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Tools to fight ticks: A never-ending story? News from the front of green acaricides and photosensitizers

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ABSTRACT

Nowadays, parasitology is facing a number of crucial challenges, including the urgent request of effective control tools against arthropod vectors of medical and veterinary importance. Ticks transmit at least the same amount or even more pathogen species than any other group of blood-feeding arthropods worldwide affecting humans and animals. Besides the development of vaccines against viruses vectored by ticks, integrated pest management practices aimed at reducing tick interactions with livestock, emerging pheromone-based control tools, and few biological control agents have been also proposed. The extensive employ of acaricides and tick repellents still remains the two most effective and ready-to-use strategies. However, the use of synthetic acaricides is limited by the development of resistance in several tick species as well as by heavy environmental concerns. In this scenario, the exploitation of botanicals as cheap and effective sources of tick repellents may represent a valid alternative, and the preservation of ethnobotanical information on the repellent and acaricidal potential of plants is crucial. On the other hand, novel photodynamic acaricides have been recently described, with a toxicity against ticks which far exceed some of the acaricides currently marketed (*e.g.* tetramethrin). In this brief review, I provide a focus on some hot news in tick control, with special reference to tick repellents of botanical origin and new photodynamic fluorescent acaricides. To my mind, knowledge on both the mentioned research issues may help researchers to build valuable roadmaps to boost tick control programs worldwide.

1. Introduction

Currently, parasitology is facing a number of key challenges, including the urgent request of effective control tools against arthropod vectors of medical and veterinary importance[1-3]. Ticks transmit at least the same amount or even more pathogen species than any other group of blood-feeding arthropods worldwide affecting humans and animals[3]. Currently, almost 900 tick species have been described. Some genera include several common species, which transmit several important agents of diseases. Ticks are divided into three families: Argasidae, also known as soft ticks (191 species), Ixodidae, commonly known as hard ticks (701 species), and Nuttalliellidae, consisting of only one species, *Nuttalliella namaqua*[4,5].

In Europe, several tick species, such as *Ixodes ricinus* and *Ixodes persulcatus*, attack humans and numerous animal species. They are important vectors of agents of dangerous pathogens, including *Borrelia* bacteria (Figure 1), viruses of spring-summer meningoencephalitis and Rickettsiales, which especially occur in Russia and neighbouring countries[6,7]. Moreover, in North America, ticks act as vectors of a wide number of pathogens causing human diseases, including anaplasmosis, babesiosis, borreliosis, Colorado tick fever, Rocky Mountain spotted fever (Figure 2), tick-borne relapsing fever, southern tick-associated rash illness, ehrlichiosis, heartland virus, Lyme disease, Powassan

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disease, tularemia and rickettsiosis[8]. From a livestock's point of view, at least 80% of the world's cattle population are at risk from ticks and tick-borne diseases[9]. Ticks affect cattle directly by causing skin damage opening up wounds, which make the animal susceptible to secondary infection, and cause toxicosis and paralysis in some instances. Indirectly and more importantly, ticks act as vectors of fatal diseases, for example babesiosis and theileriosis[10,11] (Figure 3).

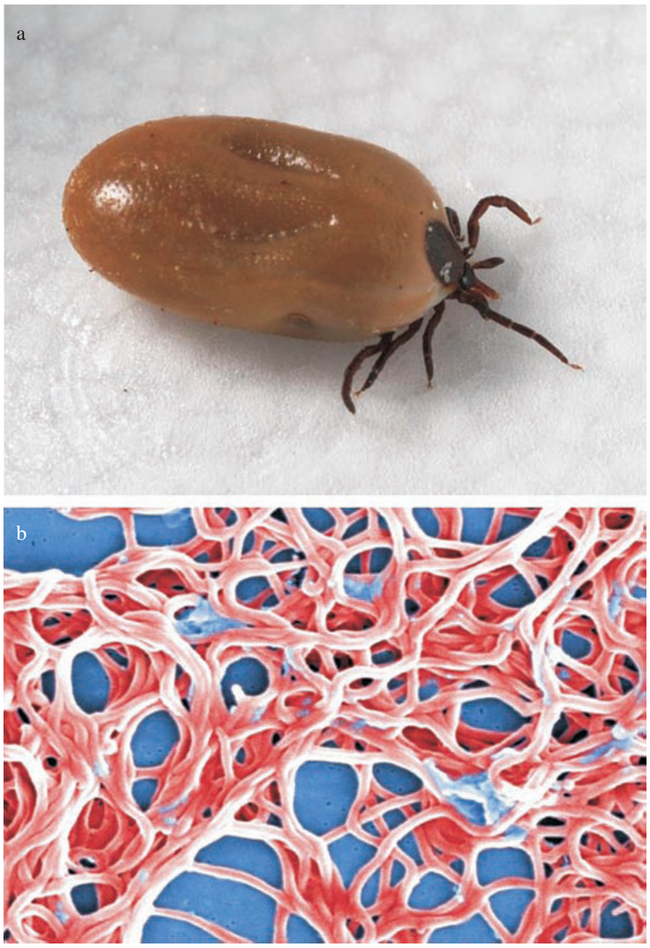

Figure 1. Engorged female of *Ixodes scapularis*, commonly known as the blacklegged or deer tick (a). This tick transmits Lyme disease, a disease caused by a spiral shaped bacterial microbe, *Borrelia burgdorferi* (b), which is widespread in Europe, Africa, Asia, and in almost all the United States (photo credit: Centers for Disease Control and Prevention, Dr. Gary Alpert and Dr. Janice Haney Carr, respectively).

2. News from the tick control front

Besides vaccines against the arbovirus vectored by ticks[12], as well as the development of biological control programs[13], and integrated pest management strategies[9], including pheromone-based control tools[14], the use of repellents and acaricides against ectoparasites is a traditional mode of treatment of people and animals[15,16]. Arsenic dips were the first effective method for controlling ticks and tick-borne diseases, and were used in many parts of the world for over 50 years before resistance to the chemical became a problem. Since the discovery of organochlorines, virtually every chemical group of pesticides developed for the control of arthropods represented among the list of products employed for the control of ticks on cattle[17]. In recent years, effective improvements in the development of acaricides with low mammalian toxicity (*e.g.* pyrethroids and avermectins) enhanced the efficacy of treatments against ticks, but at greatly increased cost[9]. Furthermore, the evolution of tick resistance to acaricides has been a major determinant of the need for new products[17]. In addition, a number of problems are associated with the use of acaricide, such as environmental pollution, contamination of meat and milk from livestock and expense especially in the developing world[3,18].

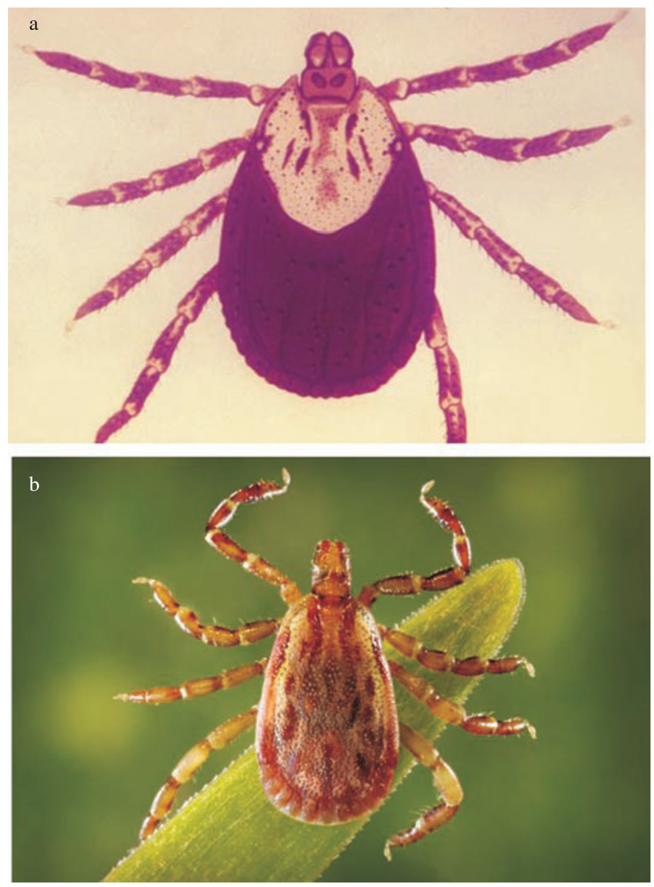

Figure 2. A female Rocky Mountain wood tick, *Dermacentor andersoni* (a), and a male yellow dog tick, *Amblyomma aureolatum* (b).
These species are major vectors of *Rickettsia rickettsii*, the agent of Rocky Mountain spotted fever in North America and Brazil, respectively (photo credit: Centers for Disease Control and Prevention, Dr. Andre J. Brooks and Dr. James Gathany, respectively).

2.1. Botanical acaricides and repellents

In this scenario, the exploitation of botanicals as cheap and effective sources of tick repellents may represent a valid alternative,