A SURVEY OF MYXOMATOSIS AND RABBIT INFESTATION TRENDS IN THE EASTERN RIVERINA, NEW SOUTH WALES, 1951–1960

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[*Manuscript received August* 14, 1961]

Summary

Broad trends in rabbit infestation and myxomatosis outbreaks in the eastern Riverina of New South Wales during the period 1951–60 are described.

After reaching a very low level in 1956 rabbit infestation is increasing again. Infestation over the past eight years has been limited to a small proportion of the region as a whole.

During the early 1950's most outbreaks of myxomatosis occurred during the spring and summer months. From 1954 onwards there was a large increase in winter outbreaks. During the last few years the trend appears to have reversed again.

Control efforts and methods vary according to the level of infestation prevailing in the region.

I. Introduction

Myxomatosis has now been enzootic among the wild rabbit, *Oryctolagus cuniculus* (L.), population of south-east Australia for more than 10 years. The remarkable decrease in numbers of rabbits that followed the great epizootics of the early 1950's is now history and forms the subject of papers and reports too numerous to mention (see A.N.Z.A.A.S. 1955; C.S.I.R.O. Aust. 1959).

Shortly after the first major outbreaks of myxomatosis (Ratcliffe *et al.* 1952) consideration was given to methods of assessing on a broad scale long-term trends in disease performance and rabbit population distribution in the eastern Riverina, to complement more intensive studies at specific localities (Myers, Marshall, and Fenner 1954; Fenner *et al.* 1957). The method finally adopted consisted of a brief annual survey of three localities, each of approximately 100 square miles, which included within their boundaries representative samples of the major habitat types in the region.

Climatically, the eastern Riverina falls within a winter-rainfall–summer-drought zone. It is bounded along its eastern and southern margins by the foothills of the Great Dividing Range which in this region have an average elevation of 1500 ft above sea level and an average annual rainfall of 30 in. To the north and west the foothills give way to the Western Plains, which have an average elevation of about 500 ft above sea level. The average annual rainfall decreases steadily with distance from the hills until it reaches 16 in. in the north-west corner of the region studied. The region is dissected by one large river, the Murray, which is usually in flood in late winter and spring (July to November), and by its tributary creeks (Fig. 1).

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One of the three areas was selected among the foothills of the Dividing Range close to Albury (Albury area), another on the plains away from the Murray River (Urana area), and the third also on the plains but bordering the river (Corowa area). The Albury area contained 30 properties of average size 2130 acres (range 130–4000 acres), the Urana area 14 properties of average size 4570 acres (range 2400–17000 acres), and the Corowa area 46 properties of average size 1390 acres (range 160–3000 acres).

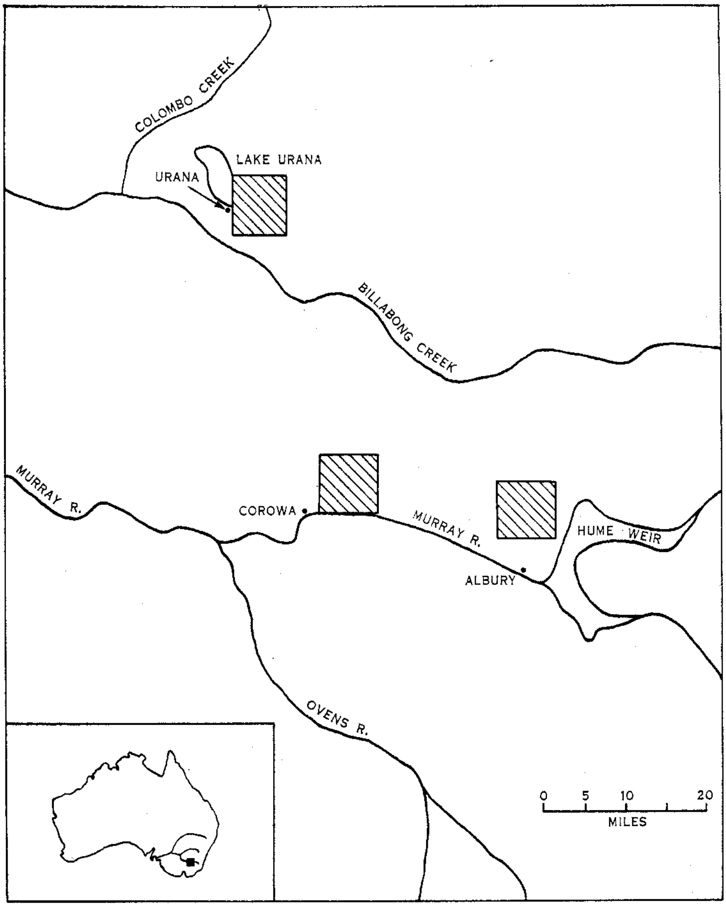

Fig. 1.—Location map of the three areas surveyed.

The properties in each locality were selected completely at random. Commencing in April 1951, each property was visited once a year during the autumn months, and details of outbreaks of myxomatosis and variations in the numbers and distribution of rabbits were obtained from the occupiers. During the first visit each property was completely surveyed, the extent of the various broad categories of habitat and the numbers and distribution of rabbits measured, and the individual farmers were instructed in the kind of information required. The same properties were visited each year.

No attempt was made to obtain accurate measurements of rabbit population density. From experience gained in intensive studies elsewhere (Myers 1954; Myers, Marshall, and Fenner 1954) three categories of infestation were devised.

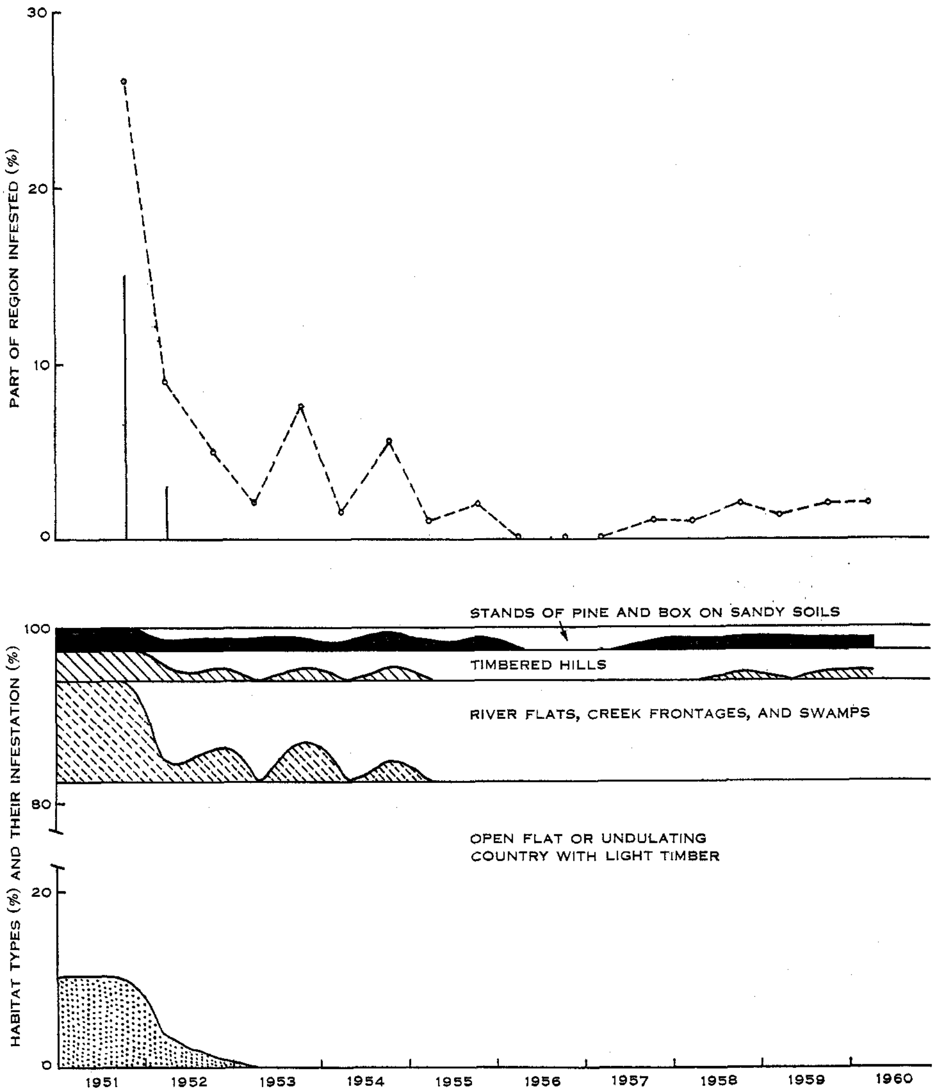

Fig. 2.—Rabbit infestation trends in the Corowa area, 1951–1960, showing relationships with habitat. Graphs of infestation represent sum of areas of high and medium density populations; areas of high density are shown by histograms. The shaded portions in the lower part of the Figure indicate areas infested by rabbits.

The term "high density" was used in reference to rabbit populations whose activities were obviously affecting the state of the pastures over large areas. Such populations were represented by the widespread, heavy infestations of rabbits typical of a large sector of the Australian countryside at the end of the 1940's. The term "medium density" was used to describe populations of rabbits showing a local and clumped distribution but not in large numbers, and "light density" to describe populations of occasional scattered rabbits. In practice, the use of these descriptive terms was found adequate for our requirements.

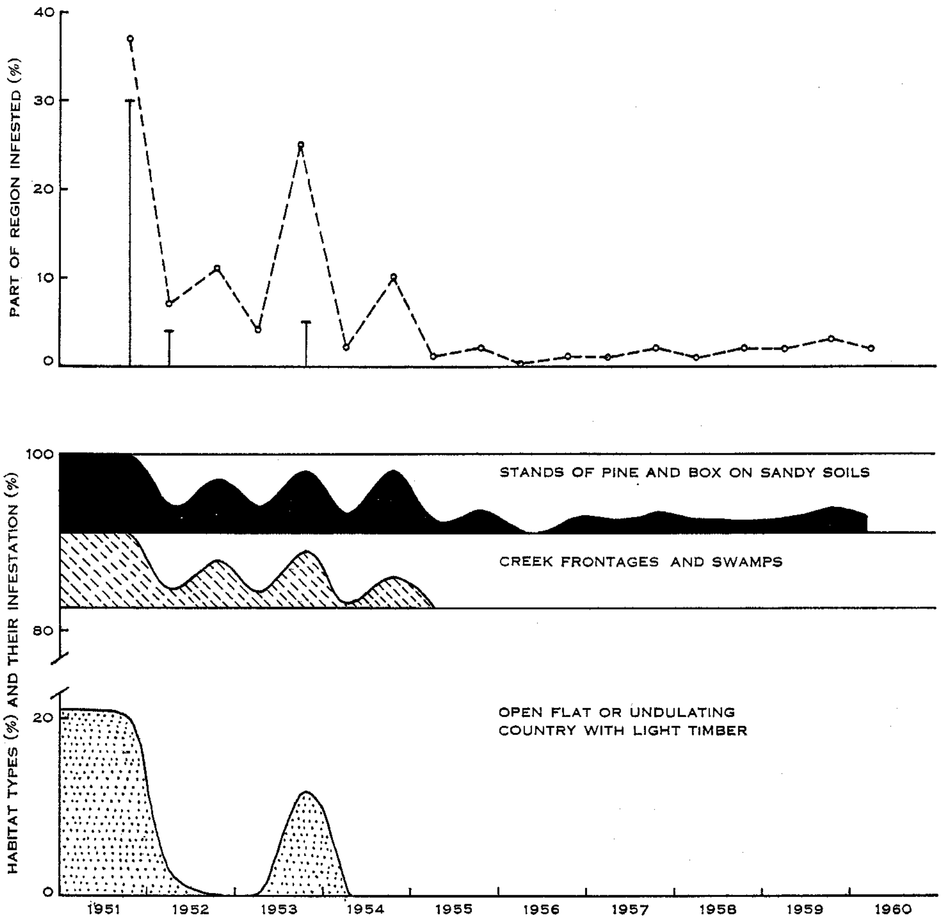

Fig. 3.—Rabbit infestation trends in the Urana area, 1951–1960, showing relationships with habitat. Graphs of infestation represent sum of areas of high and medium density populations; areas of high density are shown by histograms. The shaded portions in the lower part of the Figure indicate areas infested by rabbits.

The broad classification and measurement of the types of habitat available for rabbits were also carried out superficially, based mainly on each landholder's knowledge of the size of his paddocks and the extent of various types of country and plant cover therein.

Some information was also collected on the methods of control used each year.

II. Results

(a) *Infestation Trends*

Most of the observations are presented in Figures 2, 3, and 4. In these diagrams areas of medium and high density have been combined to form the single graph "areas of infestation".

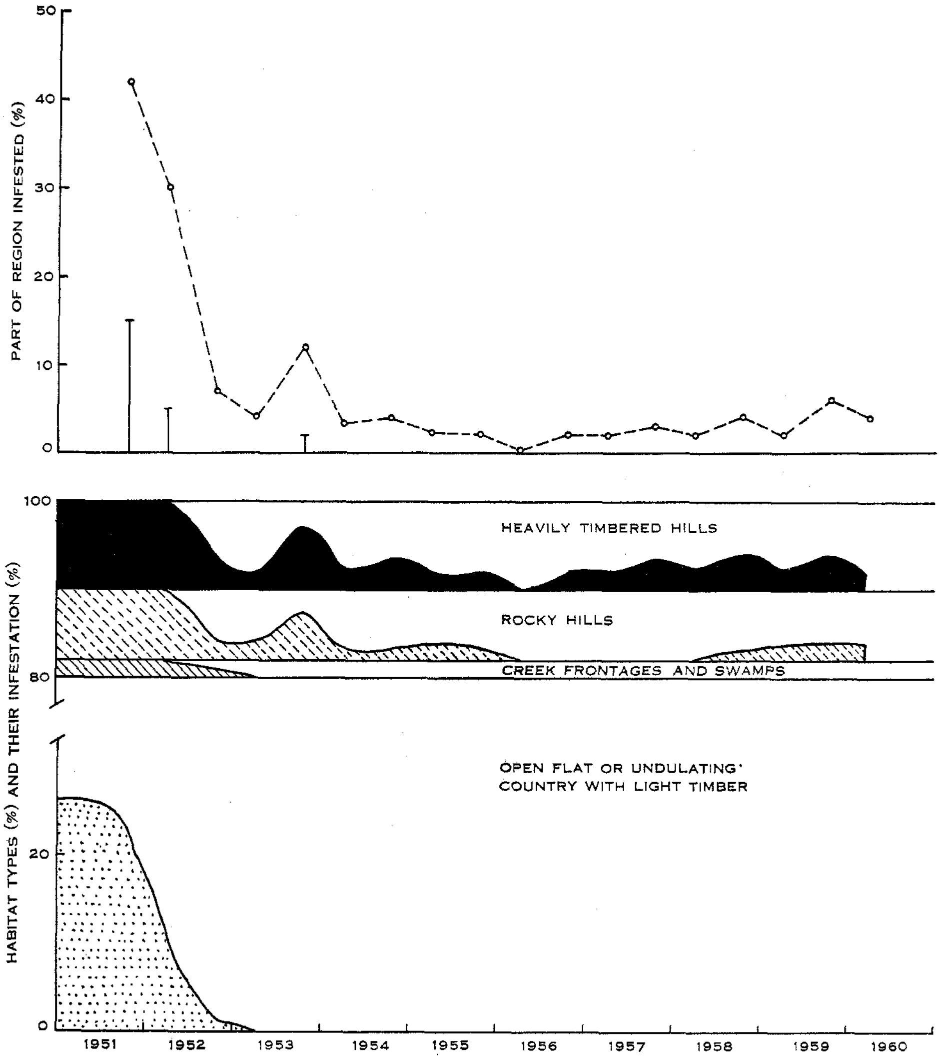

Fig. 4.—Rabbit infestation trends in the Albury area, 1951–1960, showing relationships with habitat. Graphs of infestation represent sum of areas of high and medium density populations; areas of high density are shown by histograms. The shaded portions in the lower part of the Figure indicate areas infested by rabbits.

When myxomatosis first swept through the region in 1950–51 nearly one-third of the countryside was rabbit-infested. The disease did not reach the Albury or Urana areas during the 1950–51 summers, and the graphs depict the conditions existing both prior to and following its advent. In the Corowa area myxomatosis had already been active along the river for 15 months before this survey was commenced. The graph of infestation was thus already on the down-turn when observations began.

In 1951 a large proportion of those areas infested by rabbits was inhabited by populations of high density. It was common at that time to see moving swarms of rabbits on many of the properties visited. The pastures on which they were grazing were poor and obviously overgrazed, with an almost complete absence of rye and clovers and with numerous weeds present.

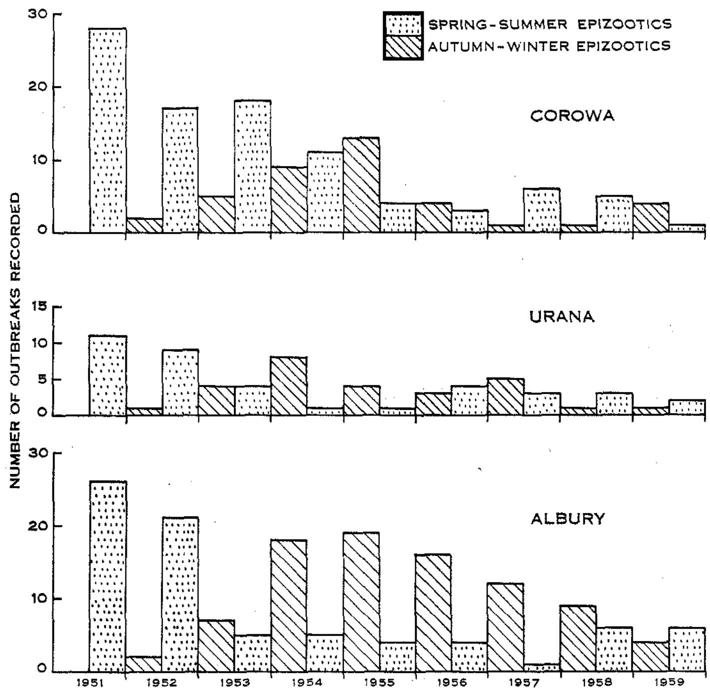

Fig. 5.—Numbers of outbreaks of myxomatosis recorded in the Corowa, Albury, and Urana areas during the spring–summer months and autumn–winter months, 1951–1959.

The level of infestation reached its lowest point in the three areas during 1956, and has shown a slight but steady increase ever since. No infestations of high density, however, have yet reappeared.

Approximately 80% of each area contains open farm lands with scattered trees. The rest of each area is occupied, in various proportions, by timbered and rocky hills, creek frontages and swamps, and stands of native pine, *Callitris columellaris* F. Muell., and box, *Eucalyptus* sp., on sandy soil. When myxomatosis first appeared, the hills, creek frontages and swamps, and pine areas were all heavily infested by rabbits, and rabbit populations had spilled out to cover a proportion of the open country. Within 3 years, because of the control efforts which followed the myxomatosis outbreak, the open country was cleared of rabbits and has remained so ever since. All of the infestation for the past 5–6 years has been confined to areas representing small proportions of the region as a whole, in particular timbered hills and stands of pine.

(*b*) *Myxomatosis*

It was not possible to obtain precise information of mortality levels due to myxomatosis in a rough survey of this type. Outbreaks of myxomatosis were common throughout the region in most years (Fig. 5). During the early 1950's, when rabbit density was still fairly high, epizootics were mainly restricted to the spring and

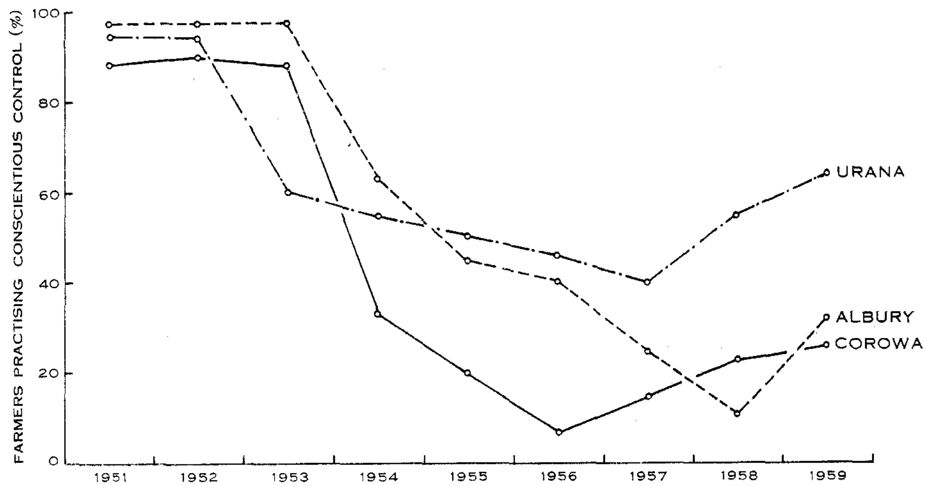

Fig. 6.—Numbers of landholders practising control of rabbits, 1951–1959.

summer months. During the middle years of the decade these were replaced to a large extent by autumn and winter outbreaks in light-density populations. Over the last two or three years there appears to have been a return to spring–summer outbreaks.

It appears likely that this trend is a reflection of vector activity in relation to host-population density. From 1951 to 1953 large rabbit populations attracted and held large vector populations (Myers, Marshall, and Fenner 1954). The lower numbers of rabbits present from 1954 onwards could have been unfavourable for the formation of local concentrations of mosquito vectors, lowered the chances of repeated feedings, and thus hindered successful transmission in any area. The autumn and winter outbreaks of the latter years were prolonged, low-level epizootics, probably reflections of ectoparasite activity and contact infection during the breeding seasons, when social activities lead to increased contact between individuals.

(*c*) *Control*

The efforts expended by landholders in the region to control rabbits are closely related to trends of rabbit infestation itself (Fig. 6).

During the early years of the 1950's almost every farmer made some attempt to limit the build-up of rabbits on his property. From 1954 to 1957, because of low rabbit numbers, attempts at control decreased greatly. From 1958 onwards rabbits tended to increase and the amount of control did likewise.

Methods of control have also shown distinct changes during the period under review (Fig. 7).

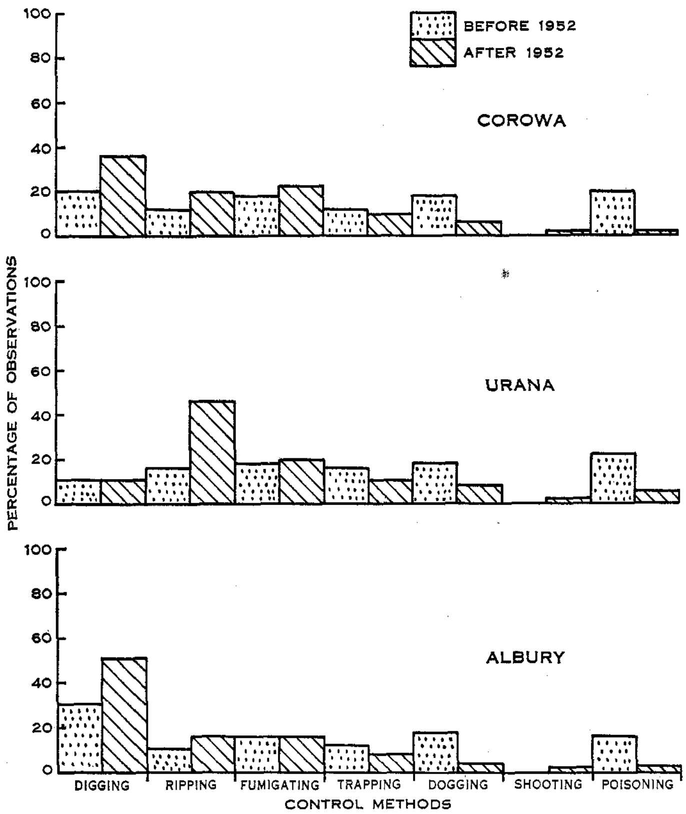

Fig. 7.—Control methods used by farmers before 1952, when rabbits were present in large numbers, and after 1952 in reduced populations of rabbits.

When myxomatosis first appeared and rabbits were in plague numbers over large areas in the region, the techniques for control used were numerous and varied. Poisoning was a lucrative profession carried on by individuals who hired their services to landholders. With the advent of myxomatosis, poisoning dissappeared as a major technique. The little poisoning that still takes place has been in response to official promotion of poison "1080", sodium fluoroacetate. The use of dog packs to hunt down rabbits or to drive them below ground prior to digging, ripping, or fumigating has likewise become a thing of the past. There has been a large proportional increase in ripping on the larger holdings, and in digging on the smaller.

Of the 30 farms in the Albury area seven were completely netted around their boundaries (one since 1950) and their owners were attempting to keep their boundaries intact. In the Corowa area 16 of the 46 farms were netted. None of the 14 farms in the Urana area was netted, although certain problem areas were fenced off. In this area of larger holdings it was generally stated that control was cheaper than netting. None of the 90 properties visited was completely free of rabbits. Most farmers appeared to be reluctant to carry control operations any further than necessary to satisfy legal requirements. Several landholders openly admitted the fostering of isolated rabbit colonies for both table use and dog food.

No attempt was made to obtain accurate information on costs of material and labour expended in rabbit control. Many landholders, however, volunteered information indicative of the trends prevailing. At Urana, several landholders whose annual control operations before 1951 used to cost £1500–2000 over a period of 4–6 weeks, now spend only £100–300 over a period of 2–10 days per year. At Albury, many landholders who used to spend over £200 per year now spend less than £15 annually. One Corowa landholder's books showed a decrease in the annual expenture on fumigant from £200 to £16. Many landholders are now spending nothing at all on rabbit control.

When this survey was completed in the autumn of 1960 only nine of the 30 men in the Albury area were attempting to control rabbits. The relative figures for Corowa are 12 out of 46 and for Urana eight out of 14.

III. Discussion

No special claims are made for the accuracy of the data presented here. The trends measured, nevertheless, appear to be real.

Rabbit infestation in the region reached its lowest point in 1956, after decreasing from plague proportions in 1950–51, and has since shown a slight but steady increase.

It is usually assumed that both the decrease in numbers and the continued depression of population have been due to myxomatosis alone. A small exercise in arithmetic throws doubt on this assumption.

Recent work (Myers and Poole, unpublished data) has demonstrated that a mean production of 30 young per adult female per year is likely to be somewhere near the maximum rate of increase to be expected in natural populations of rabbits in south-eastern Australia. The mean minimum rate is likely to be of the order of 10 young per female. Knowing that the myxomatosis case mortality rate dropped from 99·0% to approximately 90% after the first year (Myers, Marshall, and Fenner 1954) and assuming an annual turnover of breeding adults, by varying the mean annual rate of increase from 10 to 30 per female and the mortality rate from 50% to 90% it can be shown that:

(i) When the mean rate of increase is 30 young per female per year, annual mortality rates must greatly exceed 90% to suppress population growth.

(ii) When the mean rate of increase is 20 young per female per year, an annual mortality of 90% suppresses population growth. The population can grow in the face of any mortality less severe than this.

(iii) When the mean rate of increase is only 10 young per female per year, an annual mortality of 80% is necessary to supress population increase.

It is generally held that mortalities of the above orders due to myxomatosis are no longer to be expected. It seems probable, therefore, that the continuing low numbers of rabbits have been due to the effects of factors other than myxomatosis alone.

When considering rabbit infestation trends in the past decade in the light of recent intensive work (Myers and Poole, unpublished data) three years stand out as being unfavourable for population increase. The winters of 1954 and 1957 were very dry, pasture growth was delayed, and reproduction of rabbits throughout the region was affected by short breeding seasons. The winter of 1956 was extremely wet. Observations at that time showed that the mortality rate of nestling rabbits was very high. The first three years, 1951–53, were very favourable for reproduction, but during that period the case mortality rate of myxomatosis remained high. Thus for six years out of the nine studied, regional rabbit populations have been held in check by a combination of myxomatosis and seasons unfavourable either for reproduction or survival of young rabbits.

The graphs of infestation (Figs. 2–4) suggest that until 1955 the tendency for populations to recover was quite strong. The depression of infestation since then is most marked. It is not unlikely that the increased proportion of autumn–winter outbreaks has played a large part in keeping numbers low. Winter outbreaks automatically affect reproduction (Sobey and Turnbull 1956). There may also have been a considerable increase in case mortality rates owing to the effects of low temperatures on myxomatosis (Mykytowycz 1956; Marshall 1959). With the apparent rise in rabbit numbers and the swing back to spring–summer epizootics, mortalities due to myxomatosis may fall again and lead to a much more marked increase in numbers of rabbits during the years ahead.

The role of the mosquito vectors of myxomatosis in the eastern Riverina during the period under discussion has probably been overemphasized (Myers 1954). The seasonal changes in the occurrence of epizootics suggest a delicate balance between the densities of vector populations and those of their host food supply. With the crash in populations that followed the first great epizootics, local concentrations of winged vectors in areas away from their breeding places probably became non-existent. Spring–summer epizootics have been consistently recorded only along rivers and near water-holding swamps (e.g. Lake Urana). Apparently, over the later years, most transmission of myxomatosis has been due to ectoparasite activities and the close social contact between rabbits established during the breeding seasons (Myers, unpublished data).

The control of a pest species as ubiquitous and agressive as the rabbit calls for action of a kind alien to the individualistic nature of Australian landholders.

The regional effort to control rabbits rises and falls like a barometer with the pressure of rabbit numbers. During periods of high numbers most landholders effect some kind of control; usually with techniques that permit them, or their employees, to collect skins or carcasses for market in large numbers. The success of these methods is popularly measured by the numbers of animals actually picked up and counted. In years of low rabbit numbers, most landholders practise no control at all. During these periods control work is limited to the few farmers whose activities are directed sensibly towards preventing increases in rabbit populations. The techniques they utilize are not related to the numbers of rabbits collected. Thus ripping and fumigating replace trapping and poisoning. The fact that the new poison "1080" does not permit harvesting of skins was often quoted as a reason for not using it.

Killing animals in large numbers is not always conducive to control. A regional effort that intensifies in direct proportion to population growth becomes just another density-dependent factor the net effect of which is to help, rather than to hinder, the well-being of regional rabbit populations as a whole. This kind of activity, well entrenched in Australia, is a palliative, not a cure.

Regional rabbit populations are not distributed at random over all properties in a region. Rabbits do not respect the boundaries of individual properties (unless these are fully netted). The observations presented in this paper show that there are certain habitats within the region that remain perpetual refuge areas for rabbits in times of adversity. During good years the populations increase and spill out over the open and more valuable country. As a corollary, the rabbit problem in any region is not shared equally by all landholders. The small proportion of landholders whose properties happen to include large tracts of refuge areas within their boundaries carries the greatest burden for controlling rabbits in the region as a whole. Costs of control, however, are not shared, and instead of obtaining assistance from their neighbours the unfortunate owners of such properties are usually the subject of continual criticism and abuse, whether warranted or not.

It is not yet known why rabbits successfully survive in the refuge areas year after year. Such areas appear to offer maximum shelter from human and other predators, and as they are usually well drained, the rates of nestling mortality are low.

Rabbit control should be planned on a regional basis with the strategy of attack dictated by trained men, and based on a knowledge of the regional distribution of rabbit populations. The main attack should be directed always at refuge areas, and when rabbit numbers are low efforts should be increased, rather than diminished.

Despite myxomatosis, the rabbit is still a great potential threat to Australia's agricultural economy.

IV. Acknowledgments

The author is indebted to Messrs. C. S. Hale and E. Schneider, Wildlife Survey Section, C.S.I.R.O., for capable assistance during the survey.

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