A vector can be defined, in a biomedical context, as a living being (most usually an arthropod) capable of transmitting a disease to vertebrate hosts, including humans. A basic distinction can be made between mechanical vectors and biological vectors. Mechanical vectors, in any of the classes of haematophagous arthropods, are infected during a blood meal with a microorganism which is transmitted to a second host without any multiplication cycle in the vector. The infection of the vector is usually of short duration in such cases. A discussion of the complex variables involved in mechanical transmission can be found in the second issue of this volume of the Scientific and Technical Review of the World Organisation for Animal Health (the Review) (1). In contrast, in the case of a biological vector the infectious organism undergoes a cycle of multiplication in the vector, which remains infective and may transmit the infection to its progeny. From an epidemiological point of view the latter class of vector is much more important than the former in terms of its ability to start and maintain a disease outbreak.

Vector ‘competence’ refers to the genetic factors (usually heritable) that enable a vector to transmit a specific disease. Vector ‘capability’ is a wider concept which includes other factors that influence the ability of the vector to transmit a pathogen, e.g. environmental factors, such as the population densities of both vector and host, and climatic factors, including both temperature and humidity. Another distinction that can be made is between primary and secondary vectors. The relationship between a specific vector and its preferred host is usually stable but it can change, mainly for environmental reasons. A good example is the recent spread to northern Europe of bluetongue, a sheep disease originally limited to the regions of the world in which its Culicoides vector was present. Many investigations confirmed that this unexpected change in geographic distribution was accompanied by a switch from Culicoides imicola, its primary vector, to secondary vectors consisting of other Culicoides species adapted to the colder climate of northern Europe, as discussed in detail elsewhere (2).

Arthropod vectors can be broadly divided into two groups: ticks and insects. Ticks are obligate parasites that have been associated with the transmission of diseases to vertebrate animals and humans since ancient times. Domestic animals are commonly believed to be the preferred hosts of most ticks; in fact, the vast majority of ticks are parasites of wildlife and are dependent on the presence of wild animals to complete their life cycles. There are two main families of ticks, i.e. ‘hard’ ticks (Ixodidae) and ‘soft’ ticks (Argasidae), which are highly divergent in their biological characteristics, with a third family (Nutalliellidae), consisting of only one species, with intermediate characteristics (3). Hard ticks are the vectors of some of the most economically important tropical diseases of domestic animals caused by protozoa (e.g. babesiosis, theileriosis), bacteria (e.g. ehrlichiosis, spirochaetosis) and viruses (e.g. Nairobi sheep disease, Crimean-Congo
haemorrhagic fever). They are also responsible for transmitting a number of toxicoses where an infectious agent is not involved (e.g. sweating sickness, spring lamb paralysis, Karoo paralysis). Only two soft ticks are currently of veterinary importance. *Ornithodoros porcinus*, which is a member of the *O. moubata* group, is the primary vector of African swine fever (ASF) in Africa, whereas the *O. eraticus* complex was identified in Europe as the main secondary vector. The taxonomy of soft ticks is still rather controversial. Of epidemiological importance is the fact that, where they are present, *Ornithodoros* ticks are true biological vectors in the sense that they can carry the ASF virus for prolonged periods and can be part of both sylvatic and domestic cycles. Trans-ovarial and trans-stadial transmission as well as transmission between male and female soft ticks have been demonstrated. The taxonomy, life cycles and ecology of the various tick vectors are discussed in more detail elsewhere in this publication (4).

The majority of arthropod vectors belong to four orders of haematophagous insects: Phthiraptera (lice), Siphonaptera (fleas), Diptera (flies) and Hemiptera (true bugs). The latter group is not known to transmit pathogens to animals or humans. Lice are permanent ectoparasites causing physical damage and are only known as vectors of human disease, e.g. typhus fever. Fleas can act as vectors, mostly mechanical, of a variety of microorganisms in animals, including protozoa (rodent trypanosomes), bacteria (tularemia), and viruses (myxomatosis). Most of the important insect vectors of veterinary importance are the flying insects belonging to the order Diptera. Examples are the sandflies (*Phlebotomus* spp.), black flies (*Simulium* spp.), midges (*Culicoides* spp.), mosquitoes (*Aedes* spp.), horseflies (*Tabanus* spp.), tsetse flies (*Glossina* spp.) and louse flies (*Hippobosca* spp.). Their biology and importance to veterinary science is explored elsewhere (5).

A vector-borne disease can simply be defined as a disease transmitted by a living being, usually an arthropod vector, to a vertebrate host. Such a definition is an oversimplification, however, as these diseases are complex, depending on a balance between the vector, the parasite transmitted and the host. Each of the three components has an influence on the course of the disease: its incidence, geographical distribution, epidemiology, pathogenicity and, eventually, its control or eradication. The relationship between the three components can remain constant for long periods, in which case the features of the disease will remain constant and the methods to control it can be standardised. In practice, however, each of the components tends to change from time to time, leading to changes in the characteristics of the disease which often require changes in its control. This variability is one of the distinguishing features of vector-borne diseases. In its extreme form it can lead to the emergence or re-emergence of new diseases.

Many factors can influence the vector. Ecological changes, either natural or human-induced, include climate change, habitat destruction and changes in population density/distribution as a result of increased travel and trade. When these factors affect the capability of the primary vector to transmit the infectious organism the latter can adapt to a secondary vector. A good example of this phenomenon is the adaptation of the bluetongue virus to various *Culicoides* species able to survive the colder climate of northern Europe. The infectious agent can also change and adapt to different environments. Many viruses constantly go through mutations, including recombination. They undergo selection processes that lead to new strains occurring in different parts of the world, complicating its control by means of vaccination and thus necessitating the development of new vaccines. Finally, the host
animal is also affected by environmental changes. The population density of the host is critical for the completion of the infection cycle and the removal of the primary host could even lead to the eradication of the disease. It could also lead to the adaptation of either the organism or the vector to a secondary host. Examples of these possible scenarios are well known and are discussed in more detail in the second issue of this *Review* (Part II: Important diseases for veterinarians), which deals with the unique characteristics of individual vector-borne diseases and especially the problems encountered in their diagnosis and control.

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**References**


