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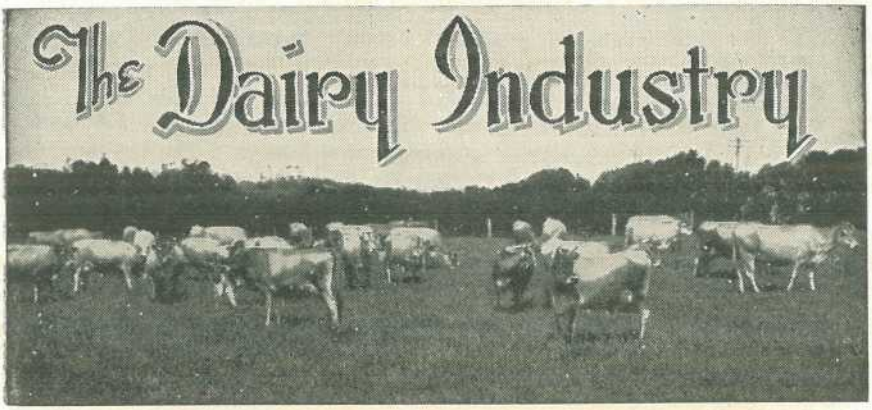

Observations on Dairying in Pakistan.

E. B. RICE, Director of Dairying.

(*Continued from page* 154 *of the September issue.*)

UTILISATION OF MILK.

The total milk production in Pakistan of 1,250 million gallons is roughly utilised in the proportions of one-third each for the fluid milk market, ghee and the indigenous milk products. Their value is estimated at approximately £450,000,000 yearly. The estimated values of other major primary commodities are—

Rice	£866,000,000
Wheat	£130,000,000
Jute	£120,000,000
Cotton	£60,000,000

Butter is chiefly consumed by people of moderate and higher incomes. It absorbs only a relatively minor proportion of the nation's milk production. Even those who eat butter have a low per capita consumption. Cheese is not manufactured on a factory scale, although there are two types of cheese. One resembling the cottage cheese of western countries is made by some villagers in West Pakistan. The other is a semi-hard rennet type. Its production takes place chiefly in East Pakistan, where it is called Dacca cheese. Powdered milk is not manufactured and only one factory makes evaporated milk. This is a military dairy, the output of which is entirely for military personnel. It is fortunate that the buttermilk, known in Pakistan as lassi, obtained from the churning of milk in the course of ghee making, is relished by villagers and thus goes to the feeding of the human population instead of stock as in many countries.

THE COLLECTION, TRANSPORT, TREATMENT AND DISTRIBUTION OF MILK.

The milk supply of towns is derived from two sources:—(*a*) milk produced by stock kept within the town area; and (*b*) milk transported from villages to towns for retail sale.

Town-produced Milk.

The city milk producer, with few exceptions, owns only a few cows or buffaloes. The milk is usually vended to consumers by the owner.

The large numbers of cows and buffaloes kept inside the towns usually do not nearly satisfy the town demand for milk, the deficit being wholly or partly made up from supplies conveyed into the towns from neighbouring villages. Since Partition the problem of ensuring an adequate milk supply for the towns has become accentuated by the large influx of refugees; in many towns the human population has increased fourfold since 1947. Estimates of availability of town-produced milk varied from 6 per cent. to 90 per cent. for different towns.

Village-produced Milk.

The villagers living in the irrigated tracts generally have sufficient milk for their own domestic needs. It is usual for them to convert the milk into ghee for their own use and for sale, and in doing so, the lassi (buttermilk obtained in the village system of first converting milk into desi, or country butter, as an intermediate stage in gheemaking) is consumed. This contains most of the nutritive constituents of milk, except fat, which is present to the extent of about 1.5 per cent. It represents a good substitute for whole milk.

In the non-irrigated areas the villagers generally do not have sufficient milk, although they are generally better off in this respect than urban people. Unfortunately, there is a tendency for the cultivators in villages who supply milk for the liquid milk trade to deprive themselves by disposing of as much as possible of their milk for this trade.

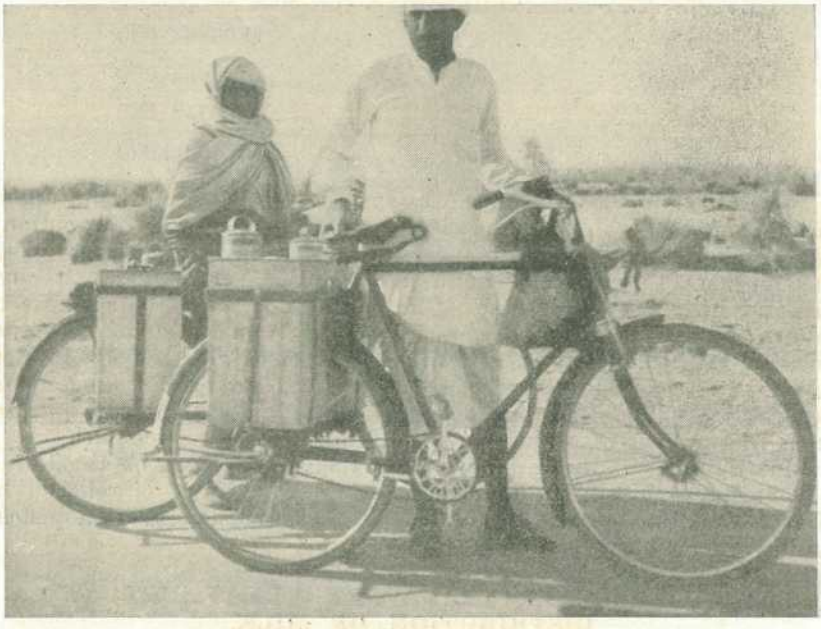

Plate 97.

Milk Being Taken from a Village to Town by Bicycle. Note the oblong milk cans.

Plate 98.

Milk Being Conveyed by Donkey. Note the straw in the mouth of the vessel.

Plate 99.

Milk in Vessels at a Village Collecting Centre. Note the various types of vessels used.

Milk from villages in close proximity to towns is taken into the towns mostly by the producer himself. For distances up to three miles, headload is a common means of delivery, while bicycles, packloads on donkeys or horses, or horse-drawn carts may be used by villagers living up to 10 miles out of the towns. For these distances, middlemen, who make loans to villagers who contract to supply a stipulated quantity of milk daily, often travel with bicycles or horse-carts to collect the milk and take it into the towns. Beyond about 10 miles, motor trucks pick up milk at certain collecting points on the road, where it is brought by means of headload, donkey, horse or bicycle by each individual producer in adjacent villages up to three and even five miles from the collecting centre. At the collecting points, agents or middlemen take delivery from the producer and tip the milk into cans or brass vessels having capacities of from 2 to 8 gallons, which are loaded on to the motor truck for the farther journey into the town.

Milk is also conveyed to the towns by rail from villages adjacent to the railway lines. The unorganised system and waste of time is again evident, as the producer usually travels on the train with his own milk to the town or one villager will travel to look after the produce of a number of his neighbours.

In only one city has an attempt been made to place the collection, transport and treatment of milk on an organised basis. This scheme was inaugurated about 10 years ago by a proprietary company in Lahore, which also has the only milk pasteurisation dairy in Pakistan, except those on the military farms. This company has motor trucks which go out to villages farther from the city (20 to 30 miles) than milk can be drawn by horse-cart or bicycle. It has collecting centres on the roadside from which it buys milk, which is measured and strained through muslin into its own cans. Agents financed by the company and working on a commission buy the small quantity of milk available from each villager and convey the bulked milk to the various collecting points. In the summer months ice is used to cool the milk during transit. This system is only applicable where there are good roads between the city and collecting stations. Systematic development of similar schemes for other large towns does seem to offer a useful means of augmenting the supplies so vital to meet the needs of the swollen town populations since Partition.

Treatment of Milk for Town Trade.

Milk pasteurising establishments similar to those of Australia and western countries are almost non-existent in Pakistan. Military farms pasteurise milk only for armed services requirements. There is only one other pasteurisation plant, which is located in Lahore. At this factory, milk is heated by the flash process to 185 deg. F., cooled and bottled. Another privately owned dairy near Karachi does, however, bottle the raw milk produced from its own herd, though its output is quite small. The widespread malpractices in the milk distribution trade and lack of public appreciation of proper milk handling make it difficult for these concerns to extend their operations.

It is the universal custom for householders in towns and people in villages to boil all milk before using it in the home. However, the lack of subsequent care soon leads to contamination and greatly impairs keeping quality. It is found necessary to re-heat every four hours during the hot months of the year to avoid souring. This custom must

undoubtedly greatly lessen any risk of transmission of milk-borne diseases to the human population and in the circumstances makes the pasteurisation of town milk supplies, as commonly adopted in other countries, not of immediate importance. It is not meant to imply that pasteurisation should be officially discouraged, but to point out that at the present time it is of secondary importance to improving the hygiene of milk production and handling, devising measures for more efficient collection and transport of the milk supply for towns and increasing the supply to ensure adequate amounts. While the present deficiency of supply in the towns continues and a relatively large proportion is produced in the towns under costly conditions, malpractices will be difficult, if not quite impossible, to stamp out. Only a full supply can help to reduce the cost to the consumer and eliminate malpractices, such as adulteration with water, so frequently done to maintain a uniform supply at all seasons of the year and to enable the producers and vendors to sell without monetary loss.

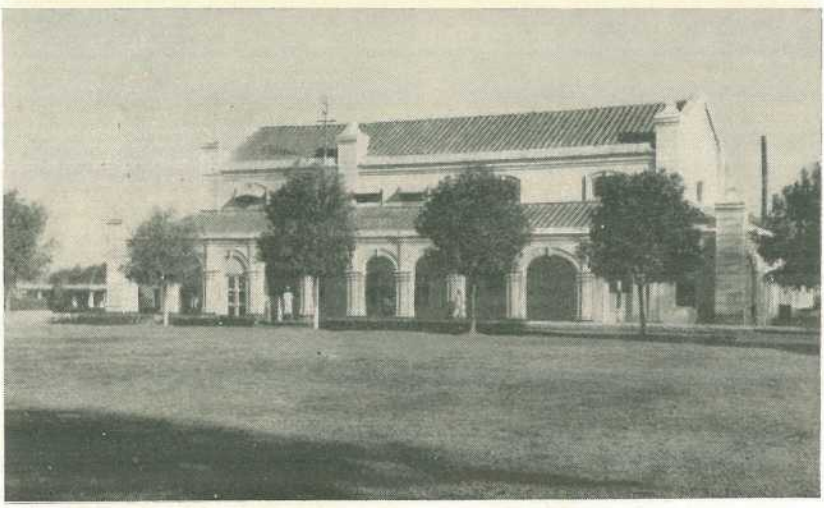

Plate 100.

A Well-Equipped Milk Pasteurising and Buttermaking Factory on a Military Dairy Farm.

The Retail Milk-distributive Trade.

Town milk producers generally sell the milk produced by them to customers by personal house to house delivery. A similar direct service from producer to consumer is common for producers living up to three to five miles from the towns. Milk from the more distant villages passes through the hands of one or more middlemen before reaching the consumer either through delivery by a vendor or direct purchase from a shop.

Milk sold in shops in the town bazaars is frequently heated and kept simmering over a slow fire all day, any not sold being converted to dahi or khoa. Many of these town dairies also make some household deliveries by foot, bicycle or tonga. In general, these dairies purchase milk from a middleman who obtains it direct from the village producers or employ their own collectors. In the bazaar milk shops the milk is exposed to contamination by dust and flies and generally handled most unsatisfactorily.

Plate 101.
Milk Simmering Over an Oven at a Town Bazaar Milk Shop.

The quantity of milk delivered by the household retail vendor is often quite small. A vendor using a bicycle would seldom carry over 60 seers (approximately 12 gallons), while by headload or the hand-carrying of the milk vessel, the quantity would be less.

MILK PRODUCTS.

Butter, cheese, condensed and powdered milk, products manufactured on a large factory scale in most dairying countries of the world, occupy a very minor place in connection with the utilisation of milk in Pakistan. Lack of good all-weather roads, the effect of summer climate on the keeping quality of milk, the small quantity produced by each individual owner and collectively in most villages, and conservatism in regard to changing centuries-old village customs, are all impediments to developing dairy manufacturing enterprises of the conventional western kind. In Pakistan, two-thirds of all milk produced is used for making indigenous milk products such as ghee, dahi, khoa and others. Per capita consumption of creamery butter is very low. European varieties of cheese do not appeal to the Pakistani palate and are too costly for the mass of the people. The small quantities imported are purchased only by the few European residents.

In countries where butter and cheese are manufactured extensively in large factories the by-products, which are of high biological value, are often fed rather wastefully to lower animals. Excepting ghee, the indigenous milk products of Pakistan conserve most of the nutrients of milk, and even in making ghee by the village method the buttermilk, known as lassi, which is drained off at an intermediate stage in the process, is practically all consumed by the villagers, by whom it is relished as a beverage.

It is, then, of foremost importance to cater for the dietary habits of the people and stimulate improved practices in manufacturing the indigenous products, which conserve most of the chief nutrients of milk, rather than to encourage large-scale butter and cheese manufacture, which also often results in loss of the chief milk nutrients as human foodstuffs.

The indigenous milk products for the villager's own domestic use, or for sale for cash, are made on a cottage-industries basis.

Creamery Butter.

In the larger towns, butter is made by numbers of small shopkeepers and a few very small dairies. The amount made per maker may vary from as little as 10 lb. to 200 lb. daily. Some dairies buy cream from producers, while others have separators. In a few cases the cream is heated in a vessel placed directly over the fire, but mostly there is no heat treatment. The cream is churned by hand agitation in galvanised iron tubs, or in small wooden or metal churns manually operated. Prior to churning, the cream is cooled in summer by town mains water, and ice is often added with the break-water.

The general quality of the butter sold is poor. It has "off" flavours and the body and texture are weak. Butter made from buffalo milk is of white colour. It is common to churn a mixture of cream from the milk of cows and buffaloes and to add colour to bring the product to the desired yellow colour. Butter is made on a larger scale at the military farms with a modern type churn fitted with internal worker rollers, but this butter is supplied only to armed services personnel.

Evaporated Milk.

Evaporated milk is manufactured at a well equipped factory at the Military Farms, Okara. Up to 4,500 gallons of buffalo milk produced on the farm are treated daily. The whole output is taken for use by the armed services.

Powdered and Condensed Milk.

Two small condenseries previously in operation ceased manufacture some years ago, while powdered milk is not made. There is, however, a substantial quantity of imported, powdered and condensed milk sold in Pakistan. There is a prejudice against powdered milk among a large proportion of the population, and in any case, the lack of suitable roads in most districts and unhygienic milk production practices would prevent the establishment of large factories to handle these products.

Indigenous Milk Products.

The indigenous milk products, all evolved to suit the local conditions, are of major importance in the dairying economy and nutrition of the people of Pakistan. They are ghee, dahi, makhan, lassi, khoa, channa, kheer, rabree and malai.

Ghee.

Ghee is essentially clarified butterfat. It is made by first curdling milk and then churning it to the indigenous butter, makhan. This is next heated to drive off water, and the curd which rises to the surface is also skimmed off. Various combinations of time and temperature are

used for converting milk into ghee, according to local customs. Ghee not needed for village domestic use is sold to ghee packers, who blend and refine it before wholesaling. Ghee is used extensively for cooking, and being more or less pure fat, will keep in the tropical climate for six to eight months. Because of the higher fat percentage, buffalo milk is preferred to cow's milk for ghee production, although commercial ghee is usually a mixture of fats of the milk of cows and buffaloes. The annual production, estimated at over 100,000 tons, is valued at £A70,000,000. Colour, grain structure, flavour and aroma are important criteria of market quality.

Adulteration of ghee is common and detection is difficult, owing to the laborious chemical analyses required and the range of physical constants. The chief adulterants are hydrogenated vegetable oils, animal fats, vegetable oils, starch and white petroleum jelly.

Under village conditions much wastage occurs during ghee making. It was reported that only about two-thirds of the fat is recovered. On military farms using better equipment, the recovery is as high as 90 per cent. There obviously is scope for investigations to be carried out with a view to devising simple, cheap and efficient equipment for the small-scale village method of making ghee.

There is a national ghee grading scheme, produce submitted thereto and conforming with the prescribed specifications being permitted to bear the Pakmark brand. However, this scheme is not widely availed of by ghee blenders, and owing to the existing shortage, the public is willing to buy ghee which is not officially graded.

The Government has a Central Ghee Control Laboratory. Under the Pakmark scheme, authorised ghee blenders and packers are required to provide a laboratory at approved ghee-making centres to analyse ghee for purity and grade it under the supervision of Government chemists. Frequent official inspections are made of the grading centres and check samples are taken for examination at the Central Laboratory. The approved packers buy the ghee from villagers and take it to the approved centres for refining, which consists of blending, heating and removal of extraneous material. The heating is done in a conical shaped iron vessel placed directly over a fire.

Dahi.

Dahi is prepared by curdling milk by means of a lactic acid culture. The culture used is a portion (1 to 3 per cent.) of the previous day's make. Dahi is consumed alone or mixed with rice; salt or sugar may be added to suit the taste of the consumer. The desired acidity varies from 0.6 to 1.0 per cent. and good dahi has a smooth texture free from gash holes. When made for retail sale, a shallow vessel is used to give a product of better appearance by concentrating the layer of fat on the surface; 50 to 85 per cent. of the fat may be in this layer.

The amount consumed, though considerable, is relatively low in comparison with that used for churning by a wooden paddle in a small metal or earthen pot into the indigenous butter, makhan.

Makhan (desi or country butter).

The method of making was briefly described in connection with dahi. The dahi is made from combined morning and evening milk and is churned daily. Makhan being essentially an intermediate product in

ghee making, there is little control of acidity developed or the quantity of water added. The loss of fat in such conditions may be as high as 25 per cent., depending upon the season of the year. Even if made daily the loss is 8 to 10 per cent. Since the country butter may be kept several days before being converted into ghee, undesirable fermentations cause the development of free fatty acids and other defects. The villagers also use makhan to spread on chappaties, the village equivalent of bread.

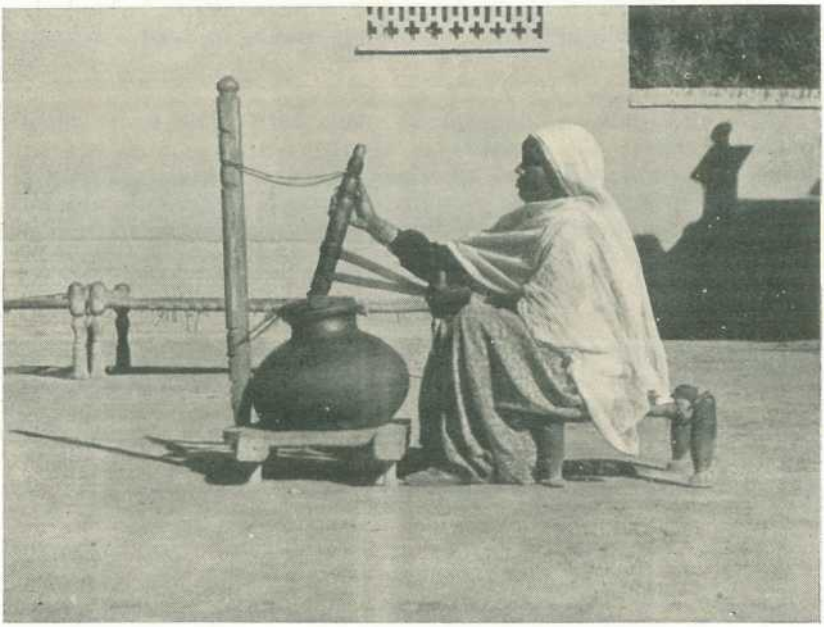

Plate 102.

The Village Method of Churning Makhan ("Country" Butter). This task is usually done by the village women.

Lassi.

This is somewhat akin to buttermilk obtained as a by-product in modern factory buttermaking. It is a refreshing beverage much appreciated by the people of West Pakistan. It can be regarded as a valuable part of the diet of the villagers, and it is fortunate that it is relished by them and not wastefully fed to stock as is so often the case with the buttermilk obtained in buttermaking in other countries.

Khoa.

Khoa, which may be likened to milk powder, is prepared by heating wholemilk over a brisk fire in a shallow, flat-bottomed iron pan, using a flattened iron stirrer to continuously stir with a circular motion. About 5 lb. milk is used per batch. Skill is required to prevent the semi-solid milk as it condenses from being burnt and browned. The process takes about 15 minutes. The final product should be white in colour, smooth to the palate, not have a rubbery feeling and not exude fat and water. It keeps for about three to four days and is eaten alone or used for preparing sweets.

Adulterants, such as rice flour and other cereal flours, are often added to khoa.

Channa.

This product is made in East Pakistan by coagulating milk heated almost to the boiling point with lactic acid (whey culture obtained from the previous day's make) or citric acid (lime juice). The hot milk, which is vigorously stirred during the addition, curdles at once. The clot is drained through muslin to remove some moisture (whey). Large quantities of channa are used for making sweets in East Pakistan.

Miscellaneous.

Other indigenous milk products made on a scale which does not appreciably affect the proportion of the nation's milk production diverted to their manufacture are kheer, rabree and malai. Products of Australia, New Zealand and western dairying countries to which they are somewhat akin are, in the case of the two first mentioned, condensed milk, and in the latter case, clotted cream.

SUMMARY.

The indigenous stock and milk products fit in with the specific environmental conditions of Pakistan and the dietary habits of the people, but it is urgently necessary to apply scientific methods and modern techniques to raise the milk yields of the stock, ensure a better quality and more adequate supply of milk for the people and improve the processing methods, quality and marketing of the indigenous milk products.

The Maintenance of Phage-Free Cheese Starter Cultures.

V. R. SMYTHE and L. G. LIGHTBODY, Dairy Research Laboratory, Toowoomba.

(*Continued from page* 182 *of the September issue.*)

STERILIZATION OF MILK AND EQUIPMENT.

The milk for cultures may be either whole or separated. The presence or absence of fat is immaterial. It is the practice in some factories to pre-sterilize empty flasks before filling with milk. This sterilization has no value—the only requirement is that the glassware be clean.

Prolonged heating of the milk causes it to become slightly brownish. Although such culture milk may appear unsightly it is apparently without detriment to starter growth. When this discolouration is noticed, the duration of heating may be reduced.

It has been the practice in many cheese factories to select milk from a particular supplier for use as starter milk. This practice is not to be recommended because any anti-bacterial property in this milk will have full sway and may affect starter development. Indeed, several instances have occurred where a selected supplier's milk, which has been excellent as judged by milk quality tests, has failed to permit normal starter growth. It is safer to take bulk milk so that any bactericidal agency is diluted.

The container for pilot and mother cultures should not be overfilled, particularly so with mother culture flasks, since overfilling tends to promote wet cotton-wool plugs. Such plugs must not be too tight, since this also will give a tendency to wet plugs. The cotton-wool plug is intended to be a filter, not an airtight closure. With screw-topped pilot culture vessels, the top must be loosened slightly during sterilization.

Mother culture and pilot culture milks are sterilized in the mother culture steamer for at least one hour.

Pipettes can be placed in the pipette cylinder and sterilized in the mother culture steamer, after which they can be carried in this cylinder from the sterilizer to the place of subculturing. Mother culture flasks of milk may be cooled in the steamer by running in water at 75-80°F. for approximately one hour, but dropping bottles for pilot cultures are usually of poorer glass and must be taken from the steamer, screwed down and allowed to cool in the air.

The bulk culture milk is sterilized most often in the bulk starter containers, usually 10-gallon cans, contained in a rectangular vat of water. The heating is by steam and should be continued for at least one hour at 200°F. or above. Allowing half an hour for milk to reach temperature, the total period of heating would then be not less than 1½ hours. When the water reaches 200°F. or thereabouts, the steam must be cut back to prevent excessive turbulence of the water. Sometimes the bulk starter milk is heated by direct steam, which gives a higher temperature than that attained by steam injection into water, but the milk should be heated for a similar period.

PROPAGATION TECHNIQUES.

All subculturing techniques are based on the fact that culture milk and starter apparatus, once properly sterilized, will be entirely free from all living organisms and will remain so until inoculated with the starter organism, or until they become contaminated from external sources. No surface, however clean, must be allowed contact with starter until it is sterilized. Any surface which has been sterilized and then left exposed to air must be flamed before use.

In addition to observing these principles, there are other precautions which have to be taken in starter propagation. These extra precautions are aimed at preventing contamination with bacteriophage.

In subculturing, a method should be evolved and adhered to rigidly. The cultures should be set out in order with the inoculated milks. After transfer of a small quantity of the clotted culture into the new culture, the latter should be immediately labelled and both old and new cultures put to one side before going on with the next inoculation. In this way the chance of failing to inoculate a culture, of mixing cultures through double inoculation, or of mislabelling cultures, is eliminated.

Pilot Cultures.

When dropper bottles are used for pilot cultures, inoculation from one bottle to another is effected quickly by using the teat and glass dropper. Flaming of the necks of the bottles can be omitted if care is taken not to touch the necks, and if transfer is very rapid.

Inoculation of the tubes can be carried out by using sterilized glass pipettes or an inoculating loop flamed between each culture. In the case of the small Erlenmeyer flasks, subculturing should be by pipette inoculation only, because a loop will deliver too small a quantity.

Mother Cultures.

Inoculation of mother cultures should be done by means of pipettes made from glass tubing. After thoroughly flaming the cotton-wool plugs and necks of the flasks, the cotton-wool plug should be removed just far enough to allow entry of the pipette. Transfer must be as rapid as possible, and no attempt should be made to measure the amount of culture transferred. Approximately 5-10 ml. is the usual amount.

Bulk Cultures.

Before any inoculations are made of bulk starter milk, care must be taken to see that the milk is properly cooled. Because there is a considerable lag between the temperature of the milk and the temperature of the cooling water, the water temperature may be misleading. It is impracticable to take the temperature of the milk without risking contamination, so the best guide is to gauge the temperature by holding the hand to the outside of the cans below water level.

The clotted mother culture should first be broken up to a smooth consistency by swirling in the mother culture flask. Inoculation of the bulk culture is done by flaming the cotton-wool plug and neck of the mother culture flask and quickly pouring a quantity of mother culture through the inoculating vent in the water-seal lid. The pouring is done through a cone of flame formed from a flame ring placed round the vent. The flame ring is shown in Plate 103. After inoculation,

the vent is closed with the rubber stopper before the flame ring is removed. As with mother culture inoculation, there is no need to measure the quantity of culture added. With single strain cultures, a quarter of a pint is just as satisfactory to inoculate 10 gallons of milk as half a pint, provided the temperature of the bulk starter is kept fairly constant at 70-75°F. Stirring of the inoculated milk is unnecessary for starter development, and is to be avoided because of the likelihood of contamination. The inoculation of a bulk culture can is shown in Plate 104. This photograph exhibits the flame ring in position with the rubber stopper removed.

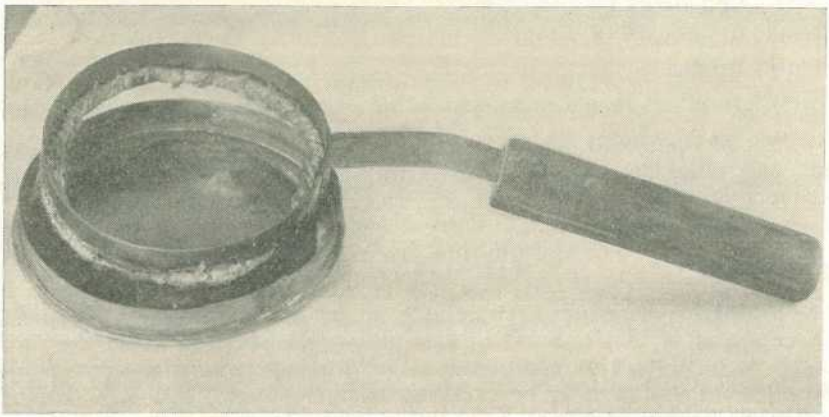

Plate 103.

The Methylated Spirit Flame Ring Through Which the Inoculum is Poured into the Bulk Starter Cans.

Plate 104.

Inoculation of Bulk Starter Cans. The rubber stopper is held clear while the inoculum is poured through the ring of flame.

Personal Element in Starter Propagation.

The person performing the subculturing has it in his power to succeed or fail in propagating the starter in an active, contamination-free state. This truth will stand elaboration, for, besides providing the most important source of starter contamination, this person determines the methods that are used in propagation and what precautions are taken. Factory experience has shown repeatedly that one operative will allow starters to be contaminated under conditions and using equipment which should be conducive to most successful starter work. On the other hand, another operative can maintain starters for long periods uncontaminated under conditions which would appear difficult and with equipment which may seem rough. It is to be concluded from this that—

(1) Elaborate apparatus is unnecessary for starter propagation—however rough it may be, it must be of sound design and construction;

(2) The personal element in starter subculturing is more important than any other factor—the careful operative who is attentive to detail will succeed whereas the operative who is careless will surely fail.

Contamination from Personnel.

The operative subculturing may contaminate the starters from his person and his clothing, particularly so when he has been working at the vats and is in the habit of setting up the starters after the day's cheese manufacture is completed. Under these conditions his person and clothing will usually be carrying bacteriophage. All skin not only carries a heavy bacterial population, but is extremely difficult to sterilize. Hands, the skin of which is usually thickened and deeply furrowed, are particularly heavy sources of contamination.

In order to guard against contamination from himself, the operative is advised to pay attention to the following precautions:—

(1) Thoroughly wash hands and arms with soap and water; dry them on a clean towel.

(2) Change clothes soiled as result of work at vats. This applies particularly to clothing splashed with whey. Don either overalls or apron kept at starter room for use only during starter propagation work.

(3) In subculturing, do not touch any part of flasks or subculturing apparatus with which starter comes in contact.

(4) Flame pipettes, necks of flasks and any surface which has been exposed to air before performing subculturing.

(5) Perform all inoculations as quickly as possible while still observing all precautions. Thus, do not attempt to accurately measure the amount of clotted culture used as inoculum.

Starter Maintenance in Large Factories.

Large cheese factories present special starter problems. One large Queensland factory has a peak of 18,000 gallons of milk daily which is handled in nine vats, employing two shifts. The amount of bulk starter required to set this milk would necessitate some 20 ten-gallon cans, which large number becomes unwieldy.

The problem has been solved by employing large bulk starter containers of 40-50 gallons capacity. Each is made as a separate unit in stainless steel and is fitted with a water jacket and water-seal lid. The filtered air intake to the cabinets is from a manifold leading to an air filter outside the factory. This bulk starter set-up is shown in Plate 105. Each starter cabinet is fitted with a draw-off cock, through which the starter is run into cans and conveyed to the vats. A dial thermometer, with bulb penetrating through to the milk compartment, provides temperature registration for each cabinet.

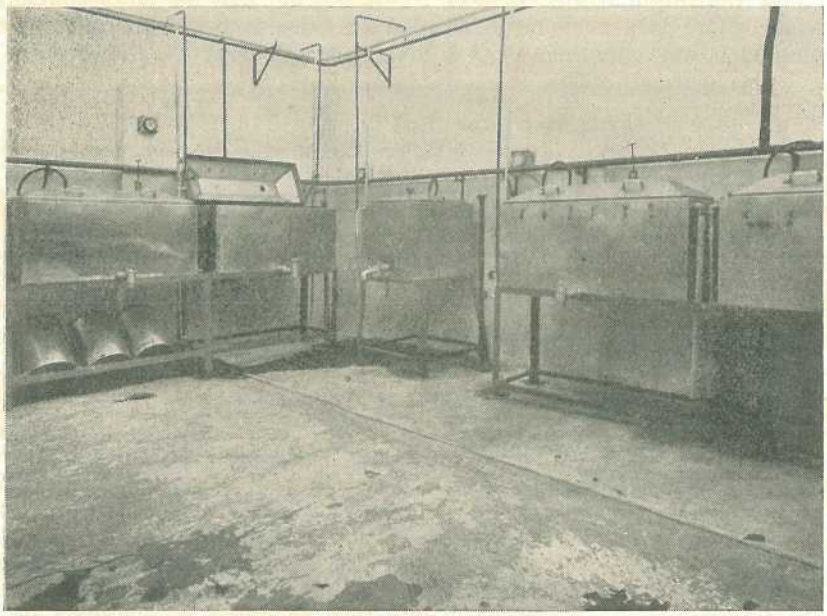

Plate 105.

Arrangement for Bulk Starter in a Large Cheese Factory. Five bulk starter cabinets, each of 40-50 gallons capacity, can be seen.

Filling of the cabinets with skim milk is by pipeline from a high-level stainless steel vat. Heating of the water is by steam through a silencer and cooling is by circulation of cold water. Provision is also made for circulation of chilled water for greater cooling intensity.

Mother cultures are carried in two-litre Erlenmeyer flasks and are propagated in the factory's own laboratory, well isolated from the cheese factory. Inoculation of the bulk cultures is done by either the starter room personnel or the laboratory staff and not by persons working at the vats.

BACTERIOPHAGE TESTS.

Examination of samples for bacteriophage may be conducted in three ways—culture tests or plaque tests for single strain starters and acid production tests for mixed cultures.

Before any samples can be tested, they must first be passed through a Seitz filter to remove all bacterial cells. Any phage present will pass through the pores of the filter-pad into the filtrate, which is then used for the tests.

For the cultural tests, a small portion of the filtered sample is added to a freshly set up starter culture in milk, which is then incubated at 30°C. for 4 hours. After this period of incubation, a smear is made from the test, stained and examined microscopically. The growth obtained in this test is compared with that obtained in a control culture (a culture of the same starter set up at the same time and similarly incubated). If phage was present in the sample tested, the starter culture will be destroyed in the four hours.

Plaque tests can also be employed for testing for the presence of phage for single strain starters. This method may be more convenient where there is a very large number of tests to be conducted, but the method is not as simple as that involving culture tests, and results are not obtained as quickly.

A tube of the media to be used is poured on to a Petri dish which has been marked in squares. When the media has set, two drops of culture are put on its surface and smeared evenly. The surface of the media is then dried before the samples to be tested are put on the plate. A small loopful of filtrate is used as inoculum and is placed on the surface of the media in one of the squares. When all inoculations are complete, the plate is incubated at 30°C. for 24 hours. It is then examined for cleared areas or plaques in the surface film of growing culture. The plaques are due to bacteriophage which prevents the growth of the culture.

If a mixed starter culture is in use, slowness or starter failures may still be due to bacteriophage infection. However, it is more difficult to show that phage is present, for the cultural tests and plaque tests explained above cannot be used. Usually not all the strains in the mixed culture are destroyed, and there would be some growth in the milk or on the plate. To test for phage for mixed cultures, a modified vitality test or acidity production test is used. A 1% inoculum of the filtered sample to be tested is added to a vitality test on the mixed culture and the acidity produced compared with that produced in a control test on the same culture. When phage is present in the sample, the vitality of the culture will be markedly reduced.

Laboratory Testing of Factory Samples.

Although bacteriophage has been found to be the most common cause of slow vats in Queensland cheese factories, it is not the only cause. Consequently, before bacteriophage can be correctly blamed for a vat stoppage, laboratory verification of the presence of phage in sufficient titre must be forthcoming. The practice has been for factories experiencing slow vats to forward to the laboratory samples of both bulk starter and vat whey. Tests have then been conducted along the lines previously described to determine bacteriophage titres for the various starter strains. The bulk starter sample is necessary to determine whether the phage infection originated in the cheese factory or was present in the starter added to the vat. Experience in both laboratory and factory has shown that a starter culture may be clotted and still be phage infected. This happens particularly when the phage gains entrance after some initial starter growth has taken place and sufficient acidity has developed to promote clotting. In such a case, the clotted culture represents a trap, for although it appears quite normal, it will not develop satisfactorily in the cheese vat.

Very large numbers of starter and whey samples have been tested in the laboratory, and whereas almost all samples of whey have proved positive for phage, few of the samples of bulk starter have been found to be infected. It has been apparent that slow vats seldom result from phage-infected starter, the cause almost always being infection from within the factory.

In addition to samples received in connection with slow vats, other samples (unclotted starter or starter milk) have been examined following starter failures prior to manufacture. Usually phage has been found to be present and to be the cause of failure to clot. Sometimes, however, the cause has been failure to inoculate, and on other occasions a sudden cold night has caused a thin culture which usually clots by the time the sample reaches the laboratory.

SOURCES OF BACTERIOPHAGE INFECTION.

It has been stated in the preliminary discussion on bacteriophage that it is not known where bacteriophages come from but that they are found wherever their host bacteria are cultivated regularly. There is some reason for believing that an ultimate source of them does not exist and that they are ubiquitous in the same way as bacteria and other micro-organisms.

Seasonal Incidence of Bacteriophage.

It will be of interest to consider here the noticeable seasonal occurrence of slow vats due to bacteriophage. Observations made in Queensland cheese factories have revealed that bacteriophages are not constantly present in any one factory; rather do they seem to come and go without any apparent explanation. However, there would appear to be a marked seasonal influence prevailing. Slow vats due to bacteriophage have been most common during the autumn and early winter months, March to June; then again during spring. Furthermore, phage attacks seem to accompany dull cloudy weather, and when the season holds dry, as in the long 1951 drought, bacteriophage failures are not common.

Such a seasonal trend has been noticed also by observant men in the cheese industry. The reasons why this should be so are not clear and any possible explanation at this stage could be only a matter of conjecture. It seems probable, however, that two factors, sunlight and humidity, may play a part.

Bacteriophage Surveys.

Whenever a factory has experienced repeated starter failures or slow vats, a survey has been conducted at the factory to determine whether or not the failures are due to contamination by bacteriophage, and if so, where the infection is originating. In surveying, samples have been taken at all possible sources of infection and the samples tested against the starter or starters which have been used. Examinations have been made of factory milk supply, water supply, rennet, factory and starter room air by exposure of culture milk, swabs of factory equipment, whey, and hands and clothing of factory personnel. The surveys have yielded very valuable information and have shown that bacteriophage infection in the cheese vat can come from several

sources in the one factory. Where a factory has been experiencing repeated slow vats, phage for the starters in use is usually well distributed throughout the factory. The following sources of infection are listed:—

1. Equipment.
2. Whey.
3. Personnel.
4. Water and drainage.
5. Air.
6. Milk supply.
7. Rennet.

Bacteriophage Contamination from Equipment.

Swab tests have repeatedly revealed a general distribution of bacteriophage on cheese factory equipment, vats and open surface coolers being common sources. In fact, in very few instances has it been possible to swab cheese vats without finding traces of infection. This experience would suggest that contamination directly from equipment surfaces provides the greater part of the phage infection in the cheese vat of milk. It would appear that cheese vats and open surface coolers are difficult pieces of equipment to sterilize thoroughly and this no doubt is an important contributing factor. The remedy lies in adequate sterilization of equipment surfaces, a subject which will be dealt with under the heading of factory hygiene.

Leaking vats are a special menace. Only too frequently has it been found that a particular vat in a factory is prone to slowness. This slowness has often been traced to leaks in the vat lining, allowing whey to seep through into the casing; this whey being protected from vat sterilization procedures, then serves as a focus of phage contamination back into the vat. It is noteworthy that this source of trouble, so common with the old tinned steel vats, has become rather rare now that stainless steel vats with welded stainless seams have come into prominent use.

Bacteriophage in Cheese Factory Whey.

Cheese factory whey is actually or potentially a culture of bacteriophage. When viewed in this light, it is seen in its right perspective. In whey, there is a massive culture of the starter organism, on which can develop an immense phage population. Through the medium of whey, the phage can become widespread throughout the whole of the factory, its precincts and the waste disposal area.

It follows logically that too much care cannot be exercised in the handling and disposal of whey. It should not be allowed to splash about so as to unnecessarily spread infection, but should be disposed of with the utmost speed and efficiency.

It is not surprising that phages in a cheese factory appear first in the whey and that thereafter they are most readily obtainable from the whey, but their occurrence within a factory is governed by so many factors that they may appear and disappear in a very irregular manner. Such factors as rotation of starter strains, survival or persistence of the phage itself, factory hygiene and whey disposal play important parts.

Bacteriophage in Water Supplies.

One case is on record in Queensland where the factory water supply was found to carry appreciable quantities of phage. In this case, the factory drew a portion of its water supply from a dam which, during heavy rains, collected and held the surface water washing from the factory waste-disposal area. The waste-disposal area was heavily charged with phage, which was washed into the dam and thereby fed back into the factory, where it contaminated all equipment with which it came in contact.

The remedy in such an instance lies in the removal of the waste-disposal area to a site where surface waters cannot wash contamination back to the factory.

Under other circumstances, it is conceivable that bore or well waters could become phage infected if they are situated near to and below the factory whey tank or waste disposal area. Unsound bore casing may lead to pollution of the bore water from surface washings. In a similar way, wells may become infected.

Bacteriophage in Air.

Bacteriophage can become air-borne and because of the minute size of its particles can remain air-borne possibly for long periods. This feature makes its control much more difficult than it would otherwise be. It was early demonstrated in New Zealand that the mist from whey separators contains large quantities of bacteriophage which become air-borne when the mist evaporates. This has been confirmed in Queensland. It is also extremely likely that phage may become air-borne if earth impregnated with whey or infected water is dried to dust and becomes blown about. Some indirect proof of the air-borne nature of phage has been supplied by the utmost success which attends the use for bulk starter cans of water-seal lids with filtered air intakes.

However, the insidious nature of air-borne phage has probably been responsible for some unbalanced viewpoints sometimes held regarding it. The idea that cheese factory air is literally loaded with bacteriophage is quite wrong. In fact, in most Queensland cheese factories where whey separators are not in use, or where they are effectively sealed to prevent emission of mist, air-borne phage has not so far been demonstrated. When it has been necessary in the laboratory to produce a suspension of phage in air, this could be done only by atomising a liquid suspension: it could not be done by violent bubbling of air through a liquid suspension.

Only a few Queensland cheese factories have practised whey separation in the past, so it appears that in this State air-borne phage, while still a source to be reckoned with, is not the main source of phage infection.

Bacteriophage in Milk Received.

The whey from cheese vats may contain large quantities of phage, which, if the whey is not sufficiently heated, is carried back to the farms and may find its way into the milk supply.

Queensland legislation was introduced requiring all whey returned to farms in milk cans to be first heated to a temperature of at least 180°F., the object of such legislation being to prevent the spread of disease-producing organisms as well as to improve quality. It was also later thought that such measures prevented the return of phage to the farm.

However, recent investigational work has shown that despite large amounts of phage being sent back to farms in unheated whey, very little was returned to the factory in the milk supply. In addition, it has been revealed that there is no connection between the phages returned to farms in whey and the frequency with which they may be present in the milk. Bacteriophage has been found in milk on a number of occasions, but the quantities have always been very small. As a result, it is now considered that the amount of phage in milk is too small, and its incidence is too irregular, to warrant the costly heat treatment of whey for the purpose of destroying phage. Provided that the whey is from pasteurised milk, there is little likelihood of pathogenic organisms being transmitted. In either case, milk cans used for transporting whey must be thoroughly washed and sterilized on return from the factory. Several factories have discontinued the heating of whey without any noticeable increase in the number of phage vats. It should be mentioned here that all these factories work single strain starters on a strict rotational system.

Bacteriophage in Rennet.

On two occasions phage has been found in cheese factory rennet in this State. On one of these occasions, the rennet was from a partly used keg, so there existed a possibility that the rennet had become contaminated while in the factory; on the other occasion, however, a new keg was opened to take the sample. This finding shows that it is possible to introduce phage into a cheese factory in the rennet supply. In the absence of any knowledge concerning the survival of phage in the stomach of calves fed with whey, or of its survival during the process of rennet extraction, it can only be surmised that rennet is a possible means of phage dissemination.

Bacteriophage on Personnel.

Emphasis has already been placed on starter contamination from personnel. During bacteriophage survey work in cheese factories, the hands of the operative performing the starter subculturing have invariably been found to carry phage; so have the aprons unless they have been changed before commencing starter propagation work. Swabs of the necks of mother culture flasks handled by operatives have also shown the presence of phage. In this regard, the practice in some factories of extinguishing flaming cotton-wool plugs by placing the cupped hand over them is to be condemned, since it frequently brings the fingers in contact with the neck of the flask, over which the starter must flow during inoculation of the bulk starter milk. It is safer to blow out the flame.

There is every reason to believe that contamination of the starter cultures from the operative's person, or as a result of irregular propagation techniques, constitutes the major means of culture contamination in this State. As a result of the work that has been done, it is thought to be even more important than contamination through infected air.

[TO BE CONTINUED.]

Horticultural Districts of Queensland.

9. The Wet Tropics.

S. E. STEPHENS, Horticulturist.

LIKE the dry tropical zone of North Queensland, the wet tropics embraces a large tract of country, much of which is closely settled but largely devoted to rural industries other than horticulture. Horticultural activities are therefore widely and somewhat thinly scattered over an extensive area.

The wet tropics includes the area of greatest rainfall in Australia, and totals of over 300 inches in 12 months have been recorded. The greater part of the area, however, experiences more moderate falls of between 80 inches and 140 inches, whilst fringing lands and odd pockets within the high rainfall belt receive only 50 inches to 60 inches. The district lies on the coastal plain and above the coastal ranges; it extends some 250 miles along the coast from Bambaroo to north of Cooktown, but nowhere extends inland for more than about 60 miles (Plate 106).

As the highest mountain chain in Queensland runs down the approximate centre of the district, no long river systems exist. Nevertheless, the Herbert, Tully, Johnstone and Barron Rivers, which rise above the coastal range and find their ways by extensive deviations through the range to the eastern coast, are no mean streams. The Burdekin river, probably the greatest river system in Queensland, taps the high rainfall area with its headwater streams and flows south on an inland course to enter the sea in the dry tropical zone. Streams rising on the eastern side of the coast range are short, steep, and numerous, carrying high water runoff following frequent downpours of from 12 to 18 inches in 24 hours.

Cairns is the principal city and leading port of the area; it has a population of approximately 18,000, and port facilities capable of handling vessels with draughts up to 28 feet. Other important towns are Ingham, Tully, Innisfail, Babinda, Gordonvale, Mossman and Cooktown on the coastal strip, and Mareeba, Atherton, Malanda, Herberton and Ravenshoe on the highlands. Other ports in the district are Lucinda Point, Mourilyan Harbour, Port Douglas and Cooktown.

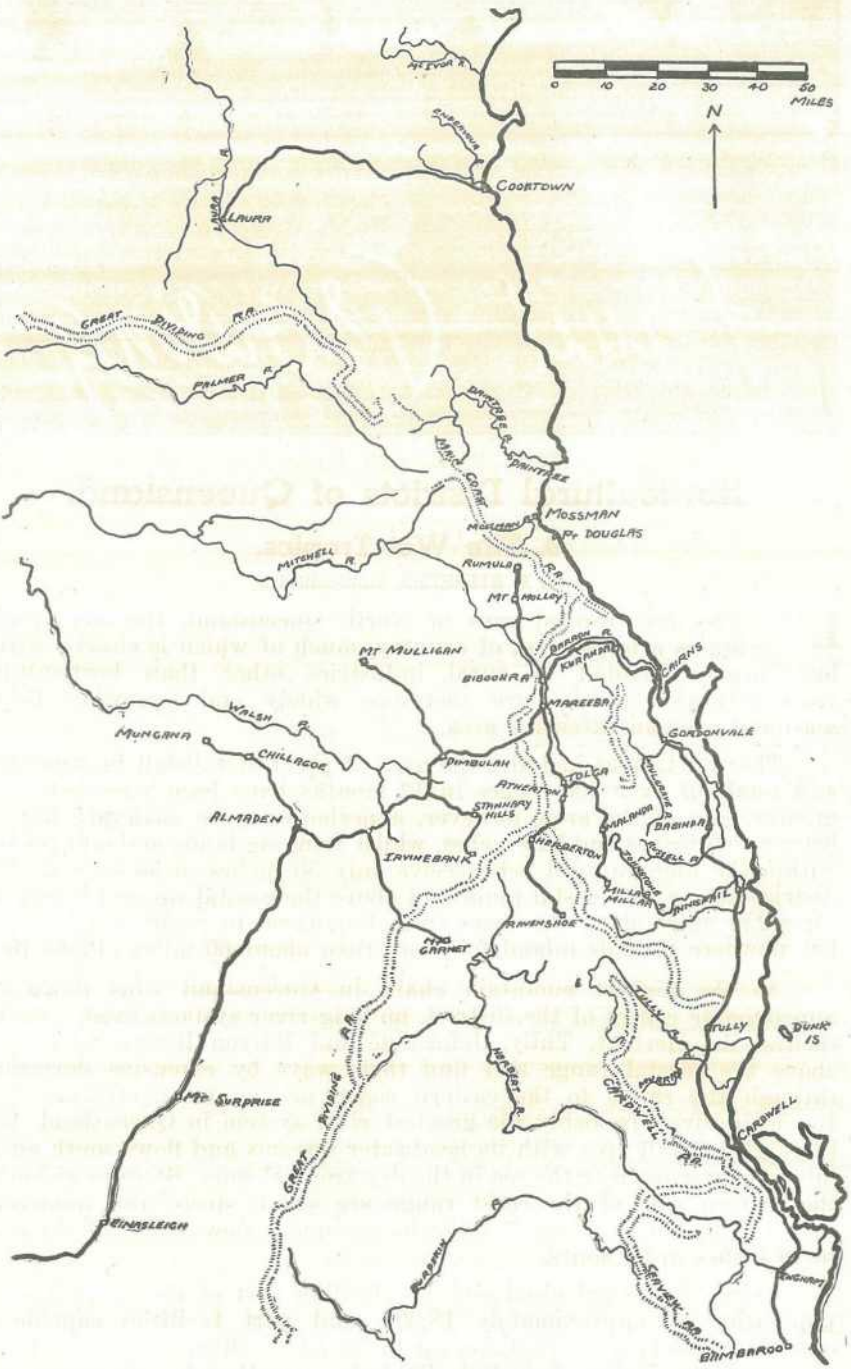

Plate 106.

Sketch Map of the Wet Tropics.

CENTRES OF PRODUCTION.

In the coastal lands, sugar cane growing is the most important rural industry and it monopolises the greater part of the arable land close to centres of population. Horticultural activities are scattered through the sugar areas on odd pieces of land not assigned to cane or unsuitable for that crop because of their size, unevenness or inaccessibility. In addition, horticultural centres exist in the Cardwell-Murray River, Clump Point, East Palmerston, Daintree, Barron River, Herberton and Kaban areas.

The Cardwell-Murray River centre is devoted chiefly to orange and mandarin growing with bananas as a secondary crop. At Clump Point, which is on the coast opposite Dunk Island, the principal crops are bananas and pineapples. In earlier times, coconuts and coffee were also grown extensively there but both have been neglected in recent years, although many of the coconut plantations still exist. At East Palmerston, a dairying district, bananas and pineapples are now grown in conjunction with that industry. Daintree also is a dairying district with banana growing as a companion industry. Along the Barron River and its tributaries between Mareeba and Kuranda, the greater part of the vegetable industry of the district is centred. This area is mainly frost-free, and as it is outside the excessively wet zone, many vegetable crops can be grown during the greater part of the year. At Mareeba, vegetables and tobacco are companion industries. Herberton is situated at an altitude of approximately 3,000 feet and its granite soils are satisfactory for the cultivation of grapes. Kaban is a growing centre of vegetable production during the wet season; as it is situated at a high elevation, its climate is relatively cool and such crops as cauliflower and rhubarb can be produced during the summer months.

HISTORICAL DEVELOPMENT.

Early development of the wet tropics more or less paralleled that of the dry tropics. In 1863, two years after the first North Queensland settlement at Bowen, ports were established at Cardwell and Cooktown. Cardwell provided an outlet for the rich grazing lands on the headwaters of the Burdekin and Herbert Rivers and a meatworks was erected there to handle the stock output. With the development of the Hodgkinson and other mineral fields, this town became the administrative centre for the whole district. Within a few years, however, Port Douglas was opened as a nearer and more accessible port for the mineral fields. Later, when a railway was built over the coast range, Cairns became the principal port. Cooktown, which was once a thriving town and the port for the very rich Palmer goldfield, declined rapidly when large scale mining came to an end.

Exploration and development of the wet coastal portions of the district was carried out by sea from Cardwell. Settlement therefore took place mainly on the sea coast and along the coastal streams (Plate 107).

Sugar cane growing was one of the first industries established. In the early days, the assistance of a labour force recruited from the Pacific Islands and Chinese labour thrown idle by the decline of the goldfields did much to develop agriculture and horticulture in the area. The Chinese cleared the jungle and planted and harvested

bananas on leased land which ultimately reverted to the owner almost ready for ploughing and planting with cane. During the last decade of the nineteenth century and the first decade of the twentieth, banana production was sufficient to maintain a regular traffic of three coastal ships per week between Cairns and Sydney and Melbourne. At the peak of production annual exports exceeded one million bunches, equivalent to approximately 25,000 tons of fruit. The frequent and regular shipping connection with southern centres of population provided an outlet for other fruit crops, and oranges, mandarins and pineapples were all cultivated extensively about Cooktown, Cairns and Cardwell.

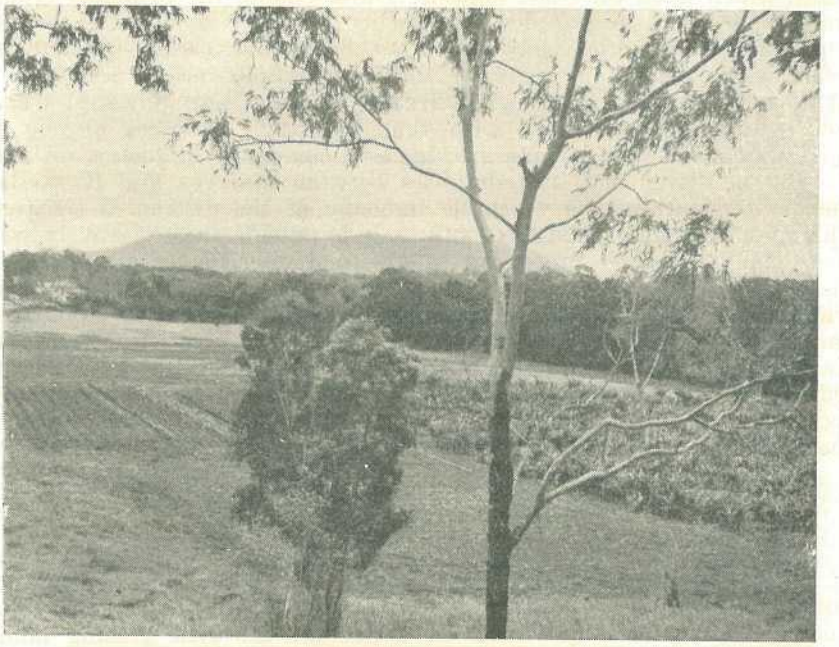

Plate 107.

A River Flat Farm. Note the tree-lined frontage; irrigation presents no difficulties.

The cessation of regular shipping services during the first world war completely destroyed the fruit industry, however, for the local demand was small and the rail link with the south was incomplete. Orchards in the Cairns district were destroyed and replaced by cane; at Cooktown and Cardwell they were simply abandoned. The banana industry, which then extended throughout the whole coastal belt from Cardwell to Cooktown, also collapsed. Subsequent efforts to resuscitate fruit growing as an industry have been hampered by distance from markets, high transport costs, and unstable markets.

The tableland areas of the district have developed broadly from mining to timber and then to agriculture, horticulture, or dairying. In the high rainfall section, dairying is now the main industry, with agriculture and horticulture as minor sidelines. In the medium

rainfall strip, agriculture is predominant, with an extensive maize belt and a smaller peanut industry near Atherton. With the aid of irrigation, the fringing areas with low rainfall have progressed rapidly and crops of tobacco and vegetables are grown on relatively small farms.

CLIMATE.

The wet tropics lie within the high summer rainfall area of the State, and receive up to three-quarters of the total annual fall in the summer months. During this period of the year, daily falls of 7 to 10 inches are not infrequent. High rains generally fall during the late summer and autumn, but spring and early summer are usually dry and most horticultural crops therefore require irrigation at these periods.

Temperature and humidity are moderately high during the summer, but as they do not vary greatly they are seldom oppressive. Monthly mean maximum temperatures at sea level are less than 90 deg. F., and at 2,500 feet altitude 85 deg. F. The monthly mean minimum temperatures at the same period of the year are 74 deg. F. on the coast and 63 deg. F. on the highlands. The mean temperature range during the summer is therefore only 16 deg. F. on the coast and 22 deg. F. at 2,500 feet.

In the winter, monthly mean maximum temperatures at sea level and at 2,500 feet altitude are respectively 78 deg. F. and 71 deg. F., whilst the mean minima at the same period are respectively 54 deg. F. and 50 deg. F.

In the coastal portion of the district, frosts are very rare and are not severe—the absolute minimum screen temperature of 34 deg. F. was recorded at Cardwell in July, 1932. On the highlands, however, frosts may occur each year at any time between the beginning of May and September. As periods of warmer weather may intervene between successive frosts, there is some risk of injury to tree and vine crops that may make new growth in a mild winter.

The prevailing wind is from the south-east and it blows steadily and strongly during a great part of the year. Northerly weather is usual during the storm season in late spring and early summer. This season is characterised by flat calms interspersed with light to moderate breezes from the north and occasional winds of gale force accompanying electrical storms.

Climatological data for Innisfail (representing the high rainfall coastal area), Cooktown (representing the lower rainfall coastal area), and Atherton (representing the moderate rainfall highland area) are set out in Table 1.

SOILS.

The cultivated soils of the district fall into four broad divisions, each of which supports large and diverse rural activities. They are the dark-red loams derived from basalt, the lighter red and brown soils derived from schists, the granitic sands and gravels, and the alluvials.

The dark-red volcanic soils cover a large part of the Atherton and Evelyn tablelands and the Innisfail district. Smaller areas of the same soil type occur at Clump Point, near Babinda, near Gordonvale, at Green Hills, and in the Cooktown locality at Shiptons Flat

TABLE 1.

CLIMATOLOGICAL DATA FOR THE WET TROPICS.

—	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.
INNISFAIL (altitude 22 feet).												
Average rainfall (inches) ..	20·04	22·65	26·73	19·95	12·42	7·23	4·75	4·91	3·52	3·22	6·37	11·70
Mean maximum temperature (°F.)	87·8	87·1	85·4	82·9	79·5	76·6	75·5	77·2	80·3	83·5	85·8	87·7
Mean minimum temperature (°F.)	72·1	71·8	70·3	67·3	63·1	59·6	57·4	57·5	60·7	64·2	67·4	70·1
COOKTOWN (altitude 17 feet).												
Average rainfall (inches) ..	14·41	13·72	15·30	8·77	2·81	1·99	0·96	1·19	0·57	1·03	2·50	6·59
Mean maximum temperature (°F.)	88·8	88·4	86·5	84·7	81·9	79·6	78·8	80·1	82·5	85·4	87·6	89·1
Mean minimum temperature (°F.)	75·3	75·1	74·6	73·3	70·3	67·8	66·2	67·3	70·0	73·0	74·7	75·4
ATHERTON (altitude 2,466 feet).												
Average rainfall (inches) ..	11·83	10·69	8·72	4·24	2·26	1·65	1·09	0·89	0·73	0·92	2·47	7·30
Mean maximum temperature (°F.)	84·2	82·3	80·1	76·5	74·3	71·7	70·9	72·6	77·9	82·3	84·3	85·3
Mean minimum temperature (°F.)	64·8	64·6	62·9	59·3	54·5	51·4	50·2	49·7	53·3	56·3	60·5	63·4

and McIvor River. These soils are very deep and normally of good structure. Usually they are only moderately acid in reaction and reasonably fertile. The surface soil, however, has a tendency to dry out, and shallow rooted crops sometimes suffer in dry weather if irrigation facilities are not available to maintain moisture supplies.

The schist soils occur on the highland area east of the Barron River and on the coastal strip in parts of the Herbert River valley, the Tully River valley and foothills, the Mulgrave valley, the Barron valley, Mossman, Cape Tribulation and many other places. In fact, a large part of the foothill land is of schist origin. Typically, a schist soil is fine textured, usually rather lighter in colour than a basaltic soil, and often fairly shallow. It often contains unweathered fragments of the schistose rocks from which it was formed. It is acid in reaction, rather deficient in available plant foods, has a tendency to lose its organic matter quickly and become floury in texture, and dries out excessively during short periods of drought. With good farming, schist soils can be quite productive, but close attention to green manure cropping, fertilizing, and irrigation is necessary.

Granitic sands and gravels are found in the Herberton and Mareeba districts, and parts of the Ingham, Cardwell, Tully, Babinda, Gordonvale, Mossman, Daintree and Cooktown districts. These soils are formed by the weathering of the granite masses that comprise large sections of the mountain ranges through the area. In the natural state they often contain a good deal of accumulated organic matter in the surface layer, which imparts a dark colour. After the humus has been lost through cropping, the colour of the soil changes to white or yellow. Granitic sands are usually well drained but the coarser textured gravels tend to dry rapidly after the organic matter has been destroyed. They become very hot when exposed to the sun and this has a detrimental effect on the roots of crops that do not produce adequate shade.

Alluvial soils (Plate 108) cover a large part of the coastal flood plain and occur in isolated pockets along the various streams that intersect other portions of the district. These soils are somewhat variable in structure and composition, depending on their location in relation to the streams by which they have been laid down, and on the original source of the material from which they have been derived. Some are of very fine texture and tend to hold excessive amounts of water after rain, whilst others drain freely. It is usual, however, for alluvials to contain rich deposits of silt. In some locations, this is replenished at short intervals by fresh deposits over the land during floods. Such soils are very rich and highly productive but they are suitable mainly for annual crops that can be planted after flood dangers are past. Care is also necessary to secure the soil by cover crops during the flood season.

VEGETATION.

High rainfall, temperature and humidity encourage vigorous plant growth, and the greater part of the coastal plain as well as much of the highland area in the higher rainfall zone was originally clothed with dense rain forest. This consisted of a multiplicity of softwood tree species reaching 60 to 80 feet in height, a dense growth of under-shrubs up to about 20 feet high, and vigorous climbing vines that overspread the other vegetation. This rain forest or tropical jungle,

known locally as "scrub," contains much timber of high commercial value for building and cabinet purposes. Logging and milling, therefore, employ a large number of people in the district.

The rain forest builds up a heavy litter of fallen leaves, twigs and branches on the forest floor. This gives a high organic matter content in the soil and results in good yields from crops planted on the freshly cleared land.

Although rain forest may be found on most soil types, differences in its composition occur. The deep volcanic soils usually carry many large trees and little undergrowth, so walking through the forest presents no difficulty. Schist soils, on the other hand, have fewer large trees and more dense undergrowth. The alluvials usually carry very dense vegetation with much tangled undergrowth that is difficult to penetrate.

In those parts of the district where rainfall is somewhat lower, and in parts of the high rainfall region where soils tend to dry out, open forest consisting chiefly of species of *Eucalyptus* is characteristic Hardwood forest soils are not necessarily poor. Some are quite suitable for cropping provided the land can be irrigated as required to maintain the soil moisture. The quality of the timber is usually a reliable guide to the soil type. Trees of vigorous and upright growth are most often found on good soil, whilst stunted and crooked timber occupies shallow soils of low fertility.

Extensive areas of land on the coastal plain, as well as smaller pockets in elevated locations, are thickly covered with stunted and twisted tea-trees. Such land is invariably subject to waterlogging during several months of the year and the soil is either clay right to the surface or consists of a shallow sandy layer on impervious clay. No horticultural uses have yet been found for land of this type.

HORTICULTURAL CROPS.

Horticultural development has been closely associated with the settlement of the area from the earliest days, but the crops grown and the volume of production have fluctuated. As previously mentioned, the banana growing industry was of major importance at the turn of the century. Citrus fruits, pineapples, mangoes, papaws, passion fruit, litchis, granadillas and grapes have been grown in the past and still are grown to a greater or smaller extent on a commercial basis. Many of the lesser known tropical fruits such as mangosteen, five corner, cashew, the various *Eugenias,* rambutan, and others are grown in limited amounts. Such strictly tropical crops as coconuts, coffee, tea and vanilla have also been grown successfully.

Vegetable crops include the full range of temperate or European vegetables and in addition sundry tropical vegetables that withstand summer heat and high rainfall.

Banana.

Banana plantations (Plate 108) are confined almost exclusively to flat land but occasionally the lower slopes of ridges are utilised. Extensive planting is confined to the coastal strip. On the highlands, plantations are small and scattered in localities where the frost risk is

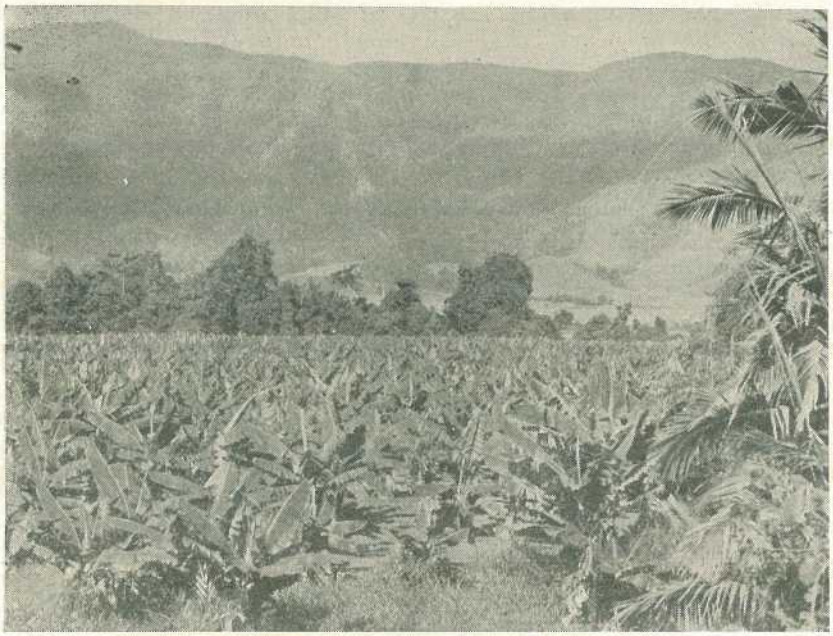

Plate 108.

A Banana Plantation on Alluvial Soil, Cairns District.

Plate 109.

A Banana Bunch. The crop thrives under wet tropical conditions.

slight. On the coastal plain, the risk of soil erosion on slopes makes the use of flat or nearly flat land almost imperative. Alluvial soils are most favoured for the crop, as the soil moisture is at a favourable level without irrigation during the greater part of the year. In some areas, such as Clump Point, where rainfall is well spread throughout the year, other soil types are planted with satisfactory results.

Ever since the earliest days of cultivation, the Cavendish variety (Plate 109) has been extensively grown. Its dwarf growth habit offers some measure of resistance to wind damage, which the taller growing varieties do not possess. Whatever the variety, however, the banana plantation is almost invariably destroyed should it lie in the path of one of the cyclones that occasionally cross the coastline. Plants that are not completely blown out or broken by cyclonic wind always have the root system so extensively ruptured that they die within a few weeks.

Gros Michel, Sugar and Lady Finger varieties were grown on a commercial scale in earlier years, but Panama disease in the plants, coupled with lower yield per acre and greater difficulties in growing and harvesting, have almost eliminated all three from commercial production. In recent years, plantings of the two tall growing sports of the Cavendish, namely Mons Mare and Williams' Hybrid, have increased. At the present time they are more favoured than the Cavendish, as they appear to be hardier and produce better fruit.

Planting on ploughed land, cultivation with machinery, and the use of fertilizers are now more widely practised than in the past. Irrigation, too, is being used by some growers.

Pineapple.

Pineapple production has been at a very low ebb for many years. The rough leaf variety is grown on a small scale in many parts of the area, chiefly for local markets. The smooth leaf variety was not favoured by local buyers and was seldom grown. The establishment of a cannery at Cairns, however, has awakened interest in the possibilities of the smooth leaf. Yields from small commercial areas in the district have exceeded 20 tons per acre and comparable crops (Plate 110) can be expected where modern methods of plantation management are practised on suitable soils in many parts of the coastal strip. Yields are considerably less with the rough leaf variety, due in part to the lower individual fruit weight and in part to the wide spacing adopted for that variety.

The area of land suitable for pineapple growing is very large, and even though much is already devoted to sugar cane, suitable areas are available in most parts of the district.

Citrus Fruits.

Citrus fruit trees are common in the tropical wet belt. Most householders have several trees in their gardens and in consequence the demand for the fruit on local markets is very limited. Centres of commercial production were established some 50 years ago at Cooktown, Cairns and Cardwell-Murray River. In the few remaining orchards at Cooktown, the Emperor mandarin is the most widely grown variety. Due to a peculiarity of the climate, this variety matures some weeks later than in other parts of the district.

Plate 110.

Smooth Leaf Pineapples in the Innisfail District. A plant crop with fruits averaging 5 lb. in weight.

The original orchards at Cairns were eradicated many years ago. Small plantings of recent date have been chiefly Late Valencia oranges for local sale at the end of the fruit season.

In the Cardwell district, orchards have been kept in production ever since the first plantings at the beginning of the century. Local markets from Townsville north absorb the greater part of the crop, but financial returns have seldom been attractive and the growers usually supplement their income from citrus by growing other crops or by obtaining employment outside their farms. Seedling oranges and seedling Emperor mandarins were most widely grown, but in recent years Joppa and Late Valencia oranges have largely replaced the seedling oranges. During 1951 a large part of the orange crop from this district was processed for juice. This outlet is likely to prove valuable in future and should absorb much of the disfigured fruit and thus regulate the fresh market supplies.

Papaw.

The papaw (Plate 111) is a common rain-forest plant in many parts of the coastal strip. Fruits of the jungle grown plants are often of good flavour but are small and lack colour.

As a cultivated fruit crop, the papaw is widely grown in all frost-free sections and is found in home gardens as frequently as are the citrus fruits. Few commercial plantations exist, but culture on a small scale, often as a companion crop with bananas, is common. Hermaphrodite types are most favoured but dioecious types are sometimes planted also. No special variety is now grown; the general practice of saving seed from open pollinated fruits in mixed plantings has tended to submerge varietal characteristics.

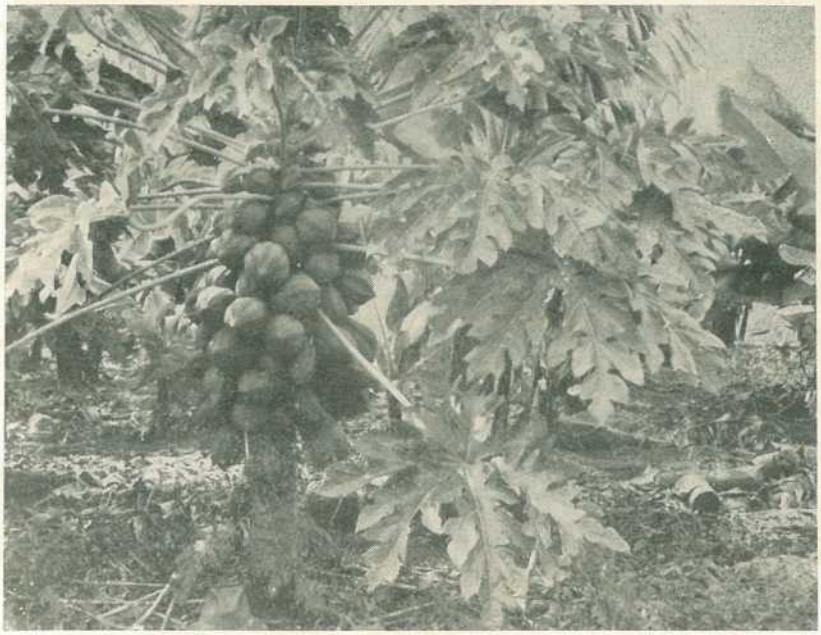

Plate 111.

A Papaw Plant. Papaws are frequently interplanted among bananas.

Under tropical conditions of climate the papaw plant tends to elongate rapidly. When the crop is field-planted in late spring or early summer, the plants grow tall and may reach eight feet or more before fruit setting takes place. The commercial life of these tall growing plants is short. Autumn planting, however, tends to restrict stem elongation and encourage low fruiting.

Passifloraceous Fruits.

The passifloraceous fruits include the purple passion fruit, the golden passion fruit, the bell apple and the large and small granadillas.

The purple passion fruit is a common rain-forest vine of the mountain slopes and tableland. Under these natural conditions it grows vigorously and fruits prolifically. Under cultivation it is more successful on the highlands than on the coastal plain.

The golden passion fruit is more vigorous and hardy than the purple variety. Its fruits are larger and slightly more acid than the purple, and the ripe skin colour is yellow. The plant flowers profusely, but fruit setting is often sparse unless hand pollination is practised.

The purple and golden passion fruits have been crossed in recent years and vines with the vigour and fruit size of the golden and wine coloured skin colour have been produced. However, the cross has not yet been fixed.

The bell apple is grown on a small scale around Cairns, where it is sometimes called the Singapore passion fruit.

The small-fruited granadilla used to be widely grown by Chinese gardeners in the Cairns and Innisfail districts. The plants are grown on an overhead horizontal frame or trellis supported on posts about seven feet clear of the ground and spaced 10 feet apart each way. These granadilla "sheds" were a feature of most Chinese market gardens, in which they often formed a covered walk leading from the garden entrance to the farm buildings. The small-fruited variety usually fruits freely and so is preferred to the large-fruited variety, which requires artificial pollination in most instances.

Fruit setting in all passifloraceous fruits is somewhat uncertain in the wet tropical zone and commercial production is therefore somewhat hazardous. However, the market is satisfactory if the crop can be produced.

Mango.

Many parts of the wet tropics are unsuitable for the mango. In all coastal parts of the district the tree grows vigorously, but in the areas of higher rainfall fruiting is rare.

The areas round Ingham, Cardwell, Cairns and Cooktown produce heavy fruit crops, but very few of the superior varieties are grown. The Common mango, which has good flavour but is exceedingly fibrous, accounts for the greater part of the production. In past years the bulk of the crop has been wasted, but during the 1951 season a considerable quantity was processed locally.

Litchi.

In subtropical and temperate parts of Australia the litchi is known only as the dried date-like fruit imported from China. The fresh fruit is grown, however, in this district. Seedling trees up to 30 feet high and with a spread of 40 feet are growing at Cairns and Mossman but their cropping habits are irregular. Marcotted trees produce the commercial crops and the varieties giving the best results are Kwai Mee and Wai Chee. The former ripens in November and early December and the latter during December and January. Marcotted trees are not readily available and any expansion of litchi growing must therefore be very slow.

Grape.

Grape growing (Plate 112) is restricted to the Herberton area, an elevated plateau on the drier fringe of the district. Winter conditions are scarcely sufficiently regular for proper dormancy in the vines, so the higher class European varieties do not thrive. Good results are obtained, however, with the hardier American varieties. Those most favoured are Improved Isabella, Ferdinand de Lesseps, Goethe and Wilder. Several plantings of Muscatels give irregular results due to the variable climate. Storm rains on the ripening fruit sometimes cause heavy losses. Local markets absorb all the crop and could handle a greater bulk, as the harvesting season is in advance of that in southern Queensland.

Coconut.

A number of small coconut plantations were established at various points along the coastal strip in the early years of the century. The palms grow well and produce satisfactorily but the areas are of insufficient size to warrant collection of the nuts and production of

copra. The demand for fresh nuts is limited but small quantities are sent to southern markets from time to time. By far the greater quantity is utilised on the plantations for stock food.

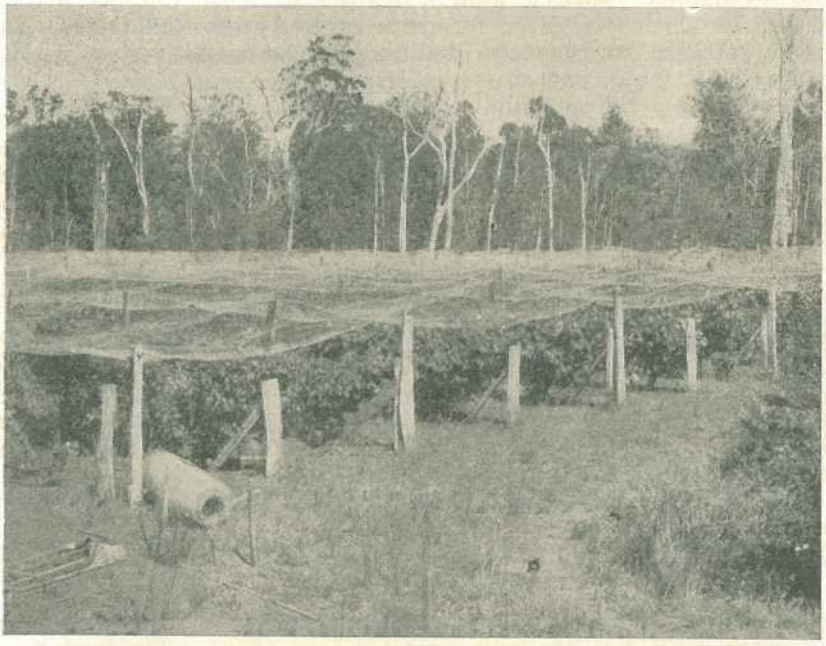

Plate 112.

Grapes in the Herberton District. The wire netting protects the fruit from birds.

Coffee.

Coffee was an important crop in the wet tropical area during the early years of this century. In 1900 there was a total of 420 acres planted to this crop in North Queensland, the main producing centres being Kuranda, Clump Point, and the Atherton Tableland. Frosts were responsible for destroying the industry in the highland areas, whilst on the coastal fringe shortage of harvesting labour defeated the growers. At the present time no commercial coffee plantations exist. The crop can be successfully grown in frost-free areas of the district, but any future development of the industry will be influenced by the economics of harvesting and processing.

Tea.

Tea (Plate 113) has not been grown as a commercial crop, but experimental plots in higher rainfall areas of the district have demonstrated that the crop will grow successfully and that tea of commercial quality can be produced. Those parts of the district where rainfall is well spread over the greater part of the year, and where temperature fluctuations between summer and winter are least, give best growth and the longest harvesting season. The commercial development of the crop depends upon mechanical harvesting methods.

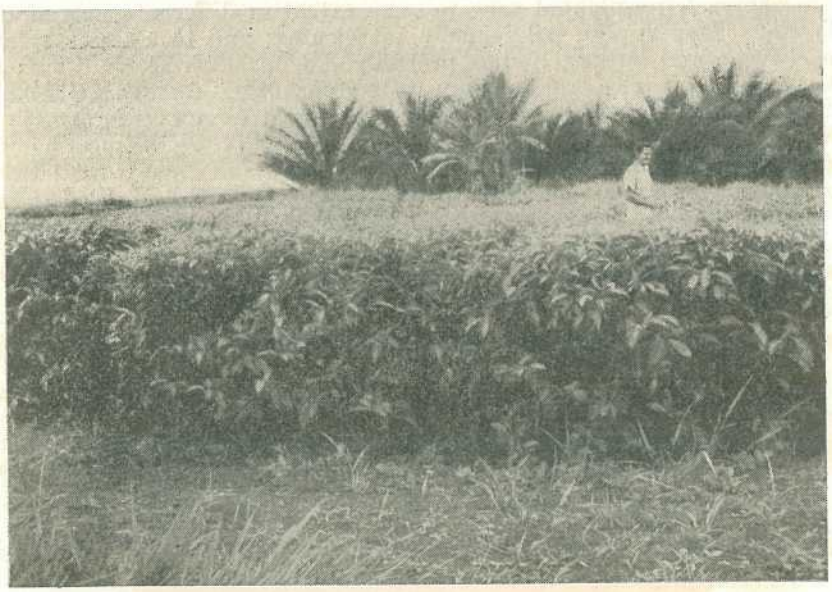

Plate 113.

Tea Growing. Experiment plots at Bureau of Tropical Agriculture.

Vegetables.

Prior to World War 2, vegetable production in the wet tropics was restricted both in quantity and season of cropping. The demand that followed large troop concentrations in the district encouraged farmers to expand the area under vegetables and to extend the cropping season. It was then found that most vegetable crops could be grown in at least some part of the district during the whole year, and the far north is now more or less independent of vegetable supplies from other parts of the State.

The most consistent crop production is obtained along the Barron River between Mareeba and Kuranda, where the annual rainfall is about 40 inches and an elevation of about 1,200 feet gives an equable climate. Beans, tomatoes and cabbage are the main crops, but cauliflowers, carrots, beet, turnips, lettuce, pumpkins, and most other vegetables are also grown. Watermelons also are sown extensively for harvesting between October and January. Irrigation is used on all these farms and is essential for successful cropping over a long season.

On the Atherton Tableland, where there is some frost risk during winter and the summer rainfall is heavy, the season for vegetables is more restricted.

On the higher tableland in the Kaban area, summer and autumn cropping is practicable and even lettuce and cauliflowers can be produced there at that period of the year.

Vegetables on the coastal strip are almost entirely grown as winter and spring crops. As the spring season is almost invariably dry, irrigation is essential to maintain continuity of production.

The varieties planted vary to some extent in different parts of the district. This applies particularly to tomatoes and to a lesser extent to cabbage and lettuce, and is probably due to climatic conditions at the cropping period rather than to soil or other factors. Burwood Prize, Sioux, Red Cloud and Stokesdale tomatoes are satisfactory in different areas. Henderson's Succession and Utility are the most widely favoured cabbages. Imperial 847, Great Lakes and New York lettuce are grown in different seasons. Brown Beauty French bean, Red Cored Chantenay carrot and Early Phenomenal cauliflower are the usual varieties of these vegetables.

Plate 114.

The Long Bean. A useful green vegetable for summer in North Queensland.

Wong Bok Chinese cabbage, Gai Choy and Pak Choy are grown more extensively than spinach. Long beans (Plate 114) are substituted for French beans on the coastal strip during the summer months. Oriental cucumber is a vigorous variety resistant to mildew that has been developed by Chinese gardeners for summer growing.

PRODUCTION AND MARKETS.

The area under crop and the approximate production during 1950-51 are shown in Table 2. Export markets are not readily available on account of the great distance from large cities, high transport costs and wastage in transit. Local markets, under normal conditions, are

strictly limited by the small population. They are also subject to frequent price fluctuations, so there is little stability for a horticultural enterprise that depends upon local fresh markets for disposal of the produce.

Fortunately, a processing outlet has recently become available by the establishment of a cannery at Cairns and a freezing plant at Townsville. Stable prices for certain horticultural crops of specified grades supplied to these processing plants should do much to stimulate the development of horticulture in the district.

TABLE 2.

Acreage and Production in the Wet Tropics for 1950–51.

	Acreage.	Production.
Fruit in Bearing—		
Bananas	238	24,225 bushels
Pineapples	61	7,659 bushels
Citrus	449	31,946 bushels
All other fruit	35	..
Fruit not yet Bearing ..	318	..
Vegetables	910	1,137 tons

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The Library Board of Queensland invites country people to make use of the resources of the Public Library of Queensland through its Country Extension Service. Books are available on a wide range of subjects, including accountancy, anthropology, architecture, auditing, aviation, biography, biology, boat-building, botany, carpentry, chemistry, cookery, drama, drawing, economics, education, engineering, farming, fruit-growing, furniture, gardening, geology, history, journalism, languages, model-making, motor vehicles, music, needlework, painting, philosophy, photography, physics, poetry, political science, psychology, radio, salesmanship, sheep and wool, sheet metal work, surveying, travel, welding, wood-carving and zoology.

The Country Extension Service is free, except that the borrower is asked to pay the cost of returning the books to the Library. Concession rates are granted by the Commissioner for Railways. Three books at a time may be borrowed and they may be held for one month from the date of issue.

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TUBERCULOSIS-FREE CATTLE HERDS.

(AS AT 11th SEPTEMBER, 1952.)

Breed.	Owner's Name and Address of Stud.
Aberdeen Angus ..	The Scottish Australian Company Ltd., Texas Station, Texas F. H. Hutton, " Bingegang," Dingo
A.I.S...	F. B. Sullivan, " Fermanagh," Pittsworth D. Sullivan, " Bantry " Stud, Rossvale, *via* Pittsworth W. Henschell, " Yarranvale," Yarranlea Con. O'Sullivan, " Navillus Stud," Greenmount H. V. Littleton, " Wongalea Stud," Hillview, Crow's Nest J. Phillips and Sons, " Sunny View," Benair, via Kingaroy Sullivan Bros. " Valera " Stud, Pittsworth Reushle Bros., " Reubydale " Stud, Ravensbourne H. F. Marquardt, " Chelmsford " Stud, Wondai W. G. Marquardt, " Springlands," Wondai A. C. and C. R. Marquardt, " Cedar Valley," Wondai A. H. Sokoll, " Chelmsford," Wondai W. and A. G. Scott, " Welena," A.I.S. Stud, Blackbutt G. Sperling, "Kooravale" Stud, Kooralgin, via Cooyar
Ayrshire	L. Holmes, " Benbecula," Yarranlea J. N. Scott, " Auchen Eden," Camp Mountain "St. Christopher's and Iona " Studs, Brookfield Road, Brisbane E. Mathie and Son, "Ainslie" Ayrshire Stud, Maleny
Friesian	C. H. Naumann, " Yarrabine Stud," Yarraman
Guernsey	C. D. Holmes, " Springview," Yarraman
Jersey	J. S. McCarthy, " Glen Erin Jersey Stud," Greenmount J. F. Lau, " Rosallen Jersey Stud," Goombungee G. Harley, Hopewell, Kingaroy Toowoomba Mental Hospital, Willowburn Farm Home for Boys, Westbrook F. J. Cox and Sons, " Rosel " Stud, Crawford, Kingaroy Line R. J. Browne, Hill 60, Yangan P. J. L. Bygrave, " The Craigan Farm," Aspley A. Verrall and Sons, " Coleburn Stud," Walloon R. J. Crawford, " Inverlaw Jersey Stud," Inverlaw, Kingaroy P. H. F. Gregory, " Carlton," Rosevale, *via* Rosewood E. A. Matthews, " Yarradale," Yarraman A. L. Semgreen, " Tecoma," Coolabunia G. & V. Beattie, " Beauvern," Antigua, Maryborough L. E. Meier, " Ardath " Stud, Boonah A. M. and L. J. Noone, "Winbirra," Stud, Mt. Esk Pocket, Esk W. S. Conochie and Sons, "Brookland" Stud, Sherwood Road, Sherwood

ANIMAL HEALTH

Leptospirosis in Cattle.

A. K. SUTHERLAND (Senior Veterinary Pathologist),
G. C. SIMMONS (Assistant Bacteriologist), Animal Health Station, Yeerongpilly,
and
G. C. KENNY (Inspector of Stock).

LEPTOSPIROSIS is an infectious disease affecting chiefly calves and to a less extent adult cattle. It has been known in calves in Queensland for many years under the names redwater of calves and ictero-haemoglobinuria of calves. In the acute form there is fever, anaemia, jaundice, and haemoglobinuria (that is, red or brownish urine due to the presence of blood pigment). In sub-acute and chronic cases the principal symptoms are nephritis (inflammation of the kidneys) and failure to thrive. The symptoms and post-mortem findings in acute leptospirosis are therefore very similar to those of tick fever (the common redwater or babesiosis), but from the earliest days it was recognised as a disease distinct from tick fever, because:—

(1) there were no tick fever organisms in the blood or kidney tissue;

(2) tick fever is uncommon in calves, and

(3) the disease occurred outside the tick-infested area of the State.

Investigations by the Department of outbreaks at Gympie in 1949 showed that the disease is caused by infection with bacteria called leptospira. The species known as *Leptospira pomona* is the only one found so far in cattle in Australia. The correct name for the disease is therefore leptospirosis, and use of this name avoids any possible confusion with tick fever (the common redwater) or with any other disease of cattle.

DISTRIBUTION.

From January, 1949, to June, 1951, 82 outbreaks of leptospirosis in cattle were recorded at Yeerongpilly (that is, were confirmed by laboratory tests). Other outbreaks in which a clinical diagnosis was made also occurred. As shown in Plate 115, outbreaks occurred in all the major dairying zones, except the Atherton Tableland, as well as at Clermont, Longreach and Muttaburra. The disease occurs also in New South Wales, Victoria and Western Australia.

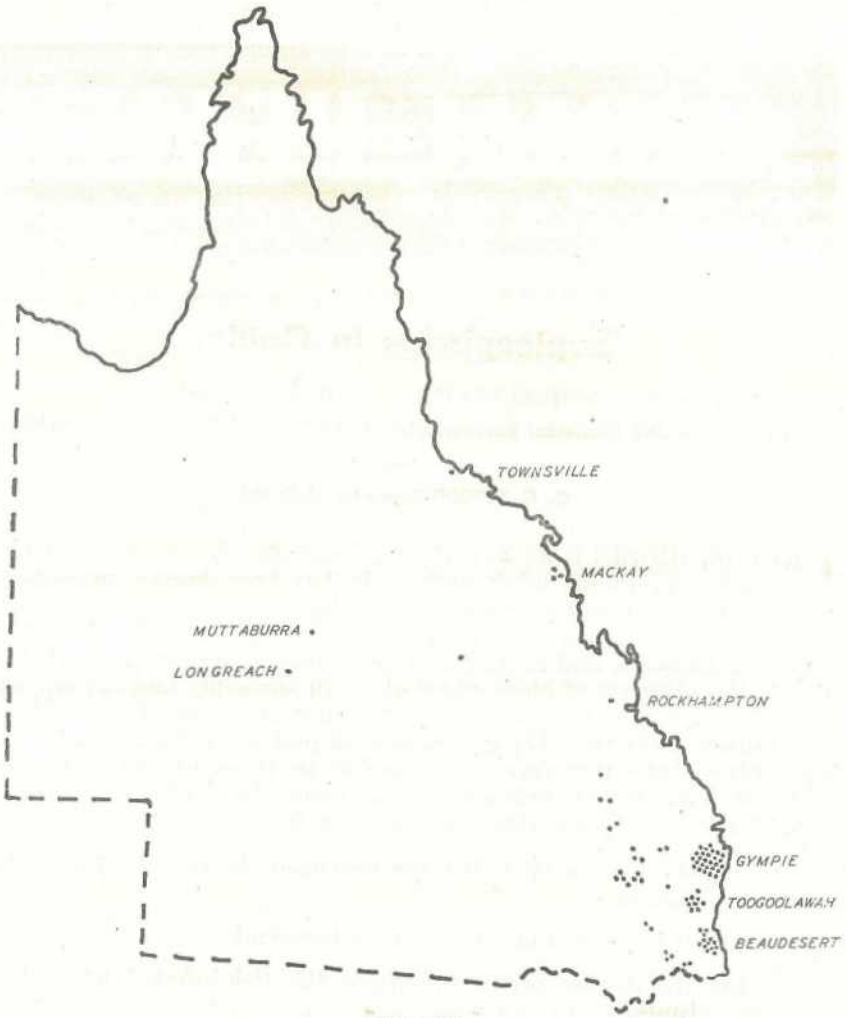


Plate 115.

Distribution of 82 Confirmed Outbreaks of Bovine Leptospirosis in Queensland from January, 1949, to June, 1951. Each dot represents one infected herd.

The animals affected in 31 outbreaks in Queensland were:—

Calves only	20 outbreaks
Calves and cows	5 outbreaks
Cows only	6 outbreaks

These figures are considered representative of outbreaks as a whole.

ECONOMIC IMPORTANCE.

In many outbreaks half the young calves in a herd have died, and some of the survivors have had to be destroyed because they failed to thrive. Among adult cattle there have been some deaths, but more serious financial loss has resulted from loss of milk production—from either temporary reduction of yield or complete drying-off of all quarters. In some affected herds there have been many abortions.

In some outbreaks the disease was transmitted to human beings who had contact with the affected cattle.

SYMPTOMS.

It must be emphasised that considerable variation in the severity and the course of the disease has occurred in different outbreaks and even among different animals within the same herd. In general, calves 1-3 months of age are affected most severely and suffer the highest death rate; calves 6-12 months usually have a milder attack, but at times are affected just as severely as the younger calves. In cows, the incidence and the death rate are usually lower, but loss of weight and loss of milk production can be serious.

Calves.

The first symptoms are usually lassitude and a tendency to tire easily and breathe rapidly when driven. In a few hours, or perhaps a day or so, there is fever and the animal is anaemic and jaundiced (that is, the mouth and eye membranes are pale and bloodless with a yellowish tinge). Haemoglobinuria is usually present for 24-48 hours, but this may be overlooked. In fatal cases death usually occurs 1-7 days after the first appearance of symptoms, but some calves may die so suddenly that they are found dead without having been seen sick. Some calves recover without treatment but are often sick for many weeks. Others develop chronic infection of the kidneys and remain unthrifty and are eventually destroyed. It has been found, too, that some calves contract the disease (and become "carriers") without exhibiting any symptoms.

The duration of the disease in calves varies a great deal. Many calves recover in about six weeks, but others remain unthrifty for much longer periods.

Adult Cattle.

In a severe attack of leptospirosis in a cow there is usually fever (temperature commonly 103°-105° but sometimes up to 107°) accompanied by rapid breathing, jaundice, anaemia and haemoglobinuria and terminating sometimes in death after 2-4 days. It must be stated again, however, that there is great variation from this typical picture. Milder cases may show only fever, loss of weight and some stiffness of muscles. Again, there may be only reduced milk yield, rough coat and normal temperature. Red urine may be passed on only one or two occasions and so is often not noticed.

When milking cows suffer an acute attack there is usually a sudden reduction in milk production. A cow that produced normally at the previous milking may produce only a little milk, which is usually curdy or watery or bloodstained; or the quarter may be hard and contain only a little blood; or again the udder may be soft and pendulous, as in a dry cow. Bloodstained milk is usually present for only the first day or two.

Most affected cows come back into production in about two weeks, although production is usually never as good as before the sickness. Some cows go dry after an acute attack.

Affected animals at times lose weight rapidly, and if the attack is severe, recovery is prolonged. In some affected herds many cows abort.

In some herds over 50% of the cows have been affected, while in other herds less than 5% have been sick. Mortality among adult cattle is not high, but it is evident that the economic loss can be heavy.

POST-MORTEM FINDINGS.

Acute fatal cases in either calves or cows almost always show anaemia, jaundice and haemoglobinuria (that is, pale watery blood, yellow discoloration of fat and other tissues and red or brown urine). The kidneys usually show abundant small haemorrhages. The spleen is sometimes soft and swollen, but never as much as in tick fever. The bile is usually thick.

In chronic cases that have been sick and unthrifty for a fortnight or more the most prominent abnormality is in the kidneys, which are usually swollen and scarred and exude fluid when cut.

DIAGNOSIS.

The symptoms and post-mortem findings in acute leptospirosis are similar to those of tick fever. As sickness due to tick fever is rare in young animals, a diagnosis of leptospirosis in calves showing fever, anaemia, jaundice and haemoglobinuria is usually correct.

In adult cattle, on the other hand, the close similarity to tick fever presents difficulties. The symptoms of tick fever and acute leptospirosis are very similar (or almost identical), but points that can be considered in an attempt to differentiate the two diseases are as follows:—

(1) Abortion is common in leptospirosis, but it is not a feature of all outbreaks; and furthermore other diseases (for example, brucellosis and vibriosis) can cause abortion.

(2) In leptospirosis milk secretion is usually reduced to a small amount of abnormal fluid.

(3) In herds affected with leptospirosis the disease usually—but not always—attacks calves as well as adult cattle.

(4) Leptospirosis does not respond to treatment with the drugs specified for tick fever—namely, Acaprin (Bayer), Piroparv (B.W. & Co.), Pirevan (Evans), Phenamidine (M. & B.) or Babesan (I.C.I.).

(5) Among adult cattle the mortality from leptospirosis is low whereas the mortality from tick fever is high (if treatment is not given). In calves the situation is reversed—that is, mortality from leptospirosis is high whereas mortality from tick fever is low.

Mild cases of leptospirosis in cows are not easy to distinguish from, and in fact have sometimes been mistaken for, three-day sickness or an unusual form of mastitis.

It is always wise, therefore, to consult the local veterinary officer or inspector of stock to make sure of the diagnosis, particularly in adult cattle, and to obtain advice on the correct treatment and preventive measures.

SPECIMENS FOR LABORATORY EXAMINATION.

The presence of leptospirosis can be detected by several different laboratory tests (for example, microscopic examinations, agglutination tests, guinea pig inoculations, &c.). However, leptospira are delicate

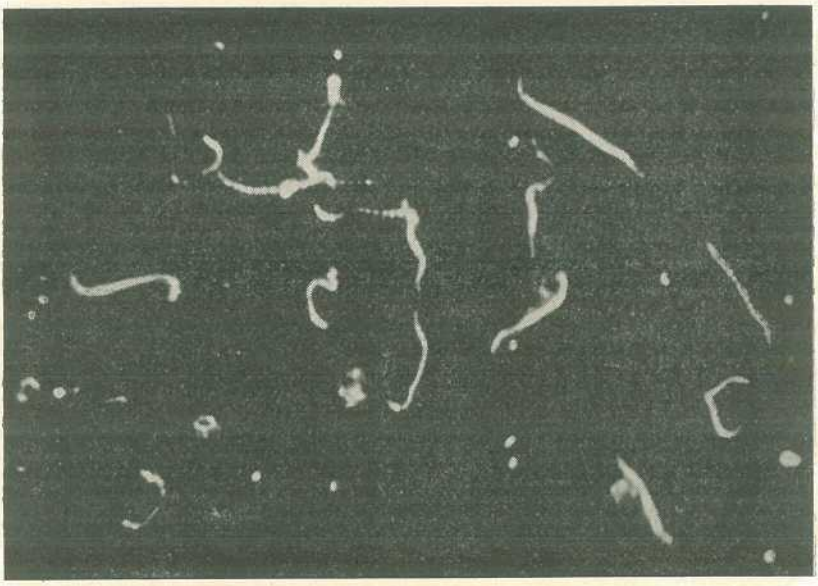


Plate 116.

Leptospira in Calf Urine, Magnified Approximately 1,600 Times. (Photo. by Mr. R. K. Keith, C.S.I.R.O., Yeerongpilly.)

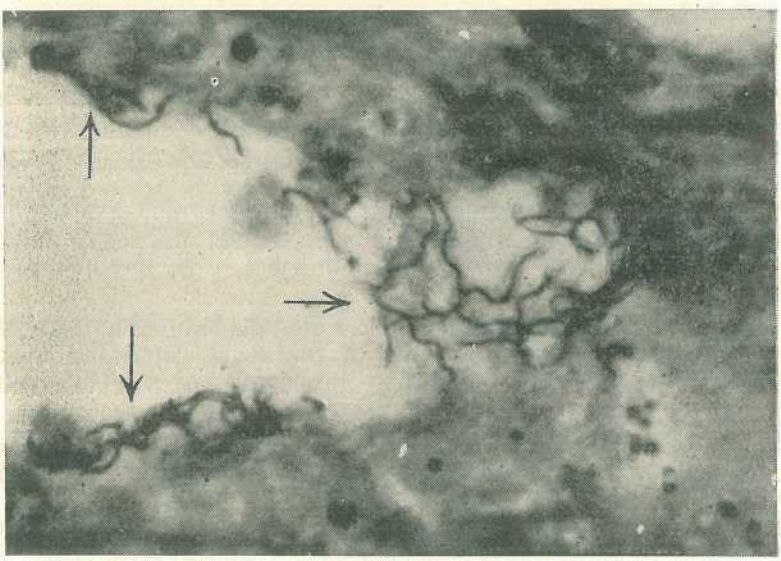


Plate 117.

Leptospira in the Kidney of a Calf. The organisms, stained black, are indicated by arrows. Magnified 2,500 times. (Photo. by Mr. R. K. Keith, C.S.I.R.O., Yeerongpilly.)

organisms sometimes not easily detected even in heavily infected specimens. It is therefore necessary that the appropriate specimens should be collected and sent to the laboratory in the proper form. Farmers who suspect the presence of the disease in their herds should therefore consult their local veterinarian or inspector of stock in order to make the best use of the available laboratory tests.

If a Departmental officer or veterinary surgeon is not available, farmers themselves could collect and send to the laboratory samples of urine and blood serum. About one ounce of urine preserved with about six drops of commercial formalin is required. Blood (20-30 c.c.) can be collected from the jugular vein and submitted without preservative in the same manner as samples for the agglutination test for brucellosis.

The tests on urine and blood will detect animals that have recovered from or are carriers of leptospirosis, but they do *not* detect animals in the acute stage of the disease. Thus, samples should be taken from several animals—six or more, including some that are recovering —if the results are to be of value.

It should be noted, too, that handling and collecting specimens from animals affected with leptospirosis is a decided risk unless the persons concerned wear rubber gloves and wash and disinfect their hands properly.

TREATMENT.

Sulphamezathine and Sulphamerazine.—These drugs appeared beneficial in some outbreaks where sick animals were detected early and dosed heavily (1 gram per 10 lb. liveweight), but they were disappointing in others.

Penicillin.—The results of treatment with penicillin (200,000 to 500,000 units per 100 lb. liveweight) injected deep into the muscles have been sometimes good and at other times disappointing. The treatment has usually relieved the acute fever, but treated animals may continue to pass leptospira in the urine for many weeks after they appear to have recovered (that is, they remain carriers of the disease).

Streptomycin.—This has been used on only a few calves. It seems to be the most promising treatment, especially as the treated calves do not pass leptospira in their urine and are therefore not carriers. The recommended treatment is 0·5 gram per 100 lb. liveweight injected intramuscularly (deep into the rump muscles) each day for two or three days.

Aureomycin.—Experiments on dogs and laboratory animals have shown that this is better than any of the above drugs for treating leptospirosis in these animals, but no information is available yet on the efficiency of aureomycin in leptospirosis of cattle.

The treatment recommended at the present time is therefore streptomycin. If this drug is not readily available, then combined simultaneous treatment with penicillin and sulphamezathine (or sulphamerazine) should be given. Treatment should be given daily for three or four days or until temperature and appetite have been restored to normal for 24 hours.

As with any treatment, it is important that the sick animals be detected in the early stages of the disease. The sick calves should of course be well cared for in a separate pen or yard, where they will not be disturbed by healthy ones.

PREVENTION.

Leptospira are passed out in the urine of cows and calves up to three months or more after the first appearance of symptoms. Hence, the urine of recovered and in-contact animals is a prolific source of infection.

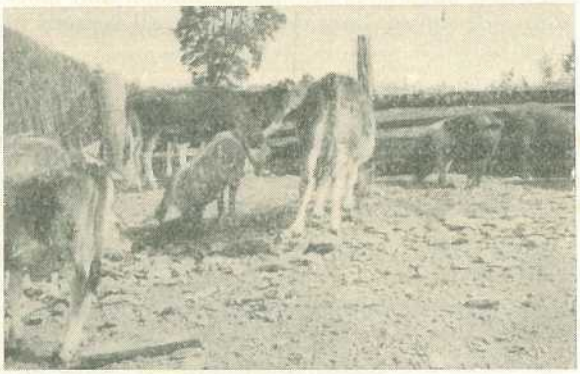


Plate 118.

Calves Kept With Pigs May Contract Leptospirosis. Pigs pass enormous numbers of leptospira in their urine, although they usually show no signs of sickness.

Pigs are often carriers of the leptospira that causes disease in cattle (namely, *Leptospira pomona*). Infected pigs usually show no signs of sickness, but they pass enormous numbers of leptospira in their urine for periods up to a year or more. Thus, the first step in preventing leptospirosis among cattle is to protect them from exposure to pig urine or to any drainage or other materials likely to be contaminated with pig urine. There is ample evidence, in fact, that dairy herds have become infected with leptospirosis by purchased pigs, particularly pigs from saleyards.

Outbreaks have also occurred among cattle that had no contact with pigs, and in these herds the disease appears to have been introduced by carrier cows or calves purchased from other farms or from saleyards.

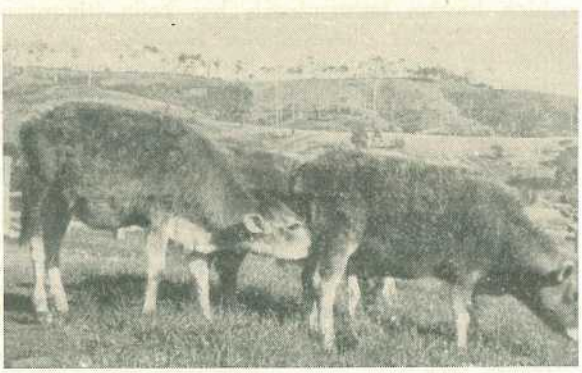


Plate 119.

The Sucking Habit of Calves Exposes Them to Infection With Leptospira from the Urine of Carrier Calves.

Leptospira are quickly destroyed by drying, but they can survive for long periods in neutral or slightly alkaline water or mud. It is therefore likely that many cattle contract the disease as a result of mud or water contaminated with urine coming in contact with their mouths or nostrils or with slight cuts and scratches on the skin. Related to this is the fact that outbreaks are more common and more severe during the wet season. However, they do occur at all seasons of the year and sometimes even on high, well-drained farms.

The habit that some calves have of sucking each other after feeding provides ample opportunity for direct transfer of infection from the urine of carrier calves to the mouth or nostrils of susceptible calves.

There is no effective vaccine for leptospirosis in cattle. The preventive measures that are recommended are:—

(1) Avoid wet or muddy conditions about yards, lanes or pastures.

(2) Keep pigs strictly separated from cattle.

(3) If pigs must be bought, then secure them from farms where the cattle are known to be healthy; pigs or calves or cows bought in saleyards can introduce leptospirosis into a healthy herd.

(4) When the disease appears in a herd, rear all calves born subsequently in strict isolation from the *whole* of the affected group (there are certain to be some carriers among the latter).

(5) If the disease appears in calves, keep them strictly isolated from the adult herd.

It seems that it should be feasible to eliminate leptospirosis from an infected farm by using blood serum and urine tests to detect the carriers among both cattle and pigs.

TRANSMISSION OF BOVINE LEPTOSPIROSIS TO MAN.

Leptospira pomona, the cause of bovine leptospirosis in Queensland, is transmissible to man, and in fact was first discovered as a cause of disease (coastal fever) among dairy farmers in the Pomona district. Cases of human leptospirosis have occurred on many of the farms on which bovine leptospirosis has been diagnosed during the past three years. Rubber gloves should therefore be worn at all times when examining affected animals. The organism is quickly destroyed by reliable disinfectants, and these should be used when ever necessary. Fortunately, no fatal human infections have been recorded in Australia.

QUEENSLAND POCKET YEAR BOOK, 1952.

Pending publication of the Queensland Year Book, 1952, the Government Statistician has issued the Queensland Pocket Year Book, 1952. This publication contains condensed statistical information on a wide variety of subjects and is a very handy reference book.

Copies may be obtained free from the Government Statistician, Treasury Building, George Street, Brisbane.

PLANT PROTECTION

Apple Pest Control in the Granite Belt.

A. W. S. MAY, Entomologist, Science Branch.

THOUGH many pests are associated with apples in the Stanthorpe area, those likely to be encountered each season are codling moth, light brown apple moth, mites, woolly aphid, and fruit fly. These destroy fruit, damage foliage or retard growth and specific measures for their control must be applied if orchardists are to obtain profitable yields.

Successful control of pests in apples depends mainly upon effective insecticides, thorough spraying and the timing of spray applications. For correct timing it is essential that growers recognise the several pests and have some knowledge of their seasonal behaviour.

A brief account of each major pest and the relative merits of measures that can be employed against them should assist growers in combating pests in their orchards. This information is necessary when planning a detailed seasonal control programme.

CODLING MOTH.

The larvae of this moth* enter the fruit and tunnel to and feed mainly upon the developing seeds and surrounding tissues. Damaged fruit usually fall from the tree.

Each spring the pest commences its activity with moth emergence from cocoons spun by overwintering larvae located under bark, in crevices on the tree, amongst refuse in the orchard, or amongst cases and packing material in or near the packing shed. The moths deposit eggs singly on the trees and these give rise to the first summer generation of grubs, which attack the newly formed crop. Development is complete by early summer, cocoons are spun, and the moths again emerge in midsummer to give rise to the second summer generation. No exact time can be given for this emergence as it depends to some extent on weather conditions. It may occur between late December and early February, although more usually in early January.

As sprays are applied to prevent grubs entering the fruit, a knowledge of when these two periods of major moth activity occur is an important factor in successful codling moth control.

Traps baited with a suitable lure can be used to attract moths, and the numbers caught at regular intervals provide means of gauging their activity throughout the season. For many years the Department has maintained traps for this purpose and has advised growers, by means of spray notices, of the most appropriate times for spray applications. Though serving as a guide, such information should be

* *Cydia pomonella* (L.).

applied according to the requirements in each orchard. Moth populations vary from orchard to orchard, depending on the efficacy of control measures applied in the previous season. Thus, more accurate information on the necessity of spray application in each orchard would be possible only if each grower maintained his own traps. Information on the use of lure traps can be obtained from Departmental officers at Stanthorpe and Toowoomba.

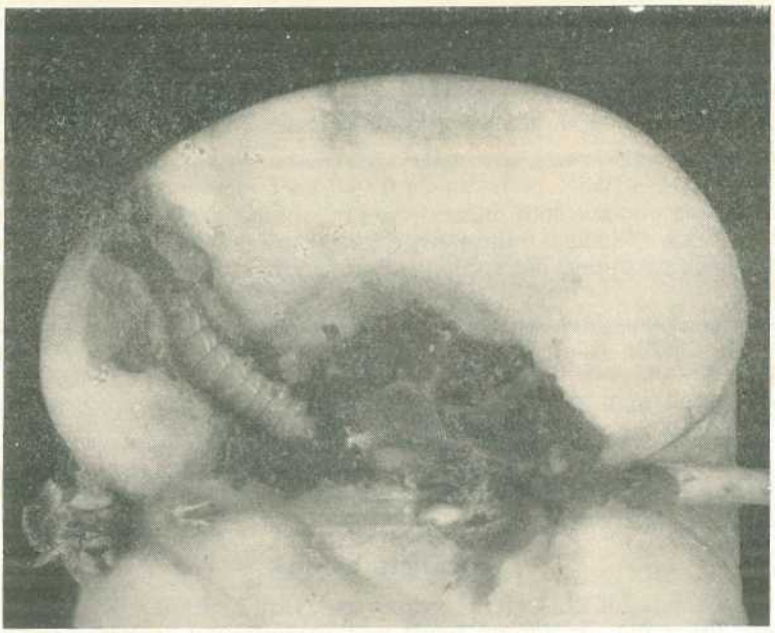


Plate 120.
Codling Moth Larvae Tunnelling in Fruit.

Many sprays or spray combinations are used by orchardists for codling moth control, but 0·1% DDT, applied during periods of major pest activity, has proved the most effective. Other insecticides should be used when populations are low to avoid additional applications of DDT and its attendant stimulation of mite and woolly aphid populations.

LIGHT BROWN APPLE MOTH.

Though closely allied to the codling moth, this insect* has different habits. It attacks a wide range of hosts, including apples, pears, grapes, apricots, plums and lupins. The last-mentioned host serves as an important source of food during the autumn and winter months and can be responsible for the presence of an appreciable pest population early in the ensuing fruit season.

Two or more generations of the pest occur during the growing period, the moths of the first commencing to emerge by early summer. Subsequent generations overlap and extend throughout late summer and autumn. Thus, moths may be present on orchards from late October onwards; they are most prevalent during the summer months.

* *Tortrix postvittana* (Walk.).

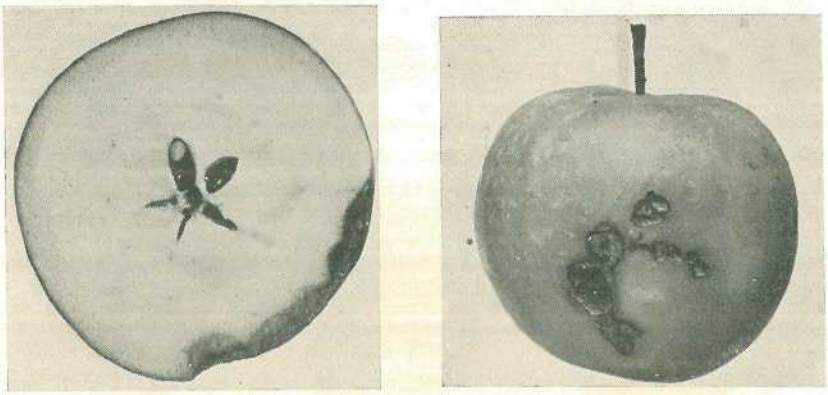


Plate 121.

Light Brown Apple Moth Damage to Fruit. Note that the injury is superficial.

Infestations in apples usually commence following egglaying on the younger leaves of leaders and terminal growth. The newly hatched grubs feed on the tissues, and spin leaves together to provide shelter. Later, as populations increase, feeding becomes more general and some fruit damage may occur. When fruit are attacked, the grubs gouge out areas of skin and underlying tissues beneath touching leaves or between adjacent fruits. Feeding is confined usually to the surface tissues, and burrowing into fruit is rare.

Though of less importance than codling moth, the light brown apple moth may cause considerable damage in certain seasons. The control of this pest is not a difficult problem and insecticide should be applied soon after larval damage becomes evident in the new growth. DDT sprays for codling moth control will check this pest, but these applications do not continue throughout the period when it is most active. Lead arsenate will prove of more benefit against the light brown apple moth.

MITES.

Mite damage occurs chiefly on the leaves, though fruit injury may result when large populations are present. These pests* feed by piercing the surface tissues and extracting sap from the underlying cells. The first symptoms of mite damage invariably occur in the older leaves both inside and towards the base of the tree. The normal green colour of the leaf is destroyed in the vicinity of each feeding puncture and the result is a yellow mottling of the foliage. When injury is severe, the entire leaf presents a yellowish-green colour. With the more susceptible varieties, Delicious and Winesap, severely injured leaves eventually redden and areas of tissue may die. Leaf shedding is not uncommon, and growth may be arrested. When mites are numerous, damage to the fruit of red apple varieties prevents normal colouring.

* *Tetranychus urticae* Koch; *Bryobia praetiosa* Koch; and an unidentified Eriophyid.

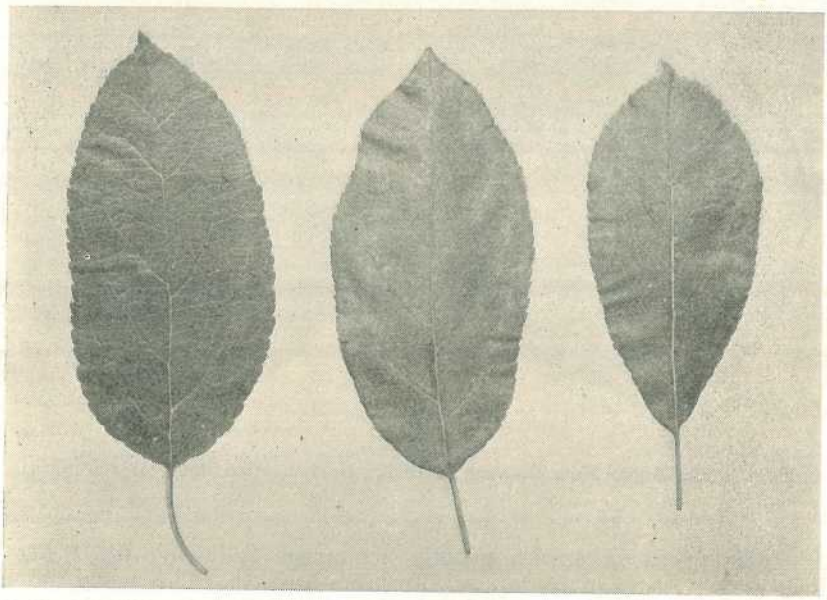


Plate 122.

Mite Injury. Left, normal leaf; centre and right, damaged leaves.

Three mites are commonly associated with apples. Two of these, namely Bryobia and an Eriophyid, are chiefly pests of deciduous fruit trees and overwinter in the egg stage on the apple tree. Egg hatching occurs in spring, when the mites crawl to the foliage and commence feeding. Populations reach a peak by midsummer. During autumn, numbers wane and the overwintering eggs are laid on the spurs and branches.

Red spider,* on the other hand, does not pass the winter in the egg stage and can feed on a wide range of plants. It is rarely prevalent on the trees until early summer, but once DDT is applied its numbers increase rapidly. The peak of activity occurs in late summer and early autumn. It is this mite that causes most of the injury each summer in orchards where DDT is used for codling moth control.

Mites breed rapidly during early summer and growers seldom can determine the prevalence of the pests before damage has occurred. Preventive treatments, therefore, should be applied before populations get out of hand; also, to be effective, miticides must be applied thoroughly.

Where dormant or semi-dormant oil sprays are used, the Bryobia and Eriophyid mites are seldom of importance during the following summer. Such sprays have little effect against red spider and summer treatment is necessary for control of this pest. These summer sprays should be applied before mite populations are large, preferably between early November and mid-December. Survivors of the other two mites from the winter oil sprays will also be checked by these summer treatments. One spraying is seldom sufficient and two closely spaced

* *Tetranychus urticae* Koch.

sprays should be applied. Many insecticides are used against mites, but E.605 (parathion) has been found most effective against all three species, and particularly against red spider. Sulphur sprays are less effective against this pest.

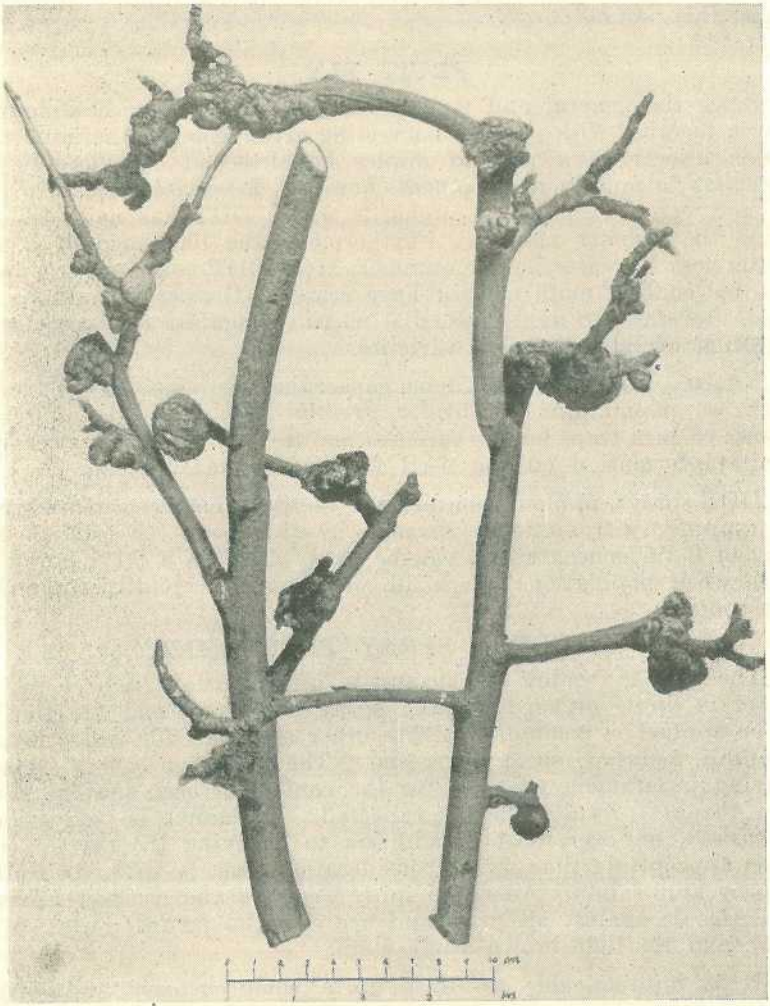


Plate 123.

Twig and Spur Galling Caused by Woolly Aphid.

WOOLLY APHID.

Woolly aphid* is not of general importance in the Stanthorpe district, but it may become a pest in certain seasons and require specific attention only in some orchards. It overwinters on the tree and colonies may be found on the spurs and on old pruning cuts in early spring. Under favourable conditions numbers *rapidly* increase and the pest spreads to new growth and causes a characteristic galling of stems. If populations are large, growth may be checked, and sticky secretions from the aphids cover fruit and branches. Sooty mould develops rapidly on this secretion and lowers fruit value.

* ***Eriosoma lanigerum*** (Hausm.).

The introduced wasp* parasite does not check populations before late summer and sprays are required to prevent damage to the new season's growth. Applications of winter oils and E.605 in the early summer for mite control usually check woolly aphid. Other summer sprays, such as nicotine sulphate and Hexone, may be used specifically against this pest.

FRUIT FLY.

Since the general and widespread use of DDT for codling moth control, together with suitable harvesting arrangements, the importance of this insect† as a pest of apples has lessened considerably. In years that favour fly development, however, losses may occur to early and mid-season varieties on orchards where DDT has not been used during the summer months. Furthermore, the likelihood of damage by this pest increases in late summer, after DDT cover spray applications for codling moth control have ceased. Growers should be prepared, therefore, to apply remedial measures against this pest for the protection of late maturing varieties.

No fixed rule can be laid down concerning the possibility of fruit fly attack, as populations will differ greatly from orchard to orchard. The use of lure traps before varieties mature will provide growers with definite information on the need for preventive spraying.

DDT sprays, applied soon after fly activity has been demonstrated by trapping, will minimise damage by this pest. A partial cover spray of 0·2% concentration can be used, although a 0·1% spray will suffice when populations are small, or when used jointly for codling moth control.

SEASONAL SPRAY PROGRAMME.

The proper timing of sprays is an important aspect of pest control in apple orchards. Each spray has its special function but can be applied in combination with other materials for wider benefits, including reduced spraying costs. The adoption of a seasonal spraying programme provides for the control of each pest at a time when the best results can be expected. It cannot be too strongly emphasised, however, that in addition to applying the correct spray at the appropriate time, every consideration must be given to methods of spray application. Adequate spray pressure and complete coverage are desirable against all pests and are essential against mites, woolly aphid, and the light-brown apple moth.

It is impracticable to draw up a comprehensive and entirely effective orchard spraying programme to satisfy requirements on all orchards. Pest populations, spraying machinery and the standard of spray application vary considerably and the orchardist must regulate his spray programme accordingly.

Codling moth control should form the basis of all programmes, for this pest will continue to cause fruit losses if spraying is neglected. Thus DDT is recommended for the early November spray and again to destroy progeny of the second generation in January.

The following spray programme will serve as a guide and, with minor modifications, can be adopted to suit conditions in most Stanthorpe apple orchards.

---

* *Aphelinus mali* (Hald.).

† *Strumeta tryoni* (Frogg.).

APPLE PEST SPRAYING PROGRAMME.

July to September.

Dormant or Semi-dormant Periods.

Use: *either Dormant oil—July or early August.*

or *Semi-dormant oil* plus *lime sulphur* at *green tip—approximately mid-September.*

Either spray will prove effective against the overwintering stages of mites and woolly aphid. These also control the San José scale* should it be troublesome.

October.

Calyx Spray.

Should moth populations be small this spray need not be applied.

Use: *either* Lead arsenate; white oil (3 lb.; 2½ pints; 100 gal.).

or Lead arsenate; zinc sulphate; hydrated lime; white oil (3 lb.; 1 lb.; 2 lb.; 2½ pints; 100 gal.).

or DDT (0·1%).

This spray is applied after the majority of petals has fallen but before the calyces are closed.

Early November.

(Approximately two weeks after time for calyx spray.)

This period is important for codling moth control.

Use: *DDT* (0·1%)—applied approximately one week after the peak of moth activity.

Alternative sprays, such as lead arsenate, nicotine sulphate—white oil and other combinations, cannot be recommended as substitutes for DDT if moths are prevalent.

Late November.

(Approximately three weeks after early November spray.)

Joint control of codling moth and the light-brown apple moth can be achieved at this time. Applications for mite and woolly aphid control also commence in this period.

Use: *A combination spray containing DDT, lead arsenate and E.* 605 to control all pests listed above.

Should codling moth populations be small, the DDT may be dispensed with in the spray. Complete tree coverage is essential for maximum benefit.

Mid-December.

If appropriate measures have been taken for codling moth and light-brown apple moth in early and late November, further sprays against these pests should not be required at this stage.

A further spray for mite control is recommended.

E. 605 will give the most effective results and should be applied not later than three weeks after the combination spray in late November. Lead arsenate may be added to this spray if light-brown apple moth is active.

---

* *Quadraspidiotus perniciosus* (Comstock.).

Early to Mid-January.

Codling moth activity can be expected in this period.

Use: *DDT* (0·1%).

Timing of spray application will depend on moth activity recorded by trapping, and should take place approximately one week after the peak of moth activity.

Control measures against mites and woolly aphid should not be required if the appropriate sprays have been applied in early summer against these pests.

Late January–Early February.

Approximately three weeks after the early or mid-January DDT spray, a further spray is required to check light-brown apple moth and codling moth activity in late summer.

Use: *A combination spray of DDT* (0·1%) *and lead arsenate* (3 *lb.*–100 *gal.*), the DDT being added if codling moth is still active. To avoid undesirable insecticide residues it may be necessary to use only white oil—nicotine sulphate (1 1/3 gal. white oil; 1 pint nicotine sulphate; 80 gal. water).

If the above programme is carried out, further spraying to control pests should not be necessary other than the *application of DDT, when required for fruit fly control.* The timing of sprays for this pest will depend largely on local conditions and can best be decided by the orchardist.

Heliothis Control in Linseed.

T. PASSLOW, Assistant Entomologist, Science Branch.

HELIOTHIS,* in some seasons, causes severe damage to linseed crops in southern Queensland. The insect is of world wide distribution, attacking numerous weed species and many crops, including maize, cotton, tobacco, tomatoes, linseed, sunflowers and green peas. It is primarily a pest of these crops during seed production. In linseed the caterpillars, or grubs, cause damage by tunnelling into the capsules and feeding on the developing seed, and when present in large numbers may cause almost complete loss of the crop.

Life History and Habits.

The moth is a stout bodied insect with a wing expanse of 1½ inches, the forewings being brown to pink in colour and the hindwings creamy yellow, each with a large marginal smoky area. It has the peculiar habit when disturbed of flying low and rapidly over the crop, and alighting again within 50 yards. Each female moth is capable of producing about 1,000 eggs, which are deposited singly on the flowers. After a few days the caterpillars hatch out and feed on the developing

* *Heliothis armigera* (Hb.).

bolls. When fully grown they measure up to two inches in length and vary in colour from green to brown and almost black. Grubs of different ages may be found in a linseed crop but all belong to the one generation, being the progeny of the moths which emerge from the overwintering pupae. This emergence commences with the warm weather of early spring and may continue for three or four weeks.

Control.

Boom spraying is the most widely used and effective method of Heliothis control in linseed. For best results DDT, in emulsion form, should be used at the rate of 1 lb. of active insecticide per acre, irrespective of the volume of spray applied. Fifteen gallons of spray per acre give adequate cover and usually one treatment shortly after moths become active during flowering is sufficient for crop protection.

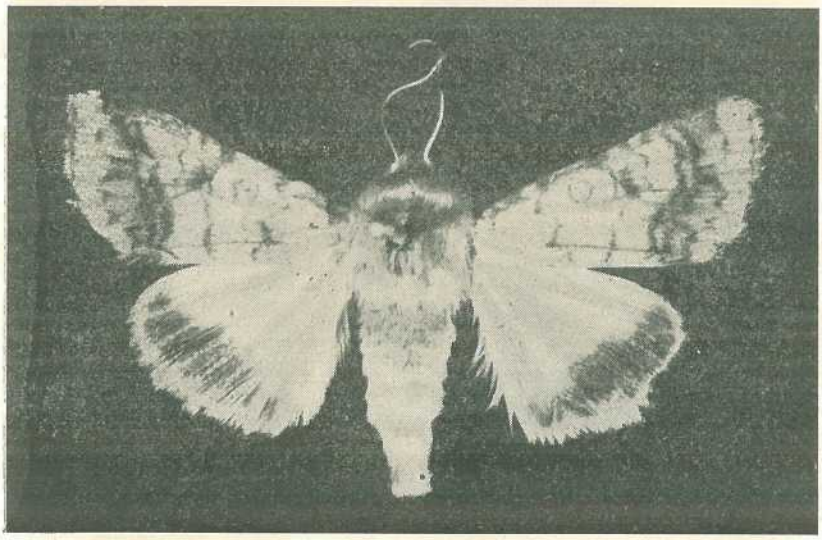


Plate 124.

A Heliothis Moth. Wingspread 1½ in. Forewings brown to pink. Hindwings creamy yellow.

Heliothis is not present in pest numbers in linseed every season, the population being dependent to a large extent on the weather, and on food supply during the previous autumn. The practice of routine spraying is therefore an unnecessary expense in seasons of low Heliothis population. *Careful crop inspections for the presence of moths during flowering will indicate whether spraying will be necessary.* If large numbers are present severe damage can be expected. Prompt action at this time minimises crop damage and is preferable to delaying treatment until grubs and their damage are seen.

The practice of early planting (late April and early May) diminishes the risk of Heliothis damage, as moths usually do not deposit eggs before mid-September. Early planted crops, in normal seasons, produce the bulk of their flowers before this time and are not, therefore, attractive to the moths. Early sowing, however, does not guarantee escape from Heliothis attack and the usual precautionary crop inspections during flowering should be practised.

Armyworm Control in Cereal Crops.

T. PASSLOW, Assistant Entomologist, Science Branch.

ARMYWORMS* periodically cause extensive damage to cereals during autumn and spring. On the Darling Downs the caterpillars may attack ripening French millet, Japanese millet, panicum, Sudan grass, young oats, barley and wheat during autumn. Spring outbreaks are more usually associated with barley.

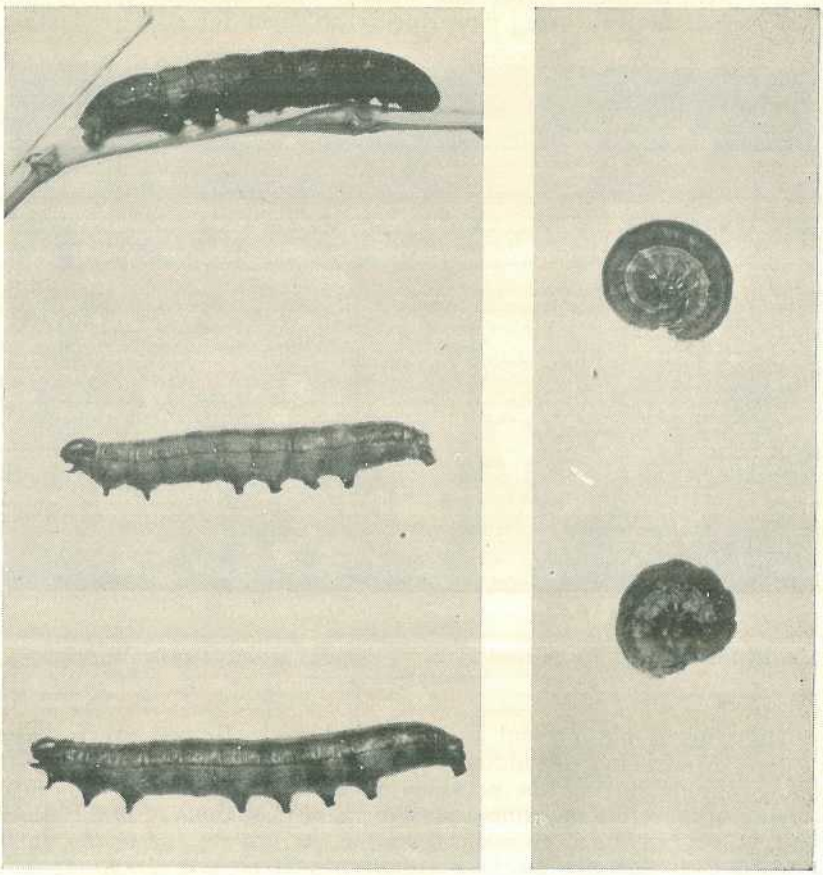


Plate 125.
Armyworm Caterpillars Extended and at Rest.

The armyworm moths are fawn to brownish in colour, about three-quarters of an inch long and 1½ inches across the outspread wings. They are nocturnal and are seldom seen. The caterpillars also are

* *Cirphis unipuncta* (Haw.).

usually inactive during the day, resting in the soil, and nearly all their feeding is done at night. When mature they measure up to two inches in length and vary in colour from green to almost black, but all are marked with two longitudinal greenish stripes.

In most crops armyworms prefer to feed on the leaves, although when the plants are young these pests chew through the stems at ground level and consume all the aboveground portions. Also, when the plants have been defoliated or have dried out with maturity, the caterpillars attack the stems, chewing through just below the heads, which then drop to the ground.

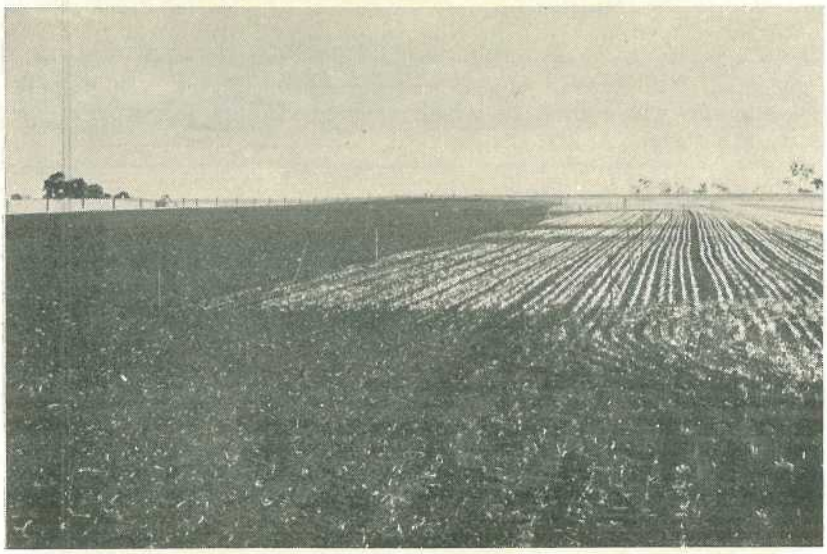


Plate 126.

Damage to a Young Cereal Crop by Advancing Armyworms. The undamaged area is portion of a trial plot protected by DDT.

Two types of infestation occur. The more common one is a light but somewhat uniform dispersal of caterpillars resulting from a wide scattering of moths within a crop. The young caterpillars are usually unnoticed as they seldom cause damage of a serious nature. With growth, however, food requirements increase and damage seems to appear quite suddenly. The second and more spectacular type of infestation develops when the caterpillars are numerous and move on a definite front, eating all palatable food as they advance. These infestations are usually from external sources such as pastures and old cultivations.

Control Measures.

The nocturnal habits of armyworms and the apparent suddenness of attacks make it almost impossible to forecast outbreaks of this pest. Farmers therefore should at the first signs of damage apply control measures quickly.

The older method of control, namely baiting, will give good results and is recommended where suitable spraying equipment is not readily available. Baits may be prepared and used as follows:—

> Throughly mix 25 lb. bran and 1 lb. Paris green, and immediately prior to use dampen with 2 gallons of water to which 1-2 quarts of molasses have been added. Two pounds of lead arsenate or 2 lb. of BHC 4% dust (0·5% gamma isomer) may be substituted for the Paris green. The bait should be crumbly and not over-moist, and is best applied in the late afternoon. In most instances the quantities mentioned will give satisfactory results if distributed carefully over half an acre. Heavier dressing will be required when dealing with the pests moving on a front.

DDT spraying is a more convenient and effective method of controlling armyworms. Half a pound of active ingredient per acre, preferably in the emulsion form, is the rate of application recommended. Where the caterpillars are moving as an army, treatment of a strip on both sides of the front will be sufficient to halt the pest. The width of this strip will depend on the severity of the attack. In dispersed outbreaks the whole area in which the caterpillars are working will require attention.

DEPARTMENTAL PUBLICATIONS.

The Department has advisory leaflets and pamphlets on a variety of subjects available to Queensland primary producers free on application.

The Division of Plant Industry list includes the following:—

Advisory Leaflets.

No. 228. The Cultivation of Some Salad Vegetables.
No. 229. Broom Millet.
No. 234. The Grape.
No. 235. Bush Hay Conservation in North-western Queensland.
No. 237. Strawberry Culture.
No. 241. The Apple.
No. 242. Pumpkins, Squashes and Marrows, and Grammas.
No. 244. Citrus Growing.

Pamphlets.

No. 148. The Vegetation of South-eastern Queensland.
No. 149. The Papaw.
No. 150. Tropical Pasture Investigations.

Division of Animal Industry Advisory Leaflets include:—

No. 33. Cattle Drafting Yards.
No. 36. Infectious Calf Pneumonia.
No. 38. Ear Notching of Pigs.
No. 41. Bracken Fern Poisoning of Cattle.
No. 44. "Swelled Head" of Sheep.

Recent Animal Industry pamphlets are:—

No. 10. The Occurrence and Control of Worm Parasites of Sheep in Queensland.
No. 11. Parasitic Worm Diseases of Cattle.
No. 12. Milch Goats.
No. 16. Lamb Marking.

Among publications of the Division of Dairying are the following pamphlets:—

No. 7. The Cleaning and Sterilizing of Dairy Utensils and Equipment.
No. 8. The Care and Operation of Milking Machines.
No. 9. An Elevated Milking Bails.

Brucellosis Testing of Swine.

The Department of Agriculture and Stock is operating a scheme whereby pig herds are tested at intervals for the occurrence of swine brucellosis (contagious abortion).

A herd listed by the Department as "brucellosis tested" is one in which all such animals as may be determined by the Director of the Department's Division of Animal Industry have been subjected to two successive tests for brucellosis, at intervals determined by him, without any positive reactors being found.

In order for a herd to be retained on the list of Tested Herds, a semi-annual or annual re-test of the herd, as determined by the Director, is required. If at a re-test any animal gives a positive reaction to the test the herd is removed from the list; it is not listed again until subsequent tests, as determined by the Director, have been carried out.

Full particulars of the Brucellosis Testing of Swine and application forms may be obtained from the Under Secretary, Department of Agriculture and Stock, William Street, Brisbane.

TESTED HERDS.

(AS AT 11th SEPTEMBER, 1952.)

Breed.	Owner's Name and Address of Stud.
Berkshire	J. J. Bailey, "Lucydale" Stud, East Greenmount
	S. Cochrane, "Stanroy" Stud, Felton
	Garrawin Stud Farm Pty. Ltd., 657 Sandgate road, Clayfield
	G. Handley, "Handleigh" Stud, Murphy's Creek
	J. L. Handley, "Meadow Vale" Stud, Lockyer
	R. G. Koplick, "Melan Terez" Stud, Rochedale
	O'Brien and Hickey, "Kildurham" Stud, Jandowae East
	E. Pukallus, "Plainby" Stud, Crow's Nest
	G. C. Traves, "Wynwood" Stud, Oakey
	E. Tumbridge, "Bidwell" Stud, Oakey
	Westbrook Farm Home for Boys, Westbrook
	H. W. Wyatte, Rocky Creek, Yarraman
	H.M. State Farm, "Palen Creek," Palen Creek
	A. R. Ludwig and Sons, "Cryna" Stud, Beaudesert
	H. H. Sellars, "Tabooba" Stud, Beaudesert
	F. Thomas, "Rosevale" Stud, Beaudesert
	D. T. Law, Trouts Road, Aspley
	C. F. W. and B. A. Schellback, "Redvilla" Stud, Kingaroy
	R. H. Crawley, "Rockthorpe" Stud, via Pittsworth
	F. R. J. Cook, "Alstonvilla," Woolvi, via Gympie
	D. E. and E. C. Apelt, "Thelmur," Oakey
	Mrs. I. M. James, "Kenmore" Stud, Cambooya
	H. L. Stark, "Florida," Kalbar
	J. H. N. Stoodley, "Stoodville," Ormiston
	H.M. State Farm, Numinbah
Large White	H. J. Franke and Sons, "Delvue" Stud, Cawdor
	Garrawin Stud Farm Pty. Ltd., 657 Sandgate road, Clayfield
	F. L. Hayward, "Curyo," Jandowae
	J. A. Heading, "Highfields," Murgon
	K. B. Jones, "Cefn" Stud, Pilton
	R. G. Koplick, "Melan Terez" Stud, Rochedale
	R. Postle, "Yarralla" Stud, Pittsworth
	E. J. Bell, "Dorne" Stud, Chinchilla
	L. C. Lobegeiger, "Bremer Valley" Stud, Moorang, via Rosewood
	J. H. G. Blakeney, "Talgai" Stud, Clifton
	H. R. Gibson, "Thistleton" Stud, Maleny
	H.M. State Farm, Numinbah
	K. A. Hancock, "Laurestonvale" Stud, Murgon
	O. H. Horton, Mannuem, Kingaroy

TESTED HERDS—continued.

Breed.	Owners Name and Address of Stud.
Large White—*continued*	V. P. McGoldrick, " Fairymeadow " Stud, Cooroy N. Woltmann and Sons, Wooroolin R. S. Powell, Kybong, via Gympie E. B. Horne, "Kalringal," Wooroolin S. T. Fowler, "Kenstan" Stud, Pittsworth J. A. and J. McNicol, "Camden," Canning Vale, Warwick H. L. Larsen, "Oakway," Kingaroy
Tamworth	S. Kanowski, " Miecho " Stud, Pinelands N. R. Potter, " Actonvale " Stud, Wellcamp D. F. L. Skerman, " Waverley " Stud, Kaimkillenbun A. C. Fletcher, " Myola " Stud, Jimbour Salvation Army Home for Boys, Riverview F. Thomas, " Rosevale " Stud, Beaudesert A. J. Surman, Noble Road, Goodna P. V. McKewin, " Wattleglen" Stud, Goombungee Department of Agriculture and Stock, Regional Experiment Station, Kairi P. V. Campbell, Lawn Hill, Lamington E. C. Phillips, "Sunny View," M.S. 90, Kingaroy T. A. Stephen, "Withcott," Helidon W. F. Kajewski, "Glenroy" Stud, Glencoe A. A. Herbst, Bahr Scrub, via Beenleigh R. G. Koplick, Grieves Rd., Rochedale H.M. State Farm, Numinbah
Wessex Saddleback ..	W. S. Douglas, " Greylight " Stud, Goombungee D. Kay and P. Hunting, " Kazan " Stud, Goodna E. Sirrett, " Iona Vale " Stud, Kuraby C. R. Smith, " Belton Park " Stud, Nara H. H. Sellars, " Tabooba " Stud, Beaudesert H. Thomas, " Eurara " Stud, Beaudesert D. T. Law, Trouts Road, Aspley G. J. Wilson, " Glenbella " Stud, Silverleigh G. J. Cooper, "Cedar Glen", Yarraman J. B. Dunlop, Acacia Road, Kuraby A. Curd, Box 35, Jandowae

ASTRONOMICAL DATA FOR QUEENSLAND.

NOVEMBER.

Supplied by W. J. Newell, Hon. Secretary of the Astronomical Society of Queensland.

TIMES OF SUNRISE AND SUNSET.

At Brisbane.			MINUTES LATER THAN BRISBANE AT OTHER PLACES.					
Day.	Rise.	Set.	Place.	Rise.	Set.	Place.	Rise.	Set.
	a.m.	p.m.						
1	4.59	6.05	Cairns	45	12	Longreach	42	28
6	4.55	6.09	Charleville	29	25	Quilpie	33	37
11	4.52	6.12	Cloncurry	61	38	Rockhampton ..	17	3
16	4.50	6.16	Cunnamulla ..	28	31	Roma	18	15
21	4.48	6.20	Dirranbandi ..	17	21	Townsville	37	12
26	4.47	6.24	Emerald	26	31	Winton	49	31
30	4.46	6.27	Hughenden ..	46	24	Warwick	3	6

TIMES OF MOONRISE AND MOONSET.

At Brisbane.		
Day.	Rise.	Set.
	p.m.	a.m.
1	5.27	3.56
2	6.32	4.34
3	7.37	5.17
4	8.39	6.05
5	9.36	6.58
6	10.27	7.54
7	11.11	8.51
8	11.50	9.48
9	..	10.44
	a.m.	
10	12.24	11.39
		p.m.
11	12.54	12.31
12	1.23	1.23
13	1.51	2.16
14	2.19	3.10
15	2.50	4.07
16	3.23	5.06
17	4.02	6.09
18	4.47	7.13
19	5.39	8.16
20	6.38	9.15
21	7.43	10.07
22	8.50	10.54
23	9.57	11.35
24	11.02	..
	p.m.	a.m.
25	12.06	12.11
26	1.09	12.46
27	2.11	1.19
28	3.13	1.53
29	4.17	2.30
30	5.21	3.10

MINUTES LATER THAN BRISBANE (SOUTHERN DISTRICTS).

Charleville 27 ; Cunnamulla 29 ; Dirranbandi 19 ;
Quilpie 35 ; Roma 17 ; Warwick 4.

MINUTES LATER THAN BRISBANE CENTRAL DISTRICTS).

Day.	Emerald.		Longreach.		Rockhampton.		Winton.	
	Rise.	Set.	Rise.	Set.	Rise.	Set.	Rise.	Set.
1	13	24	29	40	3	15	32	46
6	10	30	25	45	0	21	27	53
11	15	23	30	39	6	14	35	44
16	25	13	42	28	16	2	48	31
21	30	11	45	25	20	0	44	7
26	19	19	35	34	10	10	39	39
30	11	27	26	43	1	18	29	51

MINUTES LATER THAN BRISBANE (NORTHERN DISTRICTS).

Day.	Cairns.		Cloncurry.		Hughenden.		Townsville.	
	Rise.	Set.	Rise.	Set.	Rise.	Set.	Rise.	Set.
1	15	40	40	58	25	43	14	34
3	6	50	35	63	20	49	6	42
5	3	55	34	67	18	52	4	45
7	7	52	36	65	20	50	7	44
9	15	45	40	60	25	46	14	37
11	20	37	43	56	28	41	17	32
13	29	26	50	47	35	33	25	22
15	39	16	56	41	41	26	33	15
17	48	7	63	35	48	21	40	8
19	55	3	68	32	51	18	45	4
21	54	6	67	34	51	20	44	7
23	45	15	61	41	46	26	37	14
25	34	21	54	44	38	29	29	18
27	22	32	45	53	30	38	19	42
29	12	43	39	59	23	45	11	36
30	8	48	36	62	21	48	8	40

Phases of the Moon.—Full Moon, November 2nd, 9.10 a.m.; Last Quarter, November 10th, 1.43 a.m.; New Moon, November 17th, 10.56 p.m.; First Quarter, November 24th, 9.34 p.m.

On November 15th the sun will rise and set 20 degrees south of true east and true west respectively and on the 13th and 26th the moon will rise and set at true east and true west respectively.

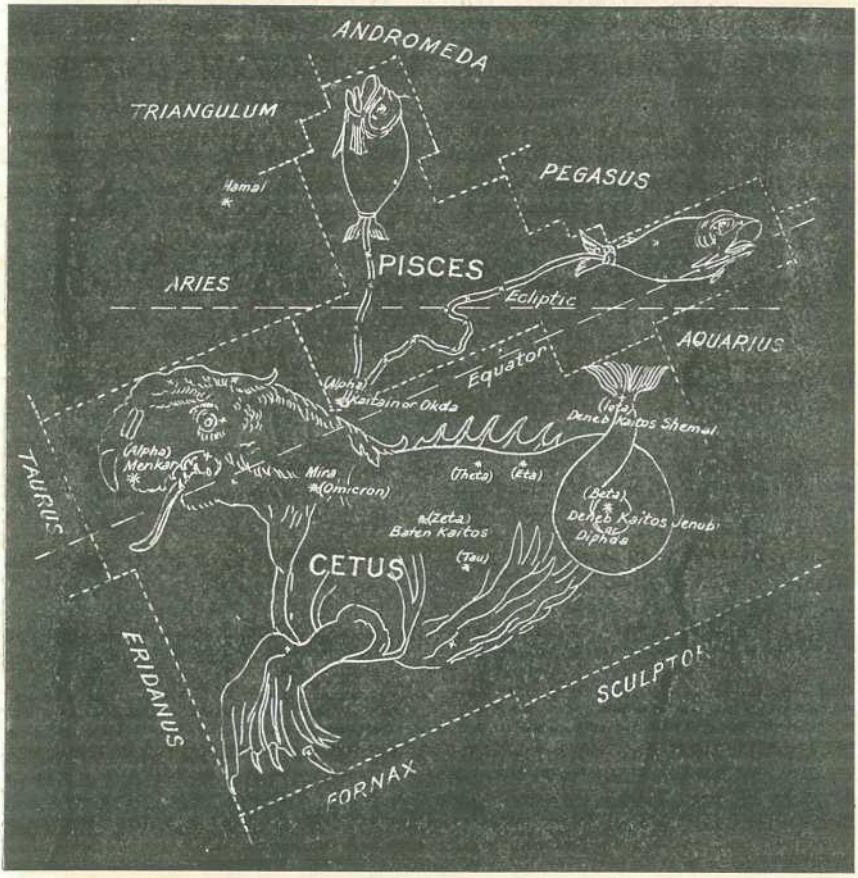
Mercury.—An evening object all this month. On the 1st, in the constellation of Scorpio, it will set 1¾ hours after the sun, and on the 10th will reach its greatest angle east of the sun. By the end of the month, still in the constellation of Scorpio, it will be in line with the sun and set about sunset. On the 8th it will be near Antares.

Venus.—Will be situated in the constellation of Ophiuchus at the beginning of the month, when it will set 2 hours 40 minutes after the sun. On the 20th the moon will be close by, and at the end of the month, in the constellation of Sagittarius, this planet will set 3 hours after the sun.

Mars.—In the constellation of Sagittarius, will set an hour or so before midnight during this month. On the 22nd the moon will pass very close to this planet.

Jupiter.—In the constellation of Aries, will now rise about sunset and be visible the whole night. The moon will be nearby on the 3rd and 30th.

Saturn.—Too close in line with the sun for observation at the beginning of the month, but by the end of the month, in the constellation of Virgo, will rise between 2.30 a.m. and 3.45 a.m.



THE CONSTELLATIONS.

Cetus (The Whale: a sea monster).

This is a large straggling group which lies between declination 10 degrees north and 25 degrees south. It lies close to the ecliptic, being south of Aries and Pisces and east of Aquarius. Menkar (Alpha Ceti) is at the southern apex of an equilateral triangle of which Hamal (Alpha Arietis) and the Pleiades form the base. It is also at the right-angle of a large 45-degrees triangle, with Hamal and Aldebaran (Alpha Tauri) marking the hypotenuse. A line from Aldebaran through Menkar and produced for about twice that distance will help to locate Omicron Ceti. This star, known as Mira, the Wonderful, was the first variable star to be discovered, being noted by Fabricus in 1596. Hevelius saw it between 1648 and 1662 and satisfied himself as to its variability. Mira is near the celestial equator. It has a mean period of 330 days. It is invisible without a telescope for about five months, sinking to a minimum of 8.5 or 9.6 mag., then it becomes visible to the naked eye for a period of about six months, rising to a maximum usually of 3rd or 4th mag. but sometimes to 2nd magnitude. At maximum the light increases about 1,400 times, apparently due to outbursts of hydrogen gas. Mira is one of the largest stars known, being about 400 times the diameter of our sun and being surpassed in size only by the giants. In 1923 it was found that Mira had a white dwarf companion at a distance of one second of arc. The companion is only 0.04 the size of the sun, making an oddly assorted pair—one of the largest and one of the smallest. Continuing the line from Menkar through Mira will bring us to Zeta Ceti, a 4th magnitude star at the eastern end of a rough quadrilateral of stars of which the others are Theta, Eta and Tau, all of about 3rd magnitude. Beta Ceti sometimes called Deneb Kaitos, is a 2nd-magnitude star to the south-west of this quadrilateral.

Pisces (The Fishes).

Pisces is a zodiacal constellation which lies on the ecliptic between Aries and Aquarius and to the south-east of the Great Square of Pegasus. The group is not easily distinguished but contains some interesting telescopic objects. It is important, too, for the fact that at present it contains the equinox or first point of Aries, the point at which the sun crosses the celestial equator on its apparent journey from south to north.