SOME CONTEMPORARY ASPECTS
OF NATURAL FOCALITY AND EPIDEMIOLOGY
OF TICK—BORNE ENCEPHALITIS

E. I. KORENBERG

Laboratory of Medical Zoology, the Gamaleya Institute of Epidemiology and Microbiology
of the USSR Academy of Medical Sciences, Moscow

Dedicated to Prof. Yu. V. Kurkevuk on the occasion of his 60th birthday

Abstract. A survey is given of the data, obtained in recent years which make it possible to consider
in different light some fundamental aspects of the circulation of tick-borne encephalitis virus in
nature and of the epidemiology of this disease.

The history of the research on tick-borne (spring-summer) encephalitis is about
40 years old and undoubtedly represents one of the most striking pages of the Soviet
and world medical-biological science. Its brilliant origin is closely connected with the
names of two prominent scientists, L. A. Zilber and E. N. Pavlovsky.

During the four summer months of 1937 an expedition to the Far East, headed
by L. A. Zilber, established the etiology as well as the most characteristic features
of epidemiology, clinical picture and pathology of the disease which had been earlier
diagnosed by some physicians as toxic influenza and by others as encephalitis of the
Japanese type. Thus, a new neuro-viral nosological form was disclosed and generally
characterized. In the course of these studies L. A. Zilber first assumed that Ixodes
persulcatus tick was the vector of the virus (Zilber 1939, 1957).

This assumption was fully confirmed by field and experimental studies carried out by
expeditions during two subsequent years. Besides, in 1938 and 1939 the research guided
by E. N. Pavlovsky was successful in achieving many important facts permitting

to conceive the main scheme of the virus circulation in nature. The most peculiar
features of tick-borne encephalitis as a disease with natural focality were first formulated
by Pavlovsky (1947).

To date over 4,000 publications have been devoted to the problems of epizootology
and epidemiology of tick-borne encephalitis. An enormous body of information has
been accumulated, but so far insufficiently generalized, and confirms the theory on
natural focality of this infection elaborated during the first years of its research and
precisely formulated in the papers of Zilber (1945) and Pavlovsky (1947). The data
obtained, however, make it necessary sometimes to consider the main aspects of the
tick-borne encephalitis virus circulation in nature and the epidemiology of this disease
in a different light.

Soon after the research of tick-borne encephalitis had been started it became clear
that its causative agent existed not only in the remote taiga of the Far East, but in
many other regions of Europe and Asia as well. To date the nosoarea of this disease
has been studied fairly thoroughly. Natural foci of tick-borne encephalitis were found to
constitute a continuous strip along the southern part of the forest zone of non-tropic Eurasia from the Mediterranean Sea to the Pacific Ocean. There is every reason to assume that over this vast territory one polytypical species of the causative agent — *Encephalophilus silvestris* — exists, of which a well-defined geographical variability is characteristic (Kucheruk et al. 1969).

Within the nosoarea in question there are some sectors with a particularly intensive epidemic manifestation of natural foci. In two westernmost sectors the main vector of the virus is the tick *Ixodes ricinus*. These sectors are situated in Czechoslovakia and in the central part of the Byelorussian SSR. In the remaining four sectors, where the mean annual infection rate is the highest and accounts for 10 to 80 cases per 100,000 population, the main vector of the agent is the tick *Ixodes persulcatus*. They are associated with the following territories: a) the Vyatka-Kama interfluve (south-eastern part of the Kirov Oblast’ and almost all Udmurt ASSR); b) the Central Ural (the south-east of the Perm Oblast’ and also central and southern part of the Sverdlovsk Oblast’); c) the southern part of West Siberia (north-east of the Altai Krai, the south-east of the Novosibirsk Oblast’, the greater part of the Kemerovo Oblast’ and Tomsk Oblast’, the south of the Krasnoyarsk Krai and the Primorye territory. The accumulated facts made it possible to consider the well-grounded typification of tick-borne encephalitis natural foci and regionalization of its nosoarea. These problems are discussed in detail in the paper of Kucheruk et al. (1969).

During the last 10—15 years much attention was paid to studies of different groups of bloodsucking arthropods as vectors of tick-borne encephalitis agent. Descriptions were given of virus isolations from fleas, gamasoid mites, mosquitoes and other bloodsucking arthropods. On the basis of these data and of some experimental studies a certain tendency was outlined to revise the established concepts of the secondary role of these arthropods in the tick-borne encephalitis foci. This fact was reflected in a number of reviews, monographs and manuals (Levkovich 1966, Levkovich et al. 1967 etc.). A particularly significant role has been ascribed to gamasoid mites. Some researchers believe that these mites can regularly disseminate the virus among their hosts, the small mammals and birds, thus accomplishing "a minor circle" of circulation of the causative agent in nature.

The possibilities of the virus penetration into the organism of most varied parasites together with the blood of their hosts are indisputable. However, the unbiased analysis of the accumulated facts makes us to conclude that so far no convincing and in all respects methodically perfect proofs of the significant role of any group of arthropods, except ixodid ticks, in the circulation of tick-borne encephalitis virus have been obtained. In the majority of instances, when gamasoid mites, fleas, mosquitoes and other non-ixodid obligatory or facultative hematophags are capable of transmitting the virus, the virus dose is apparently so small that it only provokes a latent immunization of vertebrates. In my opinion, this is their most probable epizootic significance, which should be considered while attempting to evaluate the intensity of the virus circulation in natural foci by serological tests. Only the presence of ixodid ticks can ensure a long-term existence of the virus in a certain territory. This group of arthropods alone continuously maintains the virus circulation in natural foci and is of epidemic importance.

Natural infection with tick-borne encephalitis virus was established with a different degree of reliability in 16 species of ixodid ticks: *Ixodes persulcatus*, *I. ricinus*, *I. pavelenskiy*, *I. gibbosus*, *I. lividus*, *I. trianguliceps*, *I. hexagonus*, *I. crenulatus*, *Dermacentor pictus*, *D. marginatus*, *D. silvarum*, *D. nuttalli*, *Haemaphysalis concinna*, *H. japonica douglasi*, *H. inermis*, *H. punctata*. In the near future this list will be
obviously somewhat extended, particularly due to species of the *Ixodes persulcatus* group which has been recently thoroughly revised by taxonomists (Filippova 1969) etc. However, *I. persulcatus* and *I. ricinus* are the only main vectors and reservoirs of the infection and this fact determines their primary significance in the epizootology and epidemiology of tick-borne encephalitis. In a certain combination of conditions in comparatively limited territories in the eastern part of the nosological range *H. concinna* ticks may play an important role in the maintenance of natural foci. The remaining species should be listed in the category of secondary, additional or accidental vectors.

The tick-borne encephalitis virus is harboured practically for life by all developmental stages of both engorged and unfed *I. persulcatus* and *I. ricinus* ticks and can overwinter in them. The ticks transmit the virus to their progeny transovarially and do not lose it during the metamorphosis from one stage to another; this fact makes them not only vectors but also long-term preservers as well as reservoirs of the causative agent in nature. However, quantitative regularities of transovarial and transstadial transmission of the virus have been scarcely studied and the results of experiments obtained by different researchers are rather discrepant and make possible different interpretations. Most varied and even incompatible views have been already expressed, from the denial of the possibility of transovarial transmission of the virus to the consideration of this phenomenon as absolute. Therefore, concepts of the fate of the virus in ticks, as discussed below, are rather hypothetical, though based on factual data accumulated to date.

The very possibility of transovarial transmission of the virus under conditions is apparently inconstant even in that case when tick females imbibe a large dose of virus. Most likely it occurs only if a certain period of time elapses between the moment of infective feeding of the tick and the onset of oviposition, but its minimal duration still remains unknown. This period is necessary for the penetration and sufficient accumulation of the virus in the tick’s reproductive organs. One of the mechanisms of synchronization of the complicated life cycle of *I. persulcatus* and *I. ricinus* lies in the fact that oviposition occurs in a definite season. This is accomplished due to considerable variability of the ovogenesis period, which e.g. in *I. persulcatus* in European south-taiga forests can last from 2–3 to 40–50 days depending on the period of their engorgement (Zhmáeva 1969). Accordingly, it may be assumed (Korenberg 1974) that the probability of transovarial transmission in *I. persulcatus* which are infected during feeding at the beginning of summer and have a long period of ovogenesis, is greater than in ticks which feed later. Besides, the successful infection of ticks, speed as well as degree of intensity of reproduction of the virus in their organism and consequently the possibility of transovarial transmission of the causative agent most probably depend on the state and physiological age of these arthropods. This view is supported by recent experiments of Kondrashova and Kotel'nikova (1975) who obtained different results in *I. persulcatus* females infected with exact doses of virus, depending on the physiological state of the ticks. In my opinion, the above assumptions somewhat elucidate the discrepancy of published data on the possibility of transovarial transmission of the tick-borne encephalitis virus and are worthy of a thorough experimental verification both in field and laboratory. If they prove to be true, new prospects will open for the explanation of causes which change the intensity of epizootological process in particular years.

Consequently, the possibility of transovarial transmission of the virus, in principle, is indisputable. However, even when it does occur, only some larvae hatched from one batch of eggs laid are found to be infected (according to the data available up to 20–25%). Each larva apparently receives a very small dose of the virus. Unfed
larvae are the least resistant active tick stage and their death rate is extremely high. It should be therefore admitted that the period of the existence of the virus in unfed larvae represents the most crucial stage in the circulation of tick-borne encephalitis agent in nature.

The regularity of the transstadial transmission of the tick-borne encephalitis virus in ticks arouses no doubts in any researcher. During and after tick feeding the virus apparently multiplies in the tick to a certain degree. The multiplication is positively established in imago (Shubladze and Serdyukova 1939, Benda 1958), and there are no grounds to disclaim such a possibility in immature stages. However, due to a high mortality of arthropods in each stage of the metamorphosis, only a very low number of specimens infected during the larval stage survive reaching the adult stage. In other words, two processes occur in nature with contrary influence on the population of the virus: during their life cycle the absolute number of infected ticks gradually decreases in each generation, but the concentration of the virus appears to gradually increase in the organism of each individual infected tick which survived the development from larva to engorged adult. Without a regular powerful build-up of the number of virus-carrying ticks these phenomena could not possibly continue for an unlimited long period and the circulation of the virus in nature might stop. Such a build-up is accomplished due to regular infection of ticks during feeding on viremic vertebrates.

Numerous publications are devoted to the significance of vertebrates in natural foci of tick-borne encephalitis, but still this problem has been studied very superficially. Before discussing it in detail, I would like to dwell on some general views which were already fairly definitely expressed by Zilber (1945), but which are unfortunately often underestimated by researchers while interpreting the epizootic significance of concrete facts. The occurrence of humoral immunity indicates only the contact of particular individual with the causative agent and the detection of the virus in the brain and internal organs of animals does not itself support the possibility of their participation in the circulation of the agent in nature since ticks can acquire it only with blood. In this respect, of major importance are the data of the duration and intensity of viremia, which can be obtained in experiments. However, in a majority of such experiments animals have been inoculated intracerebrally or subcutaneously with large doses of the agent and this fact does not correspond with natural conditions of its penetration into the organism. Natural infection of wild vertebrates during feeding of infected ticks on them has been simulated in experiments with a very limited set of species. These facts make it necessary to regard very cautiously all assertions about the participation in the circulation of the virus of about 130 animal species belonging to different taxonomic groups (Morozov 1961), listed in many recent reviews.

1. persulcatus and I. ricinus ticks attack mammals, birds and reptiles. An increasing number of researchers gradually come to the conclusion that the two latter groups of vertebrates do not usually take an essential part in the dissemination of the virus in natural foci (Blaškovič 1966, Korenberg 1966, Grešniková 1972, Chunikhin 1973), and associate this process mainly with mammals. However, different views have been already expressed on the significance of various mammals as soon as the studies on the epizootology of tick-borne encephalitis were started. At present almost all specialists ascribe the most important role in the accumulation and dissemination of the virus to small mammals — the hosts of immature phases of ticks. This conclusion is primarily based on the concepts of peculiarities of humoral immunity in tick-borne encephalitis. According to these concepts, antibodies forming in the blood due to the contact with the virus, are maintained for a long time and the humoral immunity prevents a further participation of mammals in the circulation of the agent. As logically appears from this concept, the role of mammals with a long lifespan, mostly large animals.
serving as hosts of adult ticks, might be limited, as they soon acquire immunity and number of their annual offspring is relatively low. By contrast, small mammals that reproduce intensively and change their populations quickly, ensure a regular influx of young non-immune individuals, thus creating favourable conditions for intensive multiplication and dissemination of the virus (Shilova 1960, Nikiforov 1968 etc.).

Convincing facts, seriously questioning the correctness of these views, were obtained in the research conducted by Prof. V. V. Kucheruk, during long-term and large-scale mapping of the distribution of different components of a natural focus, revealing the factors determining its spatial structure. It has been found, that there is no clear-cut correlation between the abundance of small mammals and the infection rate of *I. persulcatus* ticks that have fed on them. Moreover, the places with high numbers of these animals, do not coincide with the patches of the most regular and intensive circulation of the virus.

Serological surveys of populations have recently revealed that antibodies forming in the blood of vertebrates due to the contact with the tick-borne encephalitis virus do not persist for a long time. Their titres gradually decrease and antibodies relatively rapidly disappear if there is no repeated contact with antigen. This phenomenon was found in red deer, goats, cows, hedgehogs, small mammals and birds (Korenberg et al. 1964, Kucheruk et al. 1965, Korenberg and Pehelkina 1967). At present, the rapid disappearance of humoral antibodies in wild and domestic animals may apparently be regarded as one of the major general natural laws governing the epizootology of tick-borne encephalitis (Korenberg 1974). It has been also shown experimentally that the presence of antibodies in the blood of goats does not hamper the development of viremia (Korenberg and Pehelkina 1975). In a natural focus of tick-borne encephalitis the virus strains were isolated from the semi-engorged adults and nymphs of *I. persulcatus*, collected from immune red deer, 1 g of the neutralization index of sera from these ungulates reaching 5.66 and antihemagglutinin titre being up to 1:1280 (Korenberg et al. 1975). Finally the possibility of repeated viremia in the same goat was demonstrated following successive infection with tick-borne encephalitis (Korenberg and Pehelkina 1975).

The facts described make it necessary to revise some important concepts concerning the epizootology of tick-borne encephalitis. In particular they give ground to presume that long-lived large mammals capable of developing repeated though short-term viremia are of primary importance as the source of the virus for a large number of adult ticks feeding on them and their immediate progeny (Korenberg 1974a). As disclosed by the above mentioned mapping, this group of animals determines the existence of patches with stable high numbers of ticks, where a most intensive infection rate of arthropods is observed as well. In addition, a large-scale examination of red deer carried out in the Altai demonstrated that numerous nymphs of *I. persulcatus* parasitize them besides adult ticks (Korenberg et al. 1975). There is similar evidence in respect to *I. ricinus* nymphs. Consequently, it is possible that an exchange of the agent between adults and nymphs and an additional infection of these phases occur when they feed simultaneously on large wild mammals. It is likely that small mammals — hosts of larvae and nymphs, can only insignificantly change the extent of infection of the tick progeny which depends on the degree of virus-carriage of engorged adult ticks and their capacity to transmit the agent transovariably.

The generally outlined mechanism of the circulation of tick-borne encephalitis in natural foci is being complicated by natural laws governing the population ecology of vectors (Korenberg 1974b). The ticks, produced from one batch of eggs, can have a different duration of the developmental cycle depending on a combination of conditions occurring in nature. They reach the adult phase at an interval of several
years. The total number of ticks of one phase (a hemipopulation) annually represents a complex of specimens whose absolute age varies because they belong to the generations of different years. According to the variability of the duration of developmental cycle (Zhmaeva 1969) the hemipopulation of I. persulcatus adults in the south-taiga forests of the eastern part of the Russian Plain, for instance, may annually consist of ticks, whose absolute age is 3, 4, 5, 6 or even 7 years. Therefore, micropopulations of the virus harboured by ticks differ in their origin and preceding fate. Hence, an urgent necessity arises to study thoroughly the ecological polymorphism of a virus population. For the time being this aspect of the epizootology of tick-borne encephalitis as well as other natural foci infections, remains practically unknown, and this fact hampers the correct interpretation of the reasons for dynamics of the epizootic process. Nothing is yet known whether the tick's organism as the environment of the agent exerts any influence upon its biological properties (Pavlovsky et al. 1940). In particular, it is most likely that after the virus has existed in ticks for a certain period of time, its capacity to multiply in the blood of vertebrates is activated.

Accordingly, speaking in most general terms, the intensity of the epizootic process depends on the population density and the number of virus-carrying ticks as well as on the peculiarities of interrelations between the virus and vertebrates determining the possibility of its multiplication and dissemination. This intensity essentially varies in different years as it results from complex intrapopulational and biocenotic processes which have occurred in the natural focus during preceding seasons. The fluctuations in the level of the morbidity of tick-borne encephalitis in a population reflect the alterations in the intensity of the epizootic process. Thus, in the territory of the USSR within the last 25 years there were two marked upsurges of epidemic manifestation of natural foci: in 1956 and in 1969 when the morbidity reached 4.5 to 4.6 per 10,000 persons in the RSFSR. The minimum morbidity 0.5 per 10,000 persons was recorded in 1957 (Ivanova 1969). Within any part of the range of tick-borne encephalitis the number of cases registered in different years was twice to 10 times as high. However, natural foci become activated at different periods. The same year morbidity may increase in one part of the nosoarea and decrease in another. Therefore, in our opinion (Korenberg and Ivanova 1967) there is no sufficient proof for associating the dynamics of morbidity with the effects of global factors such as general rise in temperature, changes of solar activity etc.

As is generally known, man may acquire and become infected with the tick-borne encephalitis virus by tick bite (transmissive route) or by using raw goat's milk in the food (alimentary route). Cases of alimentary infection are usually recorded simultaneously with transmissive ones over the whole nosoarea of tick-borne encephalitis. They are typical of Czechoslovakia and some other Central European countries, while in the Soviet Union the majority of them (more than 50%) is associated with Byelorussia, Leningrad, Kirov, Perm, Sverdlovsk regions and the Udmurt ASSR (Ivanova 1969). The ratio of transmissive and alimentary infection in different parts of the nosoarea varies. The percentage of alimentary cases as a whole is markedly higher in areas inhabited by the main vector of the virus of the tick I. ricinus, which is less aggressive to man than I. persulcatus. In Byelorussia, for instance, about 65% of tick-borne encephalitis cases are due to the use of raw goat's milk (Votyakov 1965), while in the Udmurt ASSR where I. persulcatus ticks are prevalent, they are responsible for 25% of cases (Kozmenykh et al. 1969). Within the actual regions, cases of alimentary infection are most frequently recorded in places where a large number of goats are regularly grazed in active foci of tick-borne encephalitis with a high population density of ticks (Korenberg and Peholkina 1969). Recently it has been experimentally demonstrated, that goats are capable of contracting tick-borne encephalitis.
several times within their life span, eliminating the virus together with milk (Korenberg and Pchelkina 1975). Consequently, the same goal may be a source of infection of man during different epidemic seasons. A similar, well-documented fact has been already described by Popov and Ivanova (1968).

The general epidemiological characteristics of tick-borne encephalitis at the very beginning of its research consisted of several statements which can be summed up as follows: urban population does not become infected; antibodies in the blood of local inhabitants, produced as a result of their gradual latent immunization, protect them against the infection; mainly newcomers associated with the forest due to their occupational activities contract the infection; as a rule, children do not suffer from tick-born encephalitis; in the process of taiga cultivation the incidence of infection gradually subsides. Extensive statistical data available as well as numerous specific investigations carried out in various parts of the nosoarea make it desirable to revise all these statements (Ivanova 1969).

65 to 70% of persons with a history of tick-borne encephalitis are those living in a rural area for no less than 7—10 years. In the first place this may be explained by their extremely intensive contact with natural foci. Annually on the average 70—90% of rural inhabitants visit the forest within the nosoarea during the summer, a person visiting the forest in the European part of the USSR from 3—12 times, in Central Siberia from 23 to 48 times. During the summer every forth to eighth such visitor reported tick bites (Kuccheruk 1973).

In the USSR 70—80% of cases due to tick exposure result from visits to the forest with the economic purpose or with a view to everyday necessities and during recreation. Infection generally occurs in a long and well-cultivated area, in a radius of 3—8 km from settlements. In recent years occupational contact with forest is responsible for no more than 15—20% of the total number of tick-borne encephalitis cases recorded in the RSFSR (Ivanova 1969).

Permanent high morbidity among local rural population, contrary to previous widely spread concepts (Pavlovsky et al. 1940, Vereta and Kanter 1963, Karpov and Fedorov 1969 etc.) indicates that persons regularly contacting natural foci are not resistant to tick-borne encephalitis and antibodies present in their blood do not always prevent the disease from being clinically manifested in them. This has now been evidenced by direct virological, serological and clinical studies. Many researchers revealed viremia, isolated the virus from the blood and observed clinical manifestation of tick-borne encephalitis in persons with a high level of humoral immunity (Levkovich et al. 1960, 1967, Pogodina et al. 1962, Bychkova et al. 1963, Medvedeva and Osintsseva 1969).

All specialists and authors of review publications generally point out lasting and intense immunity in persons recovered from the disease (Vereta and Kanter 1963, Karpov and Fedorov 1963, 1969, Levkovitch et al. 1967 etc.). This fact is considered as firmly established, but present data on immunology require it to be thoroughly verified. Although well-documented repeated cases of tick-borne encephalitis have not as yet been described, they are no more doubted now (Shapoval 1972). One of the characteristic features of contemporary epidemiology of tick-borne encephalitis is high incidence of the disease among urban population, averaging in recent years 1.8 per 100,000 persons in the USSR (Ivanova 1969). It is due to the mass recreation in forests during leisure time, rapid development of all forms of tourism and to some other reasons which promote intensive contact of urban inhabitants with natural foci. The tactics and practical preventive measures against this disease in many towns of the Ural foreland, the Urals and Siberia have become one of the most complicated problems of the sanitary-epidemiological service.
In the last decades children under 14 years of age constitute annually 25—35% of a total number of tick-borne encephalitis cases, 7—10% not older than 7 years. Children are most frequently involved when alimentary infection occurs: more than a half of a total number of cases due to the use of goat’s milk is usually represented by children (Popov and Ivanova 1968, Ivanova 1969).

The peculiarities of the epidemiology of tick-borne encephalitis in different parts of its nosoarea as well as its general epidemiological characteristics are in many respects determined by social and economic conditions. Any change of these conditions inevitably results in a decrease or an increase of the risk of infection for different contingents. There is a steady increase in the direct and indirect influence of man on bioecenes in which the virus is present, affecting the regularities of epizootology and epidemiology. Forecasting of such changes is an important task in the studies of tick-borne encephalitis and other diseases with natural locality.

REFERENCES


FILIPPOVA N. A., Taxonomic aspects in the studies of ticks of the genus Ixodes latr. (Ixodoidea, Ixodidae), the vectors of tick-borne encephalitis viruses. Ent. obozr. 48: 675—688, 1969. (In Russian.)


KARPOV S. P., FEDOROV YU. V., Epidemiology and prevention of tick-borne encephalitis. Tomsk, 227 pp., 1963. (In Russian.)

—, Immunology of tick-borne encephalitis, Tomsk, 183 pp., 1966. (In Russian.)


—, The present concepts of the role of mammals in the epizootology of tick-borne encephalitis.

—, Some problems of population ecology of ixodid ticks. Zool. zh. 53: 165—175, 1974b. (In Russian.)

—, IVAHOVA L. M., On disputable statements in the interpretation of main condition of increased tick-borne encephalitis incidence in the population. Med. parazitol. 36: 270 to 275, 1977. (In Russian.)


—, Intensity of contact of goats with the tick-borne encephalitis virus and indices of the risk of alimentary infection of man. In: Kleshehoy entsefalit v Udmurtii i prile-zhashehikh oblastyakh. Izhevsk, p. 2 35—240, 1969. (In Russian.)

—, Repeated viremia in a goat following subsequent infection with tick-borne encephalitis virus. Med. parazitol. 44: 181—184, 1975. (In Russian.)


POGOVINA V. V., LEVKOVICH E. N., MAGAZANik S. S., Results of the studies on inapparent virus carriage and latent immunization in tick-borne encephalitis. Avtoreferaty dokladov na rasshirennom zasedanii komiteta po borbe s kleshehovym entsefalitom, Omsk, p. 21—23, 1962. (In Russian.)

POPOV V. F., IVAHOVA L. M., Epidemiologic features of alimentary route in tick-borne encephalitis infection in the RSFSR. Zhitmei 10: 36—42, 1968. (In Russian.)


—, KROL M. B., SMORODINTSEV A. A., Brief data on tick-borne (spring-summer) encephalitis. Medgiz M-L, 79 pp., 1940. (In Russian.)


The book has a subtitle "Development of Transmission Theory" and presents a historical survey of the origin and development of biological sciences dealing with medical arachnoentomology, particularly with the role of arthropods as vectors of man diseases. It is divided into four chapters. The introductory chapter (pp. 5—32) contains the first data on arthropods causing man diseases, starting from the oldest times up to the half of the 19th century. It describes the earliest ideas about the parasitic arthropods, the period of the first microscopic investigations of the 17th century and the following period of descriptive studies. The second chapter (pp. 33—94) deals with the formation of scientific fundamentals of medical arachnoentomology, development of the research of morphology, anatomy and systematics of the causative agents and vectors of diseases and the first theoretical generalizations in this subject. The third chapter (pp. 95—183) is devoted to the formation of the transmission theory. It discusses the main prerequisites of the origin of this theory, the history of the discoveries concerning the role of arthropods as vectors of infectious agents of diseases, the formation of the theory on the transmissive role of arthropods and the importance of the transmission theory in general biology with regard to significant participation of the Russian and Soviet biologists in these studies. The fourth chapter (pp. 184—203) deals with the history of organization and management of the scientific work in the domain of parasitology and medical arachnoentomology in both the U.S.S.R. and foreign countries. Each chapter has a special list of literature and the book concludes with an index of names. Photographs of outstanding world parasitologists are attached.

In my opinion, the last chapter should consider also the development of parasitology in socialist and some other European countries after the World War II. There have been founded many parasitological societies and numerous journals are published, which are of importance for this scientific discipline. The period of last 2 to 3 decades in general should be dealt with in more details. As regards the names of foreign authors, the original spelling is recommendable, at least in the name index. There are some misspellings in the names of authors, e.g., Claparède (p. 91), Dugès (p. 92), Nitsch (p. 93) and also in Latin names of insects, e.g., Palacopsylla (p. 5), T. foliitialis (p. 23), Rhinoestris (p. 51), Pulex and C. pipiens (p. 70), but not very numerous.

The book is a valuable source of information to all readers interested in the historical development of investigations and ideas in the field of medical arachnoentomology. It suggests the author’s deep knowledge of this subject and offers a large number of data which otherwise would be hardly available in such a comprehensive form. The author is to be congratulated on the edition of this work.

Dr. V. Černý, C.Sc.