Current Worldwide Research on Control of Ticks Involved in Animal Diseases

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The previous papers of this symposium have made it plain that ticks are, or should be, recognized to be of considerable importance to persons involved in the production of animals and in the protection of human health. Livestock are subject to attack by numerous tick species that cause loss of blood, unthrifty conditions, and paralysis, and that transmit bacterial, protozoan, rickettsial, spirochaetal, and viral diseases. Without tick control, it would be virtually impossible to raise livestock or to do so economically in many areas of the world. Thus, the use of insecticides and other tick-control measures has become an essential part of livestock production.

Although numerous tick species are economically important to the stock raiser, I shall focus attention on the measures that have been, are, or might be used to control the following 7 species which transmit animal diseases: *Boophilus decoloratus* (Koch), the blue tick; *B. microplus* (Canestrini), the southern cattle tick; *B. annulatus* (Say), the cattle tick; *Rhipicephalus evertsi* Neumann, the red tick; *R. appendiculatus* Neumann, the brown ear tick; *Amblyomma herbraeum* Koch, the bont tick; and *Dermacentor* (= *Anocentor*) *nitens* Neumann, the tropical horse tick. Emphasis will be placed on controlling these species by the direct application of insecticides to livestock, but other control methods also will be discussed.

CONTROL OF TICKS WITH IXODICIDES APPLIED TO LIVESTOCK

The standard methods of applying ixodicides to cattle were listed and described by Barnett (1961); rather than repeat the discussion of these techniques, I shall briefly review the history of the research and the current status of chemical control of the 7 tick vectors of animal diseases just listed.

Boophilus decoloratus.—The history of the resistance to insecticides of *B. decoloratus*, a vector of bovine babesiosis in South Africa, was well documented by Whitehead (1958, 1965) as follows:

Resistance to:	Developed (year)	Reported by:
Arsenic	1938	Du Toit et al. 1941
Benzene hexachloride	1948	Whitnall et al. 1952
DDT	1955	Whitehead 1956

Resistance to the arsenicals, the chlorinated cyclodiene compounds, and DDT has spread throughout the eastern coastal areas of South Africa. Therefore, in 1955 when resistance to DDT became a problem, the use of organophosphorus compounds was begun in this area, and the following insecticides have been successful in controlling strains of *B. decoloratus* that are resistant to arsenic, benzene hexachloride, and DDT:

Ixodicide	Reported by:
Bromophos-ethyl	Fiedler and Van Vuuren 1966
Carbaryl	Whitehead 1959
Compound 4072[1]	Shaw and Baker 1966
Coumaphos	Fiedler and Veldman 1957
Diazinon	Whitehead 1959
Dioxathion	Cooper 1962
Malathion	Whitehead 1959
Ronnel	Whitehead 1959

To date, there have been no reports in the literature on resistance of *B. decoloratus* to organophosphorus ixodicides (Shaw and Malcolm 1964, Whitehead 1965).

Boophilus microplus.—Much research has been done in Australia on the biology and control of *B. microplus*, another vector of bovine babesiosis. As with *B. decoloratus*, there is a well-documented history of resistance of *B. microplus* to ixodicides in Australia:

Resistance to:	Developed (year)	Reported by:
Arsenic	1942	Hitchcock and Mackerras 1947
Benzene hexachloride	1952	Hitchcock 1953
Toxaphene	1954	Norris and Stone 1956
Dieldrin	1955	Stone and Meyers 1957
DDT	1955	Stone 1957
Organophosphorus compounds		
Ridgelands strain	1963	Shaw and Malcolm 1964
Biarra strain	1966	Roulston and Wharton 1967

The history of resistance in *B. microplus* is similar to that of *B. decoloratus*—first, resistance to arsenicals, then, resistance to the chlorinated cyclodiene compounds, next, resistance to DDT, and most recently, with *B. microplus* only, resistance to the organophosphorus and carbamate compounds. There are 2 strains of *B. microplus* in Australia that possess some variable cross resistance to almost all organophosphorus and carbamate insecticides: the Ridgelands strain (Shaw and Malcolm 1964, Shaw 1966), which was discovered in 1963 and is found in numerous locations in Queensland, is resistant to most or-

[1] 2-chloro-1-(2,4-dichlorophenyl)vinyl diethyl phosphate.