The Campaign against Prickly-Pear in Australia.

WORK OF THE COMMONWEALTH PRICKLY-PEAR BOARD.

By ALAN P. DODD, Officer-in-Charge of the Investigations.

THE Commonwealth Prickly-Pear Board was instituted in 1920 to study the possibilities of the control of the prickly-pear pest in Australia by means of biological agencies. Previous investigations had established the fact that in its native home, America, prickly-pear is attacked by various insects and fungus diseases that appear to be confined to plants of the cactus family.

The Board at once commenced operations in North America, and has employed investigators in that country since; a more or less comprehensive survey has been carried out in the cactus regions of the United States, and brief excursions have been made into Mexico. South America, Argentine and Uruguay have been explored to a considerable extent. In the present year more extensive operations are planned in Mexico.

During the earlier portion of the work, attention was paid to the fungus and bacterial diseases of the cactus family, but owing to the need for special research in this subject and the inadequacy of the Board's finances, the work was allowed to lapse temporarily. However, in 1925, a research scholar in mycology was appointed and has commenced studies in the laboratories of several universities in the United States.

THE WORK IN AMERICA.

The cactus family is botanically a rather isolated group, and has evolved a considerable insect fauna that appears restricted to plants in the family. In the United States alone, the Board's entomologists have made known more than sixty species of insects that are primarily cactus feeders; in Mexico and South America other species occur; a number of these has proved new to science.

The work in America consists of the study of the insects in the field, and the breeding and forwarding of numbers of reared material, free from parasitic enemies, of all species that promise to be of use in the control of prickly-pear in Australia. Before shipments are sent, tests are carried out with each insect in order to ascertain the possibility of its being able to develop on other plants. These tests have given interesting results, and more than one insect has been eliminated because the tests showed that it was capable of sustaining its life cycle on certain economic plants. The tests are repeated in Australia against economic plants and native trees.

To date, about forty different species of cactus insects have been forwarded to Australia, in most cases many thousands of each.

THE WORK IN AUSTRALIA.

In Australia the Board has established a central laboratory at Sherwood, near Brisbane, and field stations at Westwood, near Rockhampton, Chinchilla, two hundred miles west from Brisbane, and Gravesend, on the Moree-Inverell railway in New South Wales. Sherwood acts as the quarantine station where the insects are received from America and bred through one generation to eliminate further the risk of the introduction of parasites that might exercise a serious check on the rapid multiplication of the desired insects; the bred material is then distributed to the field stations. The equipment at the field stations consists of insectaries and a great many breeding cages of various types. The function of these stations is to rear the insects in sufficient numbers to permit of liberations in the open.

Throughout the investigations one of the chief difficulties has been the acclimatisation of the introduced insects. It must be remembered that the seasons in North America are the reverse of those in Australia; thus, when an insect should be hibernating in the North American winter it must be actively feeding in an Australian summer. With most of the insects, repeated shipments over a period of two or three years have been necessary to secure their establishment in the rearing cages; indeed, certain species have quite failed to adapt themselves, either through the unsuitability of caged conditions, or to differences in climate.

Another phase of the work has been the study of the adaptability of the insects to Australian prickly-pears The two main species involved in Australia are the common pest pear, *Opuntia inermis*, and the spiny pest pear, *O. stricta*; lesser pests are the velvety tree pear, *O. tomentosa*, the smooth tree pear, *O. monacantha*, and the tiger pear, *O. aurantiaca*, while several other forms are found in scattered quantity. Very few cactus insects will attack all prickly-pears indiscriminately; most of them show a decided preference for certain forms, and in some cases will readily attack one pear and refuse to live on another.

INSECTS SUCCESSFULLY INTRODUCED INTO AUSTRALIA.

Of the insects successfully introduced into Australia, the most widely known are the cochineals, of which the most important is the wild cochineal, *D. tomentosus*. Three strains of this insect have been brought into the country from Texas, Arizona, and Chico, California, the two first by the Board, the last by independent action. All three will live readily on the two chief pest pears, but the virulence of the attack varies. The Chico cochineal is most destructive to the common pest pear, *O. inermis*, the Texas form favours the spiny pest pear, *O. stricta*, while the Arizona strain seems to be equally suited by either plant. These cochineals are being widely spread throughout Queensland and New South Wales. They are doing splendid service in many places, especially in dense pear in timbered areas, breaking up the plant masses and destroying old plants; but probably the most useful feature of their work is the manner in which they attack the young seedlings. The Indian cochineal, *D. indicus*, was introduced in 1913 by the Queensland Prickly-Pear Travelling Commission, and will exist on the smooth tree pear, *O. monacantha*, only, completely destroying large clumps of this plant in the space of a few months.

Of the plant-sucking bugs, several species of the genus Chelinidea have been acclimatised; *C. tabulata* has been liberated in many places and has increased at a very rapid rate in the field; in fact, in some localities, millions must now be present from small numbers set free in the past two or three years. *C. vittiger* has also been released at various places.

Of the internal-feeding caterpillars, one species, *Melitara junctolineella,* has been readily acclimatised; about a million have been liberated, and it is now firmly established in several localities. These caterpillars are solitary in habit, and tunnel within the joints or pads of prickly-pear. A related insect is *Melitara prodenialis,* but the caterpillars are social in habit, a number feeding together within the pear pads; recently this species has been set free in the Westwood district, and promises to be especially useful as a pear destroyer.

One of the most recent of the Board's importations has been strikingly successful in so far as rapid increase is concerned. This insect is *Cactoblastis cactorum,* a social caterpillar allied to the Melitaras. Less than three thousand larvæ arrived from Argentine in May 1925, but the increase has been so great that in February and March 1926, nine months later, sufficient stocks had been raised to warrant the release of two and a half millions throughout the pear areas. These caterpillars are voracious feeders, and should the increase in the field be sustained at one-half the rate experienced in the cages, great destruction of pear should be brought about.

Many other insects are being bred and acclimatised, and the Board is continuing the introduction of new forms, believing that the control of prickly-pear by biological means can only be brought about by the combined attack of a variety of insects operating on the different parts of the plant.

Chemical and Physical Action at Surfaces.[1]

By Dr. ERIC K. RIDEAL.

THE subject of colloid chemistry is intimately associated with the properties and peculiarities of interfaces, of which those formed by liquids and solids are the most important. The difficulties met with in an exact study of reactions taking place in colloidal systems are greatly enhanced by their dispersity, and in addition the application of thermodynamic methods to the treatment of the two-dimensional interfacial phases becomes a problem of great complexity when these phases are subdivided and not plane but curved. For these reasons the increasing attention which is being devoted to surface phenomena is a development to be welcomed. As the late Lord Rayleigh first indicated, the properties of oil films on water studied by Miss Pockels give us valuable information on molecular magnitudes, a view which has been emphasised and amply confirmed by the able experiments of numerous investigators, notably Devaux, Langmuir and Adam.

An examination of the process of spreading of oil films and their conditions of equilibrium presents several features which can be compared with phenomena occurring in three-dimensional systems. If a crystal of myristic acid be placed upon the surface of water a process of surface solution occurs, molecules are torn off the edge of the crystal in contact with the water by hydration of their polar or hydrophilic groups and float on the surface as a two-dimensional vapour. This process of surface solution continues until the vapour attains, as measured by the fall in surface tension of the water, the critical 'vapour pressure' value necessary for conversion into a two-dimensional liquid, the so-called expanded film of Adam. The liquid undergoes further two-dimensional compression by continued surface solution from the crystal, and if the temperature be sufficiently low, the expanded film is converted into a condensed film which may be liquid or solid. If the temperature be high, no formation of a condensed film occurs but the film remains in the expanded state. Compression does not proceed indefinitely, for the substance possesses but a finite surface solubility at a constant temperature and a saturation equilibrium is attained.

Both the rate of spread, which in the case of a rapidly spreading acid, such as oleic acid, rarely exceeds a linear speed of 25 cm. per second, as well as the progress of surface saturation and the transformation of the two-dimensional vapour into the expanded and condensed states, can readily be followed by observing the changes in surface tension at different points on the water when a cylinder of the acid is plunged below the surface. In the case of the spreading of solid acids, the rate of surface solution is so slow that no pressure gradient exists in the expanding film, but for acids which spread quickly molecules go into solution so rapidly that those already on the surface are actually pushed out by those entering, causing a local lowering of the surface tension.

For the long-chain fatty acids the molecular adhesion by the hydrocarbon tails is so great that these two-dimensional films, even at high temperatures, are analogous to vapours rather than gases. Substances which can exist in a state equivalent to two-dimensional gases on a water surface over the ordinary experimental temperature range must possess chains less than eleven carbon atoms long; these are appreciably soluble in water and their surface concentrations must be calculated by means of the Gibbs Thomson equation. It is found that if the force-area curves calculated in this manner for substances such as the short-chain fatty acids or alcohols on the surface of water, or at interfaces such as benzene-water or mercury-water, be plotted, they reproduce in all respects the pressure volume curves obtained by Amagat for gases at high pressures.

Not only can we examine the behaviour of matter in its various states in this two-dimensional system, but a knowledge of the variation of the equilibrium pressures with the temperature, and the application of the Clapeyron equation, also yields values for the latent heats of 'spreading' of these substances. We may note in addition that the potential difference existing at the boundary between a homogeneous aqueous phase and its vapour is profoundly modified by the presence of such films. From a knowledge of the surface concentration and the change in potential effected by the presence of the film, the change in electric moment caused by the introduction of one molecule of the fatty

[1] Based upon two lectures delivered at the Royal Institution on February 2 and 9.