

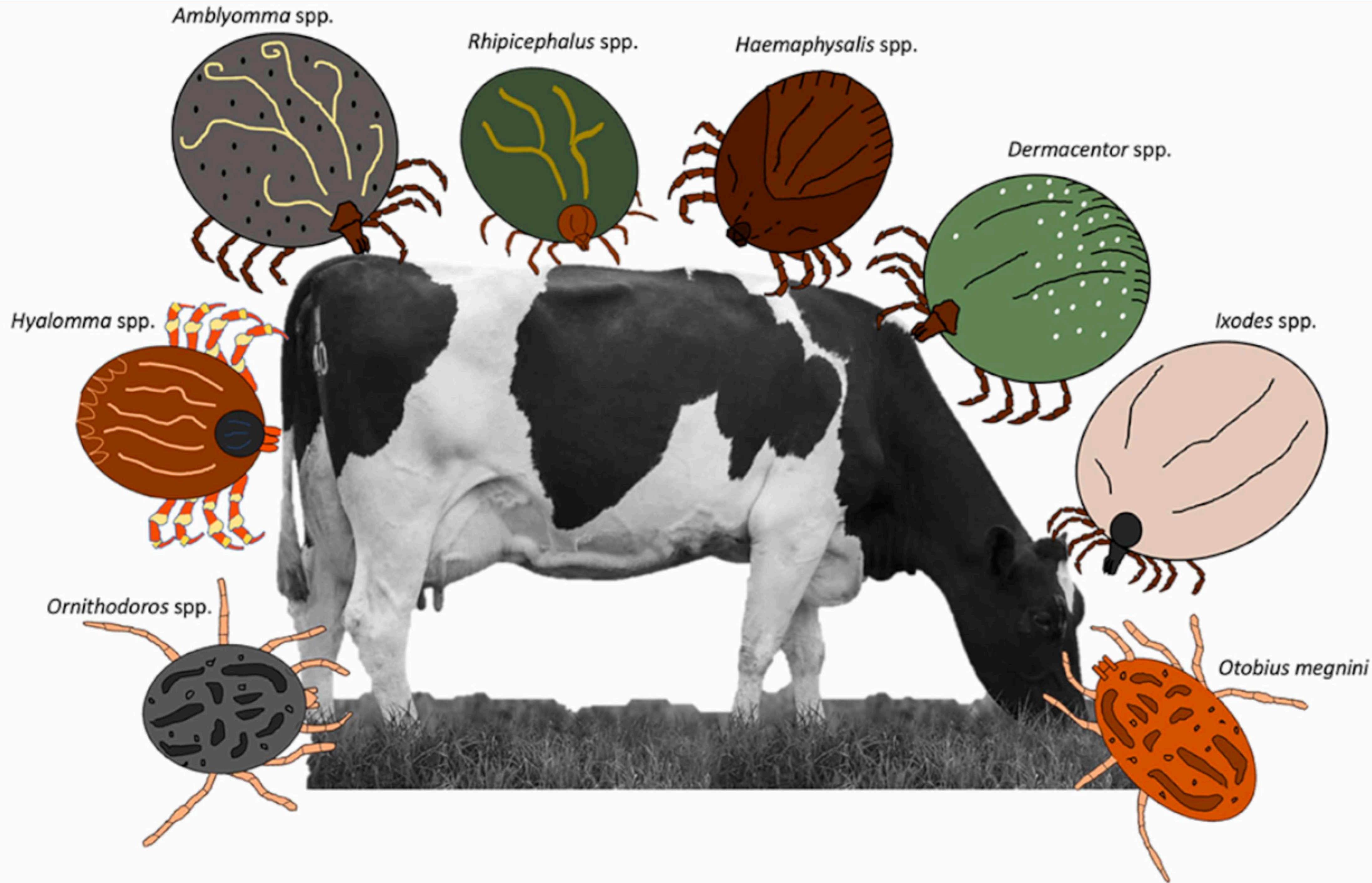


Non chemical ways to target ectoparasites

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Non chemical ways to target ectoparasites





Non chemical ways to target ectoparasites

Contents:

- **Semiochemicals- what are they? and their types**
- **Use of semiochemicals to control flies / ticks**
- **Use of bots in control**
- **Vaccines against ectoparasites**
- **Concept of concealed antigen**
- **Candidate antigens for future vaccine production**



SEMIOCHEMICALS

- **Chemical signal vehicles of host / tick origin secreted into the external environment that mediate tick behaviour**





PHEROMONES- intra species semiochemical





TYPES OF PHEROMONE

Based on the function that they perform

- **Sex pheromones**
- **Aggregation pheromones**
- **Assembly pheromones**
- **Alarm pheromones**
- **Trial pheromones**
- **Host marking pheromones**



KAIROMONES

Kairomones

▶ Volatile fatty acids

Ixodes scapularis, Amblyomma variegatum

▶ 1-octen-3-ol

Rhipicephalus microplus

▶ Carbon dioxide

Amblyomma variegatum

carbon dioxide traps – *Amblyomma variegatum*



SEX PHEROMONES

- ▶ **Produced by the females to attract males for mating**
- ▶ **Rarely produced by males**
- ▶ **Volatile, species specific and related only to smaller number of species - depends on distance**



AGGREGATION PHEROMONES

- ▶ **Aggregation pheromones**
- ▶ **Cause insects to aggregate at food sites, reproductive habitats, hibernation sites...**
- ▶ **Attracts the species of both the sexes and tend to operate over a long range**



ASSEMBLY PHEROMONES

- ▶ Arrestment (= assembly) is defined as the cessation of kinetic activity
- ▶ **Reduces the distance** between the individuals that perceive the stimulus in their environment
- ▶ Leads to **clusters of individuals** in their natural environment
- ▶ **Enhances mating** and host- finding success and is of survival value
- ▶ **Protects** ticks from **desiccation**



Pheromones can be exploited in 3 ways

- ▶ Can be used for monitoring
- ▶ Mass trapping
- ▶ Mating disruption



TWO APPROACHES

➤ Lure and kill

When the pheromone is used to lure the tick to a substrate that has an acaricide incorporated

➤ Lure and infect

When pheromone is tagged with a entomopathogen- it can be either a fungi, bacteria, nematode



ADVANTAGES

- **Environmental friendly-** the aggregation pheromone acaricide combination can be easily used in the control of tick stages on vegetations and environment
- **Efficient utility of acaricide (small quantity)**
- **Economical**
- **On host usage of acaricide reduced (attractant) / totally absent (aggregation)**
- **Highly species specific-** no impact on mammals



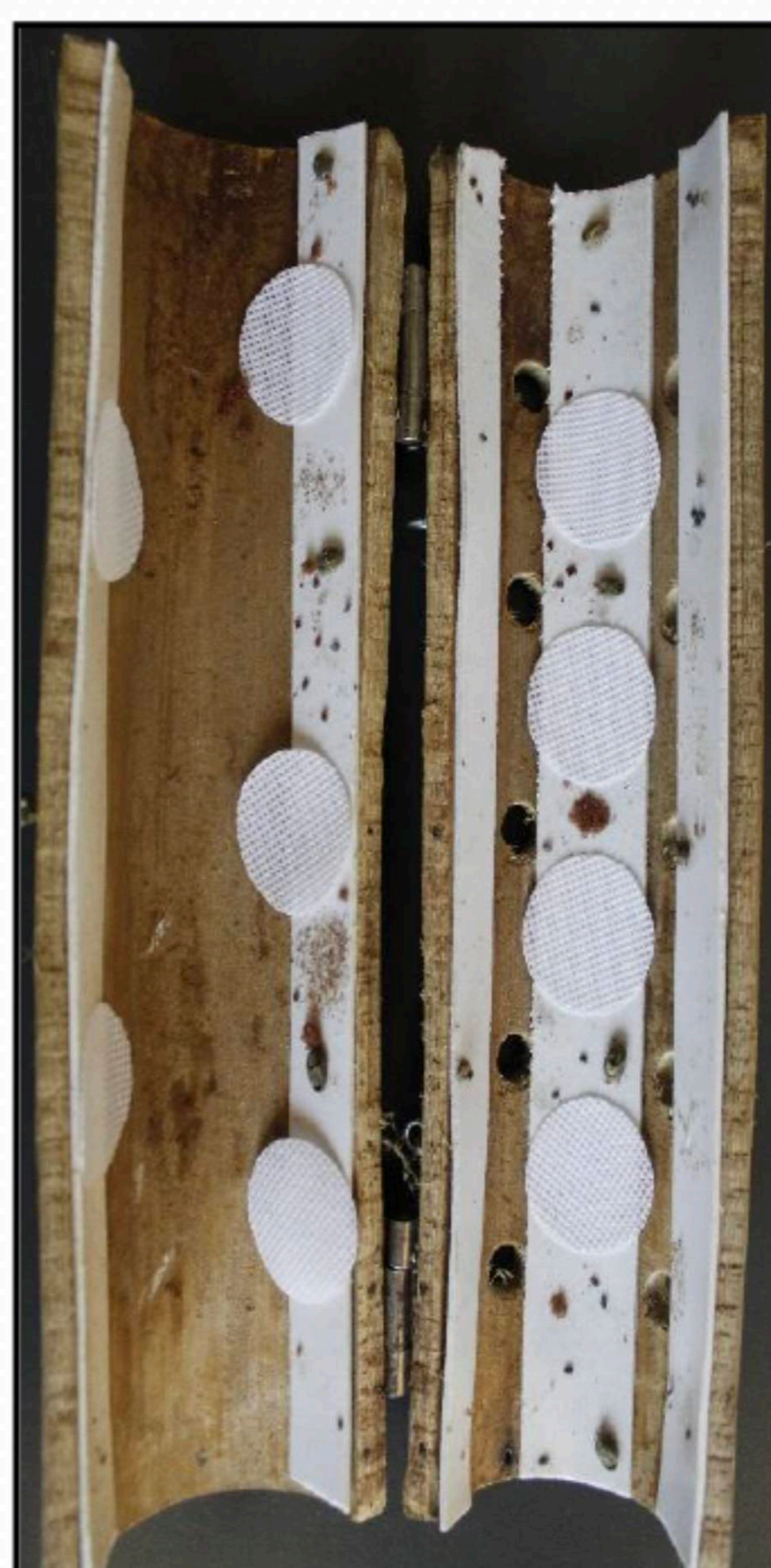
VAPOUR PATCH



AP



SP+AP



SP



Control



Oviposition pheromone

- Haematophagous insects need to identify oviposition site for their young
- The choice for suitable places for female mosquitoes to lay eggs is a key-factor for the survival of immature stages (eggs and larvae).
- The selection requires a set of chemical, visual, olfactory and tactile cues that interact with the female before laying eggs
- Habitat-related semiochemicals may play a large role and can be successfully exploited to produce **ovitraps**
- **Can be used for monitoring and control**



- ▶ oviposition pheromone was extracted from the eggs of *Aedes aegypti*
- ▶ **caproic acid-temephos** combination performed well in the laboratory as a lethal lure; caproic acid attracted more gravidmosquitoes, while temephos acted as the killing agent by restricting egg hatching and killing the larvae that hatched
- ▶ Replicates breeding area



Sex pheromone of *Musca domestica*

- ▶ (Z)-9-Tricosene is a **sex pheromone** produced by female **house flies** (*Musca domestica*) to attract males
- ▶ (Z)-9-tricosene is used in fly paper and other traps to lure male flies, trap them, and prevent them from reproducing



Habitat modification - removal or alteration of habitat utilized by the fly





Mosquito scare

- ▶ **surface aeration** would be the ideal solution to control this breeding because of the following reasons:
- ▶ Surface turbulence **prevents mosquitoes from laying eggs** on water as mosquitoes can lay eggs only if the water is completely still.
- ▶ If they do succeed in laying eggs, the eggs may drown or get damaged with the turbulence.
- ▶ If the eggs hatch, the larvae will not be able to remain on the turbulent surface and get exhausted in the process of diving down and resurfacing.
- ▶ As the **larvae** will not be able to remain on the surface and breathe, they will **suffocate and ultimately die**.
- ▶ Moreover, surface aeration will reduce anaerobic bacterial development and deplete **larval nutrition** from the microlayer.



Zebra stripes, tabanid biting flies and the aperture effect

Martin J. How Dunia Gonzales, Alison Irwin and Tim Caro

Published: 19 August 2020 <https://doi.org/10.1098/rspb.2020.1521>

- ▶ Of all hypotheses advanced for why zebras have stripes, avoidance of biting fly attack receives the most support
- ▶ The mechanisms by which stripes thwart landings are not yet understood
- ▶ A logical and popular hypothesis is that stripes interfere with optic flow patterns needed by flying insects to execute controlled landings
- ▶ This could occur through disrupting the radial symmetry of optic flow via the aperture effect (i.e. generation of false motion cues by straight edges) or through spatio - temporal aliasing (i.e. misregistration of repeated features) of evenly spaced stripes





COWS PAINTED WITH **ZEBRA** **STRIPES**





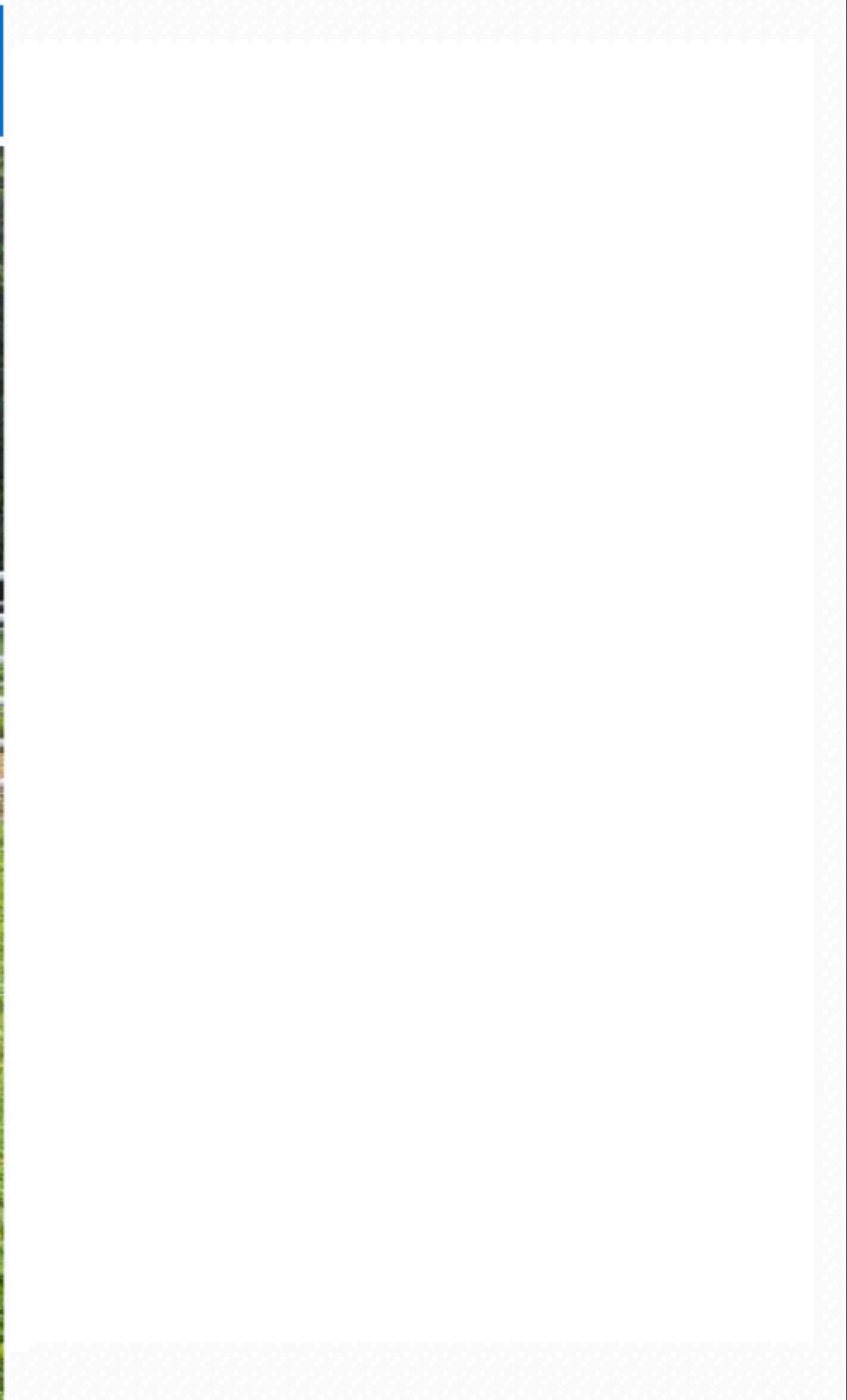
Mosquito control rings which slowly release *Bacillus thuringiensis var israelensis* into water which is toxic to mosquito larva

- ▶ **Control mosquitoes naturally**
- ▶ **Rings last for a month**
- ▶ **Each ring treats 100 square feet area**
- ▶ **Can kill mosquito larvae for a full 30 days**
- ▶ **Each slow-release, floating Control Ring treats 100 square feet of surface area in any water source**





Use of fans!!





Tick Vaccines

- ▶ **Salivary glands**
- ▶ **Midgut**
- ▶ **Reproductive organs**



Concealed Antigens

- One or more immunogenic proteins from the ticks during an infestation does not get into contact with the host immunologic system and therefore cannot, induce an immune response during the parasitism
- However once the host is artificially immunized against concealed antigens the immunological system may attack targets not exposed during the normal host parasite interaction
- These attacks may interfere with the functions of these antigens causing damages to the parasite
- Viability and fecundity are compromised.





Revolution in Development of Vaccines Against ectoparasites

- ▶ Genetically engineered
- ▶ *E. coli* expressed
- ▶ Bm 86 vaccine
- ▶ TickGARD and an yeast expressed GAVAC
- ▶ Induces antibodies to bind to Bm86 molecule on intestinal cell causing them to lyse thereby interfering with blood feeding activity of ticks
- ▶ Impairs reproductive capacity



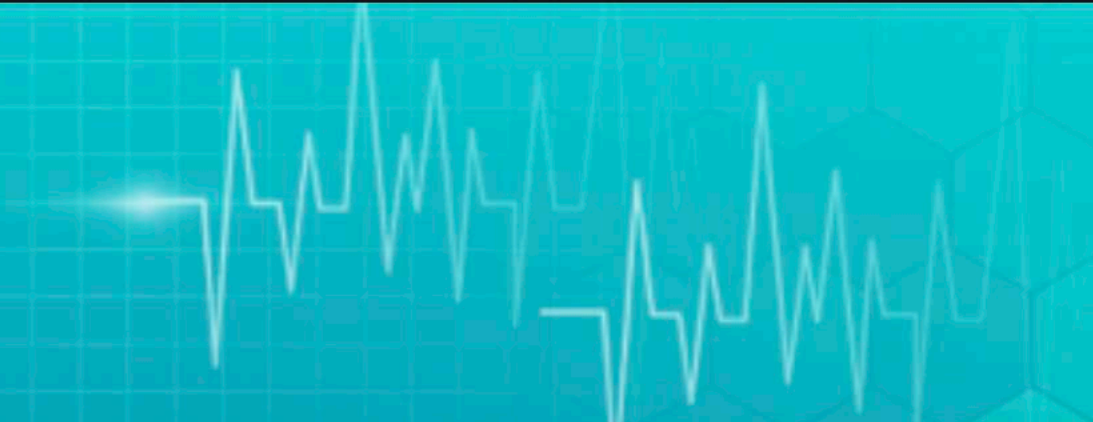
Commercial vaccines TickGARD™

- First genetically engineered *E. coli* expressed Bm 86
- Blood meal digestion in the tick is strongly and rapidly inhibited - directed against *Rhipicephalus (Boophilus) microplus*
- Reduced survival rates of ticks importantly made it less likely for the tick to reproduce.
- Reduced the number of ticks surviving between generations by 70-90%.



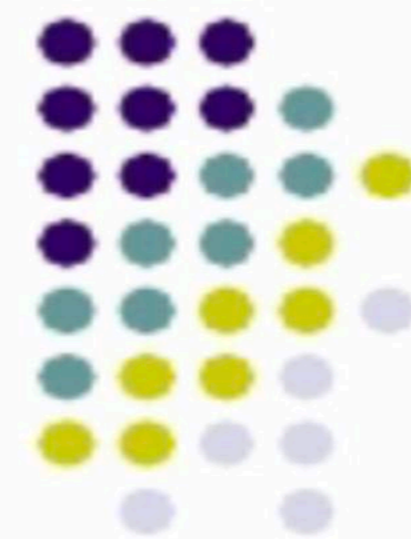
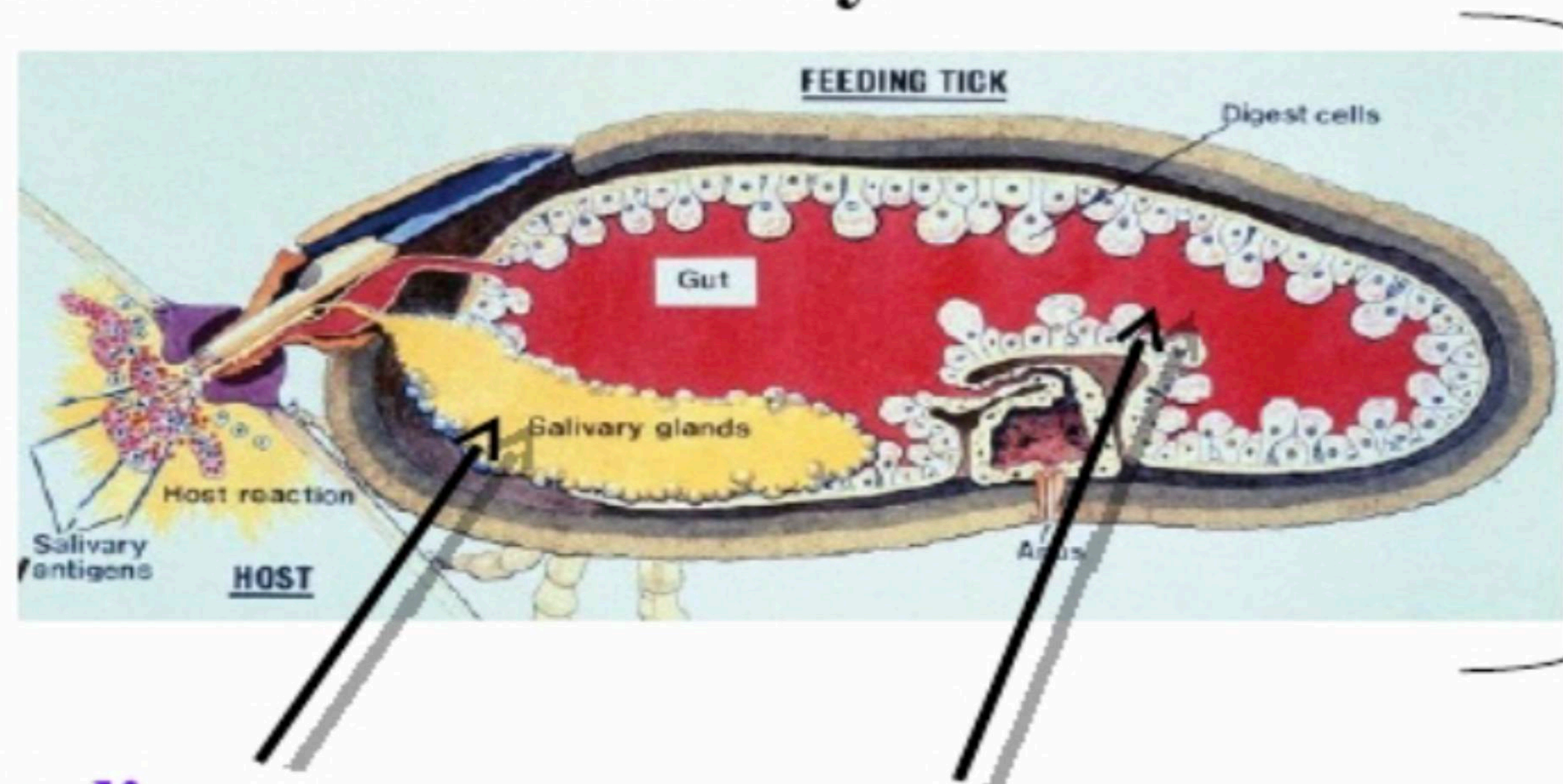
TickGARD plus TM

- ▶ **Second generation *B. microplus* vaccine Biotech Australia**
- ▶ **An altered adjuvant formulation of TickGARD - 1996**
- ▶ **Delivers higher and long lasting immunity 2-4 times higher antibody titres**
- ▶ **Tick numbers were reduced by 50% reproductive efficiency 72% reduction.**
- ▶ **A live weight gain 18.6 kg improvement over 27 weeks in immunized animals.**



Candidate antigens for future vaccines

Targets selected for study



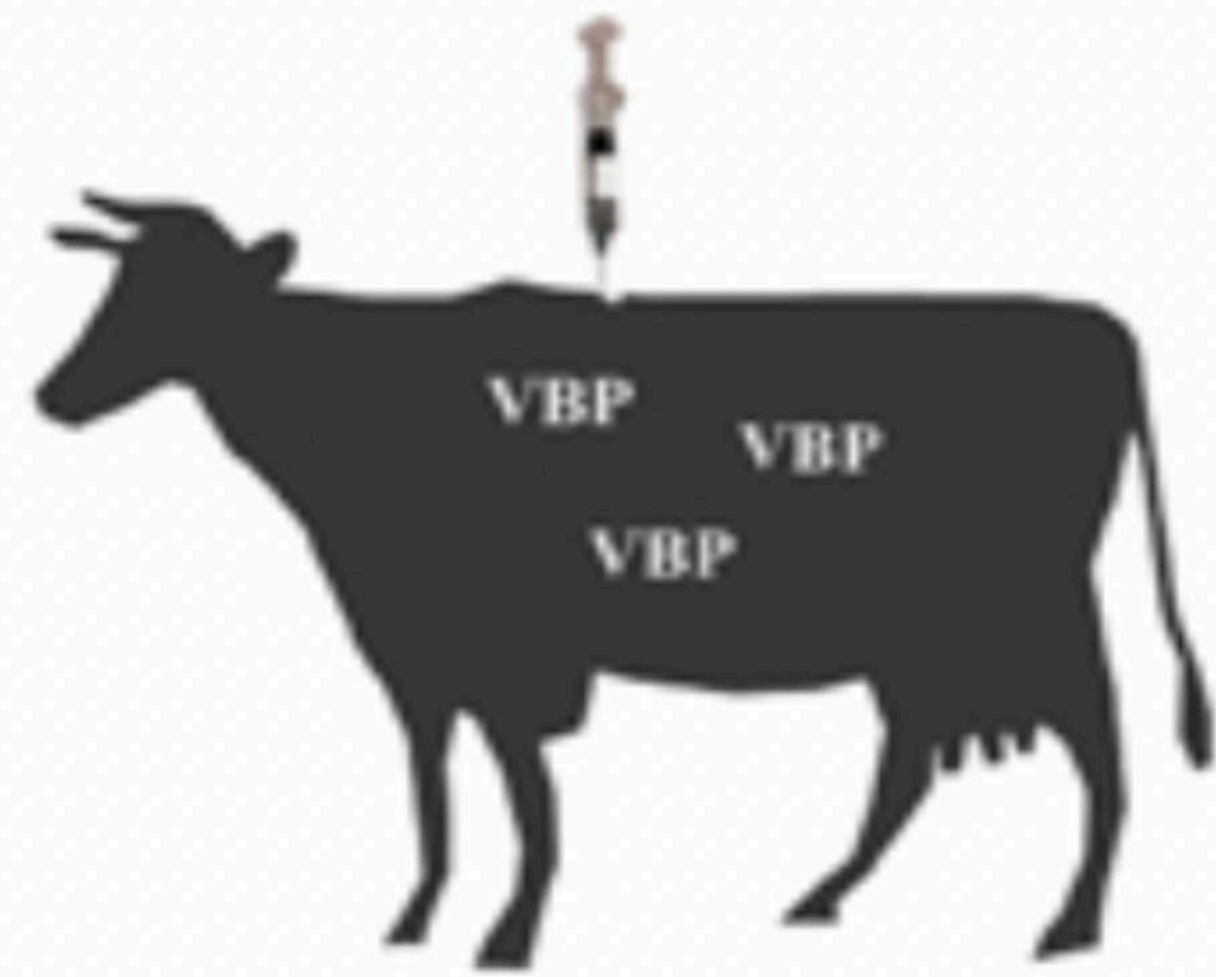
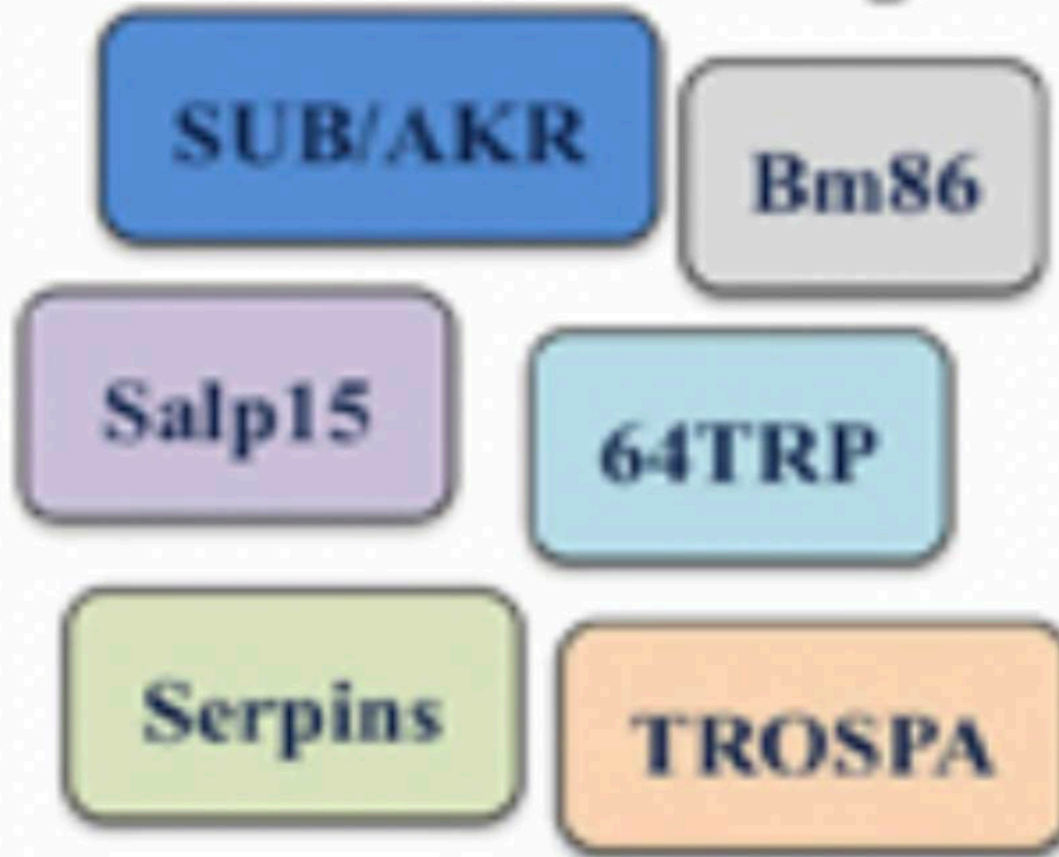
Subolesin
 (Expressed in all organs and tissues)
 Function as transcription factors in the regulation of gene expression

Calreticulin
 Anti-thrombotic and complement-inhibition activities in host

Cathepsin L
 Part of a gut-associated multi-peptidase complex. Its endopeptidase activity is important in the initial phase of haemoglobinolysis.



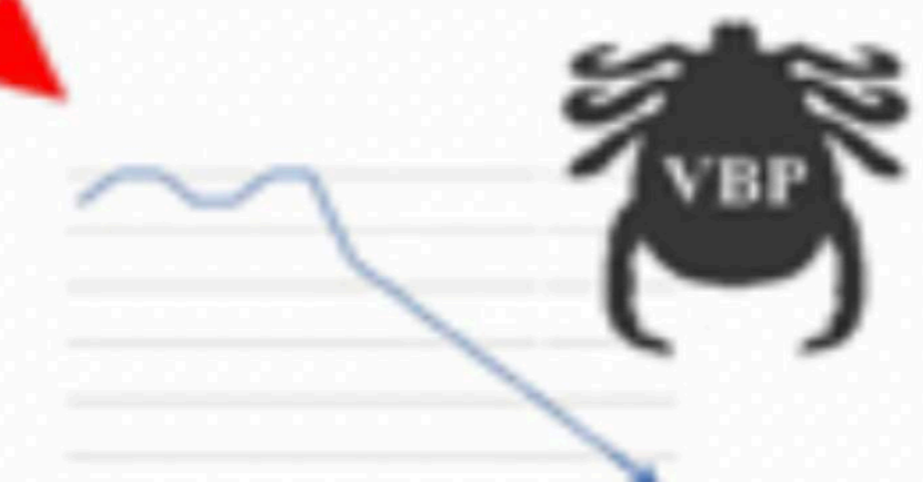
Vaccination with tick antigens



Immunization of animal populations at risk and reservoir hosts

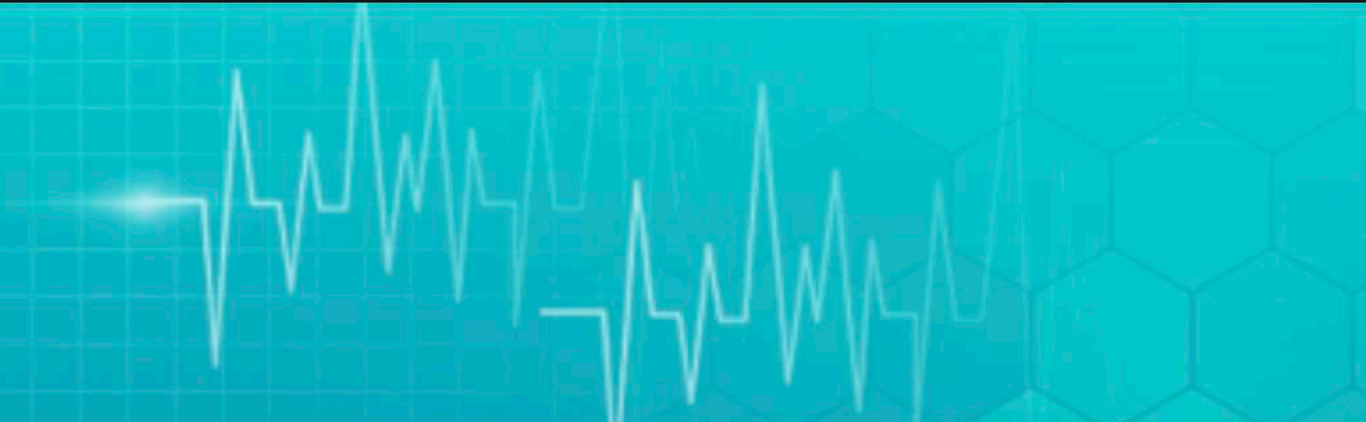


Reduction of tick infestations



Reduction in the number of infected ticks, vector-borne pathogen infection levels and vector capacity

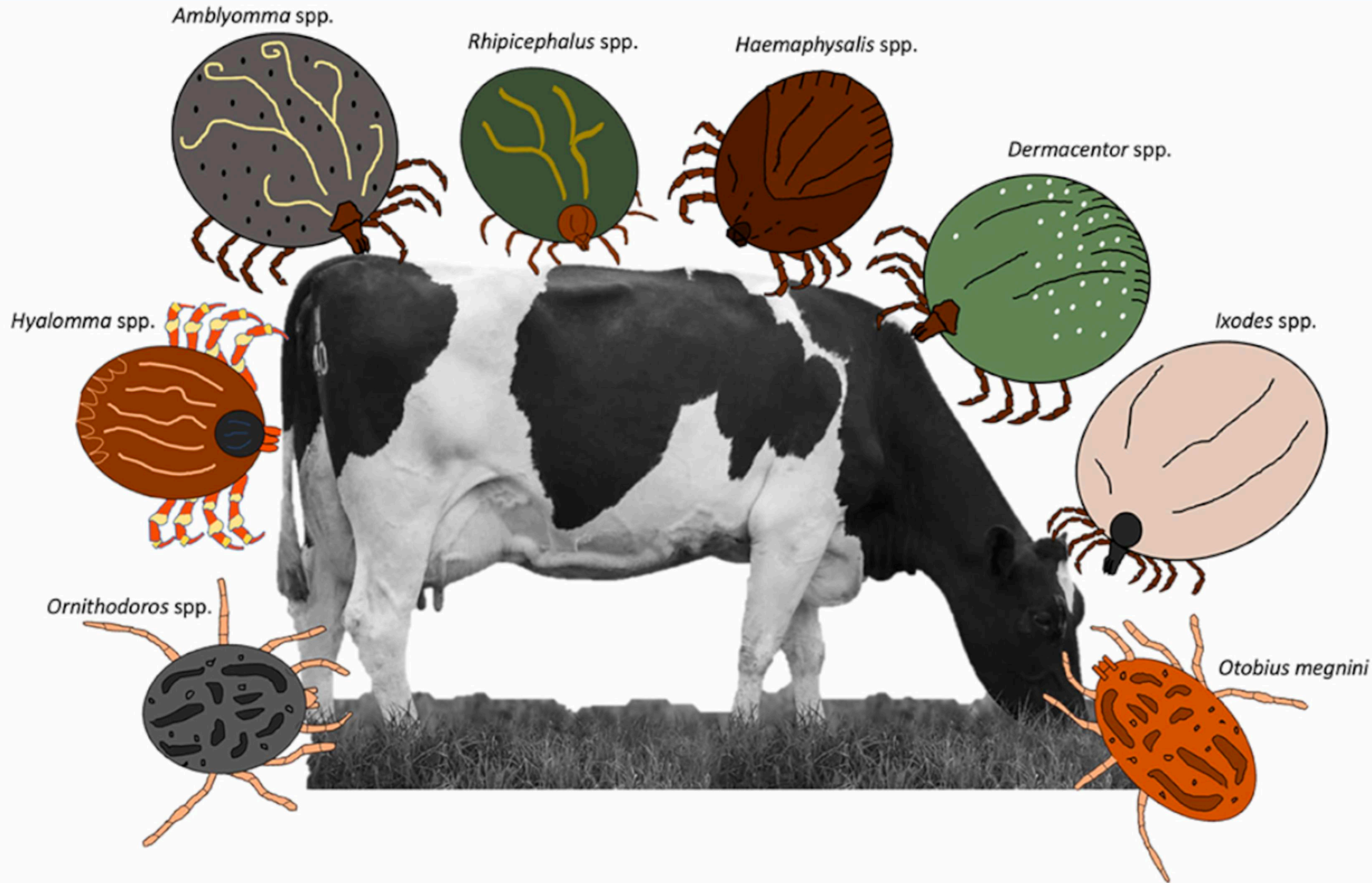
Control of tick infestations and reduction of pathogen transmission to vertebrate hosts



64 p	Rhipicephalus appendiculatus	Attachment and feeding
Yolk pro cathepsin	<i>R. microplus</i>	Expressed in eggs- but recombinant version a failure
Gut expressed iron storage protein-Ferritin 2	Silenced by RNA i	Tick feeding, oviposition, larval hatch
Subolesin	<i>Ixodes scapularis, Amblyomma americanum, Dermacentor variabilis</i>	Highly conserved protein modulating tick feeding and reproduction All tissues affected by RNA i silencing of subolesin-SAT
Tick receptor for Osp A-TROSPA	receptor for <i>Borrelia burgdorferi</i> + <i>Babesia</i>	Knockdown results in significant reduction in transmission of diseases too
Calreticulin Serum amyloid A, Kunitz type protease inhibitor	Saliva of tick	



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Thank you