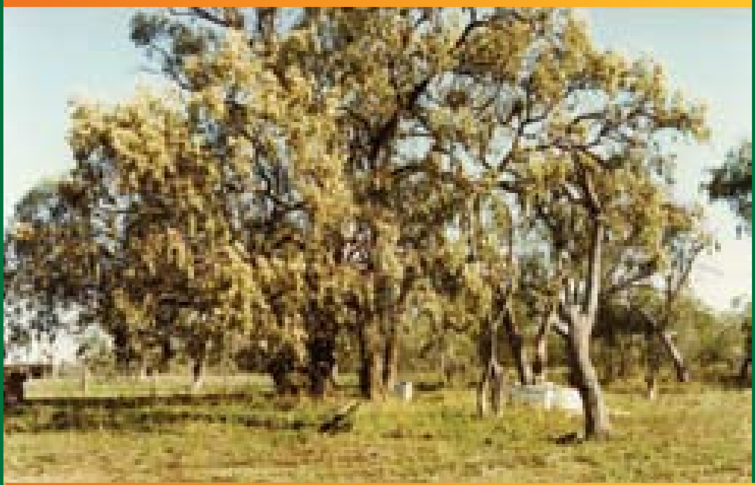

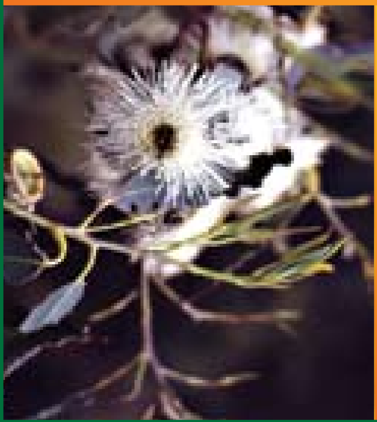

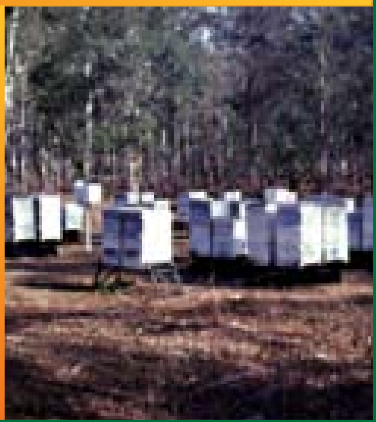

Commercial Beekeeping

in Australia

A Report for the Rural Industries Research and Development Corporation

by Frederick S. Benecke

RIRDC Pub. No. 03/037
RIRDC Project No. FSB-1A

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Foreword

The report, Commercial Beekeeping in Australia, represents a snapshot of beekeeping industry at the beginning of the third millennium. It describes the physical and cultural environment in which beekeeping is undertaken and describes production methods commonly employed by beekeepers.

This project was funded from industry revenue which is matched by funds provided by the Federal Government.

The Rural Industries Research and Development Corporation recognises that beekeeping practices have developed in this country to meet its unique conditions of climate and of flora. Australian beekeepers have shown great ingenuity in devising methods of production and patterns of management that has led to a successful national beekeeping industry. RIRDC believes these achievements are worth recording, both as an historical document, but more importantly, as a reference for those contemplating a career in beekeeping and for students of Australian primary production.

In their endeavours beekeepers have been assisted, particularly in recent years, by world standard research. RIRDC, through its Honeybee Research and Development Committee, is pleased to be a vital part of the national apicultural research effort.

This report is an addition to RIRDC’s diverse range of over 900 research publications.

Most of our publications are available for viewing, downloading or purchasing online through our website:

- downloads at www.rirdc.gov.au/reports/Index.htm
- purchases at www.rirdc.gov.au/eshop

Simon Hearn
Managing Director
Rural Industries Research and Development Corporation

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1. Introduction

Between March 1990 and March 1996 the then Honeybee Research and Development Committee (HBRDC) produced a series of reports on commercial beekeeping. One report was prepared for each State in the Commonwealth.

Honey Research Council Chairman Max Whitten said in his preface to the first report in 1990:

> *There is a recognition that many successful beekeepers throughout Australia have, through their own endeavour and experience, acquired a wealth of knowledge and understanding of beekeeping practices that lead to profitable enterprise. With the retirement of some of the older beekeepers, there is considerable danger that much of this valuable information will be lost as it has not been documented.*
>
> *The Honey Research Council believes that reasonable efforts should be made to capture this knowledge for the benefit the of other beekeepers presently in the industry and for the benefit of those who enter the profession in years to come.*
>
> *To achieve this aim the Honey Research Council has determined that this information should be collected on a State by State basis. In December 1989 a team of three was sent to Tasmania to identify the good beekeeping practices and report on beekeeping in that State. Information gathered during the visit provides the basis for this report and is the first in the proposed*

The original six State reports never achieved the circulation and attention that they deserved and since 1990, when the series began, “best practice” in Australian beekeeping has changed in several significant respects.

This publication attempts to describe Commercial Beekeeping in Australia as it exists today. It is not a textbook on beekeeping. It draws on information contained in six State reports mentioned above and incorporates additional information garnered from industry sources throughout Australia.

The author expresses his sincere thanks to those “industry sources” and lists them as an Appendix III. The work could not have been completed without their help.

2. Industry Overview

The commercial beekeeping industry in Australia comprises a relatively small number of professional beekeepers deriving most of their livelihood from beekeeping and a larger number people who keep bees for profit but who do not depend solely on beekeeping for their livelihood. There is probably some truth in the old adage that 20% of commercial beekeepers produce 80% of the national honey crop. (Less than 4% of registered beekeepers in New South Wales own more than 40% of the states' hives.)

Australia produces around 30,000 tonnes of honey, or better, each year. New South Wales is the largest producer and the Northern Territory the smallest. Australia usually exports 25-30% of total annual production.[1]

The packing and sale of honey is well ordered and most of each year's crop is committed to a handful of major packers. Similarly, a few buyers handle most of the nation's production of beeswax. A number of smaller honey exporters have entered the industry in recent years. There is no longer any legal impediment to importing honey into most of Australia.

Industry associations exist in all states and as well they each have representatives on the Federal Council of Australian Apiarists' Associations (FCAAA). The peak industry body, the Australian Honey Bee Industry Council (AHBIC), represents all sections of the industry.

The principal honey producing area of Australia is the huge swath of temperate land stretching from southern Queensland to central Victoria. Beekeepers within this area migrate extensively and frequently work in neighbouring states. A wide range of melliferous flora is utilised. The area includes the Australian Capital Territory.

South Australia is a significant producer but lacks both the diversity and the area of melliferous flora enjoyed in the eastern states. Like South Australia, the relatively small proportion of Western Australia suitable for beekeeping restricts production in that state. A significant portion of the Western Australia crop is exported.

Tasmania is by far the smallest honey producing state, but has the advantage that its main crop is dependable and fetches a premium price. A small industry has become established in the Northern Territory.

Regardless of location, beekeepers have developed management practices that are most likely to maximise their returns. But like agriculture generally, success or failure is often decided by the weather. Paid pollination, whilst important for some individuals, is as yet of relatively minor importance to the industry as a whole.

[1] Gibbs, Diana M H and Muirhead, Ian F, (1998) The Economic Value and Environmental Impact of the Australian Beekeeping Industry. A report prepared for the Australian beekeeping industry. 8-11.

The resource base on which the industry depends is shrinking. More of the nation's melliferous flora is being incorporated into conserved areas and ensuring continued access to these areas has taxed the energies of state and federal beekeeper bodies. The industry is well organised, considering its size, and most states have a mechanism for formal consultation with relevant government agencies.

Most of the world's serious bee diseases exist in Australia although the nation is so far free of varroa mite and some other exotic pests and diseases. The severity of several diseases appears to be related to nutritional deficiencies unique to Australia. Nutritional deficiencies can also significantly limit production.

The Industry by States

The Numbers

Information about numbers of beekeepers and amount of honey produced varies with the source of the information. The numbers quoted in the introduction to this chapter are from the report *The Economic Value and Environmental Impact of the Australian Beekeeping Industry* by Diana Gibbs and Ian Muirhead. (At the time of writing, available on the Australian Honeybee Industry Council [AHBIC] web site – see Appendix 1.)

State registration systems provide the only information available about numbers of beekeepers. Registration is compulsory in the states but not in the territories. In all states a registration fee is levied, based on the number of hives kept. Basing the registration fee on the number of hives kept may provide an incentive to register fewer hives than are actually kept. And it is not unknown for even commercial beekeepers to fail to register at all. So the numbers may be suspect to some degree, but they are the only ones available.

In their 1998 report, Gibbs and Muirhead calculated honey production per state by extrapolating from the numbers of hives per state. The Australian Bureau of Statistics (ABS) on the other hand collects data from beekeepers owning 50 or more hives. Not surprisingly, there are some discrepancies between the Gibbs and Muirhead 1998 report and the ABS data for the year ended 30 June 2000. Interestingly though, the two sets of numbers match fairly well except for differences between Queensland and Victoria, which could simply be due to the sometimes enormous variation in production between one year and the next.

Numbers by States

At the time of writing, the most recent information about the number of beekeepers and the number of hives kept was that compiled by New South Wales Apiary Officer Doug Somerville from information provided by the Australian states and territories as at September 19 2001.[2]

[2] Somerville, D (2001) Apiary Acts & Regulatory Activities for Each State, re Bee Diseases. NSW Agriculture, Goulburn.3.

Numbers of Beekeepers and Number of Hives, by States

State	Number of Beekeepers	Number of Hives
NSW	3,575	256,055 (+34,584 nucs)
QLD	3,426	128,671
SA	850	70,000
TAS	243	16,527
VIC	1,820	110,000
WA	989	44,854
ACT	Not sure	Not sure
NT	6	<2,000
TOTAL	**10,729**	**628,107 (Plus NSW nucs)**

The table above shows that New South Wales accounts for 41% of the nations registered hives, followed by Queensland with 20.5%, Victoria with 17.5%, South Australia 11.1%, Western Australia 7.1%, Tasmania 2.6% and the Australian Capital Territory and the Northern Territory making up the rest.

Numbers by Categories

An insight into the distribution of hive number may be gained from an analysis of New South Wales apiary registrations.

New South Wales Beekeeping Registrations at 6 April 2001

	Beekeepers	Hives
Amateur (1 to 40 hives)	2725	22898
Part Time (40 to 200 hives)	492	50271
Commercial (more than 200 hives)	321	183507
Total	3538	256739

Amateur beekeepers account for 77% of registrations and of these 2125 have less than 11 hives. (It is an interesting thought, nevertheless, that a beekeeper owning 30 hives, and perhaps moving them a couple of times a year in a trailer, may well harvest 50kg of honey per hive. A total crop of 1.5 tonnes of honey supposes a surplus for sale.)

New South Wales Commercial Beekeepers by Hive Numbers

	Beekeepers	Hives
201 to 500 hives	195	70363
501 to 1000 hives	104	77860
Greater than 1000 hives	22	35347
Total	**321**	**183570**

The analysis shown above reveals that the 22 beekeepers owning greater than 1,000 hives own on average 1,600 hives each; the 104 owning between 501 and 1,000 hives own on average 748 hives each; and, the 195 owning between 201 and 500 hives own on average 360 hives each.

The 126 beekeepers that may be termed professional beekeepers, the 3.6% owning over 500 hives, therefore account for 44% of all hives registered in New South Wales. This trend to larger commercial enterprises has steadily accelerated since the end of WWII.

It is probable that this kind of distribution also occurs in other states. That is, relatively few enterprises owning a substantial portion of total hives, but with a significant number of commercial, though not necessarily full-time, beekeepers each owning several hundred hives. It is likely that many of the nation’s commercial queen breeders fall into the category of full-time beekeepers owning several hundred hives.

Honey per Hive

The ABS report on beekeeping for the period ending 30 June 2000 shows, for each state, the quantity of honey produced and the average production per hive. Because the ABS only collects data from beekeepers owning more than 50 hives, and for other reasons, its estimates of actual production are of less value than the relative importance of production between states. The table below shows the percent of total recorded production attributable to each state and the average production per beehive.

Percent Honey Production and Average Production per Hive, by States, from ABS

State	% of national honey production	Average production per productive hive. In kg.
NSW	41.0	77.9
QLD	9.7	56.6
SA	14.0	83.7
TAS	4.4	80.3
VIC	23.0	91.6
WA	7.5	99.6

Apiary Products Other Than Bulk Honey

Beeswax is mostly a by-product of honey production and is therefore proportional between states. Beeswax production is usually reckoned at 1kg of wax for every 60kg of honey.

The coastal strip from Sydney to southern Queensland supports many, or most, of Australia's commercial queen breeding enterprises. The prevalence of queen breeders in Queensland may help to explain the apparent discrepancy between hive numbers and honey production, since queen breeders may own a relatively large number of hives, which are not kept primarily for honey production. No estimate of the value of sales of queen bee or of package bees is available. The export market, for both queen bees and for packages that contain a queen bee, is considerable.

The export of package bees is a relatively new aspect of the industry. Only the exporters know its financial worth, although figures of several million dollars are bandied about. New South Wales is the principal sources of bees for packages with some coming from Victoria and southern Queensland.

Commercial pollen production is an important diversification for many Western Australian beekeepers. Production has increased in recent years with some beekeepers able to trap three to four tonnes per year. Most of the pollen is exported both overseas and interstate. It is used in the health food industry and particularly pollen from the Red Gum (*Corymbia calophylla*) is used as a feedback protein to bees in times of poor conditions.

A number of minor apiary products provide some income to producers. Such things as the production of section honey; the making of mead and, rarely, the collection of propolis.

Recently honey from some species of Jelly Bush, *Leptospermum* species, has been marketed through pharmacies under the trade name of Medihoney®. The product is said to be particularly efficacious in treating skin ulcers. Its development was supported by RIRDC funding.

Pollination

Renting hives of bees to the growers of plants benefiting from pollination by honeybees is an important source of income to the industry. Some paid pollination is undertaken in most states, but the practice is most important in Victoria and South Australia.

Largely because of changes in agricultural practise and in land management, fewer feral bees are available to provide incidental pollination. As well, large-scale monoculture means that adequate pollination may be beyond the capacity of feral bees, even if they exist in the area. Thus the demand for rented hives is increasing, quite rapidly in some areas. Meeting the increased demand presents some problems to participating beekeepers.

Marketing

Beekeepers tend, by and large, to sell all or most of their honey to the one packer. Capilano Honey Limited (CHL), of Brisbane, Queensland is the biggest of the packers. Its main brand is “Capilano”. It has packing plants in Brisbane and Maryborough, Victoria. Many of its suppliers are also shareholders who enter contractual obligation to deliver all of their honey to the company. CHL also buys honey from non-shareholders. Over the years it has been the biggest exporter of Australian honey.

The next biggest packer is the Adelaide based Leabrook Farms. “Leabrook Farms” brand of honey appeared on the supermarket shelves in February 1992. Coopers expansion into honey packing was part of its program of diversification.

In Western Australia the co-operative society Wescobee dominates the market. Although many suppliers are also shareholders, non-shareholders receive the same prices, terms and conditions. Wescobee is the successor to the old Honey Pool. The new entity, Wescobee, was established in April 1992 when it took over the assets of the Honey Pool. The main change is that Wescobee can trade in any product, not just honey.

There are many smaller packers and independent exporters throughout Australia. Some have regular suppliers whilst they all depend to a certain extent on uncommitted producers who shop around for the best price. A number of producer packers sell to independent stores in their immediate locality. It is the handful of large packers, however, whose brands appear on the supermarket shelf and who pack most of the generic brands.

Legislation

Legislation is in place in all states and territories aimed at limiting the spread of endemic bee diseases, and at containing or eradicating exotic bee diseases, should they appear in Australia. As well as legislation concerned directly with diseases of bees, the beekeeping industry is subject to wider legislative control in all states and territories.

The several Apiaries Acts have as their chief purpose the control of bee disease and typically require apiaries to be registered, impose a registration fee and prescribe procedures to be adopted in the event of certain diseases occurring. They may also include matters not concerned with bee diseases, such as dealing with bees causing a nuisance.

Other legislation effecting where and how bees may be kept range from environment provisions of local government acts to state and federal legislation relating to pure foods, conserved areas, bio-diversity, quarantine, research and development and so on.

Producer Organisations

Each state has an association of commercial beekeepers, composed of regional branches and a central management committee. As well there are associations representing amateur beekeepers.

There is a national body representing the state associations, the Federal Council of Australian Apiarists' Associations (FCAAA) and a national body representing the whole industry, the Australian Honey Bee Industry Council (AHBIC).

It is the state associations that bear the brunt of the load of protecting the interests of their members and of the industry as a whole. They are under-funded and under-staffed and are generally struggling to make ends meet. Their revenue derives form subscriptions and to a varying extent, from commissions, sale of product at shows and so on. Most can only afford part-time paid staff and all depend extensively on their elected office bearers giving a lot of unpaid time to the organisation.

The state associations are the New South Wales Apiarists' Association Inc.; Queensland Beekeepers Association; South Australian Apiarists Association (Inc.); Tasmanian Beekeepers' Association; Victorian Apiarists Association Inc; Western Australian Farmers' Federation (Inc.) Beekeepers Section. As well, there is a Northern Territory Beekeepers' Association.

Queen breeders are represented by the Australian Queen Bee Breeders Association (AQBBA) and the several state pollination associations by the National Council of Pollination Associations (NCPA).

A guide to beekeeper associations and Government advisors appears as Appendix ii.

Peak Industry Body

The Australian Honey Bee Industry Council (AHBIC) is the peak industry body and was launched on March 1 1998. AHBIC, typically concerns itself with federal matters such as quarantine, residue levels, genetically modified organisms, international trade and so on. It is comprised of representatives of the following bodies. Their voting entitlement is also shown.

Federal Council of Australian Apiarists' Associations	7 votes*
Honey Packers and Marketers Association of Australia Inc	3 votes
Australian Queen Bee Breeders' Association	2 votes
National Council of Pollination Associations	2 votes

* New South Wales 2 votes and other states 1 vote

AHBIC is financed by voluntary contributions. The single largest contribution is from a levy on beekeepers of one cent for each kilogram of honey sold through participating packers supported by an additional contribution of half a cent per kilogram from the participating packer.

AHBIC employs a small full-time staff. A list of participating packers, queen breeders and pollinators appears in the AHBIC monthly newsletter, which may be accessed on its web site.

Bee Diseases

Australia is so far free from varroa mite and some other important exotic pests. However most of the world's serious bee diseases exist in Australia, as well as the common pests of beekeeping and a few less common ones. The diseases discussed all limit production at some time or another. Nutritional deficiencies can also significantly limit production and exacerbate disease problems.

Commercial beekeeping in Australia is dependant on successfully containing infectious diseases and on avoiding nutritionally induced ones.

3. Resource Base

The resource base on which Australian's commercial beekeepers depend remains extensive, although not as extensive as formerly. Over many years beekeepers have had to adapt to a changing resource base, however both the rate and the nature of change has accelerated.

Continuing land clearing and changes in agricultural practice, due largely to improved technology, are chiefly, but not solely, responsible for the significant physical changes to the resource base.

Increasing regulation of land use as a result of changing community perceptions and expectations have resulted in significant portions of the traditional resource base being located in conserved areas and no longer accessible to beekeepers.

The Resource Base

In broad terms, the resource base is composed of nectar and pollen producing plants growing on private and public lands. The relative importance of private and public lands varies enormously from state to state.

Tasmanian beekeepers depend in large measure on Leatherwood, *Eucryphia lucida and Eucryphia milliganii* for honey production. Leatherwood is an understorey plant to eucalypts and 60% of the resource is controlled by the Department of Parks, Wildlife and Heritage, and the other 40% is in land managed by Forestry Tasmania (FT).

West Australian beekeepers depend almost entirely on native flora growing on public lands, managed by the Department of Conservation and Land Management (CALM).

Beekeepers in Queensland, New South Wales, Victoria and South Australia, depend on a combination of both public and private land. Conserved areas often have a special significance. For instance although a large proportion of South Australian honey is produced from both native and exotic plants growing on freehold land, most apiarists interviewed in the 1993 RIRDC report Commercial Beekeeping in South Australia said that many of the sites on public lands are critical for overwintering bees. And the 1994 RIRDC Report on Queensland points out that although only 3% of Queensland is State Forest, this area represents an estimated 40% of the currently used beekeeping resource.

An analysis of major honey deliveries from suppliers living in New South Wales to the Capilano Honey Limited (then known as the Honey Corporation of Australia), for the four years 1991 to 1994, shows that 40% of the honey received came from agricultural land and 38% from forest land.[3] The analysis does not distinguish between forest on private land and forest on public lands, however it is estimated that 65% of the State's remaining forest are located on Crown Lands of one kind or another. The estate of the New South Wales National Parks & Wildlife Service alone includes 580 reserves with a total area of 5.378M ha.

Not surprisingly, the best apiary sites on forested land are fully booked and kept booked from year to year. The only way for a new entrant into the industry to gain a share of reliable sites is to buy out an existing enterprise, along with the sites that go with it.

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[3] Somerville DC and Moncur MW (1997). The importance of Eucalyptus species for honey production in New South Western Australiales, Australia. Paper for the XXXVth International Congress, Antwerp, Belgium, Sept 1997.

Physical Changes

Significant changes to the resource base pose threats to the industry. On the other hand, some changes provide benefits to the industry.

Many of Australia's principal honey producing areas are in, or adjacent to, agricultural and grazing country. In these areas weeds of pastures, roadside weeds and weeds of cultivation commonly enhance spring build-up and every now and then provide a valuable windfall crop in late summer. And some, such as Paterson's Curse, or Salvation Jane, *Echium plantagineum* are major sources of honey.

Improved weed control and minimum tillage farming methods have already reduced the population and range of exotic weeds. As well, increases in areas of cultivation of crops such as wheat and canola have reduced the incidence of some exotic weeds. Substantial areas of Paterson's Curse have disappeared in this manner. It is such arable areas that frequently provide the best honey production from Paterson's Curse and although the plant continues to spread in more marginal areas, honey production there is less dependable.

For the same reasons the formerly extensive areas of Turnip Weed *Rapistrum rugosum* and Wild Turnip *Brassica tournefortii* in northwestern New South Wales and southern Queensland, so highly valued for very early spring build-up, occur less frequently.

More efficient herbicides and methods of applying them has resulted in far fewer crops of honey from plants such as Horehound *Marrubium vulgare*, St Barnaby's Thistle *Centaurea solstitalis* and other weeds of cultivation and of roadsides.

A related cause of physical change to the resource base is the large scale planting of soft wood plantations. Soft wood plantations are long term investments that occupy land formerly used for grazing or that supported native vegetation.

Land Clearance

Forest areas and timber continue to be cleared throughout the nation. This is despite legal requirements in some states to preserve timber and despite Government programs concerned with land care, sustainable agriculture, trees on farms, catchment protection and environmental protection generally.

The Australian Bureau of Statistics is quoted as saying:[4]

> *Land Clearance. In 1999, about 470,000 hectares of native vegetation were cleared, an annual rate 40% higher than 1991.*

Even with substantial tree planting programs, Landcare Australia says that in Australia more trees are being removed each year than are being planted. Legislation controlling land clearance is a state issue, and varies accordingly. In Queensland, for instance, where protection for trees is limited, it was reported in 2001 that land clearing was occurring at a rate of 400,000 hectares a year.[5]

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[4] Stevenson, Andrew, "Bean counters get to the heart of the matter" April 5 2002 Sydney Morning Herald.
[5] Gratton, Michelle and Clennell, Andrew, "Labor vows to put an end to land clearing" October 16 2001 Sydney Morning Herald.

Dieback

Dieback of a number of species of eucalypts in several states is continuing and is a concern to beekeepers. Although research has helped to understand the problem there is no indication that it has been overcome. In the southeastern states dieback is caused largely by insects, scarabs in particular, defoliating trees. Scattered trees in agricultural areas are particularly vulnerable. In these areas then, dieback is essentially a problem of land use.

The problems of dieback in the Karri *Eucalyptus diversicolor* and Jarrah *E. marginata* forests of Western Australia are completely different from those of the eastern states. In the west, the causative organisms are soil born fungi, notably a species of phytophthora, *phytophthora cinnamomi* (PC). PC is also present in Victoria and South Australia, including Kangaroo Island, and is still spreading.

Karri forests are still quarantined for dieback disease but beekeepers are allowed access to some areas of State Forest under permit. The permit is restricted to accessing the sites during fine weather. Clear felling of Karri is continuing and some timber cutting, but the government has recently taken steps to reduce cutting and increase reserves for old growth forests.

Dieback is a serious problem in South Australia. In 1992-93 RIRDC funded a reconnaissance of the extent and severity of declining eucalypt tree health in the upper southeast of South Australia to establish an ongoing monitoring program to assess the rate of any further loss. Since then the dieback problem has become known as "Mundulla Yellows" (MY) and a considerable amount of research has taken place in an attempt to determine the cause or causes and although the causes are unknown, research on the problem is continuing. A research program funded by the Federal and South Australian State governments is being carried out by D Hanold and JW Randles at the Waite campus of the University of Adelaide. Fungi and phytoplasmas have been investigated but a casual association with MY could not be shown to date. MY symptoms can now be found in most states. In South Australia about 30 species could be affected. At present the only thing known for sure is that MY is lethal, is slow acting and affects trees of all ages. At the time of writing the research program and its funding are being reviewed.

Other Problems

Yet another cause for concern in some areas is controlled burning when used as a forest management tool. The 1991 RIRDC report Commercial Beekeeping in West Australia relates that in some areas controlled burning is carried out every five years and has had the effect of preventing moisture holding undergrowth from recovering and restabilising.

In the Northern Territory wide spread burning during the dry season is a well established practice and appears to be detrimental to some species of value to beekeeping.

Salinity remains a serious problem in many areas, notably the irrigation areas and the Murray-Darling Basin, and has been the cause of mortality of thousands of trees.

Regulation of water flows in the Murray-Darling river systems has been detrimental to large areas of River Red Gum *E. camaldulensis,* mainly by flooding the Red Gum forests at the wrong time of the year. The flooding is caused by water releases intended to maintain flows in the river system. Prior to the Murray system being regulated, the Red Gum forests on the New South Wales/Victoria border were flooded in the winter/spring and dry in the summer/autumn. They were flooded for an average of eight months in eight out of ten years. Since the river has been regulated they are flooded for an average of four months in four out of ten years and are more likely to be flooded in the summer/autumn.[6]

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[6] Mike Thompson, Regional Manager, Deniliquin, State Forests of NSW. 2002 State Conference, NSW Apiarists' Association, Griffith.

Beneficial Changes

Changes to the resource base are not all one sided however. The emergence of Canola, *Brassica* species, a type of oilseed rape, as an important crop in south eastern and south western Australia has provided beekeepers with both build-up conditions in the early spring and a useful source of honey. South western New South Wales is popular with beekeepers from Victoria as well as from New South Wales for Canola production. Swarming may be a problem in colonies left on Canola long enough to gather a crop of honey.

According to Capilano Honey Limited, New South Wales is the main producing state for Canola honey in eastern Australia and the crop represents an important source of honey, though not without its marketing problems.

Australian Canola Area, ('000ha) by State. (Australian Commodity Statistics 2000)

Area	New South Wales	Victoria	Queens-land	Western Australia	South Australia	Tasmania	Australia
1993-94	100.6	29.2	0.1	35.8	10.8	0.1	176.5
1994-95	152.9	74.5	0.1	104.1	24.5	0.2	356.2
1995-96	170.2	76.2	0.2	99.4	30.4	0.1	376.6
1996-97	173.0	92.0	0.3	106.5	36.0	0.0	407.8
1997-98	270.0	117.0	0.3	248.0	83.0	0.0	698.3
1998-99	372.0	205.0	1.0	536.0	132.0	1.0	1247.0
1999-00	523.0	283.0	1.0	909.0	200.0	1.0	1917.0

The 1999-2000 figures are provisional estimates.

Despite Western Australia having the largest area of Canola, it is not an important source of honey. Eddy Planken of Wescobee says:

> *While there is quite a bit of canola in WA we get less than 30 ton of honey from it. Over the last 5 years we have averaged around 20 - ton per year as a lot of beekeepers find it difficult to work and they also have an abundant flow in the spring on native floral resources.*

Tree Planting

Despite the continuing destruction of trees, the increasing public awareness of the value of trees and of strenuous efforts by many agencies, companies and individuals to plant trees is a plus for the industry.

A minus for the industry is the dramatic increase in plantings of softwood plantations (Mostly *Pinus radiata*.) in recent years. This form of long term mono-culture renders large areas useless for beekeeping.

The combined standing plantation resource in Australia (planted to September 2000) is 1.5 million hectares, of which 972,170 hectares (65 per cent) are softwood species and 502,620 hectares (34 per cent) are hardwood species. The greatest proportions of the plantation estate are more or less evenly distributed across the three states of New South Wales, Western Australia and Victoria. The most extensive hardwood plantation areas occur in Western Australia, Tasmania, and Victoria while the most extensive areas of softwood plantations are in New South Wales, Victoria and Queensland.

Australian hardwood plantations are dominated by *Eucalyptus* species, supplemented by a small proportion of tropical rainforest and other hardwood species. Of the total hardwood species Tasmanian Blue Gum *E. globulus* comprises 62 per cent (311,340 hectares) and other eucalypts comprise 19 per cent (95,360 hectares).[7]

Tasmanian Blue Gum may be of little use to beekeepers as it is unlikely to flower before it is cut down at about ten years of age. However fast growing species such as Flooded Gum *E. grandis* grown in southern Australia will flower well after 2-3 years from planting and could be of some local use, however the close spacing at which the trees are grown in plantations is not conducive to flower production.

Biological Control of Weeds

Experience has shown that biological control programs never completely destroy the target species. At best, the program reduces the severity of the target to the point where conventional control measures become more feasible or reduces the severity of the target to the point where it is no longer a major pest.

In point of fact biological control of weeds in Australia have so far had little impact on the beekeeping industry.

Paterson's Curse

The biggest threat to the physical resource base from biological control is the program to reduce the incidence of Paterson's Curse. In the 1997 analysis of major honey deliveries from suppliers living in New South Wales to Capilano Honey Limited, Paterson's Curse accounted for the most honey received, closely followed by the combined Ironbark species. It retains this position, and in fact Capilano reports that deliveries have increased since then. A recent report[8] stated:

> *To date six insects have been successfully released for the biological control of Paterson's Curse……… The most damaging insect so far has been the crown-boring weevil,* Mogulones larvatus *that was first released in 1991 and has established at over 400 sites nationwide. Weevil larvae cause nearly all the damage, feeding in the root crown of Paterson's Curse rosettes from autumn to spring. The largest build up of weevils has occurred in the Riverina, particularly near Yanco, New South Wales. At these sites the weevil is having an effect on whole paddocks of Paterson's Curse, attacking up to 100% of rosettes and killing 70% before flowering, over hectares of ungrazed land. One of these sites has developed to the point where the weed has to be deliberately encouraged to maintain a good source of insects for a nationwide redistribution program.*

Despite obvious progress with the biological control program, no reduction in usefulness of Paterson's Curse to beekeeping has yet been attributed to it.

Blackberry

In Tasmania, biological control of Blackberry, *Rubus fruiticosus*, has been considered for many years and investigations held into ways of achieving it.

The most favoured biological control organisms are fungi that cause leaf rust. There have been some varieties of rust present in Tasmania for many years. These rusts did not have any significant affect on honey production from Blackberries.

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[7] Bureau of Rural Sciences. Plantations Australia 2001. (Canberra)
[8] Smyth,M. (2000) The biological control of Patersons Curse/Salvation Jane. Honeybee News 1(5) 24-25.

The number of varieties of rust present in Tasmania has apparently increased in recent years and include *Fragmidium violaceum*, a variety that appeared, unannounced, at Hiawatha Creek in Victoria in 1984.

The present position in Tasmania is described thus by Harold Ayton:

> *While some varieties of blackberries may have been almost eradicated, others are still doing reasonably well but at times, not quite as vigorous as in their hey day. As with all new such agents, the first couple of years or so they seem to have some dramatic effect but then the effect seems to flatten out. This has happened here.*
>
> *Honey is still being produced from the remaining blackberry stands although the level of production here depends on when the rust gets going on the plant (weather conditions have a bearing on this). If it comes in early, prior to flowering, then honey production is fairly minimal but if it should appear during the latter flowering or after flowering, then production is pretty good.*
>
> *If they were to bring in some other varieties of the rust it may then have a greater effect on honey production. To date, I am not aware of any other rusts being introduced*.[9]

Access to the Resource Base

National Parks

Access to the nectar and pollen producing plants growing on private and public lands that constitute the resource base was taken for granted until relatively recently.

Sites on various types of Crown Land were often regulated and frequently a fee was charged for privilege of occupying them. The sites were mostly transferable and provided beekeepers exercised reasonable care few problems were experienced with land managers. There was certainly no question of banning bees.

Then a chain of separate, but related, events occurred that brought the unfettered access to the resource base into question. The first was the commitment by some conservationists to rid conserved areas of exotic plants and animals. The first that New South Wales beekeepers knew about this deeply held conviction was at the 1984 State Conference of the then Commercial Apiarists' Association (CAA), when a representative of the New South Wales National Parks and Wildlife Service (NPWS) announced that it would immediately begin to phase out beekeeping from national parks.

Strong lobbying by the CAA resulted in the Minister amending the policy in 1990 to permit apiary sites to be retained for the term of the life of the licensee. Since then the policy has been further amended in favour of the beekeeper. However, since only sites that were currently leased were included in the Minister's 1990 decision, many traditional sites not leased at the time of the decision were lost to the industry.

The situation was not dissimilar in some other states. In Queensland by the early 90s National Parks policy was that no new bee sites would be granted in National Parks and that existing sites would be phased out within three years of declaration of new parks. Negotiations by industry lead to a compromise solution.

[9] Harold Ayton, (2002), personal communication.

In Victoria, the Environment Conservation Council (ECC) began to disenfranchise beekeeper access from the early 1980s. Reference Areas and Wilderness Areas had Buffer Zones thrown around them, vastly reducing beekeeper access. Toward the end of the 1980s, huge new Wilderness Areas were created in most of the uncommitted Crown Lands left in Victoria. The boundaries of these Wilderness Areas were set, so that with the new Buffer Zones, bee sites could not be taken out adjacent to the Wilderness Area.

Bees are banned from national parks in the Northern Territory, creating something of a unique problem since many of the permanent watercourses have been made national parks.

The onus of protecting access to conserved areas became a prime responsibility of state beekeeper associations. There was little that individual beekeepers could do, and as conserved areas were almost entirely state matters, there was little that the federal beekeeper organisations could do either.

While negotiations between beekeeper organisations and State Governments were going on, a dramatic and unexpected shift in the management of conserved areas was under way. The number and area of national parks and other areas under control of the several national parks services increased greatly, mostly at the expense of state forests.

In New South Wales for example, a State Forest publication of 1996[10] estimated the area of “National park and nature reserves” at 2.6M ha. In 2001 the NPWS states that there are 580 “parks, reserves etc which are managed by NPWS” with a total area of 5.387M ha.

One of the effects of the reduction in the area of state forests and the increase in the area of conserved land is the gradual disappearance of access roads on both types of tenure. In state forests land available for timber harvesting has been greatly reduced and fewer access roads are being made or maintained. In most national parks, and in nearly all wilderness areas, existing logging roads are not maintained and in some instances are deliberately made impassable to vehicular traffic.

Regional Forest Agreements (RFA)

During the 90s a further serious matter arose that threatened the access of beekeepers to conserved areas. Commonwealth and State Governments combined to deliver the environmental, economic and social values required of sustainable forest management, as defined by the Montreal Process. The history of the Montreal Process follows on from the UN Conference on Environment and Development (UNCED), held in Rio de Janeiro in June 1992 and began when Canada convened an International Seminar of Experts on Sustainable Development of Boreal and Temperate Forests. The seminar, held in Montreal, Canada, in September 1993 focussed specifically on the development of criteria and indicators for the sustainable management of temperate and boreal forests and provided the conceptual basis for subsequent regional and international work on criteria and indicators.

The criteria and indicators for the sustainable forest were duly formulated and were applied on a regional, rather than national basis. Such regions are at a scale where the varying contributions to sustainability from different types of forest use are apparent.

A program of studies known as comprehensive regional assessments (CRA) collected data about the forests and woodlands in a number of regions in which commercial timber production is a major forest use. Following completion of these assessments the Commonwealth and relevant State Governments entered into Regional Forest Agreements (RFAs) that met the obligations of both governments and provide certainty about land use and forest management. The first of these agreements, for the East Gippsland region, was completed in February 1997. The outcome of the agreement disadvantaged the beekeeper. Forest reserved under the agreement tended to be in remote and inaccessible areas, whilst those forests most valued and most used by beekeepers are subject to clear felling. The authorities can

[10] State Forests of New South Wales (1996) Beekeeping and State forests – an Occasional Paper .(Sydney)

justly say that beekeepers have retained existing sites, but they are valueless and are likely to remain so for many years.

Beekeepers' Response

The RFA process created an enormous amount of work for state beekeeper associations. They were concerned about their capacity to adequately contribute to the CRA process because of the paucity of data on socio/economic factors relevant to the industry. The Federal Council of Australian Apiarists' Associations (FCAAA) provided funding to employ a consultant to undertake a study of the socio/economic affects of the CRA program on the beekeeping industry. The study, the *Economic Value and Environmental Impact of the Australian Beekeeping Industry,* was released in February 1998[11]. In September of the same year the New South Wales Apiarists' Association published *Keeping Bees on Forested Lands, a Code of Practice*.[12]. The Code of Practice had a forward by the Minister for Agriculture and Minister for Land and Water Conservation and was formally presented to the Minister for the Environment at Parliament House, Sydney. It showed that the industry appreciated its obligations to protecting the environment and its responsibilities to the wider community, and was accepted by State Government agencies as an earnest of the industry's intentions.

State associations attempted to cope with unprecedented legislative change and by dint of a sustained and dedicated effort by association leaders, beekeepers have retained, to varying degrees, some access to conserved areas.

Fortunately, in most states at least, beekeepers are now able to meet with relevant state agencies through consultative committees and thanks to closer industry/Government liaison than ever before, a number of good outcomes have been achieved.

Threatened Species

Yet another problem has arisen for the industry. The New South Wales Threatened Species Conservation Act (TSA) came into affect on the 1 January 1996. It was introduced to try and protect all threatened animals and plants that are native to New South Wales. The TSA replaces and amends a number of existing Conservation Acts. In 2001 the Scientific Committee, a statutory body independent of the National Parks and Wildlife Service, made a Preliminary Determination to support a proposal to list competition from feral honeybees *Apis mellifera* Linnaeus as a Key Threatening Process on Schedule 3 of the TSA.

The NPWS decided to support the nomination and now has three years, have to prepare a Threat Abatement Plan. The TSA covers all tenure of lands, both public and private. NPWS has said that it will consult with the New South Wales Apiarists' Association and community groups.

Queensland has a similar act although honeybees have not been proposed as a key threatening process.

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[11] Gibbs, Diana M H and Muirhead Ian F (1998) The Economic Value and Environmental Impact of the Australian Beekeeping Industry.
[12] Benecke F S (1998) Keeping Bees on Forested Lands – A Code of Practice. NSW Apiarists' Association Inc, Sydney.

Present Position

New South Wales

A Beekeeping Industry Consultative Committee (BICC) was established in the early 1990s and comprises representatives of all sections of the beekeeping industry and of government departments and agencies that are associated with the industry. The Committee has proved useful in maintaining effective communications between the several sections of the industry and government agencies.

In New South Wales, existing sites on the NPWS estate may be transferred when the beekeeping business is passed on to another family member (intra or inter - generational transfer). As well, sites may be transferred to the purchaser when a beekeeping business is sold. In the event of a bee site becoming vacant, the New South Wales Apiarists' Association advertises the vacant site and if there is more than one application the Association conducts a ballot. No new beekeeping sites have been granted by the NPWS estate. The current charges for bee sites is $70 per annum and GST does not apply.

State Forests in New South Wales established seven Forest Management Zones (FMZ) under the RFA process. Zones 1 and 2 cover the most sensitive areas and for these Zones conditions apply to keeping bees that are similar to those applying to NPWS. Limited transferability of existing sites and no new sites will be established. In the other five zones bee sites are leased on the first in first served principal. Bee sites allocated by the Forestry Commission are 1.5 km square in area. Tenure can be for six or twelve months. The current charges for bee sites are $70 for one year and $47 for six months, plus GST. There is no statutory limit to the number of forest bee sites held by individual beekeepers.

Travelling Stock Routes and Travelling Stock Reserves throughout New South Wales, controlled by Rural Lands Protection Boards, are available to beekeepers for rent as bee sites. Each Board sets its own permit fees. Prices range from $10 to $60 per year per site, with the average being $20. These Stock Routes and Reserves provide a large number of reasonably priced bee sites to the beekeeping industry.

Northern Territory

Bees are banned from national parks.

Queensland

The Queensland beekeeping industry has a Consultative Committee with the public land managers. Membership of the committee includes representatives from the Departments of Primary Industries, Lands, Forestry, Conservation and National Parks, Fisheries and Wetlands; as well as five industry representatives from honey producers, queen breeders and amateurs.

Beekeepers have retained their traditional access to state forests but the situation with national parks is less clear.

National Parks policy is that there will be no bee sites in National Parks. Following negotiations with industry the prohibition has been circumvented, admittedly in a rather awkward manner. Resource Reserves have been created in some National Parks and the Reserves are the actual, formerly existing apiary site. This stratagem gets around the prohibition of keeping bees in national parks, as beekeeping is a permitted use on Resource Reserves. So there are a lot of little spots within some national parks where the Resource Reserves/apiary sites are located. These factors have a major bearing on the beekeeping industry in Queensland and the 1994 RIRDC report Commercial Beekeeping in Queensland points out that most beekeepers reported that their bee site usage is 50% in forest and 50% on private land.

Duncan McMartin, Resource Chairman of the Queensland Beekeepers' Association (QBA) said in 2002[13]:

> *We are working on the Minister for the Environment and his Staff to try and get the Nature Conservation Act changed to allow beekeeping on newly created National Parks with a history of beekeeping. The Queensland Environmental Protection Agency (QEPA) has set up a number of local committees to advise on the future tenure and management of forests under the South East Queensland Forest Agreement (SEQFA). Although these committees do not consider the future of beekeeping as such, if they want a road closed or an area made into National Park then it will impact on our industry. We have beekeepers on these committees to advise and educate them. Many of the "green" representatives do not know that beekeeping is not allowed in National Parks and see no harm from us. Some, however, are opposed to all non-native species in National Parks….*
> *The Queensland Conservation Council (QCC) has been working to obtain funding, through government, for a feasibility study into planting forests for beekeepers. Some local conservationists think that if the money is available it would be better spent getting rid of feral cats and pigs than beekeepers.*

South Australia

Through the Apiary Industry Consultative Committee (AICC), the industry consults with the Department of Environment and Heritage on matters concerning bee sites in parks and reserves. The AICC can deal with any matters covered by the Environment Minister's portfolio.

Most apiarists interviewed in the 1993 RIRDC report Commercial Beekeeping in South Australia said that 75 to 80 percent of their bee sites are on private land and although only 20 to 25 percent of sites are on public lands, many of these are critical for overwintering bees. Most beekeeping sites on public land are located in a small number of parks and other conserved areas.

For example, the Ngarkat Conservation Park contains bee sites with access to *Banksia ornata*, a species valuable for overwintering bees and utilised by a large proportion of the commercially-managed hives in South Australia. Access to the area was threatened and the Honeybee Research & Development Council and other organisations supported a research project to determine the impact of commercially managed honeybees in the Ngarkat Conservation Park. The research report[14] said, in part:

> *Although the presence of honeybees reduced the quantities of nectar available at Banksia inflorescences, particularly near apiaries, there were still considerable quantities of nectar remaining at the end of the day when honeybee foraging had ceased. The quantities left over often exceeded 0.5g of sugar/inflorescence even within 100m of an apiary. These quantities were more than adequate to satisfy the energy requirements of native fauna.*

The results of the research carried out in Ngarkat was welcome news to South Australian beekeepers and the number of bee sites on government managed lands available to the industry has remained unchanged.

The public land used by apiarists falls into four categories:- Forest Reserve, Water Catchment Areas, National Parks and Heritage Agreement Areas.

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[13] Duncan McMartin, (2002) Report to AHBIC Conference on Natural Resources and Public Land Management held in Canberra April 30-May 1 2002.
[14] Paton D C (1995) Impact of honeybees on the flora and fauna of Banksia heath in Ngarkat Conservation Park. SASTA Journal 95:3-11.

At the time of writing, the fee structure was:-

All sites (other than burnt sites) attract a holding fee of $75 each plus GST.
If a site is transferred to another beekeeper, a fee of $200 is payable
If a site is burnt out, no fee is required until the site has recovered and is again ready for use, when the normal fees will apply.

Tasmania

World Heritage Areas contain 40% of Tasmania's principal honey crop, Leatherwood *Eucryphia lucida and E. milliganii.* Thus access to World Heritage Areas is of the utmost importance to the industry. Most of the remaining 60% is found in State Forests and in National Parks.

World Heritage Areas and National Parks are under the control of the Department of Primary Industries, Water and Environment. Forestry Tasmania is a statutory authority under the control of the Department of Infrastructure, Energy and Resources.

The management strategy plan adopted in relation to beekeeping in World Heritage Areas and National Parks is as follows:

(a) The existing licensed apiary sites will be permitted to continue to be operated.
(b) Licensed sites may be transferred to another fit and proper commercial beekeeper.
(c) Consideration will be given to the conditions necessary to provide for new apiary sites during the management planning process. Until this process is completed licenses for additional sites will not be granted.

Beekeepers are able to retain sites in these areas and they can be transferred to other beekeepers. Since few, if any, new roads are allowed to be constructed in World Heritage Areas and National Parks, the possibility of new sites being granted is remote.

The Tasmanian Beekeepers' Association and Forestry Tasmania consult on a regular basis and have agreed to a *Community Forest Agreement* governing the keeping of bees in state forests. The two parties have also agreed to a code of practice named *Guidelines for Beekeeping on State Forests*. Clear felling in state forests in southern Tasmania is creating serious problems for beekeepers in that area.

Victoria

The Land Conservation Act 1970 established what is now called the Environment Conservation Council (ECC) whose function is "to carry out investigations and make recommendations to the Minister with respect to the use of public land in order to provide a balanced use of land in Victoria".

Bob McDonald, Resource Chairman of the Victorian Apiarists' Association (VAA) said in 2002[15]

We have large areas of our public lands locked away from commercial harvesting of any produce. This is in Wilderness Areas, Reference Areas and similar.

We have large areas of our public lands locked up in National Parks, State Parks, Regional Parks, Special Protection Zones, Special Management Zones and, you name it, any type of Reserve that can be thought of to restrict commercial usage.

Because of the very low impact of the Beekeeping Industry on the natural environment, we have some limited access to many of the latter Parks/Reserves.

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[15] Bob McDonald, (2002) Report to AHBIC Conference on Natural Resources and Public Land Management held in Canberra April 30-May 1 2002.

Although the ECC advised Government on land use, the actual administration of bee sites in Victoria is the responsibility of the Department of Natural Resources and Environment.

Sites are provided under 3 classifications: Reserved Forest; Uncommitted Crown Lands; and, National Parks. Forest and Crown Lands allow for two categories of bee sites:

> *An annual licence renewal by rendering of an annual account. These sites are known as "Permanent Sites" and consist of 0.4 hectare of land for the bee site, and a bee range of 1.6km radius of the bee site on public land. Annual rental is based on a fee for the bee site plus a fee per hectare for all the forested public land within 1.6km radius. Rentals vary from $59.00 to $112.00 per year.*
>
> *The second category is the "Temporary Bee Site". This site covers a bee range of 0.8km and is let for a three-month or six-month periods, but can be renewed for a further period. Rental is $20.00 for three months.*

There is a great deal of competition for bee sites, and many "Temporary Bee Sites" are, in reality, held continually.

Bee sites in National Parks are allowed on a "temporary" basis as outlined above. The allocation of bee sites in National Parks is based on the following criteria: if an area of public land has a history of usage by apiarists before becoming a National Park, bee sites are allowed, providing that the placement of bee sites is not in conflict with the management of the Park. This means that usually there are some changes as to where apiarists can have sites but, generally, the industry continues to have access to National Parks.

Western Australia

The bulk of the honey (about 80-90%) produced in Western Australia is from native flora growing on conservation areas and state forest lands managed by the Department of Conservation and Land Management (CALM) and other unvested lands and reserves vested in other government agencies or local government authorities.

A Beekeepers Consultative Committee (BCC) includes representatives from the Western Australian Farmers Federation, Swan Settlers Beekeepers, Water Corporation, Pollination Association of Western Australia, Department of Land Administration, Wescobee Pty Ltd, Western Australian Beekeepers Association, Western Australian Apiarist's Society (Amateurs), Pastoralists and Graziers Association and Department of Agriculture. The objectives of the committee are to ensure three-way communication between the CALM, the beekeeping industry and other government agencies and to provide advice to the Minister for Environment and Heritage when required.

Apiary sites are set 3km distance between sites to reduce the risk of spread of bee disease and the current cost is $60 per year per site in the south west zone and $12 per year per site in the remote zone. Beekeepers are also charged an application fee of $100 for between 1-5 sites applied for at any one time within the South west region and a $50 application fee for between 1-5 sites within the Remote zone. Beekeepers are allowed to hold ten public land sites for every 100 hives owned in the south west zone and eight in the remote zone.

Bee sites are transferable with the sale of a beekeeping business but not for monetary gain. However the Minister for the Environment and Heritage is soon to release a paper for public comment relating to the Trading of Apiary Sites This proposal arose as a result of recommendations arising from the National Competition Review of the CALM Act. The fee for transferring apiary sites is $8.50 per site.

The Department has approx 2843 current apiary sites. 2074 in the South West Region and 769 in the Remote Zone. 457 are within Water Catchments, 276 are within Pastoral Leases, 978 are on State Forest, 216 are on National parks, 229 are on Nature Reserves and 631 on unallocated Crown land. The remainder will be on Shire Reserves, Timber Reserves, Freehold land held by the State etc.

4. Nutrition and Hive Management

Australian beekeepers have learned to successfully manage their hives in an often unfriendly and unpredictable environment. They have learnt the key role that nutrition plays in maximising their returns.

Beekeepers have devised migration patterns that help to achieve the fundamental aim of having hives strong and healthy at the commencement of the honey flow. They strive to have bees reared on a high plane of nutrition and to adopt the other elements of "good beekeeping practice".

Swarming is managed by a variety of methods and is not generally regarded as a serious management problem.

Beekeepers have long known that bees working some plant species quickly exhausted their supplies of pollen and colonies became broodless. They also have long understood the need to move colonies to good breeding condition prior to major honey flows and they know which plants provide long-lived bees and which don't. They also know, when queen rearing, which plants resulted in the best queens. Some beekeepers have also long suspected a relationship between nutrition and certain bee diseases and on the longevity and performance of queen bees. What beekeepers have not known is why all this was so.

Apiarists developed migration patterns to suit the known nutritional status of plants in their locality, and used them when seasonal conditions permitted. Many of these migration patterns are outlined in this chapter.

Potentially, the biggest breakthrough in improving bee nutrition has come with a better understanding of the quality of pollen available from different plant species.

Experience with supplementary feeding, particularly of protein supplements, is progressing.

The importance of providing water to bees located in arid areas is well understood and methods of providing water have been devised.

The Weather

Probably the biggest single influence of bee nutrition, and hence honey production, is the weather. Rainfall is the most important aspect of the weather to effect beekeeping. In fact it is fairly clear that honey production and rainfall are strongly correlated. This even holds true for the tropical north of Australia where below average rainfall in the wet season usually results in poor honey crops in the following dry season.

The effects of too little rain are obvious. Rainfall when it is not needed can also cause problems. Autumn flowering trees such as Belbowrie *Melaleuca quinquenervia* or Grey Gum *Eucalyptus punctata var. punctata* produce best if the weather at flowering is warm and dry, because their thin nectar is difficult to ripen and yeasts may develop in humid weather, spoiling the quality of the honey and causing a serious reduction in hive population.

For NSW and southern Queensland at least, a good rule of thumb is to move to the coast in a drought and move west when there is good rainfall. Traditionally, moving has been the only option when conditions deteriorate too much. Starvation may be temporarily held at bay by supplementary feeding however the cost of long term feeding may prove prohibitive.

Temperature is also an important consideration effecting not only honey production but also some bee diseases.

Swarming

Swarming is most likely to be a problem during the build up period in late spring/early summer. Most beekeepers do not consider swarming to be a serious impediment to honey production. Methods of controlling swarming include taking healthy brood and bees from strong colonies and using them to make up nucleus colonies or new colonies or to strengthen weak colonies; placing foundation in strong hives; moving frames of brood from the brood box to supers above the excluder; and moving colonies from good breeding conditions to a likely honey crop. Swarming is less of a problem when the colony is headed by a young queen.

Migratory Beekeeping

It is difficult to put it better than Alan Clemson[16], who said:

> *Virtually all commercial honey production in Australia is from hives that are moved (migrated) from one source of pollens and nectars to another. This is economically necessary in Australia because extremely variable rainfall and other weather conditions affect not only the budding and flowering patterns of the flora but also the pollen and nectar yields. It is quite common for an area that has provided a heavy honey crop one season to be totally unproductive the next, and a period of non- productivity may last for months or even several years. Australia's high honey production yields per hive have only been achieved through beekeepers migrating their hives throughout the year from one favourable area to another.*

With a few notable exceptions honey flows are notoriously unreliable. Even a good flowering of a usually productive plant does not always result in a good crop.

Understanding the options available for honey production in any given season requires astute observation, experience and a lot of scouting. Often there is little from which to choose, but sometimes there is more than one option available. And they will not necessarily be the same options as last year.

Most state Departments of Agriculture or equivalent have at some time published information about honey and pollen flora. Probably the most comprehensive publication is Alan Clemson’s “Honey and Pollen Flora” produced in 1985 by Inkata Press, Melbourne, for the New South Wales Department of Agriculture. Unfortunately the work is out of print, but occasionally a second-hand copy turns up.

Migration Patterns

Despite the big rigs and mechanical aids described in the chapter on Equipment, most beekeepers only move their apiaries as often as necessary and as far as necessary. They know their own locality well and prefer to work within it.

Moving hives is expensive and beekeepers do not usually undertake long moves unless necessary. There are exceptions to this generalisation. Some beekeepers are prepared to travel long distances if the potential rewards, either economic or managerial, are greater than those nearer to base.

Because of distinct variations in migration patters between regions they will be considered on a state-by-state basis. Most of the information contained in this section is from the series of RIRDC reports on Commercial Beekeeping, produced on a state-by-state basis in the early 1990s.

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[16] Clemson A A. Honey and Pollen Flora. (NSW Department of Agriculture, 1985) p 6.

New South Wales and the Australian Capital Territory

Coastal Areas

Banksia, melaleuca and heath are popular sites for over wintering. They provide a range of pollens and are warm, usually resulting in strong colonies in the spring. Agricultural and grazing area clover, associated weed flora and early eucalypts encourage continued breeding during spring, sometimes with an extractable surplus of honey. The major honey production is from the summer flowering coastal range where the pollen is often provided by a support species. Spotted gum *Corymbia maculata*, provides an excellent pollen source every three or four years, in the late summer/autumn in the north and in the winter in the south. It also provides heavy honey flows every four to ten years with moderate flows more frequently.

In early spring colonies working Grey Ironbark *E. paniculata*, that do not have a supporting pollen species, require good pollen after the flow. Supporting pollens are usually available for later flowering Grey Ironbark, including Brush Box *Lophestemon confertus* in suitable seasons.

Useful pollen providers in the foothills and eastern ranges include Blackbutt *E. pilularis*, Mahogany *E. resinifera and E. acmenoides*, Messmate *E. obliqua*, Stringybark *E. globoidea and E. muelleriana* and Bangalay *E. botryoides*. These species are used for queen rearing in the ranges.

Tablelands and Western Slopes

Along the length of the tablelands and higher slopes, apiarists migrate between a number of inland resources. Typically, apiarists work the tablelands and slopes and migrate to the coast when necessary or for a specific flow. In the southern part of the state there is a more distinct east-west migration pattern.

On the tablelands, bees tend to cease breeding during winter. A major build-up occurs during late winter and early spring on pollen flows from plants such as Turnip *Rapistrum rugosum* and *Brassica tournefortii*, Canola *Brassica* species and Cape Weed *Arctotheca calendula*, Paterson's Curse *Echium plantagineum*, Clover *Trifolium* species and early eucalypts.

Colony strength in spring can vary from good, when pollen is adequate and nosema levels low, to very poor on the same sites when soil moisture does not promote understorey pollen flora.

When weather conditions are suitable the large areas of White Clover *Trifolium repens* on the northern tablelands may provide an extractable surplus of honey in mid-summer.

In inland southern areas in particular, Paterson's Curse is a major source of honey.

St. Barnaby's Thistle *Centaurea solotitalis* is often used for late summer queen production.

Several of the eucalypt honey species do not provide adequate pollen. Yellow Box, Brown or Inland Grey Box *E. microcarpa* and Pilliga or Mallee Box *E. pilligaensis*, Mugga Ironbark and Caley's Ironbark *E. caleyi* all require supporting pollens at the honey sites or specific pollen management to correct protein inadequacies.

In some seasons the mix of honey and pollen flora in areas such as the Pilliga Scrub in northern New South Wales and ironbark forests in southern Queensland promote winter breeding and honey production. The stringybarks can provide a crop of honey in the autumn as well as good bees for the winter.

In some seasons bees over-wintered in Mugga Ironbark *E. sideroxylon* forests will breed well, particularly if supporting pollens are adequate. In other years a combination of insufficient protein and nosema infections promotes dwindling in early spring.

Far Western/Channel Country

Apiarists from all areas concentrate on Napunyah *Eucalyptus ochrophloia* and associated flora in the channel country of north western New South Wales and south western Queensland. These apiarists have a philosophy of management that is geared to channel country beekeeping. Generally, beekeepers who work Napunyah attempt to avoid pollen deficient late summer and autumn species such as Mugga and Caley's Ironbark and Brown/Inland Grey Box and Pilliga/Mallee Box which could deplete colony populations prior to migration to the winter channel country flows.

Apiarists in this area form two distinct categories – those who regularly use the channel country and the remainder who concentrate on western slopes species. With the exception of a few permanent channel country apiarists, most western apiarists regularly utilised Paterson's Curse, Capeweed and Canola in the spring and Caterpillar Weed *Heliotropium european* St. Barnaby's Thistle, Stringybark and Blueweed *Echium vulgare* in the autumn for pollen. Lignum *Muehlenbeckia cunninghamii* is also used regularly.

Rainfall to promote the growth of pollen producing plants is critical to successfully working Napunyah. Beekeepers appreciate the need to have brood in their colonies before and during the flowering of Napunyah and from time to time will feed pollen supplements in an attempt to maintain brood rearing.

Important pollen plants in the channel country included Ellangowan *Myoporum deserti*, Boobialla *M. montanum*, Lignum, *Eremophila* species, Gidgee *Acacia cambagei*, Bloodwood *Corymbia terminalis*, Coolibah *Eucalyptus microtheca*, Bimble Box *E. populnea* and River Red Gum *E. camaldulensis*.

Northern Territory

The small beekeeping industry in the Northern Territory is concentrated in the tropical north, mainly around Katherine and Darwin. Consequently, beekeepers have to contend with a wet/dry climatic regime that imposes severe restrictions on honey production. The wet extends from October to May, with the highest rainfall in January, February and March. Honey production is linked to rainfall and is likely to be best after good monsoonal rain in the wet and worst following low rainfall in the wet season. Beekeepers report that April and May are the worst two months for honey production.

Adequate supplies of pollen are usually available and beekeepers report that there is brood in the hive all year round.

Trevor Brennan, President of the Northern Territory Beekeepers' Association provided the following table of useful honey producing flora. As he points out in a footnote, the table refers to the tropical north.

Northern Territory Honey Producing Flora

Approx. flowering period	Botanical name
December – January	*Eucalyptus patellaris* (Weeping Box) *
March – May	*Spermacoce breviflora*** (a herb)
April – July (Tennant Creek area)	*Eucalyptus pachyphylla**** (Red-bud Mallee) *(ref: '*
May – August	*Eucalyptus miniata* (Woollybutt) *
June – August	*Eucalyptus tetrodonta* (Stringybark) *
June – November	*Melaleuca cajuputi* (Paperbark)
July – September	*Eucalyptus tintinans* (Salmon Gum) *
August – October	*Melaleuca argentea* (Silver-leaved paperbark)
August – November	*Eucalyptus camaldulensis* (River Red Gum) *
August – November	*Erythrophleum chlorostachys* (Ironwood) *
September – December	*Eucalyptus tectifica* (Northern Grey Box) *
November – April	*Melaleuca viridiflora* (Broad-leaved paperbark)

* Top End Native Plants by John Brock
** "The genus is a large one, the taxonomy confused and many of the species look the same, so use of the name in this instance could well cover several species." Ian Cowie, Botanist, NT Herbarium.
*** Field Guide to Eucalypts – Vol 3' – Brooker & Kleinig

With the exception of the Red-bud Mallee, all the above are known honey producers in the northern part of the Northern Territory.

Queensland

Coastal Areas

When rainfall is not excessive, coastal melaleuca, banksia and heath provide autumn honey and breeding conditions. This may be followed by the important winter flowering Spotted Gum and Narrow-leaved Ironbark *E. crebra* flows. Inland apiarists often winter on this coastal area gum and ironbark.

Pea bush *Pultenaea villosa* supported by a range of Wallum species yields pollen for spring build-up. Grazing areas include White Clover pastures. At this time some apiarists locate in or contract pollinate Macadamia Nuts *Macadamia* species. Macadamia and adjacent weeds and wallum species provide good build conditions, even though research into pollination of macadamias[17] showed that:

> *Bees did not work effectively in the macadamia flowers and fed mostly on other flowering plants in the area.*

[17] Stace, P.S.(1986). Observations on behaviour of honeybees in macadamia orchards. Australian Horticulture 84(4).

The major summer honey production is from Grey Ironbark and Brush Box in the coastal ranges. Pollen is largely from support species that include Stringybark *E. phaeotricha & E. resinifera*, Grey Gum *E. propinqua*, Apple *Angrophra* species, Wattles *Acacia* species and vines. Late summer and early autumn Bloodwoods *C. intermedia* and *C. trachypholia* and Mangrove *Aegiceras* species and *Avicennia* species support colonies prior to the coastal tea tree flowering.

Downs/inland Agriculture

Autumn and/or winter rains promote a wide range of weeds that provide good late winter/early spring colony building conditions. Turnip is the major pollen provider and Mountain Coolabah *E. orgadophila* is a useful support species. Migration to turnip to build colonies prior to Yellow Box is a regular occurrence. This area does not receive regular winter rains and in dry years there is a major pollen deficiency.

The affect of the winter flowering ironbark forests on colonies varies according to rainfall. In some years rainfall promotes wattles and associated ground flora that maintain strong colonies on the winter ironbark honey flows. In dry years severe colony decline can occur and appropriate nutritional management is essential in these instances.

Some crop pollination is reported during late winter and spring, however the post pollination condition of colonies can be poor, depending on weather conditions, stocking rate, pesticide drift and the level of supporting weed pollens.

Yellow Box is a major summer honey source and the associated Hill Gum *E. dealbata* provides both honey and pollen to maintain colonies working Yellow Box. Narrow-leaved Ironbark may also be available.

Summer rains result in good forage/build-up conditions during late summer and early autumn on the River Red Gum *E. camaldulensis* streams and adjacent black soil plains. Important forage plants include Mint Weed *Salvia reflexa*, Caltrop *Tribulus terrestris*, Carpet Weed *Phyla nodiflora*, thistles, Yellow Burr (St Barnaby's Thistle) and grain and legume crops.

Autumn box and ironbark honey flowers are pollen deficient. Strategies used on these species to minimise colony decline include:

- move out prior to the end of the flow before colonies collapse;
- rotate apiaries between honey and pollen sites;
- provide protein supplement.

In wet years Purple Top *Heliotropium amplexicaule* will maintain colonies on pollen deficient eucalypt flows. Whilst the Purple Top nectar is light in colour when collected, it darkens with age and will down grade the colour of the total crop.

Napunyah and Downs

Whilst some apiarists who work Napunyah remain in the channel country, many migrate between the downs eucalypts and channel species. In years of low pollen, channel colonies are first moved to the Downs river flats to build prior to Yellow Box and Hill Gum. The downs flats are again used to prepare colonies prior to returning to Napunyah.

Napunyah

Practices parallel those of the New South Wales apiarists who work Napunyah.

North Queensland

April -November cucurbit pollination is the central focus for nutritional management in the Burdekin area. Colonies pollinating rock melons and zucchini tend to decline and require periods of quality pollen. Jarrahdale pumpkins provide good pollen and their utilisation in the cycle refurbishes colonies pollinating other cucurbits. Good pollen is also available from Poplar Gum *E. alba*, Broad-leaved Tea-tree *Melaleuca viridiflora*, River Tea-tree *M. leucadendron*, Soapy-leaf Tea-tree *M. dealbata*, Pig Weed *Protulaca* species, Snake Weed *Stachytahmeta* species, Caltrop, Cobblers Peg *Bidens pilosa*, Sensitive Weed *Mimosa pudica*, Carbeen *E. tessellaris* and some mangroves.

On the Atherton Tableland Blue Gum *E. tereticornis*, White Mahogany *E. acmenoides*, Carbeen, Narrow-leaved Ironbark, Bloodwood, Red Stringybark *E. resinifera*, Turnip, Glycine *Clycine tomentella*, Blue Billy Goat Weed *Ageratum conyzoides* and Sarsaparella *Alphitonia petriei* are major pollen sources.

Colonies tend to decline after working tableland scrub. This appears to be the result of a long period of almost pure Flat Weed *Hypochoeris radicata* following on from Sarsaparilla at some locations. Grey Box *E. brownii* is an important north Queensland honey producer, but it is pollen deficient. Appropriate management is essential.

Other honey producing species requiring specific nutritional management include Brown/Grey Box, Caley's Ironbark, Grey Box, Mallee/Pilliga Box and White Stringybark.

South Australia

In South Australia good colony nutrition during winter can be promoted by banksia and heath, or by Coastal Mallee *E. diversifolia* and ground flora in the warmer, drier areas. These plants are the major food sources for colony build prior to Almond pollination.

Access to the winter build-up species is essential for active early spring colonies because bees tend to run down during autumn. Colonies left on Lucerne *Medicago sativa* decline and can become broodless after the main flowering. This decrease is more severe in areas without sufficient supporting pollens during lucerne flowering. Broodless colonies require one brood cycle before winter if they are to take full advantage of winter build-up species. Both Dryland Tea-tree *Melaleuca lanceolata* and Brown Stringybark *E. obliqua* promote autumn breeding.

Nutrition on Almonds *Prunus amygdalus* maintains brood rearing. In areas of intensive almond cultivation however, apiarists believe that the build-up is now at a reduced level. In these areas the plantings tend to be large and the weed control effective. As well, the stocking rate of hives/ha is higher than in areas of less intense cultivation. Intensive stocking rates may reduce the colonies stores of honey, thus adding an additional cost to providing a pollination service.

Salvation Jane (Paterson’s Curse) provides spring build-up. In some areas it provides primarily pollen and in others gives both pollen and honey. Several apiarists believe that it is a much better floral source when supporting pollens are available.

When bees that have worked White Mallee *E. gracilis* and require pollen, canola is used to commence colony refurbishment.

While most apiarists work their bees during winter, a few locate their bees at the spring locations and allow the hives to close down. Unless an early flow is available, these apiarists do not encourage early build-up. This acts as a means of swarm reduction. This procedure cannot be followed by the late winter/early spring pollinators.

Common honey species requiring specific management include: Blue Gum *E. leucoxylon,* Grey Box *E. microcarpa,* Hill/Pink Gum *E. fasciculosa,* Sugar Gum *E. cladocalyx,* Coastal Mallee (in cool, wet areas), White Mallee *E.gracilis,* Red Mallee *E. oleosa* and Lucerne.

Tasmania

Pollen is not considered a limiting factor in most areas, although an occasional deficiency may necessitate relocation to another site. The major nutritional factor in management is carbohydrate, both during the build period and after leatherwood. (See Supplementary Feeding.)

Although Tasmanian beekeeping revolves around the Leatherwood *Eucryphia lucida and E. milliganii* flow, Blackberry *Rubus fruitosus,* is also an important resource for beekeepers as it has been a more reliable nectar source than Clover. Unfortunately, Blackberry is suffering from several varieties of rust, which is making the crop less reliable than formerly. The benefit of Blackberry is reduced if the early spring is wet and as a consequence rust appears prior to flowering.

Western Australia

There is generally an abundance of good quality pollen in the traditional beekeeping areas. Pollen can be in such abundance that the bees may choke out the brood nest with pollen thereby preventing the queen from laying. Many beekeepers trap pollen, and the main sources are *Corymbia calophylla, Eucalyptus marginata, E. patens; E. wandoo, E. accedens* and mixed coastal species.

The goldfields and mallee areas are areas of low rainfall and are only worked, on average, one year in five, when above average rainfall promotes heavy budding and flowering. Beekeepers rely on these areas when traditional honey flows closer to Perth fail to produce.

Most beekeepers in Western Australia do not feed sugar as a routine part of their hive management, except in drought years when some may use it if honey stores in the hives are low.

More recently, beekeepers have shown an interest in supplementary feeding to provide essential nutritional elements that are missing from normal pollen. In making these supplements, beekeepers use sugar to make it attractive to the bees. Honey, unless irradiated, is not normally used in these supplements because it is a disease risk.

New Knowledge

Beekeepers have long suspected that many native Australian pollens lack something that bees need. They appreciate that European honeybees evolved in a Mediterranean climate in the presence of Mediterranean plants. On the other hand Australia's dominant flora, the eucalypts often produce abundant quantities of nectar and pollen and are pollinated by insects, birds, possums and fruitbats[18]. The eucalypts have no evolutionary link with European honeybees. Beekeepers soon realised that bees often did best when there were some European plants, usually weeds, in the vicinity of flowering eucalypts. But what was wrong with eucalypt pollen nobody knew.

The results of research by a number of people have shown a wide variation in the crude protein level of native pollens.

More recent research is highlighting some amino acid deficiencies in Australian pollens. As well, investigations into the role of fatty acids in pollen are in train. Thus beekeeper's understanding of the nutritional role of pollen is better than it has ever been, and seems likely to improve even further in the short to mid term.

[18] House, S.M. (1997) Reproductive biology of the eucalypts. Pp 30-55 in Williams, J.E & Woinarski, J.C.Z (Eds) *Eucalypt ecology* (Cambridge University Press: Cambridge).

On the basis of his research results, Doug Somerville has categorised many of the pollens found in southern NSW according to their crude protein levels, with a consideration for significant amino acid deficiencies[19]. The four categories used, the plant species in each category and the crude protein percentages are:

POOR QUALITY POLLENS					
SPECIES	**CP %**	**SPECIES**	**CP %**	**SPECIES**	**CP %**
Buckwheat	11	Weeping willow*	15	Saffron thistle	18
Fireweed*	12	Nodding thistle	15	Silky hakea*	18
Black sheoak*	13	Flatweed*	16	Citrus	19
Sunflower	13	Black thistle*	17	Lavender*	20
Blueberry	14	Capeweed*	17	Eggs & bacon*	20
Maize	15				

AVERAGE QUALITY POLLENS					
SPECIES	**CP %**	**SPECIES**	**CP %**	**SPECIES**	**CP %**
Red ironbark	20	White box*	23	Apple box*	24
Yellow burr	21	Onion weed*	23	Canola	24
White mallee*	21	Swamp mahogany	23	Vetch	24
Sweet scented wattle	22	Turnip weed	23	River red gum*	24
Pussy willow	22	Skeleton weed*	23	Faba bean	24
Rough barked apple	22	Alpine ash	23	Sydney golden wattle	25
Hedge mustard	22	Grey box*	24	Red stringybark*	25
Red box*	22	Manna gum	24	Currawong wattle*	25
				Woollybutt*	25

ABOVE AVERAGE QUALITY POLLEN					
SPECIES	**CP %**	**SPECIES**	**CP %**	**SPECIES**	**CP %**
Almond	25	Christmas mallee*	27	Blakely’s red gum*	29
Balansa clover	25	Bloodwood	27	Spotted gum*	29
White clover	26	Grey gum*	27	White stringybark*	29
Pear	26	Sydney blue gum*	28	Heath-leaved banksia*	29
Brittle gum*	26	Gorse	28		

EXCELLENT QUALITY POLLENS			
SPECIES	**CP %**	**SPECIES**	**CP %**
Scribbly gum	30	Lupin	34
Paterson’s curse	33	Vipers bugloss	35
Saw banksia*	33		

* Deficient in one or more essential amino acids.

The author points out that Paterson’s Curse *Echium plantagineum* pollen is of a very high quality with consistent levels of crude protein above 30%. Combine this with the ample quantity of pollen available and it is strongly arguable that this is the single most important pollen source in southern New South Wales.

[19] Somerville D C(2000) Crude protein, amino acid and fat levels of pollens collected by honeybees primarily in southern NSW. Final report: DAN 134A for the Rural Industries Research and Development Corporation. NSW Agriculture, Goulburn NSW.

It is of interest that although plants of European origin appear in each of four categories, three of the four species with the highest level of crude protein are of European origin.

Supplementary Feeding

Supplementary feeding is a management tool with many applications. Feeding carbohydrate or protein supplements, or both, to bees is a way of kick-starting colony build up in the spring; avoiding starvation; stimulating brood rearing on pollen deficient honey flows and as an integral part of queen rearing.

Carbohydrate

White cane sugar is the commonly used carbohydrate in Australia. It is fed dry or as a syrup. In general, when making sugar syrup to stimulate brood rearing, the ratio of white cane sugar to water is one part of sugar to one part of water. Heat the mix to dissolve the sugar, but cool to blood heat before feeding. Syrup is fed in all manner of contrivances, but usually in trays under a deep lid, in pepper pot feeders, frame feeders or in plastic bags. Occasionally syrup is fed from open drums.

Supplementary feeding, particularly of sugar syrup, is the norm for hives involved in producing queen cells.

In the 1990s series of RIRDC reports on Commercial Beekeeping a number of beekeepers in Queensland, NSW and Victoria reported feeding sugar from time to time. Few South Australian or Western Australian beekeepers reported feeding sugar. For Tasmanian beekeepers, however, supplementary feeding is a regular management tool.

The 1990 report Commercial Beekeeping in Tasmania states that the major nutritional factor in management is carbohydrate, both during the build-up period and after Leatherwood. Selection of strain bee and/or climate to minimise breeding after the Leatherwood and consequently conserve stores are also important management decisions in most operations. Almost all operators feed during spring. Some use combs of honey from the previous spring and many use large quantities of sugar syrup. Feeding sugar to stimulate breeding on available natural pollen is an integral part of population management between early spring and Blackberry/Clover nectar. Some apiarists take advantage of Blue Gum *Eucalyptus globulus* in some years and on other occasions Heath *leptospermum* and Prickly Box *Busaria spivosa* may reduce the sugar requirement.

From 1 to 1¼ tonnes of sugar per 100 hives may be fed in 5 litre capacity top feeders. Sugar concentration varies from 50% to as concentrated as possible. The heavier syrup reduces the possibility of fermentation, reduces the frequency of feeding and maintains breeding.

Protein Supplements

Feeding protein supplements is still not a common practice among commercial beekeepers. Those who do feed a protein supplement have the choice of using commercially produced protein patties or of mixing the supplement themselves.

Home-mixed supplements contain various proportions of irradiated pollen, brewers or torula yeast, soy flour and either sugar of some kind or honey (often irradiated) to bind the mix and increase its palatability.

There seems no definitive research on pollen supplements for Australian conditions and consequently no firm recommendations on the formulation of such supplements. Beekeepers report varied results with feeding pollen supplements.

Perhaps new knowledge of the role of fatty acids in pollen will result in substitutes that are both more attractive and more beneficial to bees.

Watering Bees

Bees need water to cool the hive and to maintain humidity in hot dry weather and as a component of brood food.

Mostly bees can find a source of water to meet their needs but in arid areas this may not be so and beekeepers take special precautions, particularly in warm weather. The most obvious strategy is to locate apiaries within easy reach of a natural water supply. This may mean locating the hives further from the nectar source than one may wish, but it is better that the bees fly further for nectar than for water in hot dry weather. Because the peak demand for water is in the hottest part of the day, bees forced to fly then are quickly exhausted.

If no natural source of water is available, and the beekeeper still wants to keep bees in the area, then water must be provided. The most primitive waterers consist of a 200 litre open topped drum nearly filled with water in which a float or floats have been placed. In areas where wild life is likely to be a problem the drum must be securely covered with wire netting and tied firmly to a tree. (Wild horses in the Pilliga Scrub in New South Wales, and presumably in other areas, when denied access to water because of the covering of wire netting will tip the drum over if they can and lick up water as it spills out.) More sophisticated waterers include a sealed container releasing water, via a ball cock, into a cinder filled shallow tray.

Apiarists regularly using the Mallee areas of northwest Victoria and southwest New South Wales periodically need to provide water for their bees. From time to time bees working in the Pilliga Scrub and other parts of northwestern New South Wales require watering.

Providing water for bees in relatively remote areas is time consuming and hence expensive. It can be more laborious if the need only arises occasionally and the beekeeper does not have the right equipment for the job.

In South Australia providing water for bees is compulsory. Surface water is very scarce in South Australia and stock are usually watered by underground bore and drinking troughs. Bees watering at these troughs can create problems, so it is required by law under the Apiaries Act to provide drinking water for bees within 200 metres of any beehive. The standard procedure is to have a rectangular tank, constructed of heavy gauge galvanised iron, of 900 - 1,300 litres capacity to carry at all times when shifting bees. The dimensions of these tanks are such as to fit in with a load of bees.

Similarly, it is a requirement of the Beekeepers Act of Western Australia to provide water to bees. Unless water is available from natural sources, beekeepers are required to provide a good and sufficient supply of water on every apiary site. These requirements have also been introduced to ensure that bees do not cause a nuisance to stock at drinking troughs and to the public.

5. Equipment

Although the equipment used by commercial beekeepers for producing honey, for moving apiaries and for extracting honey varies throughout Australia, there are more similarities than differences. The similarities are most marked among the larger operators where economies of scale are more likely to be an important consideration.

Full depth Langstroth hive bodies, either 8 frame or 10 frame, are most popular nation-wide, with 10 frame outnumbering 8 frame.

Most hives are moved on diesel trucks and the longer the distances regularly travelled, the bigger the truck and the more likely that the truck will tow a trailer. Almost all hives are loaded mechanically.

Most hives are fitted with a queen excluder and are robbed with the aid of a bee blower or an escape board. Honey is most commonly extracted in a central location in highly mechanised stainless steel extracting equipment. Bulk honey is still largely marketed in 200 litre closed head drums. Packers are encouraging their suppliers to enter into quality assurance schemes, as is the federal industry organisation, the Australian Honey Bee Industry Council (AHBIC).

Hive Materials

As beekeeping enterprises grow the need for uniformity of hive material becomes more important. There are advantages in having combs and boxes that are interchangeable, partly for easier hive manipulation but also to achieve standardised loading patterns on trucks and trailers and standardised extracting procedures.

For a commercial beekeeper the resale value of the enterprise is also an important consideration. Thus there is pressure to match the sizes and designs of one's material with those commonly used by other commercial beekeepers.

There is no standard hive size and configuration in Australia. Perhaps the most common is an all 10 frame full depth size, with a metal-bound wire excluder over the bottom box, a 50mm deep migratory lid and a bottom board with 22mm risers. Most beekeepers use nine frames in a ten frame box.

Boxes

Full depth is the most popular depth for both brood nest and honey supers. Even when honey supers of another depth are used, the brood nest is nearly always a full depth.

Hives comprising a full depth bottom box, either 10 frame or 8 frame, and smaller size honey supers are common. The smaller size honey supers are usually WSP or Ideals. One beekeeper at least uses WSP size honey supers filled with Manley frames. Manley frames have wider end bars than standard frames, thus making eight Manley frames a snug fit in an Australian 10 frame box, resulting in plump, easily un-capped combs.

The all full depth 8 frame hive is popular and is used extensively in Victoria, and to a lesser extent, in New South Wales and Western Australia. The all Ideal size 8 frame hive is popular in Tasmania. All WSP or all Manley size hives are used, but are not common. A few beekeepers use an all 12 frame full depth hive.

Plastic or Timber?

Plastic frames and boxes have so far failed to displace wooden hives and hive parts although this is not to say that they will not do so in the future. In the Northern Territory plastic cleats are sometimes used on bottom boards to help protect against termites. Plastic comb foundation is making a more serious challenge to beeswax foundation. Many commercial beekeepers, particularly those using different depth supers to bottom box, use both types of foundation. Beeswax is sometimes favoured in the brood nest because the bees more readily accept it and plastic is used in the supers. Some beekeepers paint molten beeswax onto plastic foundation to make it more acceptable to the bees. A paint roller is handy for this job.

The Australian designed plastic queen cell cup has been an outstanding success and is used almost exclusively throughout Australia.

Make or Buy?

Most woodware now comes from New Zealand, with its abundant supply of high-grade, kiln dried *Pinus radiata* (even when most woodware sold in Australia was made in Australia, the timber was imported from New Zealand). Never the less, some beekeepers make their own boxes, although not as many as formerly. The 1990 RIRDC Report on Commercial Beekeeping in Tasmania mentions that:

> *The majority of beekeepers have extensive woodworking machinery and manufacture a large percentage of their equipment used in beekeeping operations. The availability of suitable quality timber and the beekeeping annual cycle allows sufficient time to manufacture equipment with existing labour.*

And the 1993 RIRDC Report on Commercial Beekeeping in South Australia says:

> *All apiarists interviewed manufacture the bulk of their woodware equipment. One apiarist has a very well equipped workshop with sophisticated wood working machinery. All others have enough machinery to manufacture easily all their needs, other than frames.*

Preservatives

The majority of boxes are routinely treated with the wood preservative copper naphthenate prior to painting. Dipping boxes in hot paraffin wax is an alternative method of preserving boxes, though it is relatively uncommon.

Lids and Bottoms

Many commercial beekeepers make their own lids and bottom boards.

Migratory lids with a 50mm rim, either ventilated or not, are probably the most popular. They usually consist of a wooden rim and a hardboard or marine ply top, depending on whether or not they are covered with galvanised or colour bond metal. It is common to paint lids white to reduce heat. Flat wooden lids cleated at the ends are common, and less commonly, flat covers with end cleats that extend downwards for 30mm or so over the ends of the top box. Telescopic lids are far less popular than formerly, but remain common in Tasmania.

Most beekeepers use an inner mat of some kind to discourage bees from building burr comb in the lid. Common materials include heavy gauge plastic sheeting, hardboard and vinyl floor covering. Some beekeepers build an inner cover into the migratory lid, leaving a 10mm space between the inner cover and the top bars of the frames.

Bottom boards usually consist of a wooden riser of anything from 10mm to 50mm, with 22mm perhaps the most common. The bottom itself is made generally of either of galvanised metal, timber or marine ply. Some beekeepers that move their hives on pallets build the risers directly onto the pallet. Whilst many bottom boards are still fitted with an entrance closer, the practice appears to be diminishing. Both fixed and loose bottom boards are used.

Queen Excluders

Queen excluders are used on the great majority of hives. They are less common in Tasmania where beekeepers using Ideal size boxes depend on the principal honey flow to push the queen out of the honey supers. The most popular excluder by far is the metal bound wire model.

Moving Hives

Beekeepers have little trouble in matching the size of their truck, or trucks, to their needs. Not surprisingly, the larger operators tend to have more than one truck and those large-scale operators who regularly travel long distances tend to have the largest trucks, usually towing a trailer as well. Most use diesel powered vehicles.

Hive fasteners of some kind are widely used. The Emlock type is probably the most popular.

In the March 2000 issue of *Honeybee News*, New South Wales beekeeper Monte Klingner provided the following brief description of his truck and trailer units (He has two.)

> *Volvo F12   420 horsepower, with sleeper-cab*
> *Bogie drive truck with tri axle pig trailer*
> *It can carry 360 hives of bees on pallets*
> *or 1152 empty 10 frame full-depth supers*
> *or 720 supers of honey*
> *Total length is 19 metres*
> *Range is 1400 km and the tanks holds 770 litres diesel.*
> *Carries a Bobcat fork-lift.*

That is one end of the spectrum and is not unique. Other beekeepers that regularly work distant honeyflows have similar sized outfits.

More commonly, trucks are two-axle with 7 to 9 tonnes carrying capacity and tray lengths of 6 to 7.5 metres.

Beekeepers who consistently operate close to home are more likely to have smaller trucks of 4 to 6 tonnes.

Local working condition also influences the size and type of truck used. For example, some beekeepers working in large areas of sandy soil as found in South Australia favour four-wheel drive trucks.

Nearly all commercial beekeepers have a small vehicle for running around - either a utility (often with a limited-slip differential and long range fuel tanks) or a small diesel truck or a four-wheel drive of some kind.

One thing that successful commercial beekeepers have in common is the possession of reliable vehicles. A person making a living from bees cannot afford vehicle failures.

Loaders

Almost all commercial beekeepers possess a mechanical means of some kind for loading, or helping to load, hives and supers. Mostly a forklift of some kind is used when hives are on pallets or a boom loader of some kind when hives are not on pallets. A few beekeepers wheel hives onto a powered tailgate, then wheel and lift them into position on the truck.

Skid-steer forklifts of the Bobcat type are popular, as are non-skid forklifts of one kind or another. Small tractors or four wheel drive vehicles converted, usually by the beekeeper, to forklifts are still in use, and commercially made non-skid forklifts are also available. The non-skid types are preferred by some beekeepers working in sandy country and by other beekeepers who consider them to be more friendly to the environment. Forklifts are either carried on the truck or towed on a purpose built trailer.

The range of types and brands of boom loaders has something of a regional bias. Regular loaders mounted immediately behind the cab are popular in New South Wales, centre or rear mounted split booms are popular in New South Wales, Queensland, South Australia and Victoria. Powered tailgates are used by some beekeepers in Victoria and Tasmania. Western Australian beekeepers traditionally used gantry loaders, although boom loaders are also used. A few beekeepers have adopted the Hiab type of hydraulic lifter.

Boom loaders are often employed when under-supering, prior to robbing.

Open Entrance

Hives are generally moved open entrance. When travelling during daylight the load is usually covered with a bee-proof plastic net.

On long hauls, beekeepers sometimes opt to not use a net but to stop shortly after dawn and let the bees fly off the load during daylight hours and resume the journey at dusk. To exercise this option it is important that the day-long stop be reasonably close to water and reasonably far from people.

It is probable however, that in the majority of moves the hives are loaded at dusk, the move is completed during the night and the hives unloaded at dawn.

Harvesting Honey

From their beginning in early 1992 the packer Leabrook Farms would not accept honey that had been removed from hives by the use of chemical repellents. A few months later the Honey Corporation of Australia followed suite. Thus in a period of only a few months most commercial beekeepers abandoned all chemical methods of harvesting honey and adopted physical ones.

The most common method by far is the use of escape boards or clearer boards, as they are also known. Most beekeepers undersuper with sticky combs. They place the escape board above the stickies and return in twenty-four hours and remove the supers of honey. Air blowers are commonly used to remove any bees still remaining in the supers. If escape boards are left in place too long robbing may occur. Some beekeepers prefer to make only one trip to the apiary to harvest honey, and use a bee blower only.

Conditions permitting, many beekeepers simply lift the super of honey off the hive and either stand it alongside the entrance or on top of the hive (or on the previous hive, so the hive being robbed may be more easily supered). The bees, over a period of several hours, will either walk and/or fly back to the hive. As the bees often take a considerable time to leave the boxes it is essential that there is no possibility of robbing bees. The method only works well in warm weather and under ideal honey flow conditions. A bee blower is frequently used in conjunction with this method.

A few beekeepers rob by shaking bees off individual combs. These are more likely to be those using mobile extracting plants, though not exclusively.

For beekeepers extracting in central premises, for most beekeepers in other words, an additional expense is ensuring that the supers of honey stacked on the truck, or truck and trailer, are both bee-proof and dust-proof. Most beekeepers have purpose built trays on which to stack supers and either spare lids or purpose built covers.

Extracting Honey

Most of Australia's honey crop is extracted in central extracting premises. Mobile plants, many of them very efficient, are still in use. In South Australia for instance, a number of mobile plants have Quality Assurance accreditation. But, the trend for the past 50 years has been to central extracting. Bear in mind though that some beekeepers always extracted in a central plant.

The widespread adoption of queen excluders and chemical repellents (notably carbolic acid) in the early 1950s set the trend in motion. The trend to central extracting accelerated when boom loaders imported from American in the mid 1950s took the strain out of loading heavy supers of honey for their journey to the central extracting plant. The advent of uncapping machines, and to a lesser extent of centrifugal cappings separators, in the early 1960s saw the trend to central extracting firmly established.

The combined effect of the technical innovations mentioned above permitted a spectacular growth in the size of individual apiary businesses.

Mechanisation

Honey extraction has become a highly mechanised process. Honey extraction has also become a much more hygienic process than previously. Where once most of the machinery used was made of ordinary steel, sometimes galvanised and sometimes not, nowadays commercial extracting machinery is made overwhelmingly of stainless steel.

Uncapping machines are in universal service, whether extracting in a central or a mobile plant. There are a handful of popular brands, all reliable and all effective. It is usual to have a conveyer to take the uncapped combs from the uncapping machine to the extractor or extractors.

Whilst there are still semi-radial extractors in use, radial extractors are more commonly used. Radial extractors, with a vertical shaft, were made in 42 and 72 and 100 frame sizes.

Vertical shaft extractors, whilst popular and effective, have the inherent disadvantage of requiring loading and unloading to be done by hand. Nevertheless, the capital cost is lower than for setting up a horizontal shaft extractor and its ancillary equipment.

To automate the extracting process more thoroughly, a horizontal shaft extractor and pneumatic loading/unloading equipment is necessary, as well as pumping, straining/settling and cappings treatment equipment. In a large plant it is necessary to use a heat exchange and a centrifuge to handle the volume of honey/cappings mix. In all a large capital investment is required, but great savings are achieved on variable costs, most importantly, labour.

Some extracting equipment is imported, usually from the USA and New Zealand, but most is made in Australia.

One small Western Australian firm "Bee Engineering" owned and operated by Mr Peter Cash, has had a significant influence on the lay-out and design of central extracting plants built over the past 15 years. Cash designs, custom builds, assembles and installs complete extracting plants in any configuration to suit the requirements of individual beekeepers. This has enabled plants to be tailor made to suit the operator and the location, with horizontal shaft radial extractors, uncappers, heat exchangers, centrifuges, sumps, wax melters and so on, perfectly matched to maximise throughput and minimise hold-ups.

Some beekeepers use a single uncapping machine to service two horizontal shaft extractors. The conveyor from the uncapper being moved from one extractor to the other.

Beeswax Production

Production of beeswax is often regarded as an incidental sideline to honey production. Many beekeepers refine as much beeswax as possible from wax cappings with minimum effort, and discard the residue.

Most beeswax is produced from cappings as the beekeepers extract their honey. The central plant operators either melt down and clean their wax ready for market as their honey extracting is being carried out or stockpile cappings for a couple of days and then refine them. Some beekeepers refine the beeswax in the extracting room, others move the cappings to a separate wax room. Stainless steel refining vats are heated with steam, hot water or gas fire.

Whilst some beekeepers simply burn old and reject combs, others go to great pains to maximise wax production from them. In between is an increasingly common compromise of cutting old combs out of the frames. The comb is bagged and sent to a wax refiner and the old frames are burnt.

Whether or not beekeepers spend time on reclaiming wax from old combs may well depend on the time available to them. In areas with a long cold winter, recovering wax from old combs may be more attractive than in areas with regular winter honey flows.

Pollen Production

Commercial pollen production is an important diversification for many Western Australian beekeepers. It is a common practice for these beekeepers to permanently fit pollen traps to a percentage of their beehives.

The traps are constructed so that beekeepers can activate them to either trap pollen or allow the bees to bypass the trap. This allows the operator to selectively trap pollen in times of abundance.

Some beekeepers have modified their pollen traps by slightly enlarging two or three of the holes in the punch plate through which the bees can pass to detach their pollen loads. This permits the access of some bees without loss of their pollen loads and ensures adequate supply of pollen for the hive's own use during the trapping period. The enlarged holes also allow virgin queens produced as a result of supersedure, to exit for mating. This practice substantially reduces the number of queenless colonies when trapping pollen.

Pollen traps are continually being modified. Currently, besides the traps that are placed under the hives, there is a range of smaller metal traps that clip onto the front of beehives.

There are a number of beekeepers involved in pollen production and at least four beekeepers derive a large percentage of their income from this activity whilst others trap pollen to feed back to their bees over winter or when pollen resources contain poor protein pollens.

Quality Assurance (QA)

The major packers have adopted quality control measures in one form or another.

Eddy Planken of Wescobee said in a personal communication:

> *Wescobee has adopted Quality Assurance under the SQF 2000 code. We were the first fully HACCP certified packer in Australia and have had our system in place and certified for 4 years. Leabrook was certified before us for QA but is was not the full HACCP QA.*

Leabrook Farms has adopted a QA scheme and at the time of writing, Capilano Honey Limited (CHL) has a sophisticated quality assurance scheme in place for its suppliers. The Capilano scheme is voluntary and an increasing number of beekeepers have embraced the complete scheme, by upgrading their honey extracting facilities. More are anxious to do so.

The Tasmanian Government is said to be moving towards a QA scheme for beekeepers and other State Governments may do likewise.

As well, the Australian Honey Bee Industry Council (AHBIC) is well down the track to establishing a nation-wide quality assurance scheme (B-Qual) that it believes will meet the needs of industry without costing individual beekeepers as much as the more complete CHL scheme.

B-Qual

AHBIC has established B-Qual Australia Pty Ltd to develop and maintain a quality assurance program for the honey industry. Their aim is to help improve the prospects for marketing all apiary products, including queen bees and package bees, on the domestic and export markets.

The B-Qual consultative team responsible for this program consists of industry members from across Australia and representatives from Food Standards Australia New Zealand (FSANZ) and the Australian Quarantine Inspection Service (AQIS).

B-Qual has developed an "Approved Supplier Program" to help the honey industry comply with FSANZ's Food Safety Standard. The Standard has been written by FSANZ but is enforced by Government State and Territory Health Departments. Businesses that sell honey to the public are required to comply with "Food Safety Practices and General Requirements" (Standard 3.2.2) and "Food Premises and Equipment" (Standard 3.2.3). Also, Animal Health Australia (AHA) requires the honey industry to adopt an auditable biosecurity plan.

The B-Qual Standards are industry endorsed minimum requirements for those involved in honey production and processing. The standards were written for those who want to implement a quality system to meet new food safety and biosecurity requirements as well as consumer expectations.

Registration with B-Qual requires compliance with the standards appropriate for their business. Therefore, it is only necessary to tick the standards that are applicable to the business. Once standards have been agreed with and checked off, the business owner should prepare and sign a Quality Policy Statement to demonstrate commitment to the program.

6. Pollination

The invaluable service provided by European honeybees in pollinating plants is widely acknowledged. Less widely understood is the contribution that pollination provides to the beekeeping industry.

The idea that our agricultural and horticultural industries would soon become more dependent on paid pollination has been long held by the industry at large. Dependence on paid pollination is increasing, but at a slower rate than many would have hoped for. Nevertheless, there are a number of reasons why paid pollination should continue to grow.

Whilst some beekeepers derive a significant portion of their income from providing a pollination service, the overall contribution to the industry remains small. For many of the larger honey producers, pollination is a risky diversion from their core business.

Many individuals have worked hard to bring organisation to the pollination industry. There are now agreed guidelines and codes of practice for beekeepers and growers alike, and every indication that beekeepers and growers are nearer to understanding each other's problems.

For beekeepers, the greatest technical problem involved with paid pollination is achieving the necessary colony strength at the right time.

Can Pollination be Valued?

Attempting to put a dollar value on the benefits to the nation of European honeybees as pollinators is attempting to consider one factor of production whilst ignoring all the others.

Never the less several attempts have been made to assign a value to the total pollination effort. The total effort includes pollination provided by feral bees, the incidental pollination provided by commercially managed bees and the pollination from hives rented for the purpose.

In 1993 Rod Gill of the University of New England valued the pollination benefits for Australia as $1.2 billion.

In 1998 Gibbs and Muirhead made their own thorough assessment of the total benefit of pollination to the nation and arrived at much the same figure as Gill, $1.2 billion, but of course the five years difference between the two calculations implies that the latter figure represents a lower value than the former. Gibbs and Muirhead questioned the accuracy of production values published by the Australian Bureau of Statistics.

In 2002 Jenny Gordon of the Centre for International Economics, Canberra took a fresh approach to valuing the benefit of bees as pollinators and in a report to RIRDC assigned a value of $1.8 billion to honeybee pollination.

Pollination in Australia

Largely because of changes in agricultural practise and in land management (see Resources), fewer feral bees are available to provide pollination. As well, large-scale monoculture, typically such crops as almonds and rockmelons, means that adequate pollination may be beyond the capacity of feral bees, even if they exist in the area. As well, some forms of large-scale monoculture, although attractive as a source of nectar or pollen to commercially managed hives, fail to attract managed hives in sufficient numbers to provide effective unpaid, incidental pollination, for to do so would overstock the site for honey production. Thus the demand for rented hives is gradually increasing in a general sense and increasing more rapidly in specific areas. Meeting a rapidly increasing demand may present problems to beekeepers and growers alike.

As Gill[20] pointed out in 1996,

> *The value of the Horticultural Industry in Australia is $3.5 billion per annum, and 47% of this industry is based in Victoria and New South Wales. As the acreage under horticulture increases the size of individual holdings is also increasing, reducing the extent of incidental pollination by feral bees and therefore increasing the importance of the services provided by the apiarist pollinator.*

On the other hand crops benefiting honeybees, either as a source on nectar or pollen or both, and which in turn benefit from pollination by honeybees, are sought after. Thus, although canola or lucerne may appear in the lists of crops benefiting to some degree from pollination by honeybees, beekeepers are more likely to pay growers for the privilege of placing their hives in the crop than to be paid by them. (This example does not extend to specialist seed production.) As well, beekeepers sometimes provide bees for pollination simply to hold sites, or to service small contracts in their locality.

Renting hives to provide pollination is relatively common for pome and stone fruit, particularly since pesticides have long since destroyed feral colonies near growing areas. It is also common to rent hives for ensuring adequate pollination of seed crops. The biggest demand for paid pollination in southeastern Australia is for the pollination of almonds.

Large markets for paid pollination exist in the north of both Western Australia and Queensland and a smaller market in the north of the Northern Territory.

Horticulture generates the lion’s share of the pollination market, and horticulture is expanding.

State by State

Because of considerable differences in the need for paid pollination in various regions of Australia, and because of differences in attitude by both growers and beekeepers, highlights of pollination practices in various regions is considered on a state basis.

[20] Gill, Roderick (1996) The Benefits to the Beekeeping Industry and Society from Secure Access to Public Lands and their Melliferous Resources. RIRDC report. Canberra.

New South Wales

The 1993 RIRDC report “Commercial Beekeeping in New South Wales”, says that:

> *Whilst the bee industry had great expectations in the pollination sphere, this survey has indicated that current pollination practices, and rental levels, are unlikely to encourage realisation of these expectations in New South Wales. Some apiarists are operating satisfactorily under the current system, but both apiarist and farm attitudes and practices need to change if there is to be a major escalation in pollination services.”*

This would appear to still be the case today. Payment for pollination services remains the exception rather than the rule.

Pollination of pome fruit in the main growing area is common, but not without risk. Whilst the grower on whose property the bees are placed may abide by an agreement to advise of intention to spray, the grower’s neighbours may not. In areas of intensive horticultural production, such as Orange in the central tablelands, orchards tend to be small and located near to each other, thereby increasing the risk of pesticide damage to colonies.

The 1993 report also emphasised that:

> *More and more orchardists are using hail mesh to reduce the possibility of damage to their crop. The use of hail mesh requires specific practices for effective pollination. Bees must not be located under the mesh until the trees are flowering so as to avoid bees orientating themselves outside the hail mesh covered area. It is also useful to reduce the percentage of old field bees in these covered areas as the old bees are more likely to become disorientated in the covered environment. The reduction in old field bee numbers can be achieved by moving the hives under the covered areas in mid-afternoon while the bees are still flying.*

Pollination of broad acre crops such as cotton has not occurred in the manner that was once hoped for. Growers are reluctant to pay for pollination services and beekeepers are reluctant to place apiaries in areas of high pesticide usage.

Northern Territory

When Panama Disease of bananas appeared in the top end a few years ago some growers switched production from bananas to rock melons. A small but important demand now exists for bees to pollinate the new crop. The demand is helped by the near absence of feral colonies, due to the deprivation of the Rainbow Bee Eater.

Queensland

The 1994 RIRDC report “Commercial Beekeeping in Queensland” mentioned some crop pollination in southern agricultural areas but stressed the importance to the industry of pollination in northern areas. It included the following statement:

> *In the northern region, particularly in the Burdekin area, apiarists derive 50% to 80% of their gross cash flow pollinating cucurbits. Cucurbits are grown on plastic sheets under trickle irrigation on a continuous basis from April to November.*
>
> *Hives are placed in groups of four or five at a rate of 2 to 2.5 hives per hectare.*
>
> *Cucurbits generally provide good breeding conditions, and with good management hives can be used several times over the seven to eight months flowering time. The estimated cucurbit production in the Burdekin area in 1993 is presented in table below.*

Estimated Cucurbit Production in the Burdekin Area 1993

Crop	Area (ha)	Gross Value (AU$ million)
Rockmelons	900	15.0
Honey Dew Melons	240	3.5
Watermelons	200	1.2
Pumpkins	600	1.5
Zucchini	175	2.9
Squash	80	1.9
Cucumbers	175	2.8
Total	**2370**	**28.8**

The information contained in the 1994 report remains relevant according to Peter Warhurst[21] of the Queensland Department of Primary Industries. Warhurst adds:

> *There are added complications now as more pesticides have to be used to control new pests. Seedless watermelons are unattractive and require an extra hive per hectare as well as supplementary feeding. The new varieties seem to produce less pollen so it is vital to rotate hives from pollination to support species so hives get a break from pesticides and can build up on better quality and quantity pollens.*
>
> *Production may have increased 30 - 40% over the past 10 years so it is a very important production area.*

and

> *There are a couple of large citrus growers in Emerald and there is one grower who I know uses bees. He pays and has around 500ha of citrus.*

South Australia

Almonds remain the principal crop for paid pollination in South Australia. The 1993 RIRDC report "Commercial Beekeeping in South Australia" said:

> *The increase in intensive almond production appears to have reduced the value of these areas for colony build. Apiarists considered that the combination of increased stocking rates and reduction in weed pollens is responsible for the decline.*
>
> *The preparation of colonies for almonds relies heavily on access to* Banksia *species for colony brood production during winter. If alternative winter nutrition programs become necessary, current almond pollination fees would not provide adequate compensation for the increased preparation expenditure.*

Almond pollination is of particular interest not only to South Australian beekeepers but also to neighbouring Victorians and New South Wales beekeepers as well, and is dealt with in more detail later.

[21] Peter Warhurst,2002, personal communication.

Tasmania

The 1990 RIRDC report "Commercial Beekeeping in Tasmania" mentions a Department of Primary Industry survey (1989) highlighting the different crops which were pollinated in Tasmania. A summary of the number of hives, prices charged and revenue gained from these services was presented in tabular form. This table showed that the majority of hives were used for pollinating apples, cabbage, cauliflower, raspberries, carrot and onion crops. The most frequent crop pollinated was apples, accounting for 31% of the hives used for pollination.

Harold Ayton[22], Secretary of the Tasmanian Beekeepers' Association, says:

> *There is now a Tasmanian Crop Pollination Association with some 18 members. Not all pollinators are members of this Association. Most of these members would be non-commercial beekeepers and would be supplying in the vicinity of 600 hives for pollination services. Other commercial and non-commercial beekeepers, who are not members of this Association, would be supplying well in excess of this number of hives. Pollination is still a growth area in Tasmanian beekeeping.*

Victoria

It is estimated that 40,000 honey bee colonies are used each year for crop pollination in Victoria[23]. These include:

> *17,000 colonies – almonds, northwest Victoria*
> *7,000 colonies - cherries, pome including nashi, Goulburn Valley*
> *5,000 colonies - pome, cherries, berries, outer Melbourne*
> *4,500 colonies - seed crops, clover, lucerne, carrot, canola, southwest Victoria.*
> *It appears that expansion of the almond industry in Victoria within six or seven years will require over 40,000 colonies for almonds alone. Some of these colonies may need to be sourced from NSW.*

Western Australia

The 1991 RIRDC report "Commercial Beekeeping in Western Australia", includes the following information about pollination in the Ord River Irrigation Area.

> *The Ord River Irrigation Area (ORIA) in the Kimberley Region of Western Australia is the only area where growers of seed crops actively seek bee hives for pollination.*
>
> *There are currently 850 hives in the ORIA. Approximately 50% of the bee hives are owned by growers. The bee hives are managed for a fee by a resident beekeeper. The other 50% of the bee hives are owned by this same beekeeper and rented out, as needed, to the growers.*
>
> *Based on 1990 production figures, the area and type of crops grown in the ORIA and which could benefit from managed honey bee pollination are as follows.*
>
> *Cucurbits 500 ha; Sunflower 325 ha; Sunflower seed crops 180 ha; Cashews 100 ha*
>
> *However, from the information we can ascertain it appears to be extremely difficult to maintain bee hives in top condition as is required for pollination in the Kimberleys, especially during the wet season ie November to March.*

Lee Allan, of Agriculture WA, says[24], that the information shown above is still relevant and adds that:

> *…the current estimated value of bees for melons alone is more than $30 million annually.*

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22 Harold Ayton, 2002, personal communication.
23 Russell Goodman, 2002, personal communication, quoting Bob McDonald.
24 Lee Allan, 2002, personal communication.

A Western Australian innovation for providing low-cost pollination is the Bee Tubes. The Tube is made of cardboard and is protected from the elements by a plastic cover. The tubes do not contain frames or comb, but are simply loaded with about a kilogram of bees together with a laying queen. The are filled in the south of Western Australia and transported to the Ord. They are light to transport and easily disposable when pollination is complete. Evidence shows they work well.

Almond Pollination

About half of Australia's area of almonds is in South Australia, with most of the balance in Victoria and a small area in New South Wales. However, because the plantings in South Australia are older, smaller and less intensively managed, Victoria is the biggest producer.

Production continues to increase and has risen five fold since 1966. With more corporate growers entering the industry it is expected to expand still further.

As a consequence of growers obtaining their plant material from the same source, and because almond trees take six years to mature, it is possible to make reliable predictions about the future size of the industry.

It is predicted that by 2007 there will be nearly 9,000ha of mature almonds growing in southeastern Australia, or 2.2 million trees[25]. Such a planting will require something like 60,000 colonies of bees for effective pollination.

Probably the greatest technical problem facing beekeepers involved with paid pollination is achieving the necessary colony strength at the right time. This generally means having hives up to strength by late winter, so that when the first blossoms open the bees are ready to start work. This is a vital part of almond pollination and beekeepers depend on good conditions in the autumn/early winter.

In the light of the predictions above, it is worth looking at a section on almonds from Russell Goodman's Pollination Manual[26]:

> *A high population of honeybees is essential during almond flowering for a crop of nuts to be set. In fact, commercial almond production is not possible without honeybee pollination. For nuts to be set, a cultivar must receive pollen from a compatible polliniser cultivar. This transfer of pollen is known as 'cross-pollination' and honeybees are well suited to perform this task as they forage for nectar and pollen.*
>
> *Almonds flower early in late winter and spring when honeybee colonies under natural conditions have a relatively low population of adult bees. Beekeepers who provide honeybee pollination services to almond growers commence preparation of their colonies in the preceding autumn to ensure each colony has a satisfactory population of adult bees available to visit the flowers and provide the best pollination result.*
>
> *The main crop cultivar and polliniser cultivar are usually planted in adjacent rows. A high population of bees in the orchard will encourage foragers to move from row to row rather than along rows and this results in a high rate of cross-pollination and set of nuts. Use of a lower colony stocking rate than that currently recommended will probably not achieve this desired result.*
>
> *Hives are best placed in groups, situated about 300-400 metres apart so that no tree is more than 150-200m from a hive. This is because the cool weather conditions at this time of the*

[25] Chris Bennett, Industry Development Manager, Australian Almond Industry. 2002 Conference of NSW Apiarists' Association, Griffith.
[26] Goodman, R. "Pollination Manual", (2000) RIRDC.

year can restrict honeybee flight to short distances from the hive. Groups of hives are normally placed around the edge of blocks and also in the centre of large blocks. Hives should preferably face north to north-east and be positioned in weed free, sunny positions away from the shade of almond and other trees.

Almond flowers are best pollinated as soon as possible on the day they open. Delays in pollination after this time can result in a much lower rate of set and research has shown that little if any set occurs if pollination is delayed by five days or more. For this reason, delays in hive introduction to this crop should be avoided and careful distribution of hives, as described above, should be followed so that all trees are visited by bees whenever bee flight s possible.

Leaving pollination of almond orchards to feral honeybees is poor management because their numbers are too low and they cannot be distributed throughout the orchard.

7. Queen Bees and Packages

Australian beekeepers probably rear more queens than they buy, but most professional beekeepers both buy queens and queen cells from commercial queen breeders and rear queens themselves.

The beekeepers that rear most of their own replacement queens frequently buy their breeders from commercial queen breeders.

Queen breeders, in turn, buy most of their breeders from a relatively small number of reliable sources; import stock; and, select from within their own gene pool. Several genetic improvement programs have been attempted.

All beekeepers, whether honey producers or professional queen breeders, recognise the importance of nutrition in queen rearing. Most beekeepers, and certainly those in north-western NSW and south-western Queensland, also appreciate the deleterious effect of poor nutrition on the longevity and performance of queen bees as well as on the colonies that they head.

A strong export market exists for both queens and for package bees.

Importations

Australia has traditionally imported most of its breeding stock. However with stricter and more expensive quarantine protocols, importations waned for a period and have fluctuated over recent years. At the time of writing there is an upsurge in importations, with most queens coming from Europe. The upsurge is driven by the efforts of Australian queen exporters to meet the demands of their customers. In particular breeding from European imports of Italian bees for the European market and breeding from European imports of Carniolan bees for the Canadian market.

Quarantine

Queen bees could be imported relatively freely from Europe until 1964 and from USA until 1983.

Prior to the opening of a quarantine facility in Sydney in 1983, the worker bees that escorted the imported queens were changed and the original escort was dissected and examined for the presence of parasites. The queens were held in nucleus colonies until the entomologist approved their release.

Since the opening of the quarantine facility the imported queens are kept in nucleus colonies located in bee-proof flight cages. The escorts are still destroyed and examined for the presence of parasites, but now the new queens are able to lay and their brood is also tested for the presence of disease. If the queen and her brood are free from disease, larvae from the quarantined queen are released to the importer. The imported queen is never released from quarantine and is killed when the importer is finished with her. The importer of course pays for the queen to remain in quarantine.

The charges for quarantine services for queen bees were, at time of writing:

FEES FOR QUEEN BEE IMPORTERS EASTERN CREEK QUARANTINE STATION

There are two options that may be used. They are both based on a fee for the first two months. A monthly fee will apply thereafter. All fees are payable in advance of arrival and grafting.

Fee Option 1 – AQIS provides the nucleus box and all services

For a consignment of up to 6 bees	*$2000*
For a consignment of up to 9 bees	*$2600*
For a consignment of up to 12 bees	*$3200*

Fee Option 2 - Importer provides the nucleus box, AQIS provides all other services. The importer has the option of providing the nucleus colony.

For a consignment of up to 6 bees	*$1400*
For a consignment of up to 9 bees	*$1900*
For a consignment of up to 12 bees	*$2400*

A monthly fee will consist of $160 per consignment for every month after the initial 2 months. The monthly fee will not apply for June and July. One month is defined as the date of import to the same date of the next calendar month. Grafting will not be permitted unless the monthly fee has been paid.

If an importer wants to have 2 queen bees per flight cage then there is a reduction in the overall fee of $100 for every cage that contains 2 queen bees. To qualify for this reduction the two queen bees must only have been in the one flight cage.

The initial invoice fee will be reduced by $100 for every bee less than the maximum number in the consignment. For example if 4 bees arrive (under option 2) there will be a reduction in the initial invoice fee of $200 which results in a total fee of $1200 for the first two months.

Full details on all quarantine matters are available from the Australian Quarantine and Inspection Service. See appendix for address details.

Genetic Improvement Programs

A national research levy was introduced in 1980 and two breeding programs received funding from the levy, one in Western Australia and the other in New South Wales. Both involved Italians. As well, a private genetic improvement program was established in New South Wales from imported Carniolan and Italian stock.

Western Australia

European Foulbrood (EFB) has not been reported in Western Australia, although it has been endemic in the eastern states since 1977. To help maintain this EFB free status, bees, honey, used hives, hive products, or used beekeeping equipment cannot be imported into Western Australia unless accompanied by the prescribed certificate. This factor has a significant bearing on bee breeding and the availability of genetic material.

In 1980 the West Australian Department of Agriculture initiated a breeding program to ensure that the industry had continued access to good quality Italian queen bees and breeding stock. The genetic resources of this program were queens selected from the best available stock within the state.

The program was funded from the Department of Agriculture budget and from Honeybee Research & Development Council grants. Its income from sales of queens, queen cells and hive products, for the most part, was absorbed by the State Treasury.

The program was modelled on the Page/Laidlaw closed-population breeding method[27].

Two breeding stations were established. One at Perth for the production of artificially inseminated (AI) queens and the other at Rottnest Island where controlled mating in a selected drone population produced tested and untested Rottnest queens. (Rottnest Island was cleared of all other honeybees). Mainland queens were produced at various apiary sites within 150km of Perth and the area flooded with drones from the program. In total the program operated 800 to 900 mating nuclei and 300 stock hives.

Apiaries for honey production were operated and migrated in a commercial manner for the evaluation of queens selected for possible inclusion in the program as queen mothers and drone mothers. These included daughter queens produced from queens originally purchased from the program and returned by cooperating beekeepers because of their superior performance. The commercial emphasis tended to keep the program in tune with the requirements of the honey industry throughout the season.

In 1991 the funding from the HBRDC ceased and the West Australian Department of Agriculture decided to sell the improved progeny to local and eastern states beekeepers. Shortly afterwards the improved stock was sold and many of the breeding lines were purchase by a group of Western Australian beekeepers. The consortium of Western Australian beekeepers continue to maintain the breeding program using controlled mating on Rottnest Island so that the breeding lines are maintained and improved.

Hawkesbury, NSW

The second funded program, known as the Eastern Bee Breeding Scheme, was run by the University of Western Sydney, Hawkesbury. Eighty-five breeder queens were purchased and formed the genetic material for a 30 line closed population breeding program. The funding of this program also ceased in 1991 and the stock was auctioned. A group of beekeepers formed the Australian Honey Bee Improvement Program (AHBIP) and purchased queens from each of the lines and continued to conduct a closed-population breeding program. AHBIP continues to sell AI Italian breeder queens. The transfer of stock from Eastern Bee Breeding project to industry programs was completed early in 1994.

The Eastern Bee Breeding Scheme never enjoyed the success of the Western Australian scheme, possibly because of the wide range of alternative sources of queens available in the eastern states.

Hay Plain, NSW

In 1978 a branch of the New South Wales Apiarists' Association helped fund a visit to Europe by the then Principal Apiary Officer, Alan Clemson. He returned with a total of 47 Carniolan and Italian queens. Some of the virgins reared from the imported queens were instrumentally inseminated and some were taken to an isolated area in New South Wales and mated. These queens were sold to help pay the costs of importation

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[27] Page, Robert E Jr. and Laidwal, Harry H Jr (1982) Closed Population Honeybee Breeding. 1. Population Genetics and sex Determination. Journal of Apicultural Research 21(1): 30-37
Page, Robert E Jr. and Laidwal, Harry H Jr (1982) Closed Population Honeybee Breeding.2. Comparative Methods of Stock Maintenance and Selective Breeding. Journal of Apicultural Research 21(1) 38-44

Mr Joe Homer, a honey producer from Rylstone New South Wales, was the beekeeper that took the virgin queens to the isolated area on the Hay Plains. Thus began a dedicated job of stock improvement using isolated mating. For many years Horner provided the bulk of the foundation stock used by queen breeders in Queensland and New South Wales.

Common Practices

There are significant differences in queen rearing and re-queening practices between the states, but there are also many similarities.

Italian is the overwhelmingly most popular race, with much less interest in the grey races, Caucasian and Carniolan.

The Cloake system of producing queen cells, whilst not universal, is the most common, particularly among commercial queen breeders. The Cloake system is outlined in the Proceedings of the XXVIth International Congress of Apiculture, Adelaide 1977, pp 204-206 and in an article by Bruce White and Bill Winner in the December 1990 issue of the Australasian Beekeeper.

Honey producers mostly use nucleus colonies compatible with their regular hives, usually regular hive bodies divided into several compartments each of which houses a nucleus colony. Demaree boards, which in effect creates a nucleus colony on top of a regular hive, are common in all states, as are freestanding three or four frame nucleus hives. Queen breeders are much more likely than honey producers to use mini-nucs of one design or another.

Introduction by mailing cage and by the gauze Miller cage is practiced all over Australia and so is papering on for uniting colonies.

The methods of rearing and handling queen bees adopted by commercial queen breeders and by honey producers rearing queens for their own use depend on the same basic principles, but differ enough to treat them separately.

Commercial Queen Breeding

The coastal strip from Sydney to southern Queensland supports many, or most, of Australia's commercial queen breeding enterprises. The size of enterprises varies enormously, but typically a queen breeder will catch from 200-500 queens per week during the season and maintain from 900-1500 mating colonies.

Grafting under artificial light as well as field grafting is practiced. In both instances very young larvae are used. The Cloake system is the most common cell starting method. Grafts vary from one bar of 30 to two bars of 25 cells. The Cloake system is generally used to start and finish the cells. Finished queen cells are usually held in an incubator for the last 1-3 days prior to emergence.

Mating colonies include mini-nuclei, 3-5 frame single-nuclei and 2-3 nuclei in a standard hive body. The standard hive body containing multi-nuclei is preferred because it can quickly be converted to a honey production unit when not required for queen mating purposes. As well, more care is required to maintain mini nuclei in warm climates.

Mating nucleus apiaries are stocked according to forage availability and hold from 40 to 150 nuclei. The number of drone colonies in, or preferably out of but adjacent to mating yards, varies between 4 and 12 per 150 nuclei, depending on the number of cells introduced at the same time. Drone combs are introduced during July for September grafting in areas experiencing low winter temperatures.

If conditions are good, queen cells are transferred to mating nuclei as the mated queens are caged. In less favourable conditions nuclei are left queenless for a day or two.

Queen caging time commonly varies from 14 to 21 days after cell introduction. The longer period is used if extra brood is required, later in autumn when mating is slower, and for Carniolans because they take longer to mate. Surplus brood is used to boost cell feeders.

However, Australian research published in 2001 examined the number of introduced queen bees still alive 14 days after introduction (Introduction Success), and the number surviving 15 weeks after introduction (Short Term Survival)[28]. The results were:

Introduction Success

Age of queens when caught In days	% of queens alive 14 days after introduction
7	15.0
14	47.5
21	85.0
28	85.0
35	90.0

Short Term Survival

Age of queens when caught In days	% of queens alive 15 weeks after introduction
7	10.0
14	17.5
21	62.5
28	60.0
35	72.5

These results confirmed what many people had long suspected and may lead to caging times being extended to allow the young queen more time in the mating colony. Even before the research results were published, one Queensland queen breeder was advertising “All Queens are held in nucs for 28 days before catching.”[29]

Supplementary feeding is widely used by queen producers. Carbohydrate is supplied both as granular sugar during winter to maintain colonies and as a 1:1 syrup for warm weather stimulation. Queen cell starters and feeders may also be fed protein supplements, either home mixed or commercial patties.

Protection from disease is important. Commercial queen breeders are permitted to feed fumagillin to control Nosema disease. Both commercial queen breeders and honey producers rearing their own queens commonly feed oxytetracycline hydrochloride (OTC) to prevent European Foulbrood and since commercial queen breeders are constantly working their hives the possibility of an infection of American Foulbrood going undetected is quite remote.

[28] Rhodes J and Somerville D (2001) Introduction and Early Performance Success of Queen Bees. Honeybee News 2(1):13-14
[29] Advertisement, Australasian Beekeeper, October 2000. 102(4):145

Queen Banks

Queen banks are used to hold queen bees during the collection periods prior to despatch. Queen bees are generally banked for less than a week and one month is considered the maximum period that should be used. The short term banking colonies are made up in singles using brood and bees from several lines. It is important to ensure that queen bees are transferred to the bank within 20-30 minutes of being caged.

Some queen producers, as well as some honey producers, bank queens for a day, or overnight to condition them prior to introduction. They believe that this enhances acceptance.

Queen bees are shipped in both wooden and plastic mailing cages. The cages are taped into small groups, packed into ventilated foam boxes, overnight express bags or into Riteway queen shippers (a mini bank for queen despatch). Queen cells are packed in sawdust in foam coolers. Queen bees are despatched by post, overnight coach or express courier.

Seasonal Production

Honey producers require queen bees at various times of the year. In Queensland autumn requeening is popular. Eastern states napunyah producers purchase queen bees during late summer and early autumn. The major queen sales to Victoria are in spring whereas both New South Wales and South Australia have some spring requirement but tend to have a standing order of a number per month covering spring, summer and autumn. The different demand times are a result of the seasonal production pattern; the influence of associated activities such as late winter/spring almond pollination and whether queen rearing is part of swarm control or whether it occupies a lull in honey production.

Queen bee exports to Europe and North America are required in the northern hemisphere spring – our autumn.

Breeder Queen Bees

Queen producers carry a range of breeder stock from both AI and natural mating programs. As noted above, genetic improvement programs have attempted to maximise the productivity of Australian honeybees. Commonly, new breeder queen bees are selected from daughter queens of existing breeders, based on personal observation and on the favourable reports from client. Whilst the services of artificial inseminators are available for conducting controlled mating of potential breeding stock, they are not widely utilised. As noted above, there has been a resurgence of the importation of breeder queens in recent years.

Honey Producer Queen Breeding

The series of RIRDC reports on Commercial Beekeeping by state, published in the early to mid 1990s, surveyed beekeepers about whether they purchased their replacement queens or reared them themselves. To varying degrees, most did both.

The series also surveyed preferred races of bees and found Italians the most popular. Other information collected concerned preferred season for re-queening and methods employed.

Results of the 1990s surveys are shown below. It is doubtful that the practices described have changed significantly.

New South Wales

Commercial apiarists, as distinct from commercial queen breeders, reared the majority of queen bees used in NSW. Queen bees were reared in equal numbers in spring, summer and autumn by the 48% of apiarists who purchased virtually no queen bees. Only 13% of apiarists purchased all queen bee requirements, 18% more than half but not all of their requirements and 21% less than half of their requirements.

Most stock was either Italian or first cross red x black. Black stock, particularly Caucasians, were common in the north, used less by western apiarists and least of all by southern beekeepers. Overall 58% used Italians, 23% Caucasian, 1 % Carniolan and 18% race crosses.

During early population expansion when swarming was possible, combs of brood and bees were harvested to stock nuclei and splits. In this way swarm control and requeening complimented each other at swarm prone build areas.

Whilst some nucleus hives were maintained in the south, the majority of queen cells were placed in splits, sometimes a cell on each side of the board. In the north nucleus hives were the norm. In the west splits and nuclei were both common.

Splits (hive divided by a demaree board) were used to start new hives, to provide queen bees to introduce elsewhere, to requeen the split hive or to make temporary two queen colonies. Nuclei were used for mating, for paper uniting and to start new colonies.

Gauze cages were used to introduce 54% of queen bees; splits and nuclei either direct or by paper uniting 44%; and the remainder by cells direct or the queen run in.

Colonies to be requeened were selected on the basis of queen age and/or colony strength. This resulted in an estimated queen life of 18 - 24 months in the south, 12 - 18 months in the north and 12 months in the far west. The frequency of requeening was noticeably higher in areas experiencing regular pollen shortages, i.e. the north and west. These areas tended to combine requeening on a front plus spot requeening of up to 10% of the new queens that did not perform. Frequent requeening was noticeable among beekeepers working the channel country.

At the time of writing, at least one large scale beekeeper was experimenting with two queen colonies.

Northern Territory

Italians are used almost exclusively. Most are purchased from Queensland queen breeders, mainly because seasonal conditions and birds, Rainbow Bee Eaters, make queen rearing in the Northern Territory hazardous. Never the less, some queens are reared locally.

Queensland

Half of the apiarists surveyed rear the majority of their queen bees, two rear no queen bees and the remainder raise from 25-50% of their requirement. Apiarist queen rearing is carried out during late summer and autumn. Queen production colonies are situated in agricultural areas at this time of ample ground flora. Apiarist queen producers purchase breeder queen bees and either maintain several lines or regularly change the line. Only one apiarist utilised a mass selection program within the production apiary to provide breeders that are supplemented by purchased stock.

The Italian race is preferred by most apiarists. Whilst Caucasian use is low, several apiarists had used them and indicated that they would consider using Caucasians if quality stock was freely available.

A combination of single nuclei, 3 x 3 frame nuclei on a standard hive body, 4 nuclei in a 12 frame hive and split boards are used to mate queen bees. The single nuclei are used to paper both queen and bees onto weak colonies. Both Miller cages and mailing cages are used to introduce queen bees into stronger colonies. Several apiarists prefer to bank purchased queen bees a minimum of overnight to provide access to free flight worker bees before introduction.

Requeening on a front is popular in Queensland. Apiarists prefer to completely requeen on an annual basis. This requeening system results in mass replacement during autumn. As well, about 10% of colonies are again requeened in the spring, usually on the basis of colony strength, temperament, disease, and so on.

South Australia

In South Australia there is a very heavy reliance on mated queen bees from queen bee producers. Sixty-four percent of the fourteen apiarists surveyed purchased all of their queen bees. Ninety-three percent of apiarists surveyed purchased at least 50% of queen bees introduced and most of these queens originated from Queensland and New South Wales. Few apiarists purchased queen cells. Italian bees were the most popular (80%) followed by Carniolan, cross and then Caucasian.

Most apiarists received regular shipments of queen bees during spring and summer. Half of the queen bees purchased were first introduced into nuclei and the remainder either direct into hives or via queen banks. Queen bees in nuclei were often introduced with the nucleus by paper uniting. Other queen bees were introduced in mailing cages with escorts although one apiarist always released the escorts.

The most common requeening procedure was to hold nuclei equivalent to 8 - 10% of the apiary in the yard and unite as necessary. This spot requeening was achieved by one apiarist by taking a queen bank on each field visit and introducing as necessary. In this instance brood of stronger hives was moved above the queen excluder during the colony build. When a weak hive was found, the brood and bees above the excluder in a strong hive, and a new queen from the queen bank, were united with the weak hive using the paper method. A few operators preferred a central nuclei yard and one carried weak or dead hives home, melted the combs and then refurbished the unit.

Other common nuclei uses included:

- Purchase queen bees and fill nuclei during January-March, overwinter nuclei, and allow the best 100 nuclei to become hives for a new load each year.
- Overwinter strong nuclei (up to 5 combs) and use them to unite into the weaker almond pollination hives to ensure all colonies are strong.
- Place an inverted nucleus box with combs on a strong nucleus and when the queen has expanded into it, split to form two nuclei.

Hive strength was the major reason for requeening. Disease and temperament was a consideration and one apiarist also placed emphasis on absence of bridgecomb.

Most colonies were requeened only every 2-3 years. This reduced level of requeening has also been observed in other areas that have flora that promotes winter and early spring colony build.

Tasmania

Tasmanian beekeepers have a strong preference for locally produced queens, but climatic and other considerations dictate a significant use of mainland queen bees. It is said that the major problem with mainland queen bees is their tendency to breed late in the season and consume stores. Local strains tend to cease breeding soon after the leatherwood flow. This minimises stress during the winter, decreases the risk of starvation and reduces the quantity of spring feeding required.

A first cross mainland/local is often used as a breeder. These breeders are selected from production apiaries and the major selection criteria are: the tendencies to cease breeding; decreased stores consumption after leatherwood; colour; and, production.

The dominant blood is Italian with an addition of "black" which varied between Caucasian, Carniolan and British black. The preference for the dark addition is the reduced tendency to breed and consume stores after the leatherwood, although one apiarist uses the yellow breeding character to facilitate early season queen production. Most beekeepers consider yellow as a requirement for prolificacy.

A potential exists for early season queen bee production in warm areas on the east coast. By producing queens early in the season it would be possible to increase colony strength earlier in the season. This would increase the yield from blackberry/ clover because part of this flow is being sacrificed for colony build.

Queen bees are usually replaced on a needs basis. The age of the queen at replacement is generally 2 years, although some are 3 years old. The 2 queen operators, of which there were 3, effectively requeen each year because a new queen is added to the split in spring and the units are run together either just before migration to the leatherwood or when the first summer honey flows. Some single queen operators requeen on an annual basis.

Local queen bees are mated in 8 frame ideal splits, in 8 frame ideals divided into 3 nuclei, or 4 frame nuclei of various size and configuration. In all instances a proportion are allowed or encouraged to develop into hives for the next flow. The replacement queens are either paper united to production units or introduced in mailing or Miller cages using candy or paper for release.

Victoria

Almost all apiarists surveyed produce at least 75% of their queen bee requirements. Some apiarists purchase queen cells and mate the virgins in their own apiaries. Only 15% of apiarists purchase the whole of their queen bee requirements.

Italian bees are the preferred race. The use of Caucasian bees has declined and quality reduction was the reason given by most apiarists, although they also stated that whilst the Caucasians bees were good in winter they preferred Italians for summer.

The supersedure method of queen rearing is preferred. Brood is moved above the queen excluder and grafting is carried out 2 - 3 days later. Grafting may be repeated at 5-day intervals. Some apiarists graft older larvae first and the following day replace them with young larvae. Queen cells are started and finished in the same unit.

Whilst some breeder queen bees are purchased, mass selection from within the production apiaries is the most popular acquisition method. The mass selection system often involved purchasing up to 20% of untested queen bee requirements to provide new genes and line interaction to provide a wider range of stock for evaluation in the production apiaries.

Spring/summer queen rearing is carried out on the flats where a range of plants provide pollen. Mountain species support queen rearing during summer and autumn.

Most apiarists spot requeen as necessary during spring, summer and autumn taking 24 - 36 months to replace all queen bees. Within this program a complete apiary may be requeened if it is weak. Weak colonies are usually divided and both units requeened. This procedure, plus surplus nuclei from swarm control, provides new colonies to top up loads or to produce new loads.

Two apiarists preferred to unite weak colonies onto stronger units rather that to spot requeen. These apiarists often requeened on a front by splitting the whole load, requeening and building new loads of bees to replace the weaker loads.

The preferred units are either brood chambers or brood chambers split into two units by a removable iron or timber barrier. Whilst some split boards are used the term split in Victoria usually refers to divided brood chamber. Whilst some apiarists carry nuclei with loads, holding nuclei in central locations is also popular.

Queen bees are introduced to stronger colonies by mailing cages. Very weak units are refurbished by either paper or icing sugar uniting with a complete colony.

Western Australia

The importation of queen bees into Western Australia was prohibited by law in November 1977. This has confined the industry to the genetic pool of bees available in the State at that time. These were predominantly Italian bees with some Carniolan and Caucasian stock, also traces of North European Black bees occur mainly in feral colonies on the south coast.

In 1980 the West Australian Department of Agriculture initiated a breeding program to ensure that the industry had continued access to good quality Italian queen bees and breeding stock. The program was terminated in 1991. See "Genetic Improvement Programs" above.

There are now two queen producers both of whom offer Italian queens and cells bred from queen mothers selected from their own apiaries or from stock of preferred characteristics obtained from co-operating honey producers. With each of these producers, queen production is part-time with allied beekeeping operations. The queen output is mainly exported. No Artificial Insemination is used in such programs although some have the equipment and the service is available from the Department of Agriculture for a fee.

There seems to be a significant number of honey producers who rely to some degree on supersedure and self-raised queens.

Avoidance of inbreeding is considered and takes the form of using cells from a genetic background different to the likely drone population. Most honey producers who mate cells have no defined drone population plan in operation at the times virgins are mating and rely on whatever drone types, numbers and ages are available in the vicinity.

There is a minor interest in access to Caucasian and Carniolan breeding stock.

A feature of Western Australian beekeeping in the area surveyed is the almost continuous supply of pollen of many varieties. Even though it is often excessive to the point of restricting the egg - laying of the queen it does give suitable conditions for honey producers to raise their own queens at times which fit in with honey production.

Some operators maintain separate queen rearing apiaries but, more usually, each truckload of honey hives also includes a regular number of attendant queen mating nuclei. Where queen cells are required a queen mother can be brought in or chosen on a breed-from-the-best basis and the honey hives used to produce cells usually without any supplementary feeding of syrup or pollen. Cells are mostly started in queenless hives and finished in queen-right hives above queen excluders.

This practice of operating a regular number of queen mating nucleus hives in conjunction with each honey apiary ensures a handy supply of young queens and brood for boosting hive strength by the introduction of nuclei to failing or queenless hives. It also ensures virgin queens have access to adequate drone populations. The ratio of nucleus hives to honey hives varies from 1:12 and averages 1:5 with one producer aiming at 1:1 and another at 2:3.

Honey producers do their queen rearing in spring and autumn. Many prefer autumn because of the quality of the pollen from Marri (Red Gum) *Eucalyptus calophylla* and because the autumn queens, when introduced to hives in spring, build up quickly and are less prone to swarming during the following spring.

During the season hives are requeened as needed. This is done mainly at the conclusion of each visit to take honey.

Beekeepers expect queens to perform satisfactorily for up to two years with an average of 18 months.

Introduction of individual queens is done in wooden or plastic mailing cages with escorts and queen candy. Some beekeepers wrap the cage with single ply unscented toilet paper and variously with or without escort bees. This protects the queen on introduction from the bees in the hive and increases the success of queen introduction. However a far more general practice is to unite a nucleus hive with its young queen over newspaper. Failing queens are usually but not always removed. At times mated queens are banked, prior to introduction, for up to 3 weeks.

Careful systems have been developed to avoid the spreading of bee diseases through interchange of combs. These involve the numbering of nucleus hives to correspond with similarly numbered pallets or sometimes even to individual hives.

No two-queen operations were encountered.

Package Bees

The package bee industry developed in New South Wales in the late 1980s and early 1990s, mainly to satisfy the Korean market. For many years prior to the advent of packages, nucleus colonies, usually of three full depth frames, had been exported, but in relatively small numbers.

The export of packages continues and New South Wales remains the main producing state. Korea is still an important destination but the market has expanded to include Canada, the Middle East and Western Europe. Australia’s strengths as a source of queen bees and package bees are its ability to deliver bees early in the northern hemisphere spring and its current freedom from varroa mites.

At the time of writing NSW Agriculture has indicated that it is reviewing the present system of issuing the form of health certificate demanded by some importing countries.

The following account of the mechanics of the package bee industry appeared in the 1993 Report on Commercial Beekeeping in New South Wales. Little has changed since then.

Packages

A package bee container is a wire gauze sided box usually made of kraft wood or some other suitable material. Two basic sizes are produced, 2 pound and 3 pound (packages are quoted in pounds to satisfy overseas market requirements). A 2 pound package has the dimensions of 30cm x 14cm x 22cm with a queen cage suspended from the top of the package and a tin feeder placed in the middle of the package. A box or package provides sufficient volume for 2 or 3 pounds of bees.

Once bees are shaken out of their existing hives, weighed and shaken into package boxes, a tin is placed in the package containing syrup of equal volume of sugar and water or similar -depending on the method of shipment - a sugary fondant comprising 1.4kg sugar, 1.66 litres of water with 10 grams of agar is used. This mixture is boiled and stirred for one minute or until the mixture clears, then poured into the cans to solidify. This reduces the risk of spillage of the bees feed while they are in transit.

Shaking Packages

The process of shaking packages is highly labour intensive and involves a crew consisting of six plus personnel. It is necessary to process an apiary relatively quickly so as to allow the bees time to settle down and reduce robbing. During hot weather it is important to keep the bees cool. Packages can be kept in cool storage facilities prior to export.

Usually, the buyer of the bees arranges the "shaking". The crew arrives on site and sets up its equipment, scales, packages and tins. Queens for packages are taken out of queen banks and transferred to mailing cages. One or two of the crew place the lid of the hives slightly askew and commence to smoke the entrance of each hive. They are quite heavily smoked so as to force the bees out of the bottom box and above the excluder into the top box. Bees are only shaken from above a large holding cage. Each frame is shaken into this box, dislodging all the adhering bees. Once this holding cage contains 3 or 4kg of bees, it is swapped for an empty holding cage. The full cage is taken down to the members of the crew who are filling each package. Bees are weighed out of the large cage and placed in the packages.

To compensate for possible weight loss while bees are in transit, each package contains slightly more bees than that stipulated, ie, 1.7kg of bees is provided for a 1.5kg package. As each package is filled with its complement of bees, the queen cage containing a queen and a tin of sugar fondant are placed in the package. The packages are attached to four slats of timber that separate each individual package, again most important for allowing adequate ventilation and a reduction in the possibility of suffocation. Packages are held in banks of five and are stacked onto a pallet. Each pallet contains approximately 450 packages. Due to the reduced air space and problems with over-heating, each plane hold is restricted to two pallets of bees per flight. Once the required number of packages has been shaken from the apiary, shaking ceases. An average yield per double hive is 3 pounds or 1.3kg of bees. This usually leaves sufficient bees for the hive to go through the rest of the autumn period, once the excess supers have been removed.

Beekeeper Management

Not every yard of bees will be suitable for shaking for packages. The hives need to be in a strong, healthy state with a disease free status. If the colonies are not strong in numbers, a lot of work needs to be carried out by the shaking crew to get very few bees.

If the apiary is working a thin honey flow, this thin nectar will create too many problems when the crew comes to shake each comb. Ideally, an empty super should be placed on those hives to be shaken the day before. If this super is full of sticky combs, better still. The smoking action at the entrance forces the bees from the bottom boxes into the empty box on top. This allows the shaking of bees with fewer problems and evens up the cages of the bees being harvested.

At present there are three major exporters of package bees from Australia, and the bulk of the exports are from Sydney by air freight. Exports of packages usually take place during February, March and April each year. This requires a great deal of precise organisation for the exporters, as the live bees are a fragile cargo. Some export of nucleus hives also takes place.

8. Diseases and Pests

In Australia there are only half a dozen serious diseases and pests of bees, and in some areas less than that. The diseases are American foulbrood (AFB), European foulbrood (EFB), Chalkbrood, Nosema and Sacbrood; and the pests are Wax Moth, the Small Hive Beetle, ants, Cane Toads, the Bee Louse and the Rainbow Bee Eater. Although this report is not a textbook, the causal organisms and symptoms of the major diseases are discussed.

It is too early to say how the recent discovery of the Small Hive Beetle in Australia will affect commercial beekeeping.

The diseases and pests mentioned above are dealt with separately in this chapter. With a few notable exceptions they are common to all regions of Australia.

Any of the common bee diseases may limit production. The worst of them, AFB, can be cripplingly expensive to control. The loss of hives destroyed because of AFB is a minor cost compared to the cost of the additional effort required to minimise the risk of AFB spreading within the apiaries. Preventing the spread of AFB reduces, or even nullifies, some of the economies of scale achieved by modern large-scale beekeeping.

The development of EFB, Chalkbrood and Nosema is strongly influenced by temperature and nutrition. The causal organisms for these diseases are present in the colony for most of the time and symptoms appear when conditions suit the development of the causal organism.

None of the diseases of bees found in Australia are transmissible to humans – they present no threat to public health.

The pests mentioned, although serious to individual beekeepers on occasion, are generally regarded as nuisances that have to be dealt with as necessary.

The most important pests not in Australia are the mites – Varroa, Acarine and Tropilaelaps. Africanised Bees are not generally considered a serious threat. These exotic diseases are discussed separately in this chapter.

Legislation relating to bee diseases, both endemic and exotic, exists in all Australian states and territories.

Diseases and pests of bees pose an ever-present threat to commercial beekeeping. Protecting apiaries from disease and combating pests of bees and equipment make significant demands of the time and energy of commercial beekeepers.

Because of the importance of diseases and pests already present in Australia and of the threat posed by exotic diseases and pests – mostly pests – this chapter is divided into four separate sections:

- Legislation relating to diseases and pests
- Brood diseases
- Other diseases and pests
- Exotic diseases and pests

Legislation

Legislation is in place in all states and territories aimed at limiting the spread of endemic bee diseases, and at containing or eradicating exotic bee diseases, should they appear in Australia.

Legislation was first applied to the beekeeping industry early last century in response to the spread of American foulbrood (AFB), *Paenibacillus larvae,* sometimes known as American Brood Disease (ABD).

Other important diseases and pests of bees have appeared in Australia since legislation was first applied to beekeeping and they have been incorporated into existing legislation.

However, there is a clear trend by legislators to move responsibility for controlling bee diseases, particularly AFB, from the state to the industry.

Legislation by States and Territories

Bee diseases are covered by legislation in all of the states and territories. The relative Acts are[30]

Australian Capital Territory	Animal Diseases Act 1993
New South Wales	Apiaries Act 1985 (a)
Northern Territory	Stock Diseases Act (b)
Queensland	Apiary's Act 1982 (c)
South Australia	Livestock Act 1997 & Industry Funding Schemes Act 1998
Tasmania	Animal Health Act 1995, Apiary's Act 1978
Victoria	Livestock Diseases Control Act 1994
Western Australia	The Beekeepers Act & Regulations

The New South Wales Apiaries Act, and other Plant and Animal Acts are under review, and may be combined.
(a) The Northern Territory Stock Diseases Act will become the Stock Act.
(b) The Queensland Apiary's Act 1982 may be incorporated into the Stock Act.
(c) The Beekeepers Act & Regulations will form regulations under the Agriculture Protection Act.

Commonly, legislation regulating the keeping of bees has provisions for the registration of apiaries; identification of hives; disposal of infected hives; the use of removable frame hives; abandoned or neglected hives; exposed honey; disease control; and, the declaration of notifiable disease. State by state differences in legislation effecting beekeeping is included in the section on AFB.

Notifiable Diseases

With regard to endemic diseases, most legislation lists several diseases as notifiable even though in practice most attention is paid AFB and its control.

Government agencies presumably see advantage in declaring certain diseases notifiable for the sake of maintaining an avenue for legislative control and so that international trade requirements may be met.

Thus it may happen that a beekeeper is prosecuted for failing to report the presence of AFB but not for failing to report the presence of other declared diseases.

[30] Somerville, D (2001) Apiary Acts & Regulatory Activities for Each State, re Bee Diseases. NSW Agriculture, Goulburn.

The choice of diseases declared notifiable varies from state to state – or territory to territory. Some choices are difficult to comprehend. For example, in the Australian Capital Territory the legislative control of beekeeping is vested in the Animal Diseases Act 1993. Under this Act, the following diseases are listed on the Schedule of Endemic Diseases (Declaration of Endemic Diseases under the Animal Diseases Act 1993, Instrument No. 247 of 1997).

American Brood Disease
Chalk Brood Disease
European Brood Disease
Nosema Disease
Stone Brood Disease

Of the diseases listed above Chalkbrood, European foulbrood and Nosema are present in the hive all or most of the time and symptoms only occur when the colony is stressed. (See separate sections of this chapter.) Stone Brood Disease is caused by an *Aspergillus* fungus and is so rare in Australia that when a case was found in 1989 the event was reported in the Australian Veterinary Journal[31].

Never the less, the Animal Diseases Act, Section 22 (1) States:

"A person who has reasonable grounds for believing that stock is infected with an endemic stock disease shall notify the Minister in writing".

Therefore beekeepers in the ACT are obliged to notify the presence of American Foulbrood and presumably the presence of the other diseases listed on the schedule.

The New South Wales legislation, the Apiaries Act 1985, is very similar in that AFB, EFB and Chalkbrood are all declared notifiable diseases.

Exotic Diseases

All of the important exotic diseases are also notifiable. Exotic diseases, wherever found, are the concern of all of the states and the Commonwealth. Attempting to containing or eradicate exotic disease that occurs in Australia is a national effort coordinated by Agriculture and Resource Management Council of Australia and New Zealand's Australian Veterinary Emergency Plan, known as AUSVETPLAN.

AUSVETPLAN is a series of technical response plans that describe the proposed Australian approach to an exotic animal disease incursion. The documents provide guidance based on sound analysis, linking policy, strategies, implementation, coordination and emergency-management plans.

A working group of industry specialists has prepared a set of strategies for dealing with an incursion of exotic bee diseases or pests. The strategy may be viewed on the AUSVETPLAN web site.

Under certain circumstances the industry is obliged to share in the cost of controlling, or attempting to control, an incursion of pests or disease. To finance this obligation an Emergency Animal Disease (EAD) Response Cost Sharing Deed of Agreement has been ratified by industry and a levy has been imposed to create a fund to be used in the event of an exotic incursion. The fund is capped at an amount of AU$1 million.

[31] Hornitzky M.A.Z., Stace P. and Boulton J.G.,1989. A case of stonebrood in Australian honey bees (*Apis mellifera).*Australian Veterinary Journal 66(2):64.

Brood Diseases

American foulbrood (AFB)

AFB is contagious and is commonly spread throughout the apiary by the interchange of infected hive material. If untreated, infected colonies die and if neglected, all the hives in an apiary may be expected to die.

AFB is endemic throughout most of Australia. It is generally regarded as the nation's most serious disease of bees.

A national campaign to reduce the level of AFB infection is being considered by industry organisations.

Causal Organism

American foulbrood is caused by the bacterium *Paenibacillus larvae* subsp. *larvae*, whose spores are very resistant to heat and chemical disinfectants, and to drying out. The spores, however, are quite sensitive to gamma radiation from cobalt 60. Symptoms of the disease may be suppressed by use of antibiotics. The bacillus appears to be only associated with the honeybee and attacks the larvae of workers, queens and drones.

Diagnosis of AFB

The diagnosis of AFB is based on the recognition of signs of disease and the identification of *P. larvae* in diseased material. Most states provide a diagnostic service for the microscopic identification of *P. larvae* from diseased material. But more importantly for the beekeeper is the ability to recognize the clinical evidence of disease in the field. Identification guides are freely available.

Several states provide a bulk honey testing service. Commercial honey samples are cultured and linked to a trace-back system to the hives of origin. This system has provided an effective means of detecting AFB, even sub-clinical infections.[32]

Symptoms of AFB

Illustrated identification guides are freely available from state Departments of Agriculture and almost every beekeeping textbook contains a detailed account of AFB. Nevertheless, the disease is so important that it worth describing its principal symptoms.

The principal symptoms are[33]

- Brood generally dies after the cells have been capped over and the brood is stretched out on its back with the head towards the cell cappings
- When brood dies in the pupal stage the form of the pupa is carried through to the last stages of decay and the mouthparts are characteristically turned up toward the top side of the cell.
- Infected brood becomes slightly discoloured - light brownish at first, then darker brown as the disease progresses.
- After about one month the dead brood dry down to a very dark scale that adheres to the wall of the cell.
- Cappings over brood cells containing dead larvae or pupae sink inwards, become moist and have a discoloured dark chocolate appearance. Some of these capped cells are punctured, the result of

[32] Hornitzky, MAZ (1998) A Review of Control Methods for American Foulbrood. NSW Agriculture.
[33] Hornitzky, MAZ (1998) A Review of Control Methods for American Foulbrood. NSW Agriculture.

attempts by bees to remove the dead larvae or pupae. Other cells will have their caps totally removed leaving the infective larval or pupal remains exposed.

- If a match-stick is thrust into the larval remains at the sunken capped stage and is then removed, it draws out the brown, semi-fluid remains in a ropy thread
- In heavily infected colonies the brood pattern has a "pepperbox" appearance due to the irregular arrangement of healthy cells intermingled with uncapped cells and capped cells of dead brood with punctured and sunken cappings. This "pepperbox" appearance can easily be distinguished from that in European foulbrood *Melissococcus pluton* (EFB), the second major bacterial disease of honey bees, as in AFB the cappings have a dark chocolate appearance whereas the cappings on dead brood of EFB are not significantly discoloured.

The disease is not called foulbrood for nothing. When hives are seriously infected with foulbrood the smell can be foul, strong and unmistakeable, although some people have difficulty in detecting the distinctive aroma. In the past the smell was described as being like that of a carpenter’s glue pot.

Control of AFB

Control of AFB is regulated, to varying degrees, in all states and territories. Each state has its own Act of Parliament, generally aimed at minimising the spread of AFB and specifying how the disease should be treated when found.

It is salutary to note that legislation intended to control AFB has been in place throughout most of Australia since the early twentieth century. In the intervening years a fortune has been spent on inspectors’ salaries, registration fees and compensation schemes, yet nowhere has AFB been eradicated, or even adequately controlled. If anything, changes in beekeeping practices may have exacerbated the problem.

Tasmania is the only state that permits treatment of AFB with antibiotics. Since oxytetracycline hydrochloride (OTC) is available for the control of EFB in all states except Western Australia, where EFB does not occur, the possibility that it may be deliberately used for the control of symptoms of AFB cannot be discounted. As well, in areas where OTC is routinely “blanket fed” to control EFB, the possibility exists that symptoms of AFB are being unintentionally suppressed. In either case bulk honey testing, if available, should show AFB spores even if the symptoms of the disease are not evident.

In states other than Tasmania regulations exist for the disposal or sterilisation of AFB infected material. Treatments include destruction by burning, irradiation with Cobalt 60, and, dipping in hot wax. Irradiation of infected hive material is an Australian breakthrough and has largely replaced burning of infected hive material as a control mechanism.[34]

In all states, but not the territories, beekeepers are obliged to register and in some states beekeepers may be compensated for material destroyed in treating AFB. Most states have some kind of inspection service available to help enforce the provisions of their respective Acts and most states have a laboratory testing service available for the positive diagnosis of AFB.

AFB by States and Territories

Because of the sometimes wide variation in regulations and practices between states, it is necessary to examine them individually.

[34] Hornitzky, MAZ; Wills, PA(1983) Gamma radiation inactivation of *Bacillus larvae* to control American foulbrood. Journal of Apicultural Research 22:196-199.

Australian Capital Territory
Beekeepers in the Australian Capital Territory do not have to register their hives, but they do have to report the presence of the disease, in accordance with the Animal Diseases Act 1993. The usual control is to burn infected colonies. A representative of Environment ACT supervises the destruction of infected colonies.

New South Wales
AFB is common throughout NSW and a significant proportion of the State's beekeepers have had infected colonies in their apiaries at one time or another.

Control of AFB is regulated by an Apiaries Act, introduced in 1916 and amended several times since then.

Registration of apiaries is compulsory and a fee is charged.

In 1994 NSW Agriculture, the agency responsible for administering the Apiaries Act, made a major policy change in the way it administered the Act. Until 1994 advisory officers of the Department's Apiary Branch exercised regulatory powers under the Act. In 1994 they were stripped of their regulatory function, which was given to those Agricultural Inspectors willing to undertake bee work. Those Agricultural Inspectors interested in becoming Inspectors under the Apiaries Act were trained in beekeeping and disease identification. Agricultural Inspectors are multi-skilled and fit their apiary inspection work in with their other responsibilities. At the time of writing there were 18 such inspectors. An Inspector, labelled *Regulatory Specialist, Apiaries*, coordinates inspectorial in the field.

It is the beekeeper's responsibility to report the presence of AFB and the Inspector's duty to confirm that AFB is present.

Compensation
Hives confirmed to have AFB are either destroyed by burning or the hive material may be decontaminated with gamma radiation after the bees and honey have been removed from diseased hives. In either case the bees are killed before the material is destroyed or treated.

At present, where the beekeeper is registered compensation is paid at the rate of 50% of the value of the hive/s that are destroyed.

However at its 2002 State Conference, the New South Wales Apiarists' Association resolved to forgo compensation if the money collected as fees for Apiary Registration is used to fund an extensive program of bulk testing of honey. At the time of writing, this matter has not been resolved and pre-conference procedures still apply.

Discretionary powers
There are discretionary powers to refuse compensation where directions regarding disease control have not been carried out by the beekeeper or the beekeeper has caused the spread of the disease. Where the option of gamma radiation of hive materials is taken the cost of the gamma radiation is paid through the compensation fund, however, transport costs to and from the gamma radiation plant at Wetherill Park in western Sydney are paid by the beekeeper.

Section 28 of the Apiaries Act 1985 deals with compensation for loss of bees. There are 5 reasons why compensation would not be paid. Briefly:

1. Illegal entry into NSW
2. Beekeeper buys infected material intentionally to make a claim for compensation
3. Unregistered beekeeper
4. Beekeeper fails to notify disease as required by Section 22.
5. Deliberate, reckless or negligent conduct by the beekeeper caused or contributed to the spread of disease.

A beekeeper is entitled to make a claim but compensation may be refused. If this happens then the beekeeper can appeal the decision. Compensation, when approved, is paid for the following at the following rate:

- Destruction of beehive material - at 50% of the value of the hive.
- Destruction of queens - beekeeper gets $7 for each queen
- Irradiation of material - currently $22 per unit (triple) - including GST. Transport is paid by the beekeeper.

Compensation is not paid for loss of production or loss of contract.

New South Wales American Foulbrood Statistics 1980 - 2000

Year	No. Diseased	% of Total Hives Registered	% of Total Registered Beekeepers
1980-81	929	0.38%	1.30%
1981-82	449	0.17%	0.70%
1982-83	280	0.10%	1.10%
1983-84	590	0.23%	1.00%
1984-85	646	0.24%	1.70%
1985-86	549	0.21%	1.50%
1986-87	1064	0.42%	1.90%
1987-88	1812	0.71%	4.70%
1988-89	1114	0.40%	3.10%
1989-90	1550	0.56%	3.40%
1990-91	2234	0.80%	3.90%
1991-92	2497	0.90%	4.20%
1992-93	2545	0.92%	4.30%
1993-94	1312	0.47%	3.50%
1994-95	2433	0.87%	4.60%
1995-96	2221	0.80%	3.80%
1996-97	2073	0.75%	6.00%
1997-98	2747	0.90%	3.90%
1998-99	1445	0.56%	4.50%
1999-00	1401	0.53%	5.60%

The increased incidence of AFB in from 1991-92 is primarily due to the introduction of bulk honey testing for AFB spores and the trace back of any positive samples to the hives of origin.

Currently, no routine honey testing takes place in NSW although beekeepers may have testing undertaken, for a charge, on request. The charges, at the time of writing, are for three or less samples $35.05 each and for more than three samples $23.85 each.

Anecdotal evidence suggests that not all outbreaks of disease are reported. It is probable that some beekeepers, finding a hive or two with AFB, simple destroy the infected colonies (or treat them with OTC) and forego compensation rather than have the infected colonies on hand until an inspector arrives to confirm the presence of the disease.

<u>Northern Territory</u>
AFB has not been reported in the Northern Territory. It is a notifiable disease under the Stock Diseases Act.

Queensland
Control of AFB is regulated by an Apiaries Act, 1982, administered by the Queensland Department of Primary Industries (QDPI). Registration of apiaries is compulsory.

Queensland was generally reckoned to have the lowest incidence of AFB of the Australian states. A likely reason for this historically low incidence is the lengthy warm conditions in Queensland that are ideal for wax moth activity. Hives weakened or killed by AFB are quickly destroyed by wax moth, thereby reducing the likelihood of robbing and transfer of contaminated material into healthy hives.

Despite the foregoing, AFB is no longer a rarity in southern Queensland, and it is becoming more common. John Rhodes, formerly of the QDPI, says[35]:

> *The history of AFB in Queensland shows that there were no cases recorded by QDPI (then Queensland Department of Agriculture) between 1961-65. In 1990 0.3% of registered beekeepers were identified with AFB in their apiaries and in the year 2000 the number of registered beekeepers on the AFB infection list had increased to 11%. Where whole districts in a state were once considered AFB free, the bee industry is now facing a situation where each beekeeper may be examined on an apiary by apiary basis with the purpose that individual apiaries may be declared AFB free. Negative changes of this magnitude must be of major concern to all commercial beekeepers.*

AFB was virtually unknown in northern Queensland until 2000 when a hive with AFB was found on the Atherton Tableland. It was destroyed and free honey tests arranged for all beekeepers on the Tableland and around Innisfail. The Queensland Department of Primary Industry again arranged free honey tests for Cairns and the Tableland areas in 2001. Beekeepers are normally charged $17.15 per test.

In an effort to reduce the incidence of this disease even more the Queensland Department of Primary Industries has introduced a bulk honey culture program, funded by the Queensland Beekeepers' Association, to provide a better estimate of the incidence of the disease in Queensland and also to trace previously unknown sources of disease[36].

South Australia
Control of AFB is regulated by the Livestock Act, 1997 and the Primary Industries Funding Schemes Act, 1988, administered by Primary Industries and Resources SA. Registration of apiaries is compulsory.

Most hives confirmed to have AFB are destroyed by burning. South Australia does not have a commercial gamma radiation plant that can be used to decontaminate hive equipment. Hive material to be irradiated must be transported to Dandenong, Victoria for treatment. Hence the cost effectiveness of this treatment is questionable.

There is no longer a compensation scheme available to beekeepers in South Australia.

Bulk honey testing is used as a tool to locate AFB infected apiaries. The state's major honey packer, Leabrook Farms, does extensive testing for spores of AFB and supplies the South Australian Department of Primary Industries with either the test results or a sample of honey from each of its suppliers.

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[35] Rhodes, J (2001) The changing Face of American Foulbrood Disease. ABK 103:4 (155)
[36] Peter Warhurst,(2002), personal communication.

Tasmania

Control of AFB is regulated by the Animal Health Act, 1995 and the Apiary's Act, 1978, and administered by the Department of Primary Industries, Water and Environment. Registration of apiaries is compulsory.

Most Tasmanian beekeepers are not overly concerned about AFB. They are, however, very aware of AFB and are diligent in searching for it. In the spring a very careful inspection of the brood nest is made. In the early spring, hives are usually low on stores and are being fed. There is very little honey on the hives. This is when AFB is most likely to be found. Infected colonies usually have a few infected cells at the time of the spring inspection and are therefore easily treated with OTC.

Tasmania is the only state that permits treatment of AFB with antibiotics. Since treatments are undertaken in the spring, when the hives are being fed sugar and well before the honey flow commences, there is little likelihood of residues of OTC occurring in the honey. The spring dose of OTC treats both EFB and AFB. One gram of active ingredient OTC is usually fed in dry castor sugar or icing sugar over 3 treatments.

A shadow on the horizon is the possibility of *P. larvae* developing resistance to available antibiotics, as has been reported overseas. As well, it is possible that maximum residue limits for OTC in honey may be reduced to levels difficult to achieve under Tasmania's existing control regime.

Victoria

Control of AFB is regulated by the Livestock Disease Control Act, 1994, and administered by the Department of Natural Resources and Environment. Registration of apiaries is compulsory.

Victoria has a Government/industry AFB reduction program, known as "AFB Smart", which commenced in the spring of 2001. In the first year of the program, all registered apiarists owning 51 or more hives were mailed honey-sampling kits for honey culture testing (HCT) by Gribbles Veterinary Services, who will test for spores of *P. larvae.* A sample of honey is required from each apiary. In the second year, the same will apply but kits will also be mailed to all remaining apiarists. The testing program is financed by the Bees Compensation Fund to which beekeeper registrations contribute. Subsidies to beekeepers are 100% in the first year of joining the program and 50% in the second year of joining the program. Submission of samples is at present voluntary.

This program will also provide an accurate picture of the incidence of AFB in Victoria. It is too early to enable accurate data to be gathered.

Victoria pays compensation to registered beekeepers whose hives are destroyed due to AFB infection. The amount of compensation is equal the cost of gamma-irradiating a three-box hive (about $20), plus the cost of a replacement queen ($10). A beekeeper qualifying for compensation is paid these amounts regardless of whether (a) the bees, combs and hive are destroyed by burning or (b) the bees & combs are destroyed and the sound hive material sterilised by irradiation.

Western Australia

Control of AFB in WA is regulated by the Beekeepers Act, which is administered by Agriculture WA.

The Department's policy permits beekeepers to control AFB themselves. The Honey Culture Test (HCT) is used by the Department to monitor the eradication of the disease in a beekeeper's apiary. If a beekeeper fails to control the disease, the Act is used to quarantine the apiary and the beekeeper is provided with a management plan to follow to eradicate the disease. WA had a Bee Diseases Compensation Act but it was repealed in the early 1990s.

Dipping in very hot paraffin wax is acceptable for sterilising the boxes, lids and bottom boards. Bees and combs from infected hives are burnt. This procedure is used instead of burning AFB infected hives.

The “Barrier System”, a system of handling hives and hive material that provides quarantine barriers between individual hives or groups of hives, developed by Lee Allan of Agriculture WA in 1980, is also used to reduce the incidence disease.

Another important factor which influences disease control strategies in Western Australia is the absence of EFB and therefore of OTC. To help maintain the EFB-free status, bees, honey, used hives, hive products, or used beekeeping equipment cannot be imported into Western Australia unless accompanied by the prescribed certificate. This factor has a significant bearing on bee breeding, the marketing of honey and influences what disease control strategies are introduced.

National Plan

The Australian Honey Bee Industry Council (AHBIC) recently commissioned consultants Hassall & Associates P/L to prepare a “A National Approach to the Management or American Foulbrood in the Australian Honey Bee Industry”. The report has been published and AHBIC is seeking the views of state associations. This is not the first attempt to introduce a national plan for the control of AFB.

Barrier System of Hive Management

The barrier system of minimising the spread of AFB that was pioneered in Western Australia and is being adopted by beekeepers in most states.

A full barrier system is one where honey supers and combs removed from hives for extraction are returned to the hives of origin. A variant, a partial system, ensures that hive materials are maintained in particular pallets of particular loads or at least within the same load.

The application of a barrier system in Western Australia has been helped by the nature of their honey flows and beekeeping practice. Regular honey flows permits regular harvesting of honey and the maintenance of hives at roughly the same size.

In the eastern states loads of supers are commonly rotated as honey is harvested. When a barrier system is introduced sufficient additional supers must be provided to maintain the integrity of each apiary – a significant additional capital cost. As well, opportunities for harvesting honey may not be as regular in the eastern states as in Western Australia and there will be times when the majority of supers are kept in store, creating the need for additional storage space and problems of wax moth control. At least one beekeeper has found a way around this problem by labelling each box with a bar code and using a hand held bar-code reader on each visit to each apiary, thus enabling him to trace individual boxes from hive to hive using a custom designed computer program.

As often happens in the beekeeping industry, ideas are modified and refined by usage. And so the more beekeepers that adopt the barrier system the more we may expect it to be modified to suit the varying situations in which it is practiced. Certainly some beekeepers have had their extracting equipment tailor-made to suit the barrier system, by ensuring that the extractors hold discrete box loads of combs and that combs are returned to the correct box after extraction.

European foulbrood (EFB)

EFB is usually noticed in early spring when colonies are building up and to a lesser extent in autumn. Low larval mortality may occur in light infections or when the colonies are on good nectar and pollen flow conditions. High mortality of larvae, pupae and young adult bees occurs during a heavy infection or when colonies are on poor nutritional conditions.

Sub-optimal brood rearing temperatures in the spring and frequent interruption of nectar flows and pollen production places hives under stress that stimulates the development of not only EFB but also of Chalkbrood and Nosema. With all three diseases the symptoms and severity of the infection may be reduced by “good beekeeping practice”. That is, by having young queens, maintaining relatively new combs in the hive, particularly in the brood chamber; regulating the size of the hive to suit the strength of the colony; rearing bees on good conditions; taking care when moving hives and so on.

Causal Organism

European foulbrood is caused by the bacterium *Melissococcus pluton* and has been endemic throughout eastern Australia since the mid 1970s*. In old larval remains the bacterium, *Bacillus alvei*, is commonly present as a secondary invader.

Symptoms of EFB

Brood from infected hives has a "Pepper-box" appearance. The unsealed brood is affected and larvae may move to abnormal positions on the cell base or around the wall of the cell. In advanced cases the sealed brood may be affected, with sunken punctured cappings.

Larvae of less than 48 hours of age are most easily infected. Usually unsealed larvae three to five days of age in the C shape show signs of infection and commonly die at this age.

Infected larvae change from the glistening, pearly white of healthy brood to dull white, becoming yellow and then brown to almost black. Recently dead larvae are watery to pasty in appearance but rarely show signs of ropiness. Old infections rope to 10 mm and occasionally to 20 mm before breaking. Dead larvae may form scales, which are usually twisted in the cell. They do not adhere tightly to the cell wall.

Control of EFB

EFB is controlled with the antibiotic oxytetracycline hydrochloride (OTC).

Despite minor variations, the procedures and protocols for treating EFB with antibiotics is similar in all states where the disease occurs. The only antibiotic recommended for the treatment of EFB is oxytetracycline hydrochloride (OTC). In NSW three products are registered for use on honeybees and are available through registered suppliers. These three products are:

- Oxymav 100® (active ingredient 100g/kg)
- Tetravet 100® (100g/kg)
- Broodmix® (10g/kg)

These medications are available on prescription from a veterinarian or on an order to supply from an apiary officer. They will be issued only if the prescriber or Regional Veterinary Laboratory has diagnosed the disease. Most states have similar requirement, but South Australia is stricter in trying to prevent antibiotic treatment of EFB from accidentally or deliberately treating American foulbrood (AFB) and requires evidence that AFB is not present in the apiary and has not been present for the previous six months.

South Australia requires samples or inspections by an apiary officer prior to OTC being prescribed. Only apiary officers prescribe oxytetracycline, not veterinarians. The Department requires 1 or 2 representative honey samples to be submitted and paid for ($16 per sample) by the apiarist to test negative for AFB during the previous six months in order to expedite OTC prescriptions to apiarists during the spring period.

The basic principals for treating EFB with OTC are:

- Minimise the risk of OTC residues occurring in honey by undertaking treatment at least 8 weeks prior to a honey flow, or where honey is not marketed for at least 8 weeks, although at the time of writing this withholding period was under review.
- Where EFB is confirmed in an apiary only hives with EFB should be treated (spot fed) if less than 10% of the hives in the apiary are diseased. If 10% or more are diseased all hives in the apiary should be treated.
- The basic dose of OTC is one gram of active ingredient mixed with 100g of castor sugar for each two-decker hive.
- In queen rearing operations where cell starting and finishing hives are not used for honey production periodic OTC treatment of these hives may be necessary to protect queen cells from infection.

Feeding of OTC is not widely practiced in South Australia where beekeepers are more likely to unite the EFB infected colony with a strong colony. On the other hand antibiotic therapy for EFB is an essential part of beekeeping in Victoria, where it is common practice for apiarists to blanket feed with OTC in spring and sometimes in the autumn as well.

The situation in Tasmania is unique in as much as it is the only state where it is legal to treat AFB with antibiotics so that antibiotic therapy must be suitable for treating both diseases. OTC is used as a preventative treatment and blanket feeding is a routine procedure. Treatments are undertaken in the spring, when the hives are being fed sugar and well before the honey flow commences. Hives are fed the more or less standard dose one gram of active ingredient OTC per hive is fed, with sugar, over three treatments.

Distribution

Western Australia and the Northern Territory are the only areas in Australia known to be free from EFB. To help maintain this EFB free status, bees, honey, used hives, hive products, or used beekeeping equipment cannot be imported into Western Australia unless accompanied by the prescribed certificate. The disease is widespread in all other states. It is less common in northern Queensland and more common in southern New South Wales, Victoria, and Tasmania and although EFB is relatively common in South Australia, most commercial apiarists there are not overly concerned about the disease. In general, most commercial beekeepers have experienced the disease in their apiaries at some time.

* A disease called European Foulbrood, and thought to be caused by *Bacillus pluton*, was a recognised bee disease in Victoria and New South Wales long before the 1970s. It is described in the Victorian Department of Agriculture publication *Beekeeping in Victoria* (1958) and in the NSW Agriculture publication *Bees and Honey* (1959).

Chalkbrood

Although Chalkbrood is not usually fatal to honeybee colonies it can cause substantial production losses. Chalkbrood varies greatly in its severity. At its worst it causes major loss of colony strength with a consequent loss of production. This commonly occurs in spring and autumn. At other times its presence in the hive is barely noticeable. Chalkbrood seems to become a problem when colonies are stressed for some reason, but not all such colonies develop Chalkbrood.

Causal Organism

Chalkbrood is caused by the fungus *Ascosphaera apis*. It occurs widely in the temperate regions of the Northern Hemisphere and in Hawaii, New Zealand, Western Samoa and was first diagnosed in Australia in 1993. It is now endemic in most areas of Australia.

Larvae and prepupae are the targets of Chalkbrood with older larvae being the most susceptible. Eggs and pupae do not support the growth of *A. apis.*

Symptoms of Chalkbrood

Diseased dead larvae first become covered with a fluffy white growth of fungal strands (mycelia) and are swollen to the size of the cell. Later they dry into hard, shrunken, chalk-like lumps, called "mummies" which may become grey to black if spore cysts are formed. Many of the cells remain sealed in heavily infected colonies.

The spores of *A. apis* are highly resistant and can remain infective for 15 years or longer. Spores are transmitted by infected queen bees, worker bees and sealed and unsealed brood from infected colonies, contaminated pollen and contaminated tools of the apiarist. Spores remain viable in pollen for at least one year and in honey for two years.

Control of Chalkbrood

There is no cure for Chalkbrood, but it is believed that its symptoms may be reduced by “good beekeeping practice”.

It is accepted that some colonies clean out Chalkbrood infected dead brood much faster and more thoroughly than others, but more research is necessary to understand why.

Temperature and Chalkbrood

Hornitzky says in his 2001 Literature Review of Chalkbrood[37]:

> A. apis *grows best in slightly chilled larvae as its optimal temperature for growth and formation of fruiting bodies is about 30°C (Maurizio, 1934). Experiments have shown that brood is most susceptible when chilled immediately after it has been capped (Bailey, 1967). The chilling need be only a slight reduction of temperature, from the normal 35°C , for a few hours; and it can easily occur, even in warm climates, in colonies that temporarily have insufficient adult bees to incubate their brood adequately. Larvae are most likely to be chilled in early summer when colonies are growing, and drone larvae often suffer most as they are generally on the periphery of brood nests. The smallest colonies are at the greatest risk of becoming chilled because they have the lowest capacity for heat and relatively large surface areas. Heath (1982a, b), in extensive reviews, quotes several observations that chalkbrood is aggravated when colonies are rapidly expanding in spring, i.e. when the ratio of brood to*

[37] Hornitzky, M (2001) A literature review of chalkbrood – a fungal disease of honeybees. A report for the Rural Industries Research and Development Corporation.

adult bees is high, or when it is increased experimentally; and that very small colonies used for mating virgin queens or in observation hives are very susceptible. Koenig et al. *(1987) also noted that decreasing the ratio of adult bees to brood aggravated chalkbrood; and Pederson (1976) showed that artificially heating hives in spring diminished the incidence of the disease. Other non-lethal factors, such a slight infections by viruses or bacteria, or poisoning, or inadequate food from disease nurse bees may well cause the same effect as chilling by slowing the rate of development of larvae (Bailey and Ball, 1991).*

The effects described above go a long way to explain the often severe outbreaks experienced in Tasmania in the spring, when colonies are weak but being fed to encourage expansion of the brood nest.

Sacbrood

Causal Organism

Sacbrood is the most common of a group of viral diseases infecting honeybees in Australia. Hornitzky reported in 1987[38] that five viruses were detected in samples of honeybees submitted to the New South Wales Department of Agriculture Regional Veterinary Laboratory, Glenfield, from 1980 to 1983. They were sac-brood virus (SBV), black queen-cell virus (BQCV), chronic bee-paralysis virus (CBPV), Kashmir bee virus (KBV) and cloudy-wing virus (CWV). He said:

Four hundred and eighteen samples were examined during the period 1980 - 1983.

Using electron microscopy and gel-diffusion tests five specific viruses (SBV, CBPV, CWV, KBV and BQCV) were detected in 103 (24.6%) of the samples examined.

And

SBV was by far the most common virus, being detected 60 (58%) of all virus isolated and 14% of all specimens examined. KBV was the second most common virus detected, accounting for 21 (20%) of the identified virus isolates. CBPV detected in 16 (16%) samples while BQCV and CWV were each detected in 3 (3%) samples.

It seems that viral diseases in bee behave like some viral diseases in humans – we carry the virus at all times but only show symptoms when we are stressed in some way. Similarly, bees do not so much "catch" a viral disease but for some reason fail to suppress a virus they are already carrying.

Darling Pea

Many beekeepers have long believed that inadequate nutrition may be responsible for outbreaks of Sacbrood. Certainly Darling Pea, *Swainsona* species, has a strong relationship with Sacbrood in north-western New South Wales. However since *Swainsona* species contains a poison principal that produces a condition of "pea struck" or "loco" disease in livestock, it is possible that the Sacbrood symptoms exhibited by bees working Darling Pea are caused by poisoning.

The author was acquainted with a non-migratory part-time beekeeper at Murrurundi in New South Wales who protected his most valued hives from Sacbrood in years when the Darling Pea flowered by feeding them sugar syrup. (He could not afford to feed all of his hives.) Observations in South Australia suggested the efficacy of feeding sugar syrup to treat Sacbrood[39]. The report said:

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[38] Hornitzky M (1987) Prevalence of Virus Infections on Honeybees in Eastern Australia. Journal of Apicultural Research 26(3):181-185.

[39] Pinnock D E and Mew P H (1980) Sucrose Therapy for Sacbrood Disease of Bee Larvae. Waite Agricultural Institute. ABK 82(5):107

In an apiary heavily infected with Sacbrood. 40 hives treated with sucrose syrup showed a reduction in sacbrood. Brood mortality of 50% reduced to 3% in three weeks. Another 40 'check' hives were left untreated, and these showed an increase in brood mortality due to sac brood during the same period. We have observed similar results on smaller numbers of hives in several other apiaries.

Symptoms of Sacbrood

Following are the points of difference between sac brood and other brood diseases, from 1959[40]:

1. Dead larvae are stretched out in the cell in sac brood and are not found in unnatural positions as in European brood disease.
2. Larvae dead from the effects of sac brood can, with tweezers inserted carefully into the cell, be removed intact. The extracted matter resembles a tiny sac with contents of a watery nature. In American brood disease the matter is ropy and in European brood disease the larvae cannot be lifted out intact for the larval skin is too tender.
3. In sac brood the worker bees remove the dead larvae; there are not dried scales as in foul brood.*
4. There is very little odour where sac brood is present.
5. In larvae infected with sac brood the colour usually varies from light yellow to brown. (The coffee-brown colour of American brood disease is not present.)
*6. Both sealed and unsealed larvae are affected in sac brood. It is rare that any treatment is necessary, but if noticed that the infection is sufficient to weaken a colony a young Italian queen from vigorous stock should be introduced. No other treatment is recommended**.*

* In severe outbreaks, such as on Darling Pea, the quantity of dead larvae over whelms the colony. As mentioned above, the mortality may be due to poisoning and not to Sacbrood virus.
** In severe outbreaks, it is essential to move infected colonies to better breeding conditions, well away from Darling Pea.

Other Diseases and Pests

Nosema

Nosema can seriously limit production in some years, both by the direct effect of short-lived bees and by infecting the queen, often resulting in early supersedure.

The honeybee colony can tolerate a low to medium incidence of nosema. It is only when a large proportion of the bees within a colony become infected with the parasite that the colony is adversely affected. Gross contamination of the host occurs under conditions favourable to the parasite.

The antibiotic, fumagillin, is useful in controlling nosema disease, but because of the persistence of fumagillin residues, its use is restricted.

Nosema is rated as a serious disease of bees in most states.

[40] "Bees and Honey", 4th Edition, NSW Department of Agriculture, Sydney, 1959:175.

Causal Organism

Nosema disease is caused by a protozoon, *Nosema apis* Zander, a parasite of the honeybee. It is one of the Microsporidia, and is spread by spores. A protozoon is a primitive, single-celled animal that absorbs dissolved food directly through the cell wall and has only very limited powers of movement. The rather thick-walled spore stage of *N. apis* can survive outside its host and it is probable that brood combs in most hives are contaminated with spores.

Symptoms of Nosema

The most obvious effect of nosema disease on worker bees is that infected bees do not live as long as healthy ones. In light infections this may be difficult to diagnose, but in severely effected colonies it is common to see large numbers of dead and dying bees on the ground near the hive entrance.

Commonly a few dead bees will be seen near the hive entrance and the colony population does not increase they way it should.

Nosema apis spores are readily identified by simple microscopic examination.

Colony Temperature and Nosema

Nosema apis develops most rapidly at about 30°C. Development is retarded once the temperature drops into the low 10s (about clustering temperature) or rises into the mid to high 30s (typical summer temperatures in much of Australia).

The temperature most suited to nosema development is most likely to be experienced by colonies in autumn or spring. These are times of suboptimal brood rearing temperature. Colonies having difficulty in maintaining optimum brood rearing temperature commonly suffer from nosema. These are the conditions that also suit the development of chalkbrood.

Bees reared on a poor plane of nutrition appear to be more prone to nosema than bees reared on a high plane of nutrition. As more knowledge is accumulated about the nutritive value of Australian pollens so beekeepers may be able to devise better management practices for avoiding nosema.

Working winter honey flows often combines the disadvantages of suboptimal brood rearing temperatures with poor nutrition.

Winter Honey Flows

Nosema apis is generally considered to be a serious disease throughout most of the important beekeeping areas in the eastern states. Certainly the significance of the disease varies with the areas beekeepers work. Beekeepers working in north western New South Wales and parts of southern Queensland consider nosema more of a problem than their southern or western counterparts. In these areas Grey (Brown) Box *Eucalyptus microcarpa*, Pilliga or Mallee Box *E. pilligaensis*, White Box *E. albens*, Mugga Ironbark *E. sideroxylon*, Caley's Ironbark *E. caleyi* and Black Box *E. largiflorens*, (if it flowered in winter) are commonly described as flora on which bees became severely infected with nosema. However, beekeepers usually based their decision to move onto these trees on the nutritional condition of their bees prior to the considered move. For example, experienced beekeepers would rarely move bees from an autumn flow of Grey (Brown) Box onto a winter/spring flowering of White Box.

Control of Nosema

Short of feeding fumagillin, there is no real control for nosema. Beekeepers working areas where nosema is likely to be a problem pay particular attention to nutrition, both pre and post winter honey flows.

Wax Moth

The wax moth is a pest of stored combs. Occupied hives, unless very weak, have no problem with wax moth. Italian bees are particularly aggressive towards moths.

Both the greater wax moth *Galleria mellonella* and lesser wax moth *Achroia grisella* are present in Australia but *G. mellonella* is the most common and most destructive, and is what is generally meant by the term wax moth. Unless otherwise indicated, these notes refer to *G. mellonella*

Life Cycle

Female moths lay about 300 eggs on bee combs or in cracks in the hive woodware. Eggs are small, white, and are very difficult to see. They hatch in about a week outside the hive, but in a few days in the warmer conditions of the hive.

Larvae are white and about 1 mm long. They take their first meal of honey or pollen and then burrow from the surface of the comb down to the midrib. Then they tunnel through the comb, feeding on honey, pollen, beeswax, and the general debris which remains in the comb after brood rearing. Their tunnels are lined with silk and spotted with faecal pellets. Damage to the comb is rapid and it soon becomes crisscrossed with silken tunnels. Ultimately the entire substance of the comb is reduced to a mass of frass and debris.

The time wax moths spend in the larval stage varies considerably. In cold conditions or when there is a shortage of food it may be as long as six months, but in warm conditions and with abundant food larvae may become fully grown in as little as four weeks. It is in such conditions that the damage to combs is greatest.

When fully grown, greater wax moth larvae are up to 28 mm long. At this stage they move to a wooden part of the hive to pupate. Bee spaces, especially at the end or top bars of frames, are most often chosen. Before pupation, greater wax moth larvae each gnaw a shallow depression in the wood. A large number of these can seriously weaken frame end bars.

Pupation takes place in a silken cocoon, with many cocoons clustered together. The pupal stage of the greater wax moth lasts about 10 days in warm conditions.

Lesser wax moth larvae also pupate in silk cocoons, but singly rather than in the large congregations of the greater wax moth. Pupal cocoons may be found throughout the hive, especially in sacking hive mats. Pupation takes about 16 days in warm conditions.

Distribution

Although wax moth can cause extensive damage throughout most of Australia the generally warm conditions for much of the year in the top end of the Northern Territory, Queensland and north-eastern NSW are ideal for wax moth breeding whereas the relatively cool climate in Tasmania means that wax moth is less important in that state.

Beekeeping practices also influence the severity of the wax moth problem. It is not so serious in Western Australia because boxes and frames are usually used on a regular basis, leaving little time for wax moth to take hold. In the principal beekeeping areas of the eastern states however, honey flows are less regular and in some seasons supers are not rotated regularly enough to minimise wax moth infestation. Thus it is probable that from time to time beekeepers will have a large number of combs in storage during the warmer months, posing a challenge to control methods.

Control Methods

As the older and darker the comb the more prone it is to deprivation of wax moth, sorting combs to establish priority for treatment is, in theory, an advantage. In practice it may be too time consuming.

Chemical Control

Phostoxin is registered at application dose rate of 1.5 tablets/m³ under the brand names of SANPHOS, NUFARM/PESTCON and trade names FUMIGATION TABLETS and FUMITOXIN respectively in New South Wales, Queensland, Victoria, South Australia, Tasmania, Western Australia and the Australian Capital Territory and the Northern Territory, "for the control of the Larger Wax Moth and the Lesser Wax Moth in Beehives and Equipment". The major problem with this chemical is that airtight conditions are required if all stages of wax moth are to be killed. These cannot always be easily achieved and therefore reduces the effectiveness of phostoxin in the industry.

Beekeepers commonly wrap stacks of supers (on which phostoxin has been placed) in polythene sheeting joined and sealed with adhesive packaging tape.

Paradichlorobenzene (PDB) is also registered in Queensland for the control for wax moth.

Non-chemical Control

The preferred option of many beekeepers is to build cold rooms to provide a form of control that does not depend on toxic chemicals. Maintaining cold rooms at below 4ºC will protect combs from wax moth damage indefinitely, but the moth will become active again when combs are removed from the cold room. Drop the temperature to -7ºC for 4.5 hours and all stages of the wax moth life cycle will be killed. The same result will be achieved at -12ºC for 3 hours or -15ºfor 2 hours.

Some beekeepers have purpose built cold rooms capable of holding several thousand boxes whereas others use shipping containers fitted with a refrigeration unit.

Heat will also kill all stages of the wax moth, however the high temperatures required; 46ºC for 1.3 hours or 50ºC for 40 minutes, present a generally unacceptable risk.

Chemical free control may also be attempted with one of the insect-attracting light devices. One type electrocutes the adult moths attracted to the ultra-violet light and is generally known as a "Zapper". Another type attracts the moths into the device where they drown in a tray of water and is sold under the name of "Bug Eater".

Small Hive Beetle

The Small Hive Beetle (SHB) *Aethina tumida* Murray, is new to Australia and at the time of writing the local industry has little experience with the pest. It was identified in colonies in the Hawkesbury/Richmond area near Sydney late in 2002 and was probably present in the area for a year or so before that. It has since spread, in migrated hives, to several other parts of New South Wales and to parts of Queensland.

In the circumstances, eradication of the exotic pest was not an option, although its spread is being monitored. The SHB is a Notifiable Disease in NSW at least.

To date, information from the literature, including details of the pest's life cycle, is not being reflected in the SHB's behaviour in Australia.

Information for this section has been gleaned from a number of sources. Material on the insect's habits and life cycle is from a draft paper for AUSVETPLAN prepared by Russell D Goodman in Apri1 2000. Information on the observed behaviour of the pest since it was discovered in Australia has been supplied by Bruce White, NSW Agriculture; Keith McIlvride, HBRDC and from discussion with beekeepers.

From the Literature

The small hive beetle is a native of Africa where it is considered to be a secondary apiary pest and a nuisance in African races of bees. In 1998, the beetle was recorded in Florida, USA. It has since spread to a number of other US States and is considered to be a major pest of *Apis mellifera* colonies and beeswax combs. Some early reports from Florida and South Carolina suggest the beetles may be more damaging there than in Africa.

Both adult beetles and larvae infest hives where they feed on honey and pollen. The larvae have been reported to eat honeybee eggs. Larvae can severely damage and foul both honey and brood combs. Honey in combs infested by SHB larvae spoils. It ferments and gives off an odour like sour oranges. Similarly, stored supers of honey such as those in honey extracting plants or extracted combs can also be ruined by infestation by adult beetles and larvae. It is thought they eat dead and squashed bees caught in combs and supers in extracting plants. Their tunnelling can kill honeybee brood and in some cases bees will cease brood rearing.

The repellent coating caused by the small hive beetle larvae apparently causes bees to abandon severely infested combs and they may abscond from the hive if the brood nest is heavily infested (Pettis and Shimanuki 2000). Beetles can destroy strong honeybee colonies in a matter of weeks. Feral colonies are also susceptible.

The primary damage to colonies and stored honey caused by the small hive beetle is through the feeding activity of the larvae. Hives and stored equipment with heavy infestations of beetles have been described as a mess. A summary taken from various reports of damage caused by these beetles is listed below:

- Larvae tunnel through comb with stored honey or pollen, damaging or destroying cappings and comb
- Larvae defecate in honey and the honey becomes discoloured from the faeces
- Activity of the larvae causes fermentation and a frothiness in the honey; the honey develops a characteristic odour of decaying oranges
- Damage and fermentation cause honey to run out of combs, creating a mess in hives or extracting rooms
- Heavy infestations cause bees to abscond; some beekeepers have reported the rapid collapse of even strong colonies

The preferred diet of the small hive beetle is associated with active beehives and apiary products. However, recent studies (Eischen *et al.* 1999) have demonstrated that the beetle can develop normally and complete all life-cycle stages feeding on fruit such as avocado, cantaloupe and grapefruit. Beetles also fed on bananas, pineapple, grapes and mango.

Life Cycle

Female *A. tumida* lay irregular masses of eggs near or on beeswax combs within the hive and also in stored combs. Cells that contain pollen, or cells adjacent to them, are often preferred. Egg development may take 1-6 days but more commonly 2-3 days (Lundie 1940). Larvae mature within 10-14 days, but sometimes up to 24 days. The majority of pupation occurs in sandy soil at a depth of 1-10 cm and within 30 cm of the hive (Pettis and Shimanuki 2000). In the USA, it is reported that "severe damage seems to be limited to coastal areas with light sandy soils" (Wenning 2001). Adult beetles emerge after a period of 15-60 days (generally 3-4 weeks). In South Africa complete development (egg to adult) takes 38-81 days and 5 generations per year are possible during the warmer months.

Adult beetles mate soon after emergence. Young females begin laying eggs approximately one week after emergence. Early maturing beetles are generally larger than slow maturing individuals. Adult beetles may live as long as 27 weeks (Lundie 1940) and may survive as long as five days without food and water (Pettis and Shimanuki 2000).

The beetle breeds rapidly. Two or three beetles in a stack of supers containing honey and/or pollen are sufficient to cause a heavy infestation of larvae in a relatively short period.

Local Experience

The first and most critical observation is that, to date at least, the SHB has not caused any serious damage where it has been found in Australia. This fact alone probably explains why it took so long to recognise the pest. Beekeepers occasionally saw an apparently harmless beetle or two in their hives. They saw a few more after rain, when the humidity was high, but otherwise sightings were sporadic.

To date there have been few reports damage to stored material. Even in dead-out material in the field, SHB larvae were doing less damage to the combs than the same number of wax moths would have been expected to do.

In those instances where damage has occurred, the larvae of the SHB appear to have been seeking protein. Brood combs containing pollen and/or dead brood have been attacked while adjacent honey combs, whether full or stickies, have been ignored. White suggest that one possible explanation for the differences in damage to honey combs reported from the United States and that observed here is a particular difference in management practices between the two countries. In Australia the use of queen excluders is standard practice and combs above the excluder contain little pollen. In the USA it is not common practice to employ queen excluders. Bees are encouraged to breed up and supers are added to accommodate the large brood nest. The honey flow forces the colony to contract its brood nest and pollen may be expected to be found in combs of honey that were formerly brood combs or were adjacent to the brood nest.

It is much more likely to find SHBs in weak, diseased or queenless colonies that in normal healthy ones.

Reproduction

Reproduction of the SHB in Australia is not understood. It is not conforming to patterns described in the literature. For example White reports that[41]:

> *One beekeeper with SHB dug up the ground around 50 colonies and found no evidence of reproduction; one of our inspectors dug around twelve colonies and found no reproduction.*

White wonders whether Australia's large population of many ant species is acting as a biological control agent keeping reproduction low.

It is clear from beekeeper observations that healthy colonies of bees appear to be controlling infestations of SHB and that even when some damage does occur bees can expel the beetles and repair any damage.

[41] White Bruce R, (2003) Australasian Beekeeper 104:7 (289)

Feral Colonies

SHB has been found in feral colonies and has been observed to be reproducing, pupation occurring in composted material on the floor of the nest site. Beetles apparently take advantage of area of the nest site inaccessible to bees. It is therefore possible that SHB may cause more damage to feral colonies than to managed ones.

Control Measures

At present, protecting stored combs by refrigeration, as for wax moth, appears to be effective – but experience is limited. The recommended application of Phostoxin for the control of wax moth (see above) reportedly kills SHB larvae.

Adopting good beekeeping practice seems to be the only non-chemical practice likely to minimise damage caused by SHB.

The National Registration Authority Australian has issued the Honey Bee Industry Council with a permit to allow beekeepers to use FARMOZ PERMEX EC RESIDUAL INSERCICIDE, plus all other registered products containing 5OOg/L PERMETHRIM as their only active constituent, to treat soil where the SHB are likely to reproduce.

It is recommended that producers consult their Department of Agriculture or equivalent before attempting chemical treatment. The chemical is expensive and quite heavy application rates are recommended.

Research

The Honey Bee Research and Development Committee, CSIRO and the University of Western Sydney (Hawkesbury); along with NSW Agriculture are expected to undertake further research into the problem of SHB.

The Australian Honey Bee Industry Council and the Honey Bee Research and Development Committee are financing a fact-finding mission to the USA in 2003.

The infestation of *A. tumida* in Australia is being monitored.

Ants

The ubiquitous ant is a common pest of bees in many areas, particularly the drier regions.

In the past ants have largely been controlled by poison or pesticides, a practice that is no longer environmentally acceptable. As well, in many of the areas where ants cause the most problems, some landholders are producing certified “organic” product and will not tolerate pesticides or poisons being used.

In the meantime, beekeepers choose sites as far from ants as possible – or at least sites with few nests. The significant losses that ants may cause have stimulated the development of a variety of stands to make the bees in hives inaccessible to ants. One of the most successful ideas is the use of beehive stands where the legs are placed in pots of oil. This prevents the ants from crawling up the legs. Unfortunately it is impractical for most commercial beekeepers.

A campaign is presently under way in Brisbane to eradicate an infestation of the Red Imported Fire Ant, *Solenotsis invicta*. Experience in the United States indicates that the ant is more of a pest of beekeepers than of bees. Indications are that the ants will cause serious damage to the indigenous fauna should the eradication campaign fail.

Cane toads

The cane toad, *Bufo marinus* is a major problem for beekeepers along the coast of Queensland and a lesser problem on the far north coast of NSW. The cane toad is becoming a pest in the Northern Territory around Katherine and is reportedly spreading.

The toads have voracious appetites and have developed a liking for bees in their diet. Apiarists consider that the safest way to protect bees from this pest is to place the hives on stands.

These stands are made of timber or steel pipe and usually carry two hives. The legs of the toad stands fold under the frame for travelling, while the legs of the timber stands are usually dismantled from the frame. The legs splay out so that the stands are stable. The hives usually have to be up to 500mm off the ground for the bees to be safe from the toads.

A recent newspaper report[42] said:

> *Scientists are about to test a virus that could rid Australia of the cane toad. CSIRO researchers have isolated genes that aid tadpoles development into cane toads, and have identified a virus they hope will prevent the tadpoles' development.*

Bee Louse

The Bee Louse, *Braela coeca* occurs in Tasmania, but not on the Australian mainland.

These insects may occasionally be found on worker bees and drones, but they mainly infest queen bees. As a rule the adult louse does little damage, although it may eventually cause the death of the queen. It is not a true parasite, but feeds on the nectar or honey which it extracts from the mouth parts of its host. The greatest damage is caused by the larvae burrowing in the cappings of honeycombs.

In Tasmania the louse is widespread and commonly encountered. *B. caeca* is considered harmless by most beekeepers. Beekeepers consider that the louse may aggravate the queen and despoil comb when developing to the adult form.

Rainbow Bee Eater

The Rainbow Bee Eater, *Merops ornatus,* is a serious pest of bees in the Northern Territory and the tropical north of Australia generally. The bird is often a nuisance in other regions, particularly to queen rearing operations.

The birds migrate north in the winter, which coincides with the dry season there. Bellis reports[43]:

> *The birds migrate from southern Australia to northern Australia and some go beyond to PNG and eastern Indonesia and return to southern Australia in August/September to breed. Huge numbers travel through Torres Strait during these migrations.*

In the tropical north the presence of large numbers of the birds can force bees to remain in their hives for most of the day. Hundreds of birds can be present in or near apiaries.

During summer months the birds can be found in many parts of Australia and are often blamed for eating young queens that are on their nuptial flight.

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[42] "Last croak looms for cane toads" August 5 2002 Sydney Morning Herald.
[43] Glen Bellis, (2002), personal communication.

Exotic Diseases and Pests

Varroa

The greatest threat to beekeeping in Australia is probably the species of Varroa mite known as *Varroa destructor* (known henceforth in this item simply as Varroa). Australia is one of the few countries free from Varroa. It was found in the north island of New Zealand in early 2000, so it is close.

Although the Varroa mite is a native parasite of the Asian honeybee *Apis cerana*, *V. destructor* can infest the European honeybee. While the Asian honeybee can tolerate the mite, the European honeybee cannot.

Overseas experience suggests that should Varroa become established in Australia it would spread rapidly and would, within two or three years, kill most colonies not being treated with an appropriate acaricide. Treatment is expensive both for the purchase of the acaricide and for the additional labour involved. Exports of queen bees and package bees could be affected.

The effects of Varroa on the Australian industry would be overwhelmingly bad. Never the less some benefits could accrue. For example neglected and abandoned apiaries that presently may constitute a source of infection from American foulbrood would soon perish and be destroyed by wax moth, as would most feral colonies. With feral colonies gone the incidental pollination service that they provide would also disappear and perhaps more farmers and horticulturists would be obliged to pay for pollination by managed hives.

Other Mites

Tropilaelaps

The mite *Tropilaelaps clareae* may be more of a problem than even Varroa, if it ever reaches our shores. It is about half the size of *Varroa destructor* and even more deadly. Its native host is the Giant Honey Bee *Apis dorsata* but it is able to transfer to *Apis mellifera*. The treatment for Tropilaelaps is similar to that for Varroa.

Tracheal Mite

The tracheal mite *Acarapis woodi*, is the cause of what was previously known as Acarine Disease, or Isle of Wright Disease. The mite infests the trachea of the bee and slowly weakens the host, eventually killing it, or at least causing its premature death. Colonies may die when the infestation is acute. The disease is not as dramatic in its effect as the mites mentioned above. European honeybees have considerable tolerance to the mite, which is reportedly more of a problem in cooler climates. Hence, the mites are not a problem in the southern states of the USA, but they are in the northern states.

9. Appendices

Appendix I: Agencies

Commonwealth Agencies

Agriculture and Resource Management Council of Australia and New Zealand's Australian Veterinary Emergency Plan (AUSVETPLAN)
Website: www.aahc.com.au\ausvetplan

Australian Quarantine Inspection Service, GPO Box 858 Canberra 2601
Phone: 02 6272 3933. E-mail: aqis.contact@aqis.gov.au
Website: www.aqis.gov.auand

Rural Industries Research & Development Corporation (RIRDC), PO Box 4776 Kingston ACT 2604
Phone: 02 6272 4539. E-mail: rirdc@rirdc.gov.au
Website: www.rirdc.gov.au

State and Territory Agencies

Australian Capital Territory

Environment ACT, PO Box 144 Lynham ACT 2602
Phone: 02 6207 9777. E-mail: environmentACT@act.gov.au
Website: www.environment.act.gov.au

Contact Officer
Lara Zambelli, Licensing Officer, Environment ACT
Phone; 02 6207 6376. E-mail: lara.zambelli@act.gov.au

New South Wales

NSW Agriculture, Locked Bag 21 Orange NSW 2800
Phone: 02 6391 3100. E-mail: nsw.agriculture@agric.nsw.gov.au
Website: www.agric.nsw.gov.au

Advisory staff
Bruce White, Technical Specialist – Apiculture. Locked Bag 11 Windsor NSW 2756.
Phone: 02 4577 0600. E-mail: bruce.white@agric.nsw.gov.au

John Rhodes, Apiary Officer, RMB 944 Calala Lane Tamworth NSW 2340.
Phone: 02 6763 1222. E-mail: john.rhodes@agric.nsw.gov.au

Doug Somerville, Apiary Officer, PO Box 389 Goulburn NSW 2580.
Phone: 02 4828 6619. E-mail: doug.somerville@agric.nsw.gov.au

Diagnostic Services & Research
Michael Hornitzky, Principal Research Scientist, Elizabeth Macarthur Agricultural Institute, PMB 8, Camden NSW 2570.
Phone: 02 4640 6311. E-mail: michael.hornitzky@agric.nsw.gov.au

Regulatory Staff
Mick Rankmore, Regulatory Specialist, Apiaries, PO Box 546, Gunnedah NSW 2380
Phone: (02) 6742 9274. E-mail michael.rankmore@agric.nsw.gov.au
(For information concerning local regulatory officers contact the nearest office of NSW Agriculture or Mick Rankmore.)

Northern Territory

Department of Business, Industry and Resource Development
GPO Box 3000, Darwin NT 0801
Phone: 08 8999 2311. E-mail: dpif@nt.gov.au
Website: www.dme.nt.gov.au/ and www.nt.gov.au/dbird/dpif

Advisory Staff
Vicki Simlesa, Berrimah Agriculture Research Centre, Cnr of Strath and Makagon Rd, Berrimah NT 0828
Phone: 08 8999 2063. E-mail: vicki.simlesa@nt.gov.au

Regulatory Staff
Kel Small, Regional Veterinary Officer, Primary Industries and Fisheries, GPO Box 3000, Darwin NT 0801.
Phone: 08 8999 2311. E-mail: kel.small@nt.gov.au

Queensland

Queensland Department of Primary Industries, GPO Box46, Brisbane Qld 4001
Phone: 07 3239 3020.
Website: www.dpi.qld.gov.au

Advisory Staff
Peter Warhurst, Senior Apiary Officer, PO Box 231 Warwick Queensland 4370
Phone: 07 4661 1733. E-mail: warhurp@dpi.qld.gov.au

Research Staff
Hamish Lamb, Apiary Experimentalist, PO Box 5165 SCMC Nambour Queensland 4560
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South Australia

Primary Industries and Resources, South Australia. GPO Box1671 Adelaide SA 5001
Phone: 08 8226 0222
Website: www.pir.sa.gov.au

Advisory Staff
Elena Petrenas, Project Manager, GPO Box1671 Adelaide SA 5001
Phone: 08 8207 7976. E-mail: petrenas.elena@saugov.sa.gov.au

Michael Stedman, Apicultural Adviser, 33 Flemington Street Glenside SA 5065
Phone 08 8207 7975. E-mail: stedman.michael@saugov.sa.gov.au

Tasmania

Department of Primary Industries, Water and Environment, GPO Box 44 Hobart Tas 7001.
Phone: 03 6233 8011 or 1300 368 550.
Website: www.dpiwe@tas.gov.au

Regulatory Staff
David White, Stock Officer, Department of Primary Industries, Water and Environment PO Box 303 Devonport, Tas 7310.
Phone: 03 6421 7635. E-mail: David.White@dpiwe.tas.gov.au

Victoria

Department of Natural Resources and Environment, PO Box 500, East Melbourne, Vic 3002.
Phone: 03 9637 8000. E-mail: customer.service@nre.vic.gov.au
Website: www.nre.vic.gov.au

Scientific Staff
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Regulatory and Advisory Services
Peter Kaczynski, Senior Apiary Inspector, Department of Natural Resources and Environment, Shire Hall, Barkly Street, Ararat VIC 3377.
Phone: (03) 5352 1042. E-mail: peter.kaczynski@nre.vic.gov.au

(Contact details for other apiary inspectors may be obtained from either Russell Goodman or Peter Kaczynski.)

Western Australia

Agriculture Western Australia, Baron-Hay Court, South Perth WA 6151
Phone: 08 9368 3333.
Website: www.argic.wa.gov.au

Research Staff
Rob Manning, Project Manager, Agriculture Western Australia, Baron-Hay Court, South Perth WA 6151
Phone: (08) 9368 3567. E-mail: rmanning@agric.wa.gov.au

Regulatory Staff
Bill Trend, Senior Apiculturist, Agriculture Western Australia, Baron-Hay Court, South Perth WA 6151
Phone: 08 9368 3535. E-mail: btrend@agric.wa.gov.au

Appendix II: National Beekeeper Organisations

Australian Honey Bee Industry Council (AHBIC), PO Box R838 Royal Exchange NSW 1225
Phone: 02 9247 1180. E-mail: ahbic@honeybee.org.au Web site: www.honeybee.org.au

Federal Council of Australian Apiarists' Associations, 38 James Street, Ulverstone, 7315
Phone: 03 645 2089. E-mail: hayton@southcom.com.au

Australian Queen Bee Breeders' Association, MS 825, Middle Road Peak Crossing Qld 4306
Phone: 07 3206 1200. E-mail: queenbee@gil.com.au

National Association of Crop Pollination Associations, PO Box 72 Westbury Tas 7303
Phone: 03 6393 1135. E-mail tashives@tpg.com.au

State and Territory Producer Associations

New South Wales Apiarists' Association Inc, PO Box 352 Leichhardt NSW 2040
Phone: 02 9798 6240. E-mail: honeybee@accsoft.com.au

Northern Territory Beekeepers' Association, PO Box 759 Howard Springs NT 0835
Phone: 08 8988 9057. E-mail: nthoney@optusnet.com.au

Queensland Beekeepers' Association Inc, PO Box 49 Mapleton Qld 4560
Phone: 07 5445 7512. E-mail: qba@hypermax.net.au

South Australian Apiarists' Association, PO Box 87 Auburn SA 5451
Phone: 08 8849 2075. E-mail: saaa@rbe.net.au

Tasmanian Beekeepers' Association, 16826 Bass Highway, Flowerdale TAS 7325
Phone: 0364423916

Victorian Apiarists' Association, PO Box 40 California Gully, Vic 3556
Phone: 03 5446 1455. E-mail: vaainc@netcon.net.au

Western Australian Farmers' Federation (Inc.) Beekeepers Section, PO Box 6291 East Perth WA 6892
Phone: 08 9325 2933. E-mail: lucybeckwith@waff.org.au Web site: www.waff.org.au

Commercial Beekeepers' Association WA, PO Box 1515 Midland WA 6056
Phone: 08 9296 4008. Fax (08) 9296 4284

Journals

Honeybee News, PO Box 352 Leichhardt NSW 2040
Phone: 02 9798 6240. E-mail: honeybee@accsoft.com.au

The Australasian Beekeeper, 34 Racecourse Road Rutherford NSW 2320
Phone: 02 4932 7244. E-mail: pendersmaitland@bigpond.com

The Australian Bee Journal, PO Box 40 California Gully, Vic 3556
Phone: 03 5446 1455. E-mail: vaainc@netcon.net.au

Appendix III: Acknowledgements

Between March 1990 and March 1996 the then Honeybee Research and Development Committee (HBRDC) produced a series of reports on commercial beekeeping. One report was prepared for each State in the Commonwealth. The authors of the reports visited each State and interviewed commercial beekeepers, Government officials and industry leaders.

This report is loosely based on the information contained in six documents mentioned above, but incorporates a good deal of additional information garnered from industry sources throughout Australia. The information was supplied by telephone, mail and e-mail. The only visit involved was to the Northern Territory, which was not visited by the authors of the original six reports.

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Lara Zambelli, Environment ACT

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Margaret Blunden, NSWAA, Haberfield
Bob Colton, NSW Agriculture, Orange
David Fuller, NSW Agriculture, Windsor
Michael Hornitzky, NSW Agriculture, Camden
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Victoria
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Western Australia
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Peter Cash, Manufacturer, Riverton
Colin Ingram, Conservation & Land Management, Perth
Rob Manning, Agriculture Western Australia, Perth
Ed Planken, Wescobee, Bayswater

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For more information on the Honeybee Program contact:

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