cans or the vat is likely to be responsible for a part of this metallic flavour. Cans that are too large for conveyance of cream to the factory, that is, say, an eight or ten-gallon can, with only one or two gallons of cream in it, should not be used, for metallic flavours are likely to arise through the cream splashing around the sides of the can during transport to the factory.

The Nutritive Value of Pasture Plants.

Numerous inquiries are received each year by the Department of Agriculture and Stock from dairy farmers and other stockraisers regarding the relative values of different grasses and clovers for cream production and for fattening stock. One inquirer might ask whether Kikuyu grass is as nutritive as paspalum; another query a report that some newly-discovered grass is as valuable a feed as lucerne. To all who seek information of this nature, three facts must be pointed out:—

1. Chemical analysis gives some idea of feeding value, but the grazing animal is the final judge.
2. Certain plants have a higher nutritive value than others.
3. Stage of growth has a marked influence on nutritive value.

With regard to the value of chemical analyses in comparing feeding values, it must be emphasised that palatability and digestibility are factors as important as the quantity of the different nutrients in each 100 lb. of the pasture. Obviously, if a plant is distinctly unpalatable, and entirely neglected by stock as a consequence, its feeding value is nil. Again, a particular plant might appear on its chemical analysis to have a high feeding value, yet actually be quite a poor fodder because of the indigestible nature of its chemical contents. Unfortunately, feeding trials to determine the exact value of each of the better known pasture plants would be expensive to conduct, and for the time being palatability and chemical analyses (the latter interpreted in a commonsense way) must form the basis of comparative tables.

It is quite well known that paspalum, Rhodes grass, Kikuyu grass, and lucerne, for example, are of much greater feeding value than spear-grasses, barbed-wire grasses, &c. Feeding trials probably would reveal the former series to contain a higher proportion of digestible nutrients than the latter series, and chemical analyses certainly point that way. Clovers and other recognised pasture legumes generally differ from grasses in possessing a higher proportion of proteins in relation to fats and carbohydrates, but are not necessarily of higher feeding value. Indeed, for all classes of stock a mixed ration of grass and clover (or other legume) is better balanced than a pure leguminous ration.

In recent years much evidence has been collected to show that pasture in its young state is much superior to mature pasture. Short young pasture is well provided with proteins, fats, carbohydrates and minerals all in a highly digestible form. With increasing age the protein and mineral contents fall, and indigestible fibre increases at the expense of the carbohydrates. For this reason, different plants cannot be compared on their chemical analyses unless the samples analysed represent material at approximately the same stage of growth.

Second-hand Bulls.

Second-hand articles are not in demand or favoured by most people. Rightly or wrongly, we have more or less prejudice against being second-hand owner of most things. There is a pride in original ownership, whether it be a fast horse, a record-making cow, or a prize pig. This matter of prejudice or pride may be carried too far, and work injury to live stock progress. Effort is being made by those who realise the value of a proven sire to get all breeders to appreciate the second-hand well bred dairy bull. Some breeders are already following the practice of using no bull except one that has proven himself a getter of good stock. That is the measure of a sire. It is not possible, of course, for all to select a bull that has a line of capable progeny behind him. The old bulls are passing on; new breeders are demanding bulls, and not all bulls should be kept. Plans should be made to keep all sires that have proven themselves getters of good stock, and use them as long as possible. It is not uncommon to find a string of good producing and well formed cows and their sire gone to the slaughter-house, because line-breeding was not considered desirable or because the bull showed signs of being wild. If all breeders appreciated proven blood, the second-hand good dairy bull would sell for more than the new untried bull. Selling a bull under the pretext that he is wild and dangerous is not a sufficient reason, for all bulls should be treated as though they were not to be trusted and provision should be made accordingly.

In the selection of a bull, pedigree records of his ancestors and their conformation, and his type should always be considered. All these items are valuable guides to the breeder who is looking for a bull to head his herd. The crucial test, however, can only be made through use, by seeing and knowing the capabilities of his progeny. It is quite possible for a bull to be well bred and yet be unable to pass his rich inheritance on to his offspring. In short, do not hesitate to purchase a second-hand bull if he is sound, well bred, and has proven himself a good breeder.

Fat Lamb Production.

Recognising that Queensland generally lags behind other States in the production of fat lambs, the Minister for Agriculture and Stock, some two and a-half years ago, inaugurated a scheme for the encouragement of this branch of the sheep industry. Rams of British breeds were purchased in the South and distributed to farmers who had cultivation or promised to cultivate. The necessity for cultivation was urged on all farmers, it being thought by officers of the Department that fat lambs off grass country, even if prime, were more or less in the nature of a fluke. The breeds purchased were Border Leicesters, South Downs, Dorset Horns, Shropshires, and Romney Marsh.

In certain cases where a farmer owned a stud ram of particular breed, stud ewes were supplied with the idea of fostering the breeding of pure stock.

All sheep supplied to farmers are on loan, and remain the property of the Department. The progeny and wool, however, are the property of the farmers concerned.

The interest taken in the scheme, and the results to date, have been highly gratifying, and it is now no uncommon sight to see a pen of true sucker crossbred lambs on sale at Cannon Hill. Prices, too, during the period under discussion have been generally profitable.

The greatest drawback to the production of fat lambs on the Darling Downs in quantity has been, in the past and still is, the difficulty of purchasing good crossbred ewes as the mother flock.

If a start has to be made with Merinos the best ewe for fat lamb raising is bred by the introduction of one of the long wools, such as Border Leicester, Lincoln, or Romney Marsh into the strong-woolled, robust type of Merino ewe. The ewe lambs of this drop should then be retained as the future dams of the lamb-raising flock.

As to suitable ewes for the fat lamb industry, it is believed that graziers on the fringe of the Darling Downs or further out would find it profitable to join long-woolled rams of British breed with their cast-for-age ewes with the idea of selling the progeny annually as fat lamb ewes on the Downs. Into the crossbred ewe flock, as described, should be introduced a ram of the Downs type. Opinions necessarily differ in the matter of crosses. The South Down is the fashionable lamb at the present time, but it should be remembered that this cross must suffer no check from birth to block. The Dorset Horn gives a very nice lamb, early maturing and hardy. The use of the Border Leicester should be encouraged in every way. In addition to an early-maturing lamb filling every want, it must be remembered that the skin value of this lamb is worthy of consideration to a far greater extent than either the Dorset or the South Down.

Pure-bred Corriedale ewes are hard to come by, but should the opportunity occur a farmer would be well advised not to let it slip. Pure Corriedales are hard to beat, good mothers and heavy milkers, besides growing a profitable fleece.

Generally, the wool from a flock retained for fat-lamb breeding is a secondary consideration when compared with the production of fat lambs.

Eradication of Old Tobacco Plants.

The degree of success achieved in the present efforts to establish an extensive and flourishing tobacco industry in this State will be dependent in large measure on the practicability of checking the ravages of various pests and diseases. So far as Queensland is concerned, leaf miner and stem borer constitute a very serious menace to success, and it is essential that the populations of these two insects carrying over from the old crop to the new one be reduced to a minimum.

Much can be accomplished by the elimination of breeding grounds during the months intervening between successive crops of tobacco, because in some of the more important tobacco districts practically nothing but tobacco is grown. Hence, if tobacco plants are uprooted and destroyed by fire as soon as possible after the completion of the harvesting of the leaf, and if volunteer plants are similarly dealt with, the new tobacco crop should get a good start free from any serious infestation. The position will be still further improved if the destruction of these tobacco plants is accompanied by the elimination of several leaf miner weed host plants, which occur in the main tobacco districts, and are botanically closely allied to tobacco. Again, from the point of view of insect control, the production of two tobacco crops in twelve months, which has been attempted in some districts, is fraught with great danger, at least in so far as the incidence of leaf miner and stem borer is concerned, and should be avoided on that account.

The procedure just recommended will, of course, also materially help to reduce the carry-over of tobacco diseases.

Pruning Custard Apples.

Many requests are made to the Department for advice as to the reason for the shy-bearing habit of custard apple trees. Incorrect methods of pruning, and particularly pruning at the wrong time, are in large measure responsible for the trouble.

Custard apple trees possess naturally a vigorous growing habit, and if severely pruned whilst dormant during the winter, respond during the following warm months with an excessive growth of new wood, with the consequent sacrifice of the crop of fruit. The correct time for pruning in order to ensure fruit production is, therefore, most important, and the operation should be delayed until the first rise of sap in the early spring months—in Southern Queensland usually about September. The rise of sap is indicated by the swelling of the buds along the branches and the appearance of very young foliage.

If left to grow unchecked, the trees have an unruly, straggling habit of growth, with the lower branches often resting on the ground. These should be cut away, leaving about twelve inches of space between the lowest branches and the ground. Any young growths arising from the main branches and tending to crowd the inside of the tree should be pruned out, whilst the long, whip-like terminal growths at the outside of the tree should be reduced by one-third to one-half their length in order to form a compact, well-shaped head.

Derris and Cube Sprays and Dust.

Insecticides prepared from a number of species of Malayan plants belonging to the genus Derris have come into favour during recent years. These plants are well known as a source of fish poison, both in Malaya and in the South Seas, where the natives pulverise the roots and throw the resultant powder on the surface of a pool or stream containing fish. The fish are stupefied, rise to the surface, and are then collected by the natives. It has been demonstrated that certain active principles in these plants are also highly toxic to some insects, and insecticides prepared from them possess the great merit of being safe for application to edible portions of plants due for harvesting at an early date. The derris insecticides act both as a contact spray or dust and as a stomach poison, and have given very satisfactory results against the common cabbage caterpillar, the onion thrips, and various species of aphids, including the cabbage aphis.

Cubé is the name applied to a group of South American fish poison plants, which are also a source of insecticides similar to those obtained from the genus Derris.

The derris and cubé insecticides are generally marketed as proprietary lines, and the firms selling the various brands usually supply full details as to the strength of application.

Milk from Newly-calved Cows.

With the approach of spring, dairy farmers should be careful regarding their increased milk supplies, especially colostrum milk. The milk of the newly-calved cow is abnormal, and is called colostrum or beastings. It is yellow in colour, has a rather strong pungent taste, an unpleasant odour, a sickly albuminous flavour, a high specific gravity, high total solids, high albumen, and low figures for fat and sugar. The fat of colostrum has different properties from that of normal milk, and the sugar is largely glucose and not lactose—it also shows a larger proportion of phosphate than normal milk.

Such milk serves only as food for the new-born calf, and not as a means for increasing the supply to the factory. Besides serving as food for the calf it also increases the resistance of the calf to disease during the first few days of its existence. The milk becomes more normal day by day until, in seven days after calving, it is practically normal, although it may take up to a fortnight to attain perfect normal composition.

It is advisable to isolate the newly-calved cows, and for the first seven days at least this colostrum milk should not be mixed with normal milk, either for butter or cheese. Cream from such milk blended with good cream results in the whole delivery being graded down either to second grade, or in being completely rejected. Therefore, do not separate this milk on any account. Colostrum milk is quite unfit for cheese-making, since it is easily coagulated by heat, curdles very slowly with acids and rennet, and results in very poor quality cheese.

Therefore, remember (1) colostrum milk is food for young calves only; (2) it should on no account be sent to cheese factories or as cream to butter factories.

Orchard Notes

NOVEMBER.

THE COASTAL DISTRICTS.

Citrus Fruits.

In the citrus orchard the increase in temperature and the possibility of a dry period call for the utmost attention to soil conditions, particularly aeration and moisture conservation. At the slightest sign of distress, owing to lack of moisture, trees should be thoroughly irrigated whenever water is available for this purpose.

At the same time care and attention should be given to cultivation, particularly on hillside orchards, and in the coastal districts the possibility of the approach of storms will prompt growers to consider the completing of each cultivation by forming shallow drains to care for excess water and prevent soil losses.

Attention must be given to the incidence of mites, which are the direct cause of the darkening of the skin of the fruit known as "Maori." Usually the first indication of the trouble is when, with the sun shining on it, the fruit has the appearance of being covered with a grey dust. If examined with a good lens, the skin will be seen to be covered with numerous yellow slug-like insects which are living on the skin.

Under certain weather conditions scale movement may be expected.

Detailed information regarding insect control may be obtained from Department publications on the subject.

Pineapples.

Continue planting pineapples as discussed in these notes last month, always remembering that the modern practice is smaller areas, close planting with more pineapples per acre, quicker, better, and more healthy growth, and finally better fruit by liberal fertilising through the leaf bases with 10-6-10. Taken all together, these recommendations tend towards the elimination of wilt.

Bananas.

New Plantings.—November and December are very suitable planting months in most districts. Just as modern methods have effected great improvements in pineapple culture, so they might be applied in principle to banana growing. Smaller areas and larger production per acre should cut overhead costs and lighten labour, lengthen the profitable life of the plantation, and reduce the time of waiting for the crop. To this end select planting material with care, plant in large holes, and break up the ground as soon as possible after planting. To prevent the loss of top soil by erosion and to provide the bananas with a cooler and moister environment, plant a cover crop as soon as weather permits, and initial weed growth has been suppressed. This will hold the loose surface soil during the summer rains.

Young Plantations.—The correct follower or followers for each plant should be selected, if not already done, and all additional suckers suppressed. Cultivate to conserve moisture and mulch with a cover crop. A complete fertilizer will improve the coming crop.

Old Plantations.—De-sucker to one follower to each plant. Apply a complete fertilizer, if not already done, and cultivate to conserve moisture.

General.—Bait for borers; be prepared for grasshopper and caterpillar plagues; watch for bunchy top.

THE GRANITE BELT, SOUTHERN AND CENTRAL TABLELANDS.

KEEP the orchards and vineyards in a thorough state of cultivation, so as to keep down all weed growth and conserve moisture in the soil. This is important, as if a long spell of dry weather sets in, the crop of summer fruit will suffer severely from the lack of moisture. Citrus trees should be irrigated where necessary, and the land kept in a state of perfect tilth. Spraying for codlin moth should be continued, and all pip fruit trees must be bandaged at the beginning of the month; further,

the bandages must be examined at frequent intervals and all larvæ contained in them destroyed. The neglect to spray thoroughly and to attend to the bandages properly is responsible for the increase in this serious pest in the Granite Belt, and growers are warned that they must pay more attention to the destruction of this pest if they wish to grow pip fruit profitably. Fruit fly may make its appearance in the cherry crop; if so, every effort should be made to stamp out the infestation at once, as, unless this is done, and if the fly is allowed to breed unchecked the later ripening crops of plums, peaches, apples, pears, apricots, and Japanese plums are bound to become more or less badly infested. Combined action must be taken to combat this the most serious pest of the Granite Belt, and growers must realise that, unless they take this action and see that careless growers do not breed the fly wholesale, they will never keep it in check, and it will always be a very heavy tax on their industry. Rutherglen bug is another serious pest in this district, and is propagated by the million by careless orchardists. The best remedy for this pest is to keep the orchard clean and free from weeds. Brown rot in fruit should be watched for carefully, and, on its first appearance in a district, all ripening fruit should be sprayed with the sodium sulphide wash.

All kinds of leaf-eating insects should be kept in check by spraying with arsenate of lead, and all grape vines, potatoes, and tomatoes should be kept sprayed with Bordeaux or Bungundy mixture, the former for black spot and downy mildew, and the latter for early and late (Irish) blight.

WHEN THE HORSE PULLS BACK.

The two methods for curing a vice in horses which have been handled badly as youngsters described below are from "1000 Handy Hints":—

(1) If you have a horse that pulls back on the reins when you tie him up, try this old dodge. Get a light rope and double it to form a crupper. Place the loop over his tail, and the other ends through the "D" on the saddle, then through the bit-ring to the post or rail. You should have to do this only a couple of times.

Plate 255.

(2) To cure a horse that pulls back when tied up and breaks reins and bridles, an effective method is practised in the Northern Territory, where abo-broken horses are often afflicted with the habit. A hitching-post is fitted with two strong ring-bolts, one about 18 inches above the other. To the top ring-bolt the reins are attached, but with cotton or thin string so that a tug will break them away. Round the horse's neck, close behind the head, is placed a close loop of rope, preferably plaited, and tied so that it won't slip and choke the nag. From this a strong thin rope is led through the ring of the bit, through the lower ring-bolt on the post, back between the prad's legs, over his back and across his chest to return between his legs, where a slip-knot is formed. As soon as the reins snap the horse finds himself suddenly and painfully caught by head and shoulders. After one or two experiences like that you can tie him up with a strand of spider web.

Farm Notes

NOVEMBER.

FIELD.—Farmers are commencing to realise that quick-maturing wheats which possess a degree of rust resistance are more dependable than the slow-growing and often rust-susceptible kinds, which are gradually giving place to these and mid-season varieties.

Growers are advised to make every preparation to work up the surface of the ground immediately after the removal of their crops, so that the soil may be put into good condition to receive any rain which falls, the conservation of which is the best guarantee for the success of the next succeeding crop. Such initial preparation also encourages the early growth of all foreign and weed seeds and permits of their eradication by the implements used to produce the desired soil mulch. In such manner paddocks are kept clean and the purity of crops is maintained. The careful preparation of areas intended for maize-planting cannot be too strongly impressed upon growers. Deep and thorough ploughing, followed by cross-ploughing and subsequent cultivation of the soil, must precede sowing if success would be attained; and all efforts must be concentrated to obtain a good surface mulch. Failure to follow up the subsequent sowings by harrowing prior to the appearance of the young plant conduces to weed growth and very often entails, by neglect of this operation, subsequent hand-hoeing between the plants in the drills. Harrowing should be discontinued before the plant breaks through the surface, otherwise damage will accrue to the tender shoots of the young plants. When the young maize plant has hardened up it may, with advantage, be lightly harrowed in the direction of the drills, but such practice must discontinue once the plant has attained a height of 6 inches. Close cultivation by inter-row cultivation implements is necessary after every shower to conserve moisture and to prevent weed growth, care being taken to ensure each cultivation being shallower than the preceding one, and so prevent damage to the root system of the plant, which is extensive. Inter-row cultivation should cease with the advent of the cob on the plant; and, if proper attention has been given to the crop, it should, at this period, be unnecessary. Where crops are planted on the check-row principle, inter-row cultivation is facilitated, and more even crops result.

The French millets (red and white), owing to their rapid maturing qualities, form excellent intermediate or supplementary crops, and are suitable for present sowing. Their value for fodder and seed purposes is worthy of more general recognition at the hands of the average farmer.

Past dry periods have impressed upon us the necessity of providing during good seasons against the return of less favourable ones, and in this connection the cultivation of quick-growing fodder plants appeals to us. Many varieties of useful classes of fodder can be cultivated over a large portion of this State; chief of which, perhaps, are the sorghum family for grain and fodder purposes. Of the latter, Sudan grass has much to commend it, and is fast becoming one of the most favoured by stockowners. Grain sorghums, of which Feterita, Red Kaffir, and the various Milos are examples, should occupy a more prominent position for purposes of horse and pig feeding, and are particularly suited to those localities which are unsuitable for maize production. Some varieties of sorghums have strong frost-resisting qualities, and lend themselves to those localities where provision for some form of succulent fodder is necessary during the winter months.

AN APPRECIATION OF THE JOURNAL.

A Kandanga dairy farmer writes:—"Herewith please find renewal for Journal—5s. for another five years. I must say it is a journal which every man on the land should not be without . . . . I would not let it drop as long as I am occupied on the land, and file every copy I receive for reference. Thanking the Department for the Journal, which I value . . . ."

OUR BABIES.

Under this heading a series of short articles by the Medical and Nursing Staffs of the Queensland Baby Clinics, dealing with the care and general welfare of babies, has been planned in the hope of maintaining their health, increasing their happiness, and decreasing the number of avoidable deaths.

MOTHERING.

HOW important for the baby that he should have good "mothering" from his earliest infancy. The foundations of good conduct, self-control, in fact all the high qualities of character are laid down in infancy and childhood. "Mothering" includes all handling, feeding, and the mother's and guardian's whole attitude towards the baby. All babies are extremely sensitive to our way of touching them, to the tone of the voice, and the "atmosphere" we inevitably carry around with us. In an even, peaceful, loving atmosphere they thrive; in an atmosphere of unrest, worry, or irritability they either wilt or become nervy and irritable, too. Babies vary, and some are much more sensitive than others. A baby is quick to respond to the mood of the one who is handling him, but naturally he is in touch to the greatest degree with the mother who nurses him. Both mother and baby gather in a wonderful store of peace and health from these uninterrupted periods of calm. Baby seems to ask for very little in the first few months, just the right food at the right time, sleep, warmth, fresh air, and an atmosphere which allows him to grow naturally.

Regularity enters largely into good mothering. The whole universe works in rhythm, mother and baby are no exceptions to the great law of order. It is for this reason that we form a regular routine for baby with the fewest possible unnecessary breaks and changes.

Wise Loving.

He needs loving—an unloved baby shows it in his face—but it must be wise loving. This is, of course, a most difficult thing to achieve. It is hard to love unselfishly. Baby needs to be handled and loved and played with, but not just whenever his elders feel inclined to do so. Quite definitely it is bad for him during or after a feed. Many cases of vomiting are brought about by the injudicious handling of a newly-fed infant, by fondling, rocking, jogging, or jolting him, or stimulating him to smile, &c., immeditely after a feed. A healthy baby loves to lie awake talking to himself, playing with his hands or toes, growing and developing naturally and evenly. Do not disturb this precious time of healthy growth for both body and mind just for your own joy and entertainment in the responsive smile, the joyous chuckle. Undoubtedly it is hard, just because baby is so utterly lovable, responsive, and wonderful, but we are not looking very far ahead if we cannot restrain ourselves now for his ultimate good. If the nervous system is over-stimulated now, baby will grow fretful, irritable, and probably have digestive upsets. Even without these immediate results it means that he is not making the right beginning towards being the child who can amuse himself happily and independently, and who will be even-tempered, happy, and stable throughout life. Good "mothering" lays the proper foundations for the child, and the responsibility for good mothering lies with the parents.

Without a certain amount of talking to, handling, and nursing, baby would be slow and unresponsive. It is the meaningless movements of jogging, jolting, patting, etc., that are bad for him, and the absurd efforts and grimaces made to coax him to smile. Play is the natural joyous overflowing expression of an infant's growing intelligence. It may be gently encouraged, but it should always be spontaneous and not forced on the helpless little one.

IN THE FARM KITCHEN.

FRUIT DRINKS FOR SUMMER.

Among the following recipes for warm-weather drinks are many suitable for serving to small people, while grown-ups will find all of them palatable and refreshing.

Amber Fruitade.

Take 1 lb. loaf sugar, 2 large lemons, 2½ gills water, 1 grapefruit, 1 orange.

Measure sugar into a saucepan. Add the water. Stir occasionally, till sugar is dissolved. Bring to the boil. Boil for five minutes. Halve the fruit, carefully remove pulp and juice, and add to the syrup. Bring again to boiling point and allow to simmer round the edge. Skim carefully. When cold strain through a hair sieve or muslin. Add soda-water to taste.

Ben Fritski.

Take 1 cupful sugar, 1 pint cold water, 1 lb. tin grated pineapple, 1 orange, 3 lemons, 2 bottles ginger ale.

Boil sugar and water together for ten minutes. Add pineapple and the juice of orange and lemons. Strain, cool, and add chipped ice. Pour in ginger ale and serve.

Fruit Nectar.

Take 1 quart water, 2 cupfuls grapefruit, juice 4 oranges, 2 cupfuls sugar, juice 4 lemons, 1 egg-white.

Mix together the water and sugar. Heat to boiling point, then boil slowly for ten minutes. Cool, add grapefruit (cut into small pieces), lemon and orange juice. Freeze to a mash. Add stiffly-whipped egg-white, then chill for three hours, and use.

Fruit Punch (I).

Take 6 lemons, ½ cupful pineapple juice, 1 cupful weak China tea, aerated water to taste, 1 slice tinned pineapple, 2 mandarins, sugar, apple, and orange.

Squeeze the juice from the lemons. Strain and add the strained juice of the mandarins and pineapple juice. Pour into a tall jug. Add the tea, sugar to taste, and stand, stirring occasionally, until sugar is dissolved. Then add aerated water to taste. Serve ice cold, with diced pineapple and a few slices of apple and orange floating in the cup.

Fruit Punch (II).

Take 1 quart water ½ lb. sugar, 1 small tin pineapple, juice ½ lemon, 1 orange, maraschino cherries, cracked ice.

Boil together the water, sugar, and chopped pineapple for twenty minutes. Add the juice of half a lemon and one orange. When cold strain, add some maraschino cherries, and serve with cracked ice.

Fruit Lemonade.

Take 1 lemon, 6 strawberries or raspberries, sugar to taste, crushed ice.

Crush the strawberries well, add a teaspoonful sugar, the juice of one lemon,, and a little cold water. Strain into a tumbler, add a little crushed ice, and fill up with cold water.

Lemon Squash.

Take 1 lb. sugar, 1 pint cold water, 5 drops essence lemon, 2 oz. citric acid crystals.

Place in a pan the sugar and water, and bring to the boil. Boil quickly for four minutes. Remove from the gas and add the citric acid crystals and lemon essence. Stir till crystals have dissolved. Bottle when cool, and serve as required, with water or soda-water.

Orange Squash.

Take 3 oranges, 1 lemon, 3 tablespoonsful sugar, 1 pint cold water.

Cut the oranges in half and prepare two or three thin slices for garnishing. Squeeze the juice from the oranges and lemon, put into a jug and add the sugar. Allow it to stand for thirty minutes to dissolve the sugar. Add the cold water, garnish with slices of orange, and serve very cold.

Apple Water.

Take 4 large apples, 2 oz. castor sugar, 2 tablespoonsful lemon juice, rind of 1 lemon.

Peel the apples, cut them into slices, and put them into a jug with the sugar, lemon juice, and thinly cut lemon rind. Pour over the ingredients one quart of boiling water, cover, and allow to stand until quite cold. Strain and serve. This is a very refreshing drink.

Strawberry Water.

Take ½ lb. ripe strawberries, ¼ lb. sugar, ½ lemon, cold water.

Remove the stalks from the strawberries, crush them well and sprinkle the sugar over. Leave to stand for about three hours. Press the pulp through a fine sieve, add the lemon juice and one and a-half pints of cold water, and allow to stand for about two hours, stirring at frequent intervals. Strain and serve after standing on ice. This makes a good summer drink for children.

Nurseryade.

Take 4 lemons, 2 cupfuls castor sugar, 2 oranges, 1 quart boiling water.

Wash the lemons and oranges and cut the peel as thinly as possible from them. Place in a basin. Add water. Cover and stand for thirty minutes. Pour into a saucepan. Add sugar, and beat slowly till sugar is dissolved. Add strained orange and lemon juice. Bring to boil, and boil for three minutes. Cool and strain. Serve with additional water to taste.

Milk Lemonade.

Take 1 pint of cold milk, 2 pints boiling water, sugar to taste, 6 lemons.

Dissolve the sugar in the boiling water and pour it over the lemon rind, then add the lemon juice. Let it stand till cold before adding the milk.

Emerald Fruit Cocktail.

Take 1 pint grapefruit, grapefruit juice, ½ lb. seeded white grapes, 1 teaspoonful finely minced angelica, lemon juice, maraschino syrup to taste.

Mix the grapefruit pulp and juice with the grapes. Add a dash of lemon juice and maraschino syrup (or sweeten to taste), and stand till chilled. Divide between six sundae glasses and sprinkle with minced angelica.

HOW TO USE BANANAS.

Banana Glory.

Take one large ice cream block, 4 bananas, 1 tablespoonful lemon juice, 1 cupful thick cream, ½ cupful castor sugar, ½ teaspoonful vanilla essence.

Skin and mash three bananas to a pulp. Place them in a double boiler with lemon juice and sugar. Heat till almost boiling, then add vanilla and a pinch of salt. Cool. Whip the cream till stiff, then beat the banana mixture gradually into the cream. Stand till cold. Put a large ice cream block into a glass dish; pile the banana mixture on top, and arrange slices of the fourth banana round the dish. Serve decorated with halved marshmallows.

Banana Cream.

Take 6 bananas, ½ pint custard, 1 sponge sandwich, 1½ tablespoonsful raspberry jam, 2 tablespoonsful chopped walnuts, whipped cream, glace cherries.

Skin the bananas, then mash them. Add jam, crumbled sponge cake and walnuts, and mix well together. Place in a glass dish. Cover with custard, which must be cold. Pile whipped cream on top and decorate with glace cherries.

Banana Pasties.

Take 2 cupfuls flour, 2 teaspoonsful baking powder, 8 tablespoonsful butter or margarine, 1 teaspoonful brown sugar, 1 egg, 1 tablespoonful castor sugar, pinch of cinnamon, pinch of nutmeg, ½ teaspoonful salt, ½ teaspoonful butter, cold water, bananas.

First sift flour with salt and baking powder. Add castor sugar and rub in the eight tablespoonsful of butter (or margarine) with the tips of the fingers. Mix to a dough with very cold water. Roll out on a lightly floured pastry board to one-eighth of an inch in thicknesss. Cut into oblongs four and a half inches wide and six inches long. Lay a peeled banana on each piece of pastry. Allow one teaspoonful of brown sugar, pinch of nutmeg, and cinnamon, and half a teaspoonful of butter for each banana. Mix well and spread over each. Brush edges of pastry with cold water and press edges together. Place on a greased baking tin, brush with beaten egg, and bake for sixteen minutes.

Banana Mousse.

Take 4 bananas. 2 oz. sugar, 2 egg whites, ½ pint cream.

Mash the bananas and sugar to a smooth pulp. Whip the cream until stiff and mix in with the bananas. Whip the egg whites until they are a very stiff froth and fold them into the mixture as gently as possible. Put the mousse into a glass dish and serve, after standing on ice for half an hour. Garnish with chopped nuts or grated orange rind.

Banana Russe.

Take 2 egg yolks, ½ pint milk, ½ oz. gelatine, ½ gill water, 2 tablespoonsful chopped bananas, 3 tablespoonsful sherry, some lady finger biscuits, 4 whole bananas, sugar to taste, whipped cream, and cherries to decorate.

Make a custard with the egg yolks and the half-pint of milk. Add sugar to taste. Mix in chopped bananas, the sherry, and gelatine dissolved in the water. When beginning to set, pour into a buttered mould, lined with split bananas and finger biscuits. When set turn out and decorate with whipped cream and cherries.

Banana and Pineapple Royal.

Take 7 bananas, ½ pint milk, 1 small tin pineapple, ½ oz. gelatine.

Peel six of the bananas and mash them to a pulp. Drain the syrup from the pineapple and put the fruit through a mincer. Dissolve the gelatine in a saucepan with half a gill of the pineapple juice. Add the remainder of the juice to the banana pulp. Stir in also the minced pineapple, leaving a little out for decoration. Strain in the dissolved gelatine, then add the milk and some castor sugar if necessary. Turn into a dish and leave to set. Just before serving heap some minced pineapple in the centre and add the remaining banana cut in slices. Serve with cream.

Cold Banana Pudding.

Take 6 bananas, rind and juice of half lemon, 1½ tablespoonsful castor sugar, 1 tablespoonful cornflour, 1 pint of milk, 1 large tablespoonful of apricot jam.

Mix the cornflour with half a gill of the milk. Put the remainder on to heat, with one tablespoonful of sugar and the grated lemon rind. When hot pour it on to the mixed cornflour, stirring well. Pour all back into the saucepan and boil slowly for six minutes, again stirring well to prevent it from getting lumpy. Peel the bananas, mash them with a fork, and put them into the bottom of a glass dish. Sprinkle the lemon juice and remainder of the sugar over the bananas; add the apricot jam, and mix all well together. When the cornflour has slightly cooled pour it carefully over the top of the bananas, &c., but do not allow it to mix with them. Sprinkle the top with crystalised violets, and serve when cold.

Banana Hedgehogs.

Take 4 bananas, apricot jam, desiccated cocoanut, 2 oz. almonds.

Heat some apricot jam, and, if very stiff, thin down with just a little water; then rub through a sieve. Peel the bananas and spread with jam, then coat with desiccated cocoanut. Blanch the almonds and split into pieces and arrange all over the prepared bananas.

Banana Honeycomb.

Take 4 bananas, 1 pint hot water, 1 pint packet vanilla jelly crystals, cochineal.

Dissolve the jelly crystals in the hot water and leave until it is beginning to set. Peel the bananas and mash them to a fine pulp, then add to the jelly and whisk all together for a few minutes. Stir in a few drops of cochineal. Turn into a wet mould and leave to set; then turn out on to a glass dish and serve.

Banana Twists.

Take 2 bananas, 2 oz. cornflour, 2 oz. castor sugar, 3 oz. margarine, 7 oz. flour, 1 egg yolk, vanilla flavouring.

Sieve the flour and cornflour. Peel the bananas and mash them very finely. Cream the margarine and sugar, then add the egg yolk and stir the mixture quickly for a few minutes. Stir in the mashed banana, flour, and cornflour, also a few drops of vanilla and mix all together to a stiff paste. Turn it on to a floured board and roll out. Cut into strips about 7 inches long and three-eighths of an inch wide. Twist each strip and cross the two ends. Place in a slightly buttered tin, put into a moderate oven, and bake gently until biscuit colour. They will take about fifteen minutes or perhaps a little longer.

IN THE HOME GARDEN.

SOME FERTILIZING POINTS.

Now that spring is here, renewed interest will be taken in the garden, which should be a feature of every farm home. Most soils can be made to produce successful gardens, points out a departmental pamphlet, though the process requires time, energy, some expense, and an appreciation of certain fundamental principles, as well as attention to such important matters as seed and plant selection, and insect and disease control.

Intensive gardening demands a higher degree of soil fertility than does ordinary field crop culture. An efficient system of soil management should not only make allowance for the present crop, but should aim at an ever-increasing reserve of fertility. It should determine the necessity and value for the particular soil of organic matter, how most economically to apply this material, then attempt to supplement this where necessary, by liming and the addition of artificial fertilizers.

For the maintenance of fertility the city gardener has to place his chief dependence on chemical fertilizers, and the grower who lacks information as to the plant food content of his soil, and who desires to grow a wide range of crops of whose requirements he knows little, should play safe by using a high-grade "complete" fertilizer, and give a liberal application. Though he applies more than the plants actually require, the increased cost is so light that the assurance of having enough is worth the additional expense.

A complete fertilizer is one supplying nitrogen, phosphorus, and potash in forms readily available to plants. A generally applicable complete fertilizer for home garden use consists of a mixture of dried blood, superphosphate and sulphate

or chloride of potash. These substances in the proportions by weight of 3, 4, and 1 respectively give a 5-11-6 fertilizer, or one containing 5 per cent. nitrogen, 11 per cent. phosphoric acid, and 6 per cent. oxide of potash. On light-textured soils potash could be increased by using the same substances in the proportions of 2, 3, and 1, when a 4-11-8 fertilizer would be obtained.

Dried blood has many advantages as a source of nitrogen. It does not damage seeds or seedling roots, becomes available when the root system is developing, and is therefore not lost. It is a useful basal form of nitrogen application, carrying plants up to the stage where it may be advantageous to apply forcing soluble nitrogenous fertilizers.

Sulphate of ammonia may be used in place of dried blood in the complete mixture, but should be used in two-thirds the quantity. The use of sulphate of ammonia results in loss of lime from soils, and in time develops strong acidity. These harmful effects are easily overcome by liming, but it is not advisable to use this fertilizer on acid, lime-deficient soils.

The tendency in home gardens is to use quantities of manure without the application of potash and phosphate, and results in a bad nutrient balance, which accounts for the frequent reports of plants producing excessive vegetative growth, with poor flower, fruit, or tuber production. Under such conditions the addition of a mixture of four parts of superphosphate and one of sulphate or chloride of potash would result in a better nutrient balance.

For crops such as lettuce, cauliflower, cabbage, Brussels sprouts, spinach, and celery, where vigorous growth must be maintained, liquid fertilizers can be applied when the plants are well established. The following flowers, provided a complete fertilizer has been used initially, have been found to respond to nitrogenous top-dressing:—Dahlia, chrysanthemum, calendula, Iceland poppy, sweet pea, primula, &c. The soil should be moist before the application of liquid fertilizers.

The most efficient forms of nitrogen for liquid application are nitrate of potash, nitrate of soda, or a mixture of these salts, and nitrate of lime. Sulphate of ammonia, phosphate of ammonia, or a complete liquid fertilizer consisting of nitrate of potash and superphosphate may be used. These substances are soluble in water (superphosphate will leave a considerable residue) and can be dissolved at the rate of 1 to 2 oz. per gallon, and the solution run along the rows from a water-can with the sprinkler removed, or applied with a measure in the case of larger, spaced plants.

If the liquid comes in contact with the leaves, these may be hosed down after the application has been made, to obviate the possibility of injury.

The practice of broadcasting fertilizers is wasteful, since much of it will not come within the absorbing range of roots. When seeds are planted in drills, these should be opened up several inches broad at the bottom and from 1 to 3 inches deeper than the seed is to be placed. The fertilizer is then distributed along the bottom of the row, at the rate of an ounce or two to the yard, the drill filled in to the desired depth, and the planting made.

With large growing plants that are spaced, such as tomatoes, cabbages, and potatoes, a hole a foot in diameter and several inches deep can be made with a spade, and a small handful of fertilizer scattered in the hole before filling in and planting above the fertilizer. Fertilizers for potatoes should be slightly below and in a ring about the tuber, rather than directly beneath it.

BOGGED STOCK.

Plate 256.

When a horse or cattle beast becomes bogged, take a pair of chains and hook them together. Then place them under the hindquarters, about the mud level. Tie a rope from one side to the other over the beast. To the end of chains A, hitch another horse, which will be able to pull the animal out without injuring it as is so often done when a rope is attached round the bogged animal's neck.

RAINFALL IN THE AGRICULTURAL DISTRICTS.

TABLE SHOWING THE AVERAGE RAINFALL FOR THE MONTH OF AUGUST IN THE AGRICULTURAL DISTRICTS, TOGETHER WITH TOTAL RAINFALL DURING 1936 AND 1935, FOR COMPARISON.

Divisions and Stations.	Average Rainfall.		Total Rainfall.		Divisions and Stations.	Average Rainfall.		Total Rainfall.	
	Aug.,	No. of Years' Records.	Aug., 1936.	Aug., 1935.		Aug.,	No. of Years' Records.	Aug., 1936.	Aug., 1935.
North Coast.	In.		In.	In.	*Central Highlands.*	In.		In.	In
Atherton	0·90	35	0·04	1·76	Clermont	0·69	65	0·04	0·21
Cairns	1·75	54	0·10	2·85	Gindie	0·65	37	0·06	0·89
Cardwell	1·28	64	0·73	1·92	Springsure	1·04	67	0·10	0·40
Cooktown	1·22	60	0·32	1·40					
Herberton	0 65	50	Nil	0·75					
Ingham	1·41	44	3·60	0·86					
Innisfail	4 99	55	0·07	11·31					
Mossman Mill ..	1·37	23	Nil	0·83	*Darling Downs.*				
Townsville	0·51	65	Nil	Nil					
					Dalby	1·20	66	0·40	0·94
Central Coast.					Emu Vale	1·07	40	0·39	0·46
					Hermitage	1·15	30	..	0·45
Ayr	0·56	49	Nil	Nil	Jimbour	1·15	48	0·22	0·68
Bowen	0·65	65	Nil	0·05	Miles	1·10	51	0·36	0·81
Charters Towers ..	0·53	54	Nil	Nil	Stanthorpe	1·77	63	0·67	0·74
Mackay	1·04	65	0·13	1·00	Toowoomba ..	1·64	64	0·06	0·95
Proserpine	1·35	33	0·35	1·54	Warwick	1·44	71	0·51	0·62
St. Lawrence ..	0 81	65	Nil	1·06					
South Coast.									
					Maranoa.				
Biggenden	1·10	37	Nil	1·11					
Bundaberg	1·28	53	0·58	0·59	Roma	0·91	62	0·48	0·59
Brisbane	1·98	84	0·10	1·64					
Caboolture	1·54	49	0·08	2·21					
Childers	1·22	41	0·13	1·19					
Crohamhurst	2·22	43	0·10	4·96					
Esk	1·47	49	0·16	0·82					
Gayndah	1·16	65	Nil	0·83					
Gympie	1·72	66	0·01	1·73	*State Farms, &c.*				
Kilkivan	1·42	57	Nil	0·58					
Maryborough ..	1·69	65	Nil	1·16	Bungeworgoral ..	0·74	22	0·40	..
Nambour	1·89	40	0·36	4·62	Gatton College ..	1·11	37	Nil	0·51
Nanango	1·33	54	0·08	1·35	Kairi	0·91	22	..	..
Rockhampton ..	0·83	65	0·03	0·52	Mackay Sugar Experiment Station	0·88	39	0·10	0·68
Woodford	1·69	49	Nil	2·63					

A. S. RICHARDS, Divisional Meteorologist.

CLIMATOLOGICAL TABLE—AUGUST, 1936.

COMPILED FROM TELEGRAPHIC REPORTS.

Districts and Stations.	Means Atmospheric Pressure at 9 a.m.	Shade Temperature.						Rainfall.	
		Means.		Extremes.				Total.	Wet Days.
		Max.	Min.	Max.	Date.	Min.	Date.		
Coastal.	In.	Deg.	Deg.	Deg.		Deg.		Points.	
Cooktown	29·96	81	68	83	2, 3, 24, 31	58	26	32	4
Herberton	..	76	51	84	25	42	19, 20 21	Nil	..
Rockhampton	30·06	81	55	88	25	47	1	3	2
Brisbane	30·09	75	51	86	24	45	1	10	2
Darling Downs.									
Dalby	30·08	73	41	85	27	30	1	40	1
Stanthorpe	..	66	32	74	24	22	1	67	3
Toowoomba	..	69	42	80	27	31	1	6	1
Mid-Interior.									
Georgetown	29·99	89	55	95	26	45	20	Nil	..
Longreach	30·04	83	49	92	17, 26 27	40	6	10	1
Mitchell	30·07	75	40	89	27	31	1	39	1
Western									
Burketown	29·98	88	60	99	16	51	23	Nil	..
Boulia	30·03	83	52	96	24	45	5, 30, 31	Nil	..
Thargomindah	30·04	74	47	88	16, 24	40	10, 2	75	2

ASTRONOMICAL DATA FOR QUEENSLAND.

TIMES COMPUTED BY D. EGLINTON AND A. C. EGLINTON.

TIMES OF SUNRISE, SUNSET, AND MOONRISE.

AT WARWICK.

	October, 1936.		November, 1936.		Oct., 1936.	Nov., 1936.
	Rises.	Sets.	Rises.	Sets.	Rises.	Rises.
					p.m.	p.m.
1	5 33	5·51	5.3	6.9	6·21	8.33
2	5·31	5·51	5.2	6.10	7·31	9.26
3	5·30	5·52	5.1	6.11	8·41	10.33
4	5·29	5·53	5.0	6.12	9·48	11.19
5	5·28	5·53	5.0	6.12	10·51	..
						a.m.
6	5·27	5·54	4.59	6.13	11·49	12.1
7	5·26	5·54	4.58	6.14	..	12.39
					a.m.	
8	5·25	5·55	4.57	6.15	12·41	1·11
9	5·24	5·55	4·57	6.15	1.23	1·43
10	5·23	5·56	4·56	6.16	2·3	2·16
11	5·22	5·56	4·56	6.17	2·35	2·45
12	5·21	5·57	4·55	6.18	3·10	3·16
13	5·20	5·57	4·55	6.18	3·40	3·52
14	5·19	5·58	4·54	6·19	4·11	4·29
15	5·18	5·58	4·54	6.20	4·41	5·11
16	5·17	5·59	4·53	6.21	5·17	5·58
17	5·16	5·59	4·53	6.22	5·51	6·49
18	5·15	6·0	4·52	6.23	6·30	7.41
19	5·14	6·1	4·52	6.23	7·13	8.36
20	5·12	6·1	4·52	6.24	8·0	9.37
21	5·11	6·2	4 51	6.25	8·52	10.35
22	5·10	6·3	4·51	6.26	9·46	11.34
						p.m.
23	5·9	6·3	4·51	6.27	10·44	12.35
24	5·8	6·4	4·50	6·28	11·43	1·36
25	5·8	6·5	4·50	6.28	12·42	2.41
26	5·7	6·5	4.50	6.29	1.45	3.49
27	5·6	6·6	4·50	6.29	2·49	4·59
28	5·6	6·7	4·49	6.30	3·54	5.59
29	5·5	6·7	4.49	6.30	5·1	7.16
30	5·4	6·8	4.49	6.31	6·45	8.17
31	5·3	6·9			7.23	

Phases of the Moon, Occultations, &c.

7 Oct.,	☽	Last Quarter	10 28	p.m.
15 ,,	●	New Moon	8 20	p.m.
23 ,,	☾	First Quarter	10 53	p.m.
30 ,,	○	Full Moon	3 57	p.m.

Apogee, 16th October, at 6.30 p.m.
Perigee, 2nd October, at 1.2 a.m.
Perigee, 31st October, at 12.36 a.m.

The only popular conjunction this month will occur on the 20th at 9 p.m. when the Moon in sickle-shape will pass Jupiter only about half a degree to the north of it. With the striking constellation Scarpio nearby a most interesting group of heavenly bodies may be seen. Jupiter is still in the narrow southern part of Orphiucus, slowly increasing its distance eastward from Antares, a fixed star of the 1st magnitude near the path of the planets.

On the 25th at 4 p.m. Mars and Neptune, in Leo, will be less than half a degree apart, Mars has traveled through nearly the whole constellation since the 3rd of September, while the far distant and apparently slowly advancing Neptune has been in that constellation since January, 1921.

A wide conjunction of Saturn and the Moon will occur at 1 p.m. on the 27th, an hour and 49 minutes before the Moon rises.

On the 31st Uranus, in Aries, will be in opposition to the Sun, rising as the Sun sets and vice versa.

Mercury rises at 5.25 a.m., 8 minutes before the Sun, and sets at 5.51 p.m. with the Sun on the 1st; on the 15th it rises at 4.32 a.m., 46 minutes before the Sun, and sets at 4.36 p.m., 1 hour 22 minutes before it.

Venus rises at 6.48 a.m., 1 hour 15 minutes after the Sun and sets at 7.44 p.m., 1 hour 53 minutes after it on the 1st; on the 15th it rises at 6.47 a.m., 1 hour 29 minutes after the Sun, and sets at 8.9 p m., 2 hours 11 minutes after it.

Mars rises at 3.57 a.m., 1 hour 36 minutes before the Sun and sets at 3.13 p.m., 2 hours 38 minutes before it on the 1st; on the 15th it rises at 3.29 a.m., 1 hour 49 minutes before the Sun and sets at 2.55 p m., 3 hours 3 minutes before it.

Jupiter rises at 9.31 a.m. and sets at 11.15 p.m. on the 1st; on the 15th it rises at 8.46 a.m. and sets at 10.28 p.m

Saturn rises at 4.14 p.m. and sets at 4.50 a.m. on the 1st; on the 15th it rises at 3.16 p.m. and sets at 3.52 a.m.

The Southern Cross will be at its greatest western elongation, position III. as on the clock-face about 6 p.m. on the 1st October. It will reach position IV. about 8 p.m. and disappear at Warwick about 10 p.m. reaching the Southern meridian about midnight.

6 Nov.	☽	Last Quarter	11 28	p.m.
14 ,,	●	New Moon	2 42	p.m.
22 ,,	☾	First Quarter	11 19	a.m.
29 ,,	○	Full Moon	2 12	a.m.

Apogee, 12th November, at 7.48 p.m.
Perigee 28th November, at 12.24 a.m.

For places west of Warwick and nearly in the same latitude, 28 degrees 12 minutes S. add 4 minutes for each degree of longitude. For example, at Inglewood, add 4 minutes to the times given above for Warwick; at Goondiwindi, add 8 minutes; at St. George, 14 minutes; at Cunnamulla, 25 minutes; at Thargomindah, 33 minutes; and at Oontoo, 43 minutes.

The moonlight nights for each month can best be ascertained by noticing the dates when the moon will be in the first quarter and when full. In the latter case the moon will rise somewhat about the time the sun sets, and the moonlight then extends all through the night; when at the first quarter the moon rises somewhat about six hours before the sun sets, and it is moonlight only till about midnight. After full moon it will be later each evening before it rises, and when in the last quarter it will not generally rise till after midnight.

It must be remembered that the times referred to are only roughly approximate, as the relative positions of the sun and moon vary considerably.