PEST-MANAGEMENT CONCEPTS AND CONTROL OF TICK PARALYSIS IN BRITISH COLUMBIA

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ABSTRACT

Actual and potential methods for controlling and reducing paralysis of livestock and humans by the tick **Dermacentor andersoni** Stiles are analyzed, and assigned tentative "Geier ratings" of cost and effectiveness. Four broad categories of control are discussed: protection from toxins, prevention of engorgement, avoidance, and reduction in numbers of ticks.

Some control methods are undesirable because of their effects on the eco-system, including game animals. More information is needed on immunology of mammals to tick toxins and tick feeding, on variations and genetics of paralysing ability in ticks, on range management in relation to paralysis, on the effects of herbicides on rodents and ticks, and on life-table parameters of ticks and rodents.

Introduction

Recent thinking on pest-management considers not only pests which affect man's use of some resource but the entire eco-system in which the pests occur (Clarke *et al,* 1967). This raises questions whether man, or some section of society, is utilizing the resource in the best way, taking into account economic, aesthetic and other aspects. Complex problems of desirable aims and means have arisen, for instance, in managing "wilderness" parks, in the relation of sport fishing in New Brunswick to DDT spraying of pulpwood forests, and in the siting of airfields in or near favourite bird haunts. This paper reviews present and potential methods of control of tick paralysis in British Columbia from the point of view of effectiveness, costs, and resource management. Such broad reviews of narrow fields are published too rarely, but are necessary to indicate priorities in pest control, and to enlist the interest of workers in related fields of enquiry. The pest-management concept emphasizes selectiveness in control, and fitting control methods to the biology of the noxious species (Geier, 1966).

The Problem

Classical tick paralysis in British Columbia is caused by *Dermacentor andersoni* Stiles. Rich (1957) described cases of toxicosis of cattle caused by *Otobius megnini,* but these are distinct from the ascending paralysis due to *D. andersoni,* described by Gregson (1962) and others.

Tick paralysis of cattle is of major concern in many parts of the cattle ranching area, even though large outbreaks are less common than formerly (Gregson, 1966), doubtless due to the widespread adoption of annual backline spraying with BHC. The numbers of sheep in tick areas are declining, horses are rarely paralysed, and dogs usually recover because the owner removes the ticks, so that cattle are the most important species of livestock at risk. A few cases of human paralysis are reported each year to the Kamloops laboratory (Jellison & Gregson, 1950), and probably at least an equal number are not reported. Human fatalities, usually due to delay in removing the tick, still occur despite extensive publicity on the need for protective clothing and prompt removal of the ticks. Jellison and Gregson (1950) pointed out that girl children are more likely to be paralysed than boys because long hair tends to make a tick on the nape of the neck inconspicuous. Children on Indian reserves may tend to come in contact with tick foci more often than others, and records are now being kept to see whether these children provide a disproportionate number of paralysis cases.

Control Methods

Early hopes for control of *Dermacentor* ticks by Chalcid wasps were not fulfilled (Cooley and Kohls, 1934).

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Control measures recommended by entomologists [e.g. Hearle (1938), Neilson, Rich and Procter (1966), Neilson and Gregson (1967)] in British Columbia have been largely confined to reducing rodents, protecting cattle with acaricides, and protective clothing and de-ticking for humans. In contrast, in Australia, investigations by veterinarian Clunies-Ross and the Commonwealth serum laboratories, were directed towards curative measures applied to the paralysed mammal and in particular to the development of hyper-immune sera (Seddon, 1951).

The basic problem of *D. andersoni* on cattle in British Columbia is preventing paralysis. The main tick season, from late March to early May, is quite brief in the cattle areas and there is little indication that ticks are ever present in sufficient numbers to cause irreversible weight losses or other damage in the cattle.

Prevention of tick paralysis in cattle can be considered under four major headings.

A. Protecting susceptible animals from effects of toxins, needing no reduction in numbers of ticks engorging on the cattle.

B. Preventing ticks feeding to the stage of engorgement which is necessary to cause paralysis, with no attempt to reduce the numbers of ticks encountered by the cattle.

C. Reducing the numbers of ticks encountered by the cattle, but not reducing the numbers present on cattle ranges in general.

D. Reducing the number of ticks on cattle range, or in the entire range of the "paralysis strain" of *D. andersoni*. (Prairie strains rarely if ever cause cattle paralysis—Wilkinson and Lawson, 1965.)

Various techniques grouped under these headings, with selected references in the literature and brief remarks, are shown in Table 1. The Geier ratings are for satisfactoriness of treatment based on the diagram in Clark *et al* (1967), which rates treatments for excellence along scales for "long-term reliability of protection," and "required frequency and intensity of human intervention." The ratings are provisional because many of these measures have never been given long term full-scale trial. The monetary cost of most of the measures is unknown. Insecticide for the BHC spray of cattle, B(4) (a) costs only about 65c per animal per year.

Only items under sections A(2), A(3), A(4) and D would be applicable to reduction of tick paralysis of humans. Items under Section D would acquire added importance if tick-borne diseases in Canada (Gregson, 1964), become more virulent or new diseases are introduced, or if tick vectors interfere with eradication or serum-testing of brucellosis of cattle (Volkova *et al*, 1960).

Long term investigations under B (1) should be started to see whether an inheritable resistance to ticks or tick paralysis can be detected in a variety of breeds of cattle, and developed by selection. The high Geier rating compensates for the inherent difficulties in investigating and applying this method. The reasons for lack of paralysis in wild ungulates are obscure (Wilkinson, 1965).

For successful investigation of control measures under D (1), D (2) and D (3), much more knowledge is needed on the host-potential (Milne, 1949), of the several species of wild animals inhabiting tick foci in the spring range of cattle. The main methods proposed at present involve capture-mark-release studies on rodent and other hosts, to provide data for life-tables of tick populations on selected study areas. Preliminary experiments, and theoretical considerations of sampling populations of such a polyphagous tick and its mobile hosts, indicate that the compilation of useful life-tables will be very difficult even with much more massively supported efforts than are likely to be available. Nevertheless, by applying crude approximations, in the belief that some data are better than none, it should be possible to improve our

TABLE 1—Status of knowledge on methods for control of tick paralysis of cattle in British Columbia.

METHOD	Not investigated or no publications known	Related problem investigated	Investigations in progress, at Kamloops I—Introductory A—Advanced	Probable Geier rating*	REMARKS
A. Protection of susceptible animals from paralysis					
(1) Immunization against paralysis, e.g. by serum from hyper-immune host		Seddon (1951)		B3	Hyper-immune serum gives 14 day protection of dogs from **Ixodes holocyclus** in Australia.
(2) Cure of paralysis by hyper-immune serum		Seddon (1951)		C2/C3	This author discusses curative action of hyper-immune serum for dogs paralysed by **Ixodes holocyclus.**
(3) Chemical antidotes	+			C2/C3	This and the preceding method would be dependent on finding the paralysed cattle and administering the antidote or serum before death occurs. Toxin has not yet been isolated or identified.
(4) Replacement of paralysing strain of **D. andersoni** by non-paralysing strain, by distribution of non-paralysing males	+			B2	Paralysis by **D. andersoni** is confined to the northwestern portion of its distribution (Jellison & Gregson, 1950).
B. Prevention of engorgement of ticks, after crawling on cattle					
(1) Breed resistance		Riek (1962) Wilkinson (1962)		A1 or A2	A long term solution. Conservative approach in accepting only a few cattle breeds (e.g. Hereford), is lessening, but willingness to include resistance to tick paralysis in a selective breeding program is doubtful.
(2) Age resistance			I	B2	Apparent greater susceptibility of yearling cattle compared with cows, calves and two year olds, needs scientific investigation. Exclusion of susceptible age groups from heavily infested areas may be practicable, on some properties.
(3) Induced resistance					
(a) from antigen of same species		Riek (1958)		B2	In deer there is a possibility that prior infestations with **D. albipictus** reduce susceptibility either to **D. andersoni** infestation or to paralysis (Wilkinson, 1965).
(b) from antigen of other tick species			I	B2	

(4) Insecticides on cattle (a) Sprays, etc.			A	A3	Unusually concentrated (0.25% BHC) spray on back lines is highly effective [Neilson, Rich & Procter (1966)]. BHC residues in cattle need re-examination (Rich, unpublished). Possibility of resistant strains of ticks developing.
(b) Systemics		Drummond & Graham (1964)		B3	Further investigations are needed in translocation of systemic insecticides applied as sprays, pour-on, and in feed. May have short residual periods.
(c) Repellent or other compound interfering with engorgement behavior, with 7-14 day residual period	+			B3	
C. Cattle prevented from encountering ticks					
(1) Fall grazing of infested fields or relatively small "tick foci," instead of spring grazing	+			A2	Yield of forage may be nearly as great, and the practice would probably be beneficial to bunch grass (**Agropyron spicatum**). Some rearrangement of fencing may be necessary, and water may be a problem.
(2) Only less active groups of cattle, e.g. cows and calves graze tick areas	+			B2 or A2	This appears to account for lack of paralysis in some areas with tick infested hillsides. No close investigation has been made.
D. Reductions of total number of ticks on cattle range					
(1) Vegetation modification			A	A2 or B2	Hypothesis of independence rejected (P=0.001), i.e. implication of association with shrubs, in one field in Kamloops area (Wilkinson, 1967). Qualitatively appears to be generally applicable to the shrub species mentioned. Due to forestry regulations and nature of tick foci, prospects for use of controlled fires are poor. Herbicide trials are in progress.
(2) Reduction of wild hosts (a) hosts of immature stage, mainly rodents		Parker (1933) Shilova **et al** (1967)		B2	Parker stated that destruction of Columbian ground squirrels, along with other measures, was locally and partially successful in reducing **D. andersoni** numbers in the Bitter-root Valley. No controlled experiments were mentioned. Shilova is more optimistic concerning control of **Ixodes persulcatus** by aerial and manual applications of poison baits.
(b) hosts of all stages, and host of adult stage			I	C3	Untreated susceptible cattle are probably more favourable hosts than wild large animals (deer, coyotes), and probably could substitute for porcupines.

(3) Reduction of ticks on rodents					
(a) Burrow dusting and rodent dusting		Kartman (1958)		B2	Kartman's paper refers to control of fleas on **Microtus** and other rodents by using DDT in bait boxes. Possible danger of pesticides accumulating in or sterilizing desirable predators, through the food chain, if chlorinated hydrocarbons used.
(b) Baits for rodents with systemic action on ticks		Shilova **et al** (1967)		B2	Promising trials of rodent baits, combined with systemic acaricides, against **Ixodes** ticks. No information on effects on predators.
(4) Dusting of large areas with acaricides		Uspensky (1967)		B2	50 kg of 10% DDT dust/hectare against **Ixodes.** Same comments on residues as 3(a). Also possible damage to sport fisheries.
(5) Reduction of free living ticks as a by-product of cattle-spraying			A	A2	This effect could change Geier rating of B. 4(a) from A3 to A2 and could be used to reduce risk to human population, by grazing treated cattle in the problem area.
(6) Artificial induction of diapause			I	B3 or B2	Some authors (Barker **et al** 1964), have suggested that diapause might be prevented in "long-day" insects by a single flash effectively extending day-length. This might also conceivably be used to force "short-day" ticks into diapause, over limited areas.
(7) Liberation of effectively sterilized males					
(a) Irradiated males			I	B2	Irradiation of large numbers of male ticks technically feasible, but males can, and females appear to, mate more than once (Gregson unpublished).
(b) Males with genetic incompatibility	+		I	B2	No genetic incompatibilities have yet been recorded. Subsequent matings with normal males may downgrade this to C2 Geier rating.

* In accordance with the general practice of excellence culminating with A1, Geier's categories (Clark **et al** 1967) have been recoded as Protection: A=High, B=Satisfactory, C=Limited.
Intervention required (after method well established): 1=Minimal, 2=Less than annual, 3=Annual or more frequent.

knowledge of the major hosts that maintain tick populations on cattle range. Using this knowledge, it may be possible to modify the environment so that it becomes unfavourable to ticks; this may well be economically worthwhile, for instance, on selected areas of cattle range, around settlements where children wander, and on camp grounds. The great majority of tick paralysis cases in British Columbia are due to ticks picked up in montane forest or in tick foci in grasslands (Wilkinson, 1967).

Massive and widespread applications of DDT, such as 5 kg/hectare, Table 1 D (4), may be undesirable because of concentration in wildlife food chains, storage in soil, and danger to fish. Such treatments have been considered justifiable in the U.S.S.R. to protect humans from encephalitis carried mainly by *Ixodes* ticks. Uspensky (1967), mentioned an annual application of 10^7 kg of 10% DDT dust over 200,000 hectares. However, Uspensky implies that more economical methods should be found, and that the incidence of encephalitis has not been reduced as much as expected.

Much of the spring range of cattle is used by deer and gamebirds. These are a valuable source of meat and recreation and of income to sellers of supplies and services to hunters; moreover wild animals have an aesthetic value to an even wider circle of people. Widespread destruction of shrubs D (1) would be inadvisable because these shrubs (Wilkinson, 1967), are valuable as the main winter browse species for deer, and may be of importance to grouse. Preliminary experiments have been in progress at Kamloops since 1965 to discover if destruction of shrubs is an effective and economically feasible method of reducing ticks in small tick foci within large relatively uninfested areas of grassland, or around settlements and campsites.

Discussion

The work of Clark *et al* (1967) and Beirne (1967), should encourage applied biologists to re-examine pest organisms against the background of the eco-system and with optimum use of resources in mind. Often they will be hampered by a lack of definition of the objectives in resource utilization, because conflicts of interest between different sections of the community are likely to continue for some time.

Detailed analysis of any insect control problem will probably reveal important gaps in our knowledge, as in Table 1. The study of these basic problems closely related to potential control measures seems particularly appropriate to government laboratories, since pursuit of abstract knowledge can best be left to universities, aided by relatively short term studies by students. Detailed work on well known methods, such as studies of dosage and methods of application of pesticides under local conditions, is appropriate to those close to the extension field.

This analysis of the problem of tick paralysis shows the extent of the specialties involved, ranging from mammalian immunology, through insecticide toxicology and tick ecology, to range ecology and agronomy. A balanced effort of wide coverage is needed, scaled to the importance of the problem, to identify and pursue the most profitable lines of investigation and control.

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