THE CONQUEST OF PRICKLY PEAR

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The control and eradication of prickly-pear in Queensland and New South Wales by the insect, Cactoblastis cactorum, is, I suppose, known throughout Australia. Furthermore, it is recognised in scientific circles all over the world as the outstanding example of the eclipse of a weed pest by the application of natural control methods. Cactoblastis is virtually a household word in our State. The transformation within the space of a few years of the prickly-pear country from a useless wilderness, choking pastoral and agricultural development, to a scene of prosperous endeavour is now accepted as an accomplished fact. Already we tend to forget that fifteen years ago the checking of the onward march of prickly-pear, let alone the freeing from its octopus grip of the densely infested areas, appeared to be a hopeless task. We are very much inclined to overlook the fact that we have witnessed something akin to miraculous. Cactoblastis has enacted the role of a beneficent Providence and has handed us back a great territory that we or our parents lost through neglect and lack of effort and vision.

Although the results of the biological campaign are familiar and are displayed for all to see, the story behind the success is worth the telling or re-telling. If in doing so, I cover ground that is well-known to you, my excuse lies in the circumstance that it is necessary to recapitulate to some degree.

The Problem That Was

As we are all aware, prickly-pears are not natives of Australia, but of America. The genus Opuntia contains about 400 species, which are found in their native state from the northern prairies of the United States to the Argentine. The group is an important one in the Cactaceae, a botanical order which is indigenous to the Americas, and which, although it contains plants

of very varied habit of growth, is not closely related to other plant families. The main characteristic of prickly-pears and of nearly all Cacti is that they are devoid of leaves, the function of which is assumed by the green stems, generally known as segments, pads or joints, and botanically termed cladodes. Of course, although prickly-pears belong to North and South America, they have established themselves in various parts of the globe and have assumed pest importance in several countries. Nowhere have they reached such alarming weed dimensions as in Australia. Here it should be stated that prickly-pears are not pests in America, at least not as we understand the application of the term to these plants. It is true that of recent years steps have been taken to destroy them in certain parts of Texas where sheep eat the fruit and younger growth, develop sore mouths, and so become more liable to the attack of screw-worm flies, a problem allied to our blowfly problem.

About 25 different kinds of prickly-pear and related Cacti have been naturalised in Australia. Of this number, two became very serious pests over wide areas, while several others reached noxious weed importance. The major pests, Opuntia inermis and O. stricta, are natives of the southern coastline of the United States. O. inermis is the common pest pear of Queensland and New South Wales, while the spiny pest pear, O. stricta, overran several million acres in Central Queensland.

The history of the introduction of these two plants cannot be traced. Inermis was brought into Australia somewhere before 1839, for in that year there is a record of a plant being taken from Sydney to be grown at Scone, New South Wales. Stricta is said to have originated as a hedge at Rockhampton about 1870. Cuttings of the original plants of inermis were grown as hedges around homesteads in the pastoral areas being opened up between 1840 and 1860. Hence the spread of prickly-pear was not from one centre but radiated from a number of initial focal points. By 1900, prickly-pear was established over about 10,000,000 acres. In the next twenty-five years, until the peak of this extraordinary plant invasion was reached about 1925 or 1926, the increase was truly alarming. At least 60,000,000 acres had become affected, of which 50,000,000 were in Queensland and 10,000,000 in the northern half

of New South Wales. Roughly 30,000,000 acres represented dense infestations, the remaining fifty per cent. being scattered pear of varying degrees of density. Great sections of the fertile twenty to thirty inch rainfall region of the Darling Downs, Maranoa, Warrego, and Central districts had been completely occupied by the weed. Hundreds of settlers were driven off the land; pastoral properties were abandoned and homesteads deserted. In many sections there were hundreds of square miles of impenetrable fastnesses of prickly-pear. One travelled mile after mile along main roads that were mere car-width tracks lined by a green wall three to six feet high.

Mechanical and chemical methods of eradication are not economically practicable against a vigorous weed pest in pastoral country, since the cost of application is much greater than the value of the land. So, attention was gradually drawn to the possibility of defeating prickly-pear by making use of its natural insect enemies. After much preliminary discussion, and a very valuable world survey of the position by a Queensland Prickly-Pear Travelling Commission in 1912-1914, the Governments of the Commonwealth, New South Wales and Queensland agreed to a joint investigation. As a result, the Commonwealth Prickly-Pear Board, an independent body financed by the three Governments, was formed in 1920. The Board ceased to function in 1940, when Queensland and New South Wales assumed responsibility for the continuance of biological control within their boundaries.

The Scope and Aim of the Investigations

The Board's policy aimed at the establishment of many, or at least several, different kinds of insects, the combined activities of which might exercise some curb on the spread of the plant. The introduction and establishment of prickly-pear insects was not as simple a matter as it might seem.

Firstly, the insects had to be discovered in America. Secondly, it was necessary to learn whether they were purely enemies of prickly-pear in their natural state. Thirdly, the various insects had to be studied, so that their rate of increase and their capacity to injure prickly-pear could be gauged! It was essential that insects of potential value should be dispatched to Australia and those of little value discarded.

Fourthly, when a particular kind of insect was deemed worthy of introduction, it was fundamentally important that proof should be available of the insect's inability to live on plants other than prickly-pear. Such proof was secured by submitting the insects to large series of starvation tests on a great many kinds of plants of economic value. If, under this rigorous procedure, any species of insect was found capable of breeding on any plant except prickly-pear, it was at once eliminated from further consideration, notwithstanding the fact that in America it confined its feeding entirely to prickly-pear.

And, fifthly, the enemies of the insects themselves, that is to say the predatory and parasitic insects that kept the prickly-pear feeders in check, had to be excluded, often by careful rearing work, in order that when liberated in Australia the prickly-pear insects would multiply unhindered by their natural control agents.

Seventeen Years Investigations

For a period of seventeen years between 1920 and 1937, entomologists of the Board were engaged on the work of discovering and studying the cactus insects of North and South America. They visited every country in the two continents and in the adjacent islands where prickly-pears occurred at all freely or even very scatteredly. As a result of this intensive investigation there were located approximately 150 different kinds of insects that were restricted to feeding and breeding on prickly-pears and other Cacti. The most important groups of cactus insects are:—

(a) Moth caterpillars that tunnel either singly or in colonies within the plants or in the fruit.

(b) Beetle larvae that bore in the stems and branches.

(c) Plant-sucking bugs that attack the growth and the fruit.

(d) Cochineal insects, which are mealy-bugs or soft scale insects, that suck the growth and the fruit.

Of the 150 different kinds of cactus insects, about fifty were found to be sufficiently injurious to be worth the attempt to establish them in Australia, and were dispatched from America, often in large numbers over a period of several years. However, many of these

forms could not be acclimatised after prolonged efforts. Others were given up after further investigation had shown that they were unlikely to be of real value. Thus for the various reasons already indicated, twelve only among the 150 discovered cactus insects became established in this country. There is little doubt that this number could have been augmented materially, if two considerations had not operated, namely—

(a) The strongest precautions taken to ensure that the introduced forms would not be able to live on plants other than prickly-pear.

(b) The desire to utilise species that possessed a definite value in destroying or checking the pest pears.

Mass Breeding of Insects

The organisation in Australia comprised a central investigational and quarantine laboratory at Sherwood, and several field stations in the heart of the infested territory—three in Queensland and two in New South Wales. These stations were equipped with hundreds of cages for the mass breeding of the insects.

In the earlier years of the investigation, from 1921 to 1925, several kinds of insects were successfully acclimatised. These included strains of cochineal insects, the plant-sucking Chelinidea bugs, and the prickly-pear red spider mite. I have already remarked that the policy aimed at the establishment of a complex of insect enemies, the activities of which would gradually exert some degree of control. Certainly no one anticipated the remarkable achievements of Cactoblastis cactorum, nor conceived that one particular kind of insect could bring about such devastation. Cactoblastis was introduced in 1925 and commenced to cause marked destruction in 1928. Meanwhile, between 1924 and 1928, cochineal, red spider and Chelinidea had increased to very large numbers and were giving promising results. Had Cactoblastis not come into the picture, the earlier insects would have justified the biological experiment, for they were already beginning to exercise a definite measure of control in reducing the density of impenetrable areas, in killing seedlings and individual older plants, and in destroying immature fruit.

The Story of Cactoblastis Castorum

This insect is a native of certain parts of the Ar-

gentine and adjacent countries of South America, and is a member of the most dominant group among cactus insects, namely the moth borers. The perfect insect is a rather plain looking browny-grey moth. The caterpillars live in colonies within the prickly-pear stems or segments, tunnelling freely and causing rapid decay; they are brightly coloured, being orange or orange red with black markings. The eggs are laid in curious chains, known as eggsticks, each of which contains an average number of about seventy-five eggs. Each female moth is capable of laying from 100 to 300 eggs. There are two generations annually, a long winter and a shorter summer generation. In the winter generation the eggs are laid in January and February and hatch in February and March. The larvae feed through the autumn and winter, enter the cocoon or pupal stage in September, and emerge as moths in October. The eggs of the summer generation hatch in November; the larvae are full-grown and spin their cocoons in January and early February.

One introduction only of this successful insect was made, 2750 being sent from the Argentine early in 1925. The caterpillars developed through the winter at Sherwood, and in September-October 1925, the moths from these larvae laid 100,000 eggs. All these eggs were housed in rearing cages, and the next generation in February-March 1926 produced 2,540,000 eggs. Thus in twelve months the original sending of 2,750 eggs had multiplied to more than $2\frac{1}{2}$ millions, an increase of 900-fold. The ease with which Cactoblastis was acclimatised and the manner in which it increased from the outset contrasted strongly with the erratic behaviour of related moth borers from North America.

The first trial liberations were made in February and March 1926. Large scale rearing in cages was continued until the end of 1927, when 9,000,000 eggs of the insect had been liberated at many places selected in Queensland and New South Wales. By this time, within two years of the release of the first stocks, the increase at some of the liberation points had been so great that ample numbers were available in the field for distribution, and cage rearing was no longer required.

The value of Cactoblastis having now been proved, the next step was to bring about its establishment throughout the length and breadth of the pear terri-

tory. Mass distribution was commenced in 1928 and was completed in 1930, during which period the huge total of 3,000,000,000 eggs was released. The field stations became hives of industry, with gangs of men employed in the collection of cocoons and eggs from the field, the daily gathering of eggs from hundreds of cages, and the packing and despatching of the eggs free of cost to landowners or for distribution by men working from motor lorries along all trafficable roads. To give some idea of the scope of the operations, it can be remarked that in one month alone one field station housed 6½ million cocoons and secured 81½ million eggs, of which number over 4 million eggs were laid in one night. Another illustration of the rapid increase of the insect is cited. At one locality where 100,000 eggs were liberated in February 1926, 300 million eggs were gathered in February 1930, one man collecting as many as 4 million eggs or about 60,000 eggsticks in eight hours.

Incredible Rapidity

Although a collapse of the prickly-pear under the onslaught of Cactoblastis had taken place over more or less extensive acreages at many points by 1929, widespread destruction of the great tracts of the pest followed in the wake of the mass distribution campaign. The last big area of primary pear in Queensland succumbed in 1933, seven years after the initial trial liberations had been made. During the years 1930 to 1933 there was an enormous population of the insect; its numbers were incredible, and the rapidity with which the pear disappeared was equally astounding. The situation along the Moonie River will serve as an illustration. In August 1930 for 150 miles along the river, prickly-pear was in its full vigour, its continuity almost unbroken by clearings, the road which followed the stream being a mere lane walled in by the pest; Cactoblastis was present at intervals in very light numbers, as yet it had caused no destruction whatever. Exactly two years later, in August 1932, when I travelled the same road, the transformation was extraordinary; ninety per cent. of the pear had collapsed; for mile after mile one saw nothing but masses of rotting pulp.

Regrowth and Its Control

The destruction of the original stands of prickly-pear did not, usually, mean eradication, for the butts

had not disintegrated. The plant possesses very strong recuperative powers, and will grow vigorously from small portions of sound tissue. For the first two or three years after the advent of Cactoblastis, regrowth was not a pronounced feature of the situation. As the areas of destroyed pear were comparatively small, any new growth was soon attacked through the insect spreading from the large adjacent stands of the plant.

However in 1931 to 1933, great expanses of the original pear were killed very quickly, in a few months, often in a few weeks. Cactoblastis suddenly exhausted its food supply, and its population was decimated. The caterpillars starved to death in enormous numbers. Thus, the primary pear was replaced by secondary growth which developed very rapidly and which soon appeared as formidable as the original infestation, especially since Cactoblastis was now too lightly distributed to effect early control. But re-distribution was not found necessary. One of the strongest characteristics of this insect is its ability to increase from very small to very large numbers in the course of a generation or two, when food and climate requirements are favourable. By 1934 it was obvious that Cactoblastis was regaining its ascendancy, and the following year regrowth was under control. There was only one big wave of regrowth, although there have continued to be recurrences on a much smaller scale.

Ninety-five Per Cent. Eradicated

In this State it is no exaggeration to affirm that more than ninety-five per cent. of the former quantity of the two pest pears has been eradicated. All that remain in most districts are scattered, often very widely scattered plants. Over many extensive belts of what was impenetrable prickly-pear there is no trace of the plant's survival. Patches of moderately heavy growth, varying from a few acres to a maximum of a few thousand acres, do persist at infrequent intervals, mainly in the more southern districts. But it is doubtful whether the combined area of all existing patches of relatively dense or heavily scattered pear would exceed 100,000 acres. Yet, fourteen years ago, there were 25,000,000 acres of dense pear. What a contrast, and what a tribute to the effectiveness of Cactoblastis cactorum. Queensland has been freed, to all practical

purposes, from this great plant octopus. And Cactoblastis still survives wherever prickly-pear remains to continue its efficient control.

Reclamation of the Prickly-Pear Lands

The value of the results achieved by Cactoblastis can hardly be over-estimated. Due to its marvellous accomplishments, the pear territory was transformed during the ten years period referred to from virtual uselessness to prosperous productivity. The full extent of the increased production from the re-won lands, however, will not be realised for some years.

Reclaiming has involved a great deal of work in fitting the lands for the pastoral and agricultural industries. Practically the whole of the pear-infested area was more or less heavily timbered, either in the form of brigalow and belar scrubs or of eucalyptus forests. The land was of little value for farming, dairying or grazing until the trees had been destroyed for the most part. Again, as the country was poorly supplied with surface water, catchment dams and tanks have had to be constructed on each new holding or on individual paddocks in the case of large grazing properties. Thirdly, the new blocks have had to be fenced. And, fourthly, in the former compact extensive belts of dense pear, access roads aggregating hundreds of miles have had to be made. The unwanted trees have been killed over millions of acres; many hundreds of water catchment excavations have been formed; thousands of miles of new fencing have been erected. Homes of new settlers, woolsheds, dairy sheds, barns, etc., have appeared everywhere. In fact the face of the reclaimed country has been changed completely. Some idea of the capital outlay in this development work can be gleaned by citing the case of 1,000,000 acres of former dense pear, heavily-timbered country now being used for sheep grazing in the Roma district; the cost of the improvements is estimated at £345,000, or nearly 7/- an acre, divided as follows:—

Timber destruction	£150,000
Water provision	90,000
Fencing	30,000
Buildings, woolsheds, etc.	75,000

In Queensland 22,000,000 acres of what was dense pear land have been selected for settlement. Of course, these figures do not tell the whole story of the freeing

of the country from the stranglehold of the pest, for they do not take into account the very big acreage made up of relatively small individual areas of heavy pear, nor the great extent of the more scattered infestations. Prior to the subjugation of the prickly-pear, the value of these 22,000,000 acres was almost nil. Free from the pest, the capital value would average 10/- an acre, without taking into consideration the worth of the new improvements in fencing, water facilities, removal of timber, etc. Hence, here alone, through the availability for grazing, dairying and agricultural purposes of hitherto unusable land, the State has gained an asset of at least £10,000,000. And it must be remembered that the production from these lands will be worth many times this sum.

Cotton, maize, wheat and other crops are being sucessfully grown on reclaimed land. For example in the year 1938 the township of Wallumbilla despatched 240,000 bushels of wheat, at least 75 per cent. of which was produced from former dense pear areas. But the greatest expansion in the more closely settled districts has been in the dairying industry. The area previously under impenetrable prickly-pear now converted to dairying must exceed 1,000,000 acres, on which there are many hundreds of new settlers. To show the development of this industry, I shall quote two typical cases. At Chinchilla in 1926, the year the first releases of Cactoblastis were made, a small butter factory produced 400,000 pounds of butter. In 1939 a modern factory produced 3,100,000 pounds. This seven-fold increase can be attributed solely to the disappearance of prickly-pear. At Gayndah where the better class land was covered with the pest, butter production rose from 515,200 pounds in 1926 to 2,596,720 pounds in 1939, a five-fold improvement.

If the stimulus to farming and dairying has been very marked, the expansion of the pastoral industry has been much greater, more particularly as regards woolgrowing. It is estimated that within another two or three years 5,000,000 sheep will be grazing on land that until 1928 was overrun with the pest; this will mean an increase of between twenty and twenty-five per cent. in the State's average flocks. I should judge that there must already be 2,500,000 sheep on the retrieved lands. The following figures serve to indicate the progress:—

In the Roma Land Agents' district, the 1927 and 1939 comparative records are:—

	Number of Sheep	Bales of Wool
1927	1,349,300	31,624
1939	2,187,400	54,685

The increase of 838,100 sheep and 23,060 bales of wool is directly due to production from the old pear lands. At the present average price of £16/10/- a bale, the extra yield in 1939 represents £385,000.

During the same twelve-year period, the number of sheep in the Goondiwindi petty sessions district has almost doubled from 425,500 in 1927 to 815,500 in 1939. In the Dalby-Chinchilla country, where a considerable portion of the reclaimed land is being devoted to dairying and agriculture, the sheep flocks have increased from 291,900 in 1918 to 768,550 in 1938.

The influx of population and capital, the expenditure on pastoral, agricultural and dairying development, and the increased production have revitalised the many towns and smaller settlements in or adjacent to the former prickly-pear territory. Public buildings, offices, shops and residences have sprung up everywhere. Between 1926 and 1939 the population of three typical towns has increased as follows:—

	1926	1939
Dalby	2,600	3,600
Chinchilla	1,100	1,800
Goondiwindi	1,500	2,800

In the nine-year period from 1930 to 1939, 175 new residences were erected in Dalby, the same number in Goondiwindi, and 150 in Chinchilla. A sum in excess of £200,000 was expended on new buildings in Dalby, between 1928 and 1940. Since 1930 at least £175,000 has been spent in Goondiwindi and £75,000 in Chinchilla for similar purposes.

This address indicates, I trust, what Queensland to Castoblastis cactorum. I shall close with one observation. In the Chinchilla district, a small community at Boonarga, dairying on land that was overrun with the densest prickly-pear, built, a few years ago, a general social and meeting hall and named it The Cactoblastis Memorial Hall. Boonarga's commendable action is the sole public recognition of our debt to this remarkable insect. Will Queensland ever erect its "Sea-Gull Monument"?