TICKS (IXODOIDEA) IN ISRAELI TOWNS

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Abstract - Among argasid ticks, *Argas reflexus* is one of the main parasites entering and living in houses in many Israeli towns. Its hosts are birds, mainly doves, closely linked with human dwellings. *A. latus*, a member of the *A. reflexus* group known only from Turkmenistan, was found in houses in several areas of Jerusalem where it attacked and bit humans. A case of massive attacks of *Ornithodoros coniceps* was recorded in an apartment in central Jerusalem, probably connected with chickens kept in a nearby yard. *Rhipicephalus sanguineus* (Ixodidae), the main vector of Mediterranean spotted fever, populates numerous grass-covered sites, sometimes very small ones, in Jerusalem and many other towns. Since *R. sanguineus* is closely connected with dogs, a number of domestic foci of this tick were revealed in Jerusalem, Tel-Aviv and Beer-Sheva. In such cases, the development of the tick often changes from the normal 3-host cycle to a 2-host cycle when the larvae do not leave the dogs after feeding but molt into nymphs which feed again on the same host. *R. turanicus* prevailed in more humid sites of waste grounds of several Israeli towns, mainly in the coastal plain (e.g., Tel-Aviv and Haifa). Occasional bites of *Ixodes redikorzevi* followed by toxicosis have been recorded in Jerusalem, its surroundings and in several other towns. Adult *Haemaphysalis parva* have sometimes been found in Jerusalem on dogs in winter months. Several cases of the introduction of tick vectors from the U.S.A. to Israel, either on people or in their luggage, with subsequent attachment to their carriers were recorded. The following species were identified: nymphal *Ixodes scapularis* brought from New Jersey, adult *Amblyomma americanum* from New York, and adult *Dermacentor variabilis* from Alabama.
Key Words - Ticks, *Rhipicephalus*, Mediterranean spotted fever, *Ixodes*, human toxicosis, Israel

INTRODUCTION

If the early stages of urbanization were followed by the disappearance from towns of many animals including some bloodsucking arthropods, the last decades have been characterized by a reappearance of many of them, very often with new patterns of population ecology, as well as by an appearance of some new ones. Ticks did not attract strong attention at the beginning of this process but now they have become an essential component of urban arthropod pests, being especially important because of their vectorial capacity concerning some very dangerous human and animal diseases. Records on ticks in towns are now published quite regularly (Daiter, 1985; Daniel and Cerny, 1990; Gilot *et al.*, 1992; Raoult *et al.*, 1993). The increasing number of dogs acquired by town inhabitants may be considered as one of the main causes of the present development. The growing desire of humans to return to nature and to spend as much time there as possible, often together with their pets, also stimulates the introduction of ticks into towns. The increasing movement for environmental protection including that in towns has essentially contributed to this process. Although ticks have often been recorded from Israeli towns (Theodor and Costa, 1967), no methodical survey has been carried out and the real epidemiological significance of urban ticks has not yet been estimated. This paper is the first attempt to evaluate the problem using the data jointly obtained by the Entomology Laboratory of the Ministry of Health and by the acarologists of the Hebrew University of Jerusalem during several recent years.

MATERIALS AND METHODS

Ticks were collected by the authors during 1991 to 1998 using standard methods, and were also brought by people who found ticks attached to themselves or their relatives, or by physicians, veterinary doctors and exterminators. Several dog owners, who regularly gave us ticks found on their dogs, were especially

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useful. The methods of tick collection were the following: flagging (for tick collection) and dragging (for tick census) of vegetation; examination of dogs; examination of apartments whose owners complained of ticks inside their homes. Detailed questioning of the inhabitants concerning the history of the tick invasion followed the examination of apartments. Since the spots of vegetation where ticks were looked for were sometimes very small, we used as a unit of tick abundance the number of ticks collected per unit time and not per unit distance. The general distance of censuses in cultivated areas (parks, gardens) was more than 4 km and in non-cultivated areas 3.6 km. The total number of dogs examined was 56, but dogs that were examined annually were counted every time. Dogs with insecticidal collars were not examined. The Department of Epidemiology of the Ministry of Health collates all the reported cases of tick-borne diseases and publishes them regularly.

RESULTS

Tick species that were documented from Israeli towns are presented in Table 1.

Argasidae

The pigeon tick, *Argas reflexus* (F.), was long considered to be the main argasid tick in Israel attacking man in his home. There are documented records on this species from Jerusalem and from Eilat. In both cases, pigeons were in the immediate vicinity of the infested homes. Recently, *A. latus* Filippova, one of the newly described species of the *A. reflexus* group, was also recorded in Israel. This species has been found in four localities in Jerusalem, two cases consisting of massive infestations in 2nd and 3rd floor apartments, with the families suffering from tick bites over periods of 3 to 4 years. The ticks emerged from wall and window frame cracks and electricity points, and could be seen crawling over the walls of the apartments. In both cases, pigeons are assumed to be the main host of *A. latus*.

In 1997 and 1998, a massive infestation of *Ornithodoros coniceps* (Canestrini) was recorded from a Jerusalem apartment where ticks had infested the whole house and all the occupants were bitten. One resident had very severe reactions to the tick bites and had to be hospitalized and treated with antibiotics. Following the first attack, it was discovered that the children of the household had played in a nearby yard where chickens were kept. However, spraying of the home in 1997 did not prevent the 2nd large infestation in 1998, in which the head of the household was again hospitalized for toxicosis following tick bites. This is the first report of *O. coniceps* attacking man in an urban area in Israel.

Ixodidae

The brown dog tick *Rhipicephalus sanguineus* (Latreille), the main vector and reservoir of *Rickettsia conorii*, the causative agent of Mediterranean spotted fever (MSF), is the most common tick that can be found in towns. Examination of dogs carried out in Jerusalem during the peak of tick activity (May-June) showed that from 45 to 75% of dogs had at least one adult tick up to a maximum of 12 adults attached or crawling over the dog (Table 2). Attempts to collect ticks in cultivated areas (gardens, parks) where grass was regularly mown were unsuccessful. At the same time, the non-cultivated areas, sometimes very small spots covered with wild and dry vegetation, are populated with *R. sanguineus*, especially in areas with a dense population of dogs (Table 2).

An interesting phenomenon of the establishment of domestic foci of this species was registered several times. A single female fully engorged on a dog that drops in or near a human dwelling initiated the beginning of a focus. Such foci could be of 2 types: either in and near kennels in small yards or gardens near the dwelling (pseudo-domestic foci) or just inside apartments, often in many-story buildings, where dogs are kept indoors. In such cases, the development of the tick often changes from the normal 3-host cycle to a 2-host cycle when the larvae do not leave the dogs after feeding but molt into nymphs which feed again on the same host. Engorged nymphs leave the host and migrate upwards over the walls. In the yards, they locate in small depressions inside the walls on the outer side of the house, sometimes creating large clusters. Inside apartments, they also move upwards over the inner walls being especially visible,

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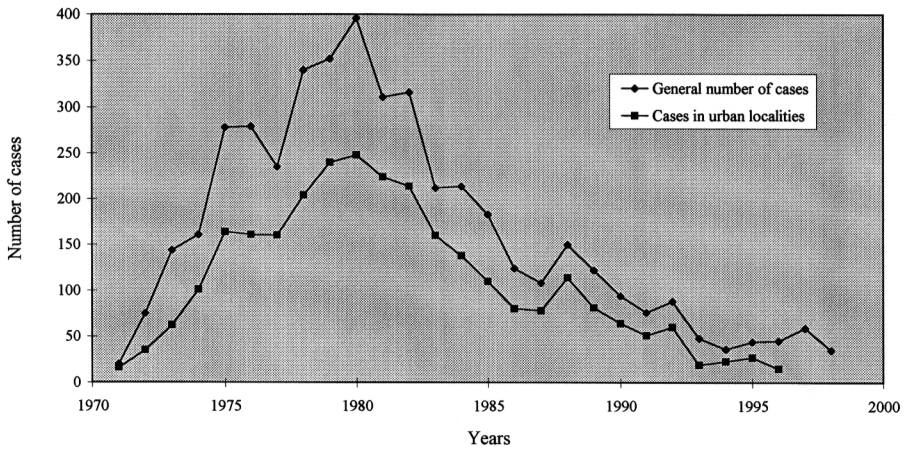
Table 1. List of tick findings in Israeli towns.

Ticks originally found in Israel		Ticks introduced into Israel	
Species	Location (towns)	Species	Location (towns)
Argas reflexus	Jerusalem, Eilat	*Ixodes scapularis*	Zichron-Yaakov
Argas latus	Jerusalem	*Amblyomma americanum*	Jerusalem
Ornithodoros coniceps	Jerusalem	*Dermacentor variabilis*	Jerusalem
Rhipicephalus sanguineus	Jerusalem, Tel-Aviv, Beer-Sheva, and many smaller towns		
Rhipicephalus turanicus	Tel-Aviv, Haifa		
Ixodes redikorzevi	Jerusalem, Beit- Shemesh, and many smaller towns		
Haemaphysalis parva	Jerusalem		

Table 2. Data on occurrence of *Rhipicephalus sanguineus* in Jerusalem (average data for May-June of 1991-1998).

Site of tick collection	No. adult ticks per 100 m of route (Mean ± SD)	% dogs infested by ticks (Mean ± SD)	No. adult ticks per 1 infested do (Mean ± SD)
Cultivated parks and gardens	0	62.5 ± 17.8	3.8 ± 3.5
Non-cultivated areas with wild and dry vegetation	1.2 ± 0.65		

Number of reported cases of MSF in Israel (1971 to 1998)
(data of the Department of Epidemiology, Ministry of Health)



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so that inhabitants collect them at this time. The majority of such foci were observed in Jerusalem but there is also information about their existence in Beer-Sheva and Tel-Aviv (Mumcuoglu, personal communication).

The consequent close association between man and *R. sanguineus* has resulted in a significant number of cases of MSF in Israel. Figure 1 shows the number of the reported cases of this disease over the past 28 years. Between 1971 and 1980, the number of cases gradually increased from 20 to a peak of 396 per year. After 1980, the morbidity significantly decreased, dropping to a level of less than 100 cases per year from 1990 onwards (Figure 1). During all this time, there were occasionally one to four deaths per year, mainly of children or elderly persons. An analysis of the reported cases of MSF (if we exclude the first three years of morbidity records when many cases were missed because of hypodiagnostics) clearly shows that between 58% and 76% of the cases were from cities, towns and urban localities, the remainder being from villages, kibbutzim, Bedouin settlements, etc.

Rhipicephalus turanicus Pomerantzev prevailed in more humid sites in waste grounds of some Israeli towns, situated mainly in the coastal plain (Tel-Aviv, Haifa and some others). Regular observations were made by one of the authors over three years in early May in Yarkon Park located in Greater Tel-Aviv. The park is partly wooded but most of it is waste ground covered by various vegetation including clusters of bushes and some trees. In more humid sites of this part it was possible to collect by flagging up to 20 adults of this species during 30 min. In wooded parts of the park only single ticks were collected by flagging, but one of the dog owners who walked with his dog in these sites, regularly collected ticks from the dog during April to May. The park is widely visited by people, especially during weekends and holidays.

A number of cases when female *Ixodes redikorzevi* Olenev attacked and bit people, were recorded in Israel. Though such cases mainly take place in or near villages or small towns, several cases are known from Jerusalem, Beit-Shemesh and several other towns in different parts of the country. Attachment of this tick to people is followed by the development of various toxic effects that usually disappear soon after tick removal.

Several findings of *Haemaphysalis parva* (Neumann) (=*H. otophila*) on dogs in Jerusalem took place only in the winter months (January-February) and only after dog owners took their dogs into wooded areas.

Several cases of the introduction of tick vectors from the U.S.A. to Israel, either on people or in their luggage with subsequent attachment to their carriers are known. Only during 1997-1998 3 significant cases were recorded. A nymphal *Ixodes scapularis* Say was found attached to a young boy in Zichron-Yaakov 2 days after coming from New Jersey to Israel. Prophylactic treatment of the child with doxycycline was recommended by the family doctor. An adult *Amblyomma americanum* (L.) female was found on a man of 57 in Jerusalem who had just returned from New York. A female adult *Dermacentor variabilis* (Say) was found attached for approximately 3-3.5 days to a Jerusalem woman of 65 who had returned from Alabama 8 days previously. In both cases no treatment was recommended and neither patients had any subsequent symptoms of tick-borne diseases.

DISCUSSION

Any case of tick findings in urban areas is interesting and important from two points of view: the epidemiological significance of the species found and the possibility of the establishment of a stable local population of the introduced species.

Regarding argasid ticks in Israeli towns, it is impossible at present to estimate their epidemiological role. The capability of ticks from the *Argas reflexus* group to transmit pathogens of domestic birds, as well as their closeness to human dwellings make their possible involvement into human epidemiology quite possible. On the other hand, only fragmentary data exist on their role as carriers of human pathogens (Filippova, 1966; Hoogstraal *et al.*, 1979). Besides, it is too early to assume that the full species

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composition of urban argasids in Israel is known. The massive findings of *A. latus* in Jerusalem and its presence in other sites in Israel (Filippova *et al.*, 1999) might be followed by new findings of this, as well as other species. The same concerns *O. coniceps* whose epizootiological significance was studied as early as the 1930s (Filippova, 1966) but up to now is unclear, whereas its epidemiological importance is completely unknown.

Rhipicephalus sanguineus is without any doubt the most important tick species in Israeli towns. The percentage of dog infestation in Jerusalem is very high, being even much higher than in Kibbutz Ze'elim in the Negev Desert (Mumcuoglu *et al.*, 1993), one of the most known foci of this tick in Israel. A special study of more than 100 cases of MSF in Jerusalem and its closest suburbs (Jacobson, 1982) showed that 72% of the patients were infected in a home environment and 87% had been exposed to a dog prior to becoming infected. Patients came not only from newly build suburbs bordering on the open countryside, but also from the old established wealthy neighborhoods in the central part of the city.

The high infection rates of this tick with *Rickettsia conorii* was found not only in Israel but also in other Mediterranean countries, including large towns in Italy and France (Guberman *et al.*, 1996). Antibodies to *R. conorii* were found among inhabitants of Beer-Sheva approximately in the same percentage as among people from agricultural settlements or small towns (Gross *et al.*, 1983). The average number of MSF cases in towns increased obviously, though not always significantly, from 63% annually during 1976-1980 to 70% annually during 1986-1990. During the last decade, when the total number of MSF cases dramatically decreased, a large fluctuation and some reduction of the proportion of urban cases is observed which may be partly explained by better education of the human population about this disease.

The discovery of domestic foci of *R. sanguineus* with the change from the 3-host life cycle to the 2-host cycle, which obviously increases the speed of its development, creates an additional and very dangerous factor of tick influence on urban human populations. It is also proposed (Harrison *et al.*, 1997) that subadult *R. sanguineus* feed on humans much more often than was previously suspected. Transovarial and transstadial transmission of rickettsiae in this species makes the importance of its domestic foci even more significant.

As for *R. turanicus*, there was only indirect evidence of its possible epidemiological significance in the Mediterranean region (Ioffe-Uspensky *et al.*, 1997), though it is known as a potential vector of rickettsiae of North Asian tick typhus and Q-fever in Central Asia (Balashov and Daiter, 1973; Berdyev, 1980). However, Guberman *et al.* (1996) reported about several specimens of this species infected with spotted fever group rickettsiae in southern Israel. There are also data on the isolation of two new rickettsial strains with unknown pathogenicity in southern France (Beati *et al.*, 1992).

Ixodes redikorzevi should be considered as another epidemiologically significant species, even though the number of its attacks on humans is low and toxic symptoms usually disappear soon after tick removal (Kassis *et al.*, 1997). Since the taxonomic status of different populations of this species is not clear yet (Filippova, 1977), we avoid using the subspecies name for this Israeli tick, *I. redikorzevi theodori* (Warburton, 1927; Arthur, 1955). However, the ability to attack humans is specific only for ticks from Israel (and possibly from adjacent countries where this species might also be found) and has never been mentioned in the more northern parts of the species range.

Concerning *Haemaphysalis parva*, this tick is not so numerous in the field and has no obvious epidemiological significance. Its findings in towns are the result of introductions by dogs from wooded areas and such an introduction would be unlikely to create a stable population of this tick in urban areas.

The cases of transatlantic tick introduction are much more noteworthy. Each of the three species recently brought to Israel from the U.S. are important vectors of several diseases, such as Lyme disease, human babesiosis and human granulocytic ehrlichiosis (*Ixodes scapularis*), human monocytic ehrlichiosis, Q-fever, tularemia and tick paralysis (*Amblyomma americanum*) and Rocky Mountain spotted fever (*Dermacentor variabilis*). These diseases are mostly unknown in Israel which creates a danger

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of wrong diagnosis and delayed treatment. An introduction of ticks purely on humans would hardly provide an opportunity of infection for other people. However, the probable transportation of *D. variabilis* in luggage (Uspensky *et al.*, 1997) becomes an obvious danger for human contacts (relatives and friends of the travelers). Such cases are certainly quite rare but one can assume that many more ticks are introduced into Israel with pets. Unfortunately, thorough veterinary examination of pets brought to Israel is not carried out.

An interesting question is whether it is possible that some of these tick species could initiate a local population. There is no doubt that it is impossible for *I. scapularis* and *D. variabilis*, typical forest species with a requirement of fairly high humidity (Fish, 1993; Sonenshine, 1993). However, theoretically it is possible to consider *A. americanum* as a potential immigrant to a new area. The rapid increase of its range in the U.S. (Means and White, 1997), which is partly explained by the significant increase of turkey populations (*A. americanum* is not only the lone star tick but also the turkey tick), is evidence of high plasticity of this species to various ecological conditions. Being common and often very abundant in southern and southeastern states, this tick provides some features of a typical forest species (Uspensky *et al.*, 1999) and has now moved to the north of the U.S. along the Atlantic coast (Means and White, 1997). Since this species is now widely distributed in the eastern states, most often visited by Israelis, the introduction of a number of specimens to Israel becomes realistic. There are suitable hosts in Israel for all stages of *A. americanum*. The development of an effective veterinary control in Israeli airports and ports is a necessary condition to prevent such an unpleasant prospect.

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