Bovine theileriosis in the USSR

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Summary: The results of chemotherapy for Theileria annulata infection have not been very satisfactory, and there are problems associated with the use of acaricides to control the tick vectors of the parasite. Consequently, recent research in the Soviet Union has concentrated on immunisation. A vaccine based on attenuated strains of T. annulata has been introduced for field use, and the results obtained so far are summarised.

KEYWORDS: Cattle diseases - Protozoal infections - Theileria - Theileria annulata - USSR.

Theileriosis is a serious transmissible disease of domestic artiodactyles, caused by pathogenic protozoa which develop in lymphoid cells and erythrocytes. The clinical disease is manifested by enlargement of superficial lymph nodes, continuous fever, and disorders of the cardiovascular, digestive and haemopoietic organs.

In the USSR the following species have been identified in cattle: Theileria annulata, T. mutans, T. sergenti and T. orientalis. The most widespread infection is theileriosis caused by T. annulata. It is controversial whether T. sergenti and T. orientalis, described in the Far East of the USSR, are actually independent species.

The vectors of T. annulata are the ticks Hyalomma detritum, H. anatolicum, H. plumbeum and H. scupense. The vectors of T. sergenti are Haemaphysalis longicornis and H. japonica.

Ever since the discovery of the aetiology of theileriosis, considerable research has been conducted on species of the causal agent, vectors, biology, distribution, clinical aspects, pathogenesis and immunogenesis, and on the development of diagnostic, therapeutic and prophylactic procedures.

Serological techniques (slow complement fixation test, immunofluorescence, immuno-enzyme analysis, etc.) have been introduced in the USSR in order to detect infected and convalescent animals, to monitor the therapeutic and sterilising efficacy of chemotherapeutic substances, and also to study the immunological basis for developing methods of specific prophylaxis.

A wide variety of therapeutic substances has been tried in various countries for treating theileriosis. In the USSR over 80 such substances and combinations have been tested. The best results have been obtained with various combinations of

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Quinocide (primaquine), Bigumal (proguanil), Azidin (diminazene aceturate), Sulfantrol and Trypaflavine, along with antibiotics and vitamins, for use in the early stage of the disease.

In order to make therapy more effective, substances have been developed which lessen the severity of the disease. This direction is potentially very rewarding, because theileriosis results in very severe lesions of internal organs, metabolic disorders and often a definite change in mineral metabolism. It is no coincidence that the most effective substances have been trace elements.

However, the use of these substances is incapable of solving the problem. Losses from theileriosis are still considerable because of a high mortality rate (30-90% of affected animals), abortion, infertility, reduced milk yield, reduced slaughter yield and inferior meat quality in slaughtered animals.

In zones affected by theileriosis it has proved difficult to increase the productivity of local breeds by crossbreeding, because the breeds used for this purpose are more susceptible to the disease.

A scheme for protecting animals has been developed in recent years, based on keeping the cattle housed (where this is possible) and providing regular weekly treatment with an acaricide against the tick vectors during the season of theileriosis (which in many Republics lasts from March to November). But the major group of dairy cows cannot be treated in this way against ticks, because of the prolonged excretion of pesticide in their milk. In addition, the pesticides contaminate the environment and lead to the development of resistant populations of tick vectors.

These facts have led to a change in the emphasis of research in the USSR towards developing a method of immunisation. At various times attempts have been made to immunise animals with the following: blood, spleen cells and lymph node suspensions from recovered and affected cattle; parasites of weakly virulent strains, obtained by passage through a warm-blooded host without participation of the tick vector; a suspension of salivary glands from infected ticks; Theileria attenuated by exposure to ionising radiation, etc. However, none of these methods has been adopted for field use.

To arrive at ways of attenuating the virulence of the causal agent, the only suitable method consisted in propagating Theileria in cell culture, and performing a detailed study of the host-parasite relationships at the cellular level.

At the All-Union Institute for Experimental Veterinary Medicine (in Moscow) we have developed the theoretical and practical basis for a highly immunogenic vaccine against *T. annulata* infection in cattle, using strains obtained from six geographical areas of the USSR (including both highly virulent and less virulent strains).

Experiments on large numbers of animals have shown that it is possible to attenuate strains of *Theileria* found in the USSR. Determination of the optimum time for growth of the parasite in cultures of lymphoid cells has led to the development of attenuated, highly immunogenic strains of *Theileria*. In various experiments aimed at comparing the immunogenicity of *Theileria* strains, obtained from the tissues of donors infected by means of ticks and infective blood, it was found that during the process of persistence in the warm-blooded host, *Theileria* undergoes antigenic variation which can be continued *in vitro*, resulting in a loss of their ability to induce a firm immunity to the original strain which developed in ticks.
To infect donor animals we used the natural method of direct infection from vector ticks.

It was found that the process of culturing did not lead to reversion to the original virulence of the strains. An important finding was that strains of *Theileria* from various geographical zones were immunologically identical, exhibiting cross-immunity. A single injection of attenuated strains into susceptible calves protected them from the disease when they were exposed to highly virulent, heterologous field strains.

The results obtained have led to the immunisation of cattle in all areas in which theileriosis occurs, using vaccines prepared from a single strain of *T. annulata*.

The postvaccinal response is similar in cattle of different breeds and different ages. The optimum immunising dose of vaccine has been determined. Animals vaccinated once and grazing regularly on tick-infested pastures have remained free from the disease for eight years (limit of observation). Under conditions where there is no contact with infective ticks, the animals are protected for at least four years (limit of observation).

Results of immunological tests show that the immune response of an animal to theileriosis is characterised by complex and multiple stages, reflecting the life cycle of the causal agent. At an early stage of infection the parasites invade the lymphoid cells of lymph nodes, spleen and other organs, stimulating the development of an immune response.

From the results obtained in studying the immunity of cattle to theileriosis, we recommend annual contact between immunised cattle and infective ticks. This is because such contact results in hyperimmunisation, activating the immune system of the body (manifested by enhanced immunoglobulin concentrations, complement-fixing antibody, fluorescent antibody and considerable blast transformation in the T and B lymphocyte systems). Such animals appear to be completely normal, but the strength of immunity is restored to its original level.

The scientific principles for using the vaccine under field conditions, including methods, timing and number of immunisations, have been established.

The next step involved developing the technology for vaccine production, cryopreservation and vaccine testing, and its transfer to vaccine factories.

The vaccine has been introduced for field use. In infected areas special attention is paid to vaccinating heifer calves to be used for breeding, transported from disease-free zones at the end of autumn and in spring, and also the offspring of heifers transported earlier, which have not yet been exposed to the tick vectors of theileriosis.

Vaccinated cattle are put to graze on tick-infested pasture within an area infected with theileriosis, in the summer-autumn period.

To test the efficacy of vaccination, unvaccinated calves are placed in a batch of vaccinated calves. In addition, record is kept of any illness or loss from theileriosis among the young stock of adjoining farms where vaccination has not been practised.

The tests have shown that all the unvaccinated controls develop theileriosis after a variable time spent at pasture, and 27-40% (or more) die. In unvaccinated herds, most of the young stock have developed theileriosis, with considerable losses.
Among vaccinated animals there has been no case of theileriosis. Thus observations over many years have shown that the immunity in calves vaccinated once remains intact provided that the animals are exposed to infective ticks once a year.

To conclude, the wide use of vaccine against theileriosis has prevented losses among susceptible cattle, including imported high-yielding cows, which makes it feasible to carry out breed improvement in areas affected by this disease. Vaccination also considerably reduces contamination of animal products and the environment by pesticides used for controlling the tick vectors.

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**LA THEILÉRIOSE BOVINE EN URSS.** – N.I. Stépanova et V.T. Zablotskii.

Résumé : Les résultats de la chimiothérapie pour la prophylaxie de l’infection à *Theileria annulata* n’ont pas été très satisfaisants, et l’emploi des acaricides pour combattre les tiques vectrices du parasite pose des problèmes. C’est pourquoi, dernièrement, la recherche s’est orientée en Union Soviétique vers l’immunisation. Un vaccin préparé à partir de souches atténuées de *T. annulata* a été mis au point et appliqué sur le terrain. Les résultats obtenus jusqu’à présent sont présentés.

MOTS-CLÉS : Infections à protozoaires - Maladies des bovins - Theileria - *Theileria annulata* - URSS.

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**TEILERIASIS BOVINA EN LA UNIÓN SOVIÉTICA.** – N.I. Stepanova y V.T. Zablotskii.

Resumen: Los resultados de la quimioterapia para el control de la infección por *Theileria annulata* no han sido muy satisfactorios y el empleo de acaricidas para luchar contra las garrapatas, vectoras del parásito, plantea problemas. Por tal motivo, en la Unión Soviética, la investigación se ha concentrado recientemente en la inmunización. Se ha puesto a punto una vacuna preparada en base a cepas atenuadas de *T. annulata* que se ha aplicado en el terreno. Los autores presentan los resultados obtenidos hasta ahora.

PALABRAS CLAVE: Enfermedades de los bovinos - Infecciones por protozoarios - Theileria - *Theileria annulata* - Unión Soviética.