CHEMICAL CONTROL OF LICE ON CATTLE AND OTHER ANIMALS

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Introduction

Virtually every higher animal, including man, is parasitized by one or more species of lice. Pediculosis is an important economic problem of many species of livestock (Figure 4) and poultry. At present the lice can only be controlled with insecticides (Figure 5). This review deals with the principal classes of insecticides available to control these pests on cattle, pigs, sheep, and poultry. Particular attention is given to recent advances in application techniques.

Biology and Systematics of Lice in Livestock and Poultry

The lice found in domesticated animals are highly specific parasites belonging to two orders, the Anoplura, or sucking lice, and the Mallophaga, or biting lice (Lancaster and Meisch, 1986). They all live near the skin, on the hair, wool, or feathers of their particular hosts. They transfer from one host to another by direct contact when animals are kept close together during mating and feeding activities. The life cycles of all lice are similar in that the eggs when laid are attached to the hair or feathers which hatch into nymphs that pass through three nymphal instars before adult emergence.

Table 1 shows the most important species of lice found in livestock and poultry.

Table 1. Principal Species of Biting and Sucking Lice on Cattle, Sheep, Pigs and Poultry.

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<thead>
<tr>
<th></th>
<th>Cattle</th>
<th>Sheep</th>
<th>Pigs</th>
<th>Poultry</th>
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<tbody>
<tr>
<td>Sucking Lice</td>
<td>Linognathus vituli</td>
<td>Linognathus pedalis</td>
<td>Haematopinus suis</td>
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<td></td>
<td>Haematopinus eurysternus</td>
<td>Linognathus ovillus</td>
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<td></td>
<td>Solenopotes capillatus</td>
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<tr>
<td>Biting Lice</td>
<td>Bovicola bovis</td>
<td>Bovicola ovis</td>
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Treatments for Lice before World War II

Hall (1936), Culbertson (1942) and Matthysse (1946) have reviewed the information on materials applied to cattle and other livestock before 1940. These included herbals (balsam of Peru), botanical insecticides (tobacco, pyrethrum, derris), solvents (chloroform, benzene, carbon disulphide), inorganics (sulphur, lime sulphur, arsenicals), aromatics (phenol, naphthalenes) and petroleum derivatives. Matthysse (1946) concluded that rotenone dust was the most effective treatment. Most of these treatments have been superseded by modern insecticides. Notable exceptions are pyrethrum and, to a much lesser extent, lime sulphur, sulphur, and rotenone.

The lice attacking horses, Haematopinus asini and Bovicola equi, are similar to H. eurysternus (Figure 1) and B. bovis (Figure 2) infesting cattle. The goat louse, B. caprae, is similar to B. ovis. Linognathus stenopsis is the other louse infecting goats. Since all these species of lice are closely associated with their host and die quickly if removed or dislodged, treatment is directed at the host animal. It is essential that all animals kept together are treated at the same time and it is important to pre-treat all animals that are being introduced into a group free of lice.

Organochlorine (OC) Treatments

The use of OC insecticides began after World War II. These compounds are neurotoxic substances (Hart, 1986). In developed countries, most OC's have been abandoned because of their persistence in animal tissues and environmental side effects.
Nevertheless, methoxychlor, toxaphene, and lindane are still in use and show a high activity against lice and other ectoparasites. Methoxychlor, a DDT analogue, has high activity and marked biodegradability which allows its use on meat and milk-producing animals. Toxaphene, a complex mixture resulting from the chlorination of camphene, lindane, the gamma-isomer of hexachlorocyclohexane, and bromocyclohexen are still popular animal and human antiparasitic treatments. They are used as sprays, washes, dips and dusts. Lindane is lipophilic but readily metabolized by mammals, factors that lead to equilibrium residue levels in fatty tissues, which depend on the level of exposure.

**Organophosphorus (OP) and Carbamate Treatments**

These compounds which were developed in the 1950's and early 1960's act as cholinesterase inhibitors. They control lice at low concentrations (Smith and Richards, 1955), are less persistent and biodegradable; they therefore exhibit more desirable properties than most OC's. Consequently, many OP and carbamate insecticides used in veterinary medicine have fairly wide safety margins and have been widely and successfully used against lice and other parasitic arthropods. Malathion, coumaphos, crotoxynphos, dichlorvos, tetrachlorvinphos, chlorfenvimphos, phosmet, famphe, fenithion, fenchlorphos, trichlorfon, and diazinon are among the most popular OP insecticides used on livestock and poultry. They are applied as body sprays, dips, dusts or backrubbers. Formulation of some OP's in collars, ear tags, pour-ons and spots-on has extended the use of these chemicals (see below). The chemistry and biochemistry of OP's has been reviewed by Fest and Schmidt (1982).

Only a few carbamates have been widely used as large animal antiparasitics. The N-methyl carbamate, carbayl, possesses high efficacy and low toxicity. Its detoxification is rapid and residues in food products from treated animals are very low. The chemistry and biochemistry of this class of pesticides has been reviewed by Kuhl and Dorough (1976).

**Pyrethroid and Pyrethroid-like Treatments**

The natural pyrethrins are extracted from pyrethrum flowers and are still widely used, usually in association with synergists such as piperonyl butoxide to retard metabolic detoxification and thereby enhance efficacy. In the 1970's, the development and evaluation of synthetic pyrethroids represented a dramatic advance in the control of ectoparasitic infestations of domesticated animals and man (Zebra, 1988). Pyrethroids cause hyperexcitation followed by convulsions and death in arthropods.

In addition to pyrethroids *per se* a few compounds have been recently developed which lack the cyclopropane ring but retain a pyrethroid-like mode of action eg. fenervalate and fluycythrinlate.

Natural and synthetic pyrethroids are readily detoxified by metabolism. The resulting metabolites are rapidly eliminated and of little toxicological consequence making these compounds relatively safe and with a short environmental persistence.
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Many pyrethroids are lipophilic; this has allowed the development of pour-on and spot-on formulations which are very suitable for mass treatment against lice and other ectoparasites which has considerably broadened their range of use (see below). The different aspects of the pyrethroids have been reviewed by Casida (1973) and Elliott (1977).

Ivermectin and Abamectin

Ivermectin and abamectin belong to a newer group of potent antiparasitic agents and are fermentation products from Streptomyces avermitilis (Burg and Stapley, 1989). These systemic compounds are relatively persistent, broad spectrum toxicants active against nematodes, acarines and insects.

Different formulations of ivermectin that can be applied by injection, orally and topically are available, and the type of formulation can have a marked effect on the antiparasitic activity. In general, the injectable formulation exhibits the highest activity against many species of ectoparasites. However, biting lice such as B. (Damaella) bovis (Figure 2) and B. ovis from cattle and sheep, respectively, are not eliminated consistently from animals given a therapeutic injection or oral administration of ivermectin, whereas sucking lice that ingest blood or body fluids from their host are highly susceptible (Benz et al. 1989). This difference may be related to the superficial feeding pattern of biting lice since when ivermectin is applied topically to cattle it effectively controls several ectoparasites (Barth et al., 1986; Alva-Valdes et al., 1986; Hotson et al., 1985) including sucking and biting lice.

Ivermectin persists sufficiently long to kill newly emerged larvae as well as nymphs as they begin to feed. Ivermectin is relatively slow acting and live lice recovered from cattle during the first week after an injection, after which the lice are killed for up to 8 weeks after treatment. Ivermectin is formulated as a paste for oral use in horses, and is not approved for louse control (Campbell et al., 1989).

Few data are available on the antiparasitic activity of abamectin (Avermectin B1) applied to livestock and so far the product is registered in Australia only where the recommended dose of 200 mg/kg body weight is highly active against Linognathus vituli (Figure 3) (Benz and Cox, 1989).

Recent Treatment Technologies

Advances in application techniques to increase the persistence of ectoparasicides while maintaining their efficacy and avoiding the problems associated with dipping and spraying have been reviewed by Nolan et al. (1981).

Insecticide-Impregnated Ear Tags

Insecticide-impregnated ear tags have been developed for the control of horn flies and ticks on cattle. Tests with ear tags containing OP's (chlorpyrifos, tetrachlorvinphos) or synthetic pyrethroids (fenvalerate, cypermethrin, flucythrin or permethrin) for the control of lice have shown that in general they gradually reduced but did not provide control of sucking and biting lice (Drummond et al., 1988).

Dermal Treatments

Pour-ons and spot-ons have largely replaced sprays and dusts for treatment of cattle, sheep and pigs because of their ease of use and their primary use for grub (warble fly) control. People interested should refer to a recent paper by Tarry (1986) about progress in warble fly eradication in the UK.

The most popular pour-ons or spot-ons contain OP's such as chlorpyrifos, phosmet, fenthion and trichlorfon or the synthetic pyrethroids, cypermethrin and deltamethrin. Pour-ons and spot-ons containing pyrethroids are non-systemic but disperse over the whole body surface through the hair or wool grease and over the skin. This explains the slow but long-acting activity of many of these compounds. For example, in sheep infected with B.ovis, a pour-on treatment of 2.5% cypermethrin applied at the rate of 5 mg/kg or more, kills the mobile lice and nymphs shortly after hatching from the egg. A high degree of control is obtained 4 to 6 weeks after treatment and sheep are protected against re-infestations for 16 weeks (Henderson and McPhee, 1983).
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Figure Bovicola equi infestation shoulder of horse.

Other Systemics

In addition to the avermectins, the activity of nifluridine, an experimental benzimidazole systemic, given as a single subcutaneous injection, at 4 mg/kg to cattle, eliminates sucking but not biting lice (Boisvenue and Clymer, 1982).

Continuous Release Devices

The potential of ivermectin in sustained-release devices (Nolan et al., 1981; Miller et al., 1986) and their development is currently in progress but there are no data available on their activity against lice in livestock (Benz et al., 1989). Sustained-release technology will encourage the re-examination of several compounds previously discarded because of problems associated with their stability or application limitations.

REFERENCES


