Overview of Zoonotic Diseases in Turkey: The One Health Concept and Future Threats -5

Zoonotic Parasitic Protozoans (Protozooses): A number of parasitic protozoa with zoonotic characteristics cause serious infections in humans and animals, and lead to economic losses in Turkey as well as globally. The reported zoonotic protozoan infections from Turkey are listed in Table 1. Leishmaniasis is a most important vector-borne zoonotic disease caused by several Leishmania species in the Trypanosomatidae family. The infection mostly occurs in two clinical forms: visceral leishmanisis and cutaneous leishmanisis. The disease affects both humans and animals, such as dogs, cats, cattle, and equids. The transmission of the disease agents is through the bite of infected Phlebotomine sand flies in the Psychodidae family (386). Zoonotic visceral leishmaniasis (ZVL) is caused by Leishmania infantum and cutaneous leishmaniasis (CL) is caused by L. tropica and L. infantum in Turkey (21). These diseases in humans are compulsory notifiable diseases in Turkey for years. The ZVL occurs in the Aegean and Mediterranean regions endemically. However, the infection has been reported sporadically in other regions of the country as well. It is consistent with Mediterranean type and mostly seen in infants. Leishmania strains isolated from human/dogs in different regions were identified as L. infantum MON-1 and MON-98 by multilocus enzyme electrophoresis, also known as zymodeme analysis. In Turkey, CL has been spreading from endemic regions to other regions because of different epidemiological factors. CL with different clinical types was reported from numerous provinces, but more than 90% of the cases were concentrated in the southeastern regions, eastern Mediterranean and Aegean of the country. According to Ministry of Health’s official records, 46,003 new cases were reported between 1990 and 2010. Major migrations that have arisen due to the civil wars in Syria in recent years have made CL much more important for public health in Turkey. Twelve specific microsatellite markers have been identified in the analyses made on the isolates obtained from Turkish and Syrian patients in Sanliurfa region where 45% of the cases of CL detected in Turkey are seen (387). The result suggests that L. tropica is a more complicated zoonotic protozoan parasite than is suspected. This of course not only made the struggle more difficult, but also created a potential danger especially for the epidemiology of CL (387). Additionally, in a study performed to demonstrate the effects of Syrian civil war on the epidemiology of CL in the Gaziantep province in southeast part of Turkey, a total of 567 people were hospitalized with the suspicion of CL, and 263 (46.4%) of them were found positive by parasitological examination. Overall, 174 (66.15%), 88 (33.46%), and 1 (0.38%) of the positive patients were grouped as Turkish, Syrians, and Afghan, respectively. Tissue samples on slides obtained from 34 CL suspected patients were also analyzed using polymerase chain reaction (PCR), and 20 of them were found positive. Eighteen (9 Turkish and 9 Syrians) of the PCR positive samples were identified as L. tropica, while two (1 Turkish and 1 Syrian) were L. infantum (388). These molecular epidemiological findings indicate that public health in Turkey and other European countries is under threat of new L. tropica and L. infantum strains. In contrast, Canine Leishmaniasis (CanL) is another serious form of the disease that occurs in dogs and wild canids. Dogs can be infected with several Leishmania species, but the most important clinical form of canine leishmaniasis is viscerocutaneous leishmaniasis caused by L. infantum. CanL mainly occurs in the Mediterranean Basin. The infection is also prevalent in dogs in Mediterranean and Aegean regions of Turkey. Another form of the infection is feline leishmaniosis caused by L. infantum, which sporadically occurs in domestic cats in various parts of the world. It was reported that a case of clinical feline leishmaniosis caused by L. infantum was seen in Agean region of Turkey (330). Toxoplasmosis is the most prevalent zoonotic protozoan disease throughout the world caused by three infective forms (sporozoite, bradyzoite, and tachyzoite) of Toxoplasma gondii, which has 3 strain types (I, II, and III) in the Toxoplasmatinae subfamily. The infection could lead to serious global health problems in humans. The transmission of T. gondii is possible by congenital, carnivorism, and fecal-oral route. Toxoplasma gondii is a protozoan parasite that infects nearly all mammal and bird species worldwide. In the life cycle of T. gondii, all members of Felidae family serve as definitive hosts, while birds and all mammals, including man play a role as an intermediate host. Usually asymptomatic, toxoplasmosis can be severe and even fatal to many hosts, including people, particularly causing abortions in cattle and sheep that lead to huge economic losses in livestock industry (389). Elucidating the contribution of genetic variation among parasites to the patterns of disease transmission and manifestations has been the goal of many studies for the molecular epidemiology of toxoplasmosis. In a study that focused on the geographic variation of T. gondii strains, most genotypes of the parasite were detected as locale specific, but some were found conserved across continents and closely related to one other, indicating a recent radiation of a pandemic genotype (390). In Turkey, the seroprevalence of T. gondii was detected as 43% in domestic cats (391), 68.57% in dogs (392), 1.9% in horses (393), 66% in cattle (23), 33.76% in sheep (23), 63.2% in goats (394), 1.66% in domestic fowls (395), and 9.09% in prey birds (396). The general prevalence of toxoplasmosis ranged between 39.5% and 78% in animals (397). However, the prevalence of toxoplasmosis in different groups of humans, such as (i) hospital patients, (ii) people who are occupationally in close contact with animals or working in meat industry, (iii) apparently healthy people, and (iv) a special group that contains homosexuals and hemodialysis patients were reported as 13.9%–85.3%; 20.7%– 57.6%; 23.0%–43.7%, and 16.3%- 76.6%, respectively (397). Sarcosporidiosis is an important disease of animals and humans that occurs worldwide, and causes serious economic losses in livestock industry. Although the infection in humans is rare, it was reported that recent international attention on sarcocystosis has concentrated on recurrent outbreaks of muscular sarcocystosis among tourists visiting Malaysia (398). Animals and humans can be infected by the oral route with developmental stages of several Sarcocystis species. Sarcocystis species require both definitive and intermediate hosts to complete their life cycle. In the cases of intestinal sarcocystosis, humans can serve as definitive hosts for two species acquired from eating undercooked meat: S. hominis from beef and S. suihominis from pork. Clinical manifestations, such as nausea, stomachache, and diarrhea in humans with intestinal sarcocystosis, can be varied depending on the number of cysts ingested and appear more severe with pork than with beef. Humans can play a role as intermediate hosts for S. nesbitti, which is a species with reptilian definitive host. Humans can be infected by ingesting the sporocysts of the parasite from feces-contaminated food or water and the environment. In infected people, diagnosing the infection is difficult at the early phases, but some clinical signs, including fever, headache, and myalgia may be evident, and later, intramuscular cysts characterized with myositis can develop. Presumptive diagnosis related to travel history to tropical regions, elevated serum enzyme levels, and eosinophilia can be confirmed by finding sarcocystis in muscle biopsy material. There is no vaccine or confirmed effective antiparasitic drug for muscular sarcocystosis, but anti-inflammatory drugs may reduce the disease symptoms. Prevention strategies are also discussed (398). In Turkey, several Sarcocystis species have been detected in some mammalian intermediate hosts, such as sheep, goats, cattle, water buffaloes, horses, donkeys, and pigs and in some avian intermediate hosts, such as turkey and partridges, and some Sarcocystis species were also identified in definitive hosts, such as dogs and cats (399). There is no official report on cases of zoonotic sarcaoproidiosis in humans in Turkey. Giardiasis is one of the most common zoonotic intestinal protozoan diseases caused by Giardia spp in the Giardiinae subfamily and occurs in humans and animals worldwide, particularly in developing countries; WHO has classified this infection as a neglected disease (400). One species in Giardia genus Giardia duodenalis (syn. Giardia lamblia and Giardia intestinalis) causes giardiasis in humans and domesticated animals, including livestock, dogs, cats, and wildlife; hence, giardiasis is considered a zoonotic disease (401, 402). Direct evidence that human giardiasis can be an example of a zoonosis, ie, a human infection acquired from non-human hosts under “natural” conditions (via ingestion of G. duodenalis cysts excreted by animals) is limited (403). Giardia cysts have environmental resistance and survive for a long time under natural conditions (over 65 days at 4°C). After ingestion of the cysts by the host, primarily, the walls of cysts are broken down by bile salts, low pH, stomach acids, and some other factors. After this excystation, the trophozoites are released in the duodenum, undergo repeated mitotic division, and finally develop into an environment resistant cyst form. These cysts can pass through the intestine via feces and spread to the environment by contaminated water, food, and fomites and by direct physical contact. The most important epidemiologic aspect for giardiasis is to understand the host range of different Giardia species and strains/genotypes (assemblages), the potential for cross-species transmission, and risk and environmental factors involved in the exposure to the pathogen. This is particularly important in determining the zoonotic potential of Giardia infections in domestic animals and in determining the human disease burden attributable to parasites of animal origin (402, 403). A significant association between the occurrence of Giardia infections in calves and calf handlers has been shown in a study in Bangladesh (404). In Turkey, G. intestinalis was identified in 5 of 30 small ruminants (19 kids and 11 lambs) with neonatal diarrhea at clinics of a veterinary faculty in the Burdur province of the Mediterranean region (405). However, changes in serum cytokine levels were determined in 92 giardiasic children infected with G. lamblia at a Medical Centre in the Malatya province located in the eastern part of the country, and all of the sick children were treated using metronidazole (406). Amoebiasis or Amoebic Dysentery is an intestinal disease caused by an anaerobic parasitic amoebozoan protozoa, Entamoeba histolytica of the Entamoebidae family. The reservoir of E. histolytica is man. The infection is seen worldwide but often affects anyone, who lives in tropical regions with poor sanitary conditions. The disease causes mild to severe colitis and hepatic amoebiasis in infected individuals. The fecal-oral transmission of the infection is possible by ingestion of the infective cysts via contaminated water or food or flies or fomites. Workers or personnel at departments of laboratory animals may be infected from fecal matter contaminated on skin or on clothing. The disease also occurs clinically with chronic and mild colitis in animals, such as dogs and monkeys. E. histolytica can be found in the large intestine of rats as a commensal, but sometimes it can cause amoebic dysentery too. In Turkey, the disease is also a prevalent infection among humans. In a study, trichrome-stained 49 smear samples of 51 patients were found positive for E. histolytica/dispar at clinics of the Ege University Hospital in the Izmir province of the Aegean region, Turkey (407). A case of amoebic liver abscess caused by penetration of amoebic trophozoites of E. histolytica was diagnosed at the clinics of a university hospital in the Istanbul province (408). Cryptosporidiosis is another important water-borne zoonotic protozoan disease caused by several apicomplexan parasites belonging the genus Cryptosoridium in the Cryptosporidiidae in the subphylum of Apicomplexa family and occurs globally with a devastating economic impact on the livestock industry. Cryptosporidium species infect both the gastrointestinal and respiratory tracts of a wide variety of animals (mammals, birds, reptiles, amphibians, and fish), including man. The infection is one of the major problems of farm animals, particularly C. parvum is seen as the most common entero-pathogen during the first weeks of life of newborn calves, lambs, goat kids, and piglets, and is thought to be a critical agent in the etiology of the “neonatal diarrhea syndrome” in newborns (409). The majority of human infections are caused by either C. hominis and/or C. parvum, and the disease mainly involves the infection of jejunum and ileum, resulting in a watery diarrhea. The infection may involve the biliary tract, stomach, and lungs in immunodeficient and immunosuppressed individuals (401). The persistent diarrhea and malabsorption can seriously threaten the life of the infected person, particularly in patients with AIDS (410). A significant association between the occurrence of Cryptosporidium infections in calves and calf handlers has been shown in a study in Bangladesh (404). A vaccine is not available for immunization against cryptosporidiosis, and an etiologic specific treatment option has also not been practiced for the infection. However, antidiarrheal medicine may be used to slow down the diarrhea. Actually, the major control measures of the infection are limited to sanitation, good hygienic conditions, and education. In Turkey, cryptosporidiosis is also a prevalent disease, and its prevalence in humans was reported in the range 4.9%-39.08% (22). In contrast, several molecular epidemiological studies have been performed for bovine cryptosporidiosis in the calves in different parts of Turkey. In one of these investigations, the molecular prevalence of crytospridiosis was found as 20.7% in neonatal calves with diarrhea in different localities of the Nevsehir province of the Capadoccia region, and C. parvum was detected as predominant species with a 15.3% prevalence (411). Another molecular study was conducted on cryptosporidiosis in cattle (up to 2 months calves with diarrhea and others) to investigate their reservoir importance for the epidemiology of disease in the Burdur area of the Mediterranean region, and C. parvum, C. ryanae and C. bovis parasites were identified related to bovine cryptosporidiosis and the total prevalence the disease was detected as 37.2%, with C. parvum as the predominant parasite in the region (412). Conversely, in the Konya province of Central Anatolia, only C. parvum was detected molecularly related to bovine cryptosporidiosis in clinically diarrheic calves that were up to 2 months old (413). Rhinosporidiosis is a chronic granulomatous infection of humans caused by a protist, Rhinosporidium seeberi, in Mesomycetozoea. The analysis of the aligned sequence and inference of phylogenetic relationships showed that R. seeberi is a protist from a novel clade of parasites that infect fish and amphibians. The disease usually manifests as vascular friable polyps that arise from the nasal mucosa or external structures of the eye in infected individual. The etiologic pathogen organism causes similar infections in amphibians and fish (414). Another molecular work has demonstrated evidence that R. seeberi may have host-specific strains (eg, human vs dog versus swan) (415). Humans generally acquire the infection by contact of the nasal mucosa with infectious material when bathing in ponds contaminated by animal feces (416). In Turkey, a case of cutaneous rhinosporidiosis localized in the nasal philtrum in a patient, who had a polyploid lesion was diagnosed at the clinics of the Akdeniz University Hospital in the Antalya province (417). Cystoisosporiasis (formerly Isosporiasis or human cocciddiosis) is a food/water-borne intestinal infection of humans caused by the coccidian protozoan parasite Cystoisospora belli (formerly Isospora belli) in the Sarcocystidae family. The infection often occurs in the tropical and subtropical regions of the world. Humans are infected by ingestion of sporulated oocysts of the parasite via contaminated food and/or water. The infection clinically manifests as watery diarrhea in sick individuals. It was experimentally demonstrated that Isospora belli can cause infection in animals, such as monkey, dog, pig, rat, mouse, guinea pig, and rabbit (418). Hence, Cystoisospora belli may be regarded as a potential zoonotic coccidian pathogen. In Turkey, a few cases of cystoisosporiasis were reported in some immunosuppressed individuals (419, 420). Arthropod zoonosis: Arthropods can be found on humans and/ or animals as ectoparasites and can adversely affect both humans and animals in several ways. They also live as urban pests (421). The ectoparasites or vectors can contaminate stored food and transmit many pathogens or introduce diseases in new and/or instable geographic areas epidemiologically. There are direct nonallergic effects, such as tissue damage due to stings and bites, as well as vesicating fluid exposure, and tissue infestation by the larval stages of the parasites themselves (e.g., myiasis). Additionally, some venoms produce necrosis in hosts tissues and some others can lead to neurological effects. Indirect effects on human and animal health comprise disease transmission (as a vector) and allergic reactions due to bites, irritations, and stings as well as reactions to some structures on arthropods, emanations, or secretions on arthropods (422). Basically, the attacks of arthropods on humans and animals could be classified as insect infestation or acar infestation, depending on the origin of the parasite. Besides being vectors for various diseases, the species of arthropods that have zoonotic importance in the orders of Blattaria, Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, and Siphonaptera can cause direct infestations in humans and animals. The reported arthropod infestations in Turkey are as follows: Bugs in Blattaria are commonly named as cockroaches. Cockroaches are the most important pests of the urban area and occur primarily in the tropical and subtropical regions of the world. Some cockroach species in the genera of Periplaneta and Blattella occur in caves and in animal barns, particularly in the animal feed deposits and feed with animal waste or organic matter. Cockroaches adversely affect human health via sometimes biting sleeping children, entering into ear canals of humans, and mechanical contamination of food with many pathogens (423). In Turkey, Blattella germanica was found to harbor intestinal parasites of public health importance (424). Coleoptera (Beetles) have a very low medical and veterinary importance. However, some coprophagous and necrophagous species of beetles in the families of Dermestidae and Silphidae have been suspected of mechanically spreading the spores of Bacillus anthracis (423). Darkling beetles in Tenebrionidae family cause the infestation of feeds in chicken houses and may transmit Salmonella bacteria from infected chickens mechanically, leading to high economic losses in the poultry sector. Both larval and adult forms of the lesser mealworm beetle Alphitobius diaperinus may transmit Salmonella typhimurium and S. chester from infected chickens. In contrast, the small hive beetle, Aethina tumida of the Nitidulidae family causes severe infestation and leads to the destruction of honey bee colonies with huge economic losses. If the beetle infestation is sufficiently heavy in a honey bee colony, it may cause bees to abandon their hive. The presence of hive beetles can be an early marker in the detection of the Colony Collapse Disorder for honey bees. In addition, the beetles can also be a pest for stored combs with honey/without honey (425). In Turkey, there is no study related to beetles with medical and veterinary importance. However, in a study, several species of dung beetles in Scarabaeidae family have been reported from the Black Sea region of Turkey (426). Diptera (true flies) is one of the largest insect orders in the world and includes many species, which have medical and veterinary importance in the Nematocera and Brachycera suborders. Most commonly, flies in this order cause serious infestations both in humans and in animals. Most of them also serve vectorial roles for the transmission of several diseases, which lead to huge economic losses in different regions of the world, particularly in the tropical and subtropical areas. Nematocera suborder contains many flies with conspicuously long antennae, such as mosquitoes, black flies, midges, and sand flies, while Brachycera include flies with short antennae, such as horse flies, deer flies, house flies, stable flies, and tsetse flies. Some flies of Diptera can also cause cases of myiasis via their maggot type larva both in humans and in animals (427). Mosquitoes are one of the most important ectoparasitic flies in the Culicidae family and commonly cause serious infestations of both humans and animals. Particularly, they inflict more human suffering than other hosts. Mosquito bites can lead to severe skin irritation through an allergic reaction to the saliva of mosquitoes, which causes the red bump and itching on the skin of the infested individuals; additionally, severe mosquito infestations may lead to anemia and even deaths as seen in the old periods of human history. Every year nearly over one million people globally die from mosquito-borne infections. However, mosquitoes also transmit several pathogens, such as viruses and parasites, to some susceptible animals, such as dogs and horses. The mosquito-borne diseases include West Nile virus (WNV), Eastern equine encephalitis, dengue, encephalitis, yellow fever, chikungunya, St. Louis encephalitis, LaCrosse encephalitis, Western Equine encephalitis, Zika virus, human malaria, avian malaria, filariasis, and dirofilariasis. In Turkey, a total of 55 mosquito species have been reported (428). Recently, in a study conducted to investigate the potential vectors of Dirofilaria immitis using molecular techniques in Central Anatolia region of Turkey, Aedes vexans and Culex pipiens were detected as vectors in the Kayseri region of Central Anatolia (429). In another study performed to detect Culex pipiens biotypes in the Kayseri region using a real-time PCR technique, Cx. pipiens form pipiens, hybrids of Cx. pipiens form pipiens, and Cx. pipiens form molestus were identified as biotypes among the genomic DNA isolates (430). However, in a study that was carried out via molecular techniques to investigate avian Plasmodium parasites and to determine the hemosporidian parasite lineages in mosquito samples in the Kayseri area of Central Anatolia region, Turkey, the samples of Cx. pipiens, Cx. theileri, Ae. Vexans, and Culiseta annulata were found positive for avian malaria and avian hemosporidian parasites, and Cx. pipiens was also shown as a major vector of avian Plasmodium parasites (431). Black flies are small but powerful flies with autogenous and anautogenous characteristics in the Simuliidae family and can be formidable pests for humans, domestic animals, and wildlife, affecting virtually all facets of outdoor life. Black flies are distributed worldwide with the exception of Antartica and some oceanic islands. The black fly Simulium (Wilhelmia) lineatum is among the most widely distributed members of the Simuliidae family, ranging from the British Isles to eastern China (432, 433). Occasionally, some severe infestations of black flies at the level of disasters also lead to devastating economic losses in some countries. The public health importance of black flies is commonly related to the blood-seeking females and the disease agents they transmit. The females transmit the nematodes Onchocerca volvulus (river-blindness) and Mansonella ozzardi (mansonelliasis) to humans, and they are also suspected of the Altamira syndrome in humans in Brazil. However, black flies can transmit some other pathogens, such as Onchocerca lienalis and Leucocytozzoon spp to bovids and to birds, respectively. Black flies can also cause multideaths of animals, which are seen suddenly, particularly in cattle due to simulotoxicosis and toxic shock (434). In Turkey, some Simulium species have been reported, which showed pest characteristics and caused outbreaks (432, 433, 435, 436). In contrast, in a study that was performed for molecular detection of blood-feeding preferences of Simulium species in Central Kizilirmak Basin of Turkey, Onchocerca sp and Leucocytozoon sp were detected in the samples of Simulium spp. collected from the area (437). In last three decades, two cases of simulotoxicosis in cattle herds with over 100 sudden deaths were observed in the Erzurum province of eastern Turkey (438). In a study, which was conducted to investigate the economic costs associated with a 2006–2007 outbreak of Simulium (Wilhelmia) spp. in the Cappadocia region of Turkey, the economic losses were calculated as US$ 5.45 million according to 2013 prices (27). Biting Midges are very small flies belonging to the Ceratopogonidae family and occur in the temperate and tropical areas of the world. Biting midges infest both humans and animals and cause discomfort. In addition, biting midges serve as vectors for a number of viruses, protozoans, and nematodes. Among the more important viral diseases are Oropouche fever in humans; bluetongue and epizootic hemorrhagic in ruminants; and African horsesickness in equines (439). In Turkey, a total of 57 Culicoides spp were reported from different localities in Marmara, Aegean, Mediterranean, Central Anatolia, and the Eastern and Southeastern Anatolia regions (440). In a different study conducted to investigate Culicoides spp by molecular techniques in the ecosystem of Sultan marshes near the Kayseri province in Central Anatolia, a total of 10 Culicoides spp were identified, and C. circumscriptus and C. nubeculosus complexes were found as the predominant species in the ecosystem (441). Sand flies are an important hematophagous group belonging to the genera Phlebotomus and Lutzomyia of Phlebotominae subfamily in the Psychodidae family. During crepuscular time or at night, the females of sand flies feed on various mammals, reptiles, and birds. These bloodfeeding flies include the primary vectors of leishmaniasis, bartonellosis, and pappataci fever. In the old world, lesihmaniasis was transmitted to humans and animals by Plebotomus spp, while the Lutzomyia spp spread leishmaniasis in the new world (442). In Turkey, a total of 19 Phlebotomus spp were reported from distinct regions, such as Aegean, Mediterranean, Southeastern Anatolia, and Western Black Sea (443). Meanwhile, it was reported that four serotypes of phleboviruses, and phlebovirus RNA were determined in the Mediterranean region and around the Ankara province in Turkey, respectively (35). Horse flies and deer flies belong to the Tabanidae family and attack humans and animals. They are large hematophagus and their adult feeding activity is diurnal, but occasionally crepuscular or nocturnal. In the most temperate areas, tabanids are primarily nuisance pests of humans. In this regard, they can pose economically significant problems for local tourism. Tabanids transmit some pathogens as biological (for Loa and Elaeophora schneideri) and mechanical (for Equine infectious anemia, bovine leukemia, hog cholera, Anaplasma marginale, Francisella tularensis, Bacillus anthracis, Besnoitia besnoiti, Trypanasoma evansi, and Try. vivax) vectors (439). In Turkey, a total of 161 species belonging to 11 genera of Tabanidae family were reported from different regions (444). Muscid flies can be grouped ecologically as filth flies (house fly, stable fly, garbage fly, false stable fly, little house fly, and latrine fly), dung flies (horn fly and face fly), and sweat flies (sweat flies). Muscid flies also can be grouped depending on their mouthparts as biting (stable fly, Stomoxys calcitrans; Horn fly, Haematobia irritans; and Bufffalo fly Hae. irritans exgua) and nonbiting flies (house fly, Musca domestica; bazaar fly, M. sor bens; bush fly M. vetustissima; face fly, M. autumnalis; false stable fly, Muscina stabulans; little house fly, Fannia canicularis; garbage fly, Hydrotaea spp.; sweat flies, Hydrotaea spp.), and all the important muscid flies are anautogenous that require proteins to complete their first gonotrophic cycle. Except for house fly, their seasonal patterns in abundance differ among the species, years, and locations. Most muscid flies of medical and veterinary importance are multivoltine, developing through two or more generations per breeding season. Adults of some important flies affect humans commonly as nuisance, occasionally as vector of several pathogens, and rarely as agents of myiasis. The cosmopolitan house fly and stable fly have more medical importance than others (445). In Turkey, a total of 11 species belonging to the Muscidae family have been reported from the Cukurova area (446). Myiasis is the invasion of a living vertebrate animal by larvae of myiatic flies in the superfamilies Tipuloidea, Psychodoidea, Stratiomyoidea, Asiloidea, Platypezoidea, Syrphoidea, Tephritoidea, Ephydroidea, Carnoidea, Muscoidea, and Oestrroidea and are classified as accidental, facultative, obligatory, and emporary. Myiasis can also be categorized as gastrointestinal, urogenital, ocular, nasopharyngeal, auricular, and cutaneous depending on the site of larval invasion (447). In Turkey, several cases of myiasis in humans were reported from different regions (448-450). Hemiptera are the kissing bugs and bed bugs, which are annoying nocturnal pests that feed on humans and animals by sucking blood. Kissing bugs in the Reduviidae family transmit Trypanosoma cruzi in some countries of Central and South America. The bed bugs Cimex lectularius of the Cimicidae family are external parasites of humans. In Turkey, actually, C. lectularius is one of the prevalent ectoparasites in houses and also in the coops for poultry, but its infestations were not documented sufficiently. However, a report related to C. lectularis infestation in a 46-year-old woman with poor personal hygiene was recorded in the Sakarya province of the Marmara region (451). Hymenoptera order contains ants, bees, and wasps, and these insects are abundant throughout most of the world and constitute a significant proportion of all insects. A number of species of ants, bees, and wasps occasionally are harmful to humans and animals, and cause problematic cases, such as poisoning, allergies, and anaphylaxis (452). In Turkey, recently, a fatal case caused by massive honey bee stings on a 10-year-old boy who was subjected to 5989 honey bee attacks was reported from the Erciyes University Hospital in the Kayseri province, and this case was also shown as the highest number of honey bee stings in the literature to date (453). Lepidoptera order includes the species of moths and butterflies, which are recognized as economic pest of the cultivated plants on which their larvae feed. However, adult moths also can be a nuisance because of their attraction to lights and often entering homes at night, but butterflies are rare pests. In most cases of a medical-veterinary nature, it is the caterpillar larval stage that is involved. Some urticating caterpillars of the Limacodidae, Megalopygidae and Saturniidae families cause urticaria and moth dermatitis in humans, while the majority of caterpillars within the Lasiocampidae, Notodontidae, Thaumetopoidae, and Lymantriidae families induce abortions in pregnant mares and also in dromedary camels due to the ingestion of the larval forms during grazing in the infested areas (454). There is no official report on urticating caterpillar infestations in both humans and animals in Turkey. Siphonaptera (fleas) are hematophagous and morphologically unique ectoparasites, and they feed by sucking blood on different warm-blooded hosts, including man, worldwide. Most fleas in the Pulicidae family, with other important fleas belonging to the Ceratophyllidae, Leptopsyllidae, or Vermipsyllidae have medical or veterinary importance. Occasionally, members of other families, notably the Hystrichopsyllidae and Rhopalopsyllidae, also feed on humans and domestic animals. Human flea (Pulex irritans), cat flea (Ctenocephalides felis), dog flea (Ctenocephalides canis), oriental rat flea (Xenopsylla cheopis), and chigoe (Tunga penetrans) can cause zoonotic infestations in both humans and animals. Fleas can cause considerable discomfort and occasionally lead to secondary infections of bite wounds. The bites of fleas can cause dermatitis and allergic reactions. In addition to the intense irritation, fleas transmit various diseases, such as myxomatosis, Q fever, tularemia, murine typhus, sylvatic epidemic typhus, plague, murine trypanosomiasis, rabbit trypanosomiasis, canine filariasis, double-pored tapeworm (Dipylidium caninum), rodent tapeworm (Hymenolepis diminuta), and Dwarf tapeworm (Hymenolepis nana) (455). In Turkey, in a study that was conducted to investigate the species of fleas around Ankara, 9 species of fleas belonging to 6 genera of 4 families were identified morphologically, and Pulex irritans, Ctenocephalides canis, Chaetopsylla globiceps, and Ctenocephalides felis were identified as prevalent species, with the prevalence of 31.91%, 29.79%, 23.89%, and 11.92%, respectively (456). Zoonotic scabies is a rare form of canine scabies, also called pseudo scabies in humans. Sarcoptic mange in dogs is caused by Sarcoptes scabiei var. canis belonging to the Sarcoptidae family and affects body parts of dogs, which are devoid of hair, such as the head, chest, abdomen, neck, face, ears, elbow, and hocks. Basically, each species of the mite prefers one specific type of host, and it does not live long or reproduce away from the preferred host. However, occasionally humans can be infested with sarcoptic mange by close contact with infested dogs. Intense pruritis and irritation due to hypersensitivity reactions are seen as major clinical manifestations in infested individuals. The incubation period is shorter, the symptoms are transient, and the infestation is self-limiting. A case of a zoonotic sarcoptic mange caused by Sarcoptes scabiei var. canis in a 56-year-old man was reported from India (457). In Turkey, frequently cases of sarcoptic mange with manifested local or generalized forms in dogs are seen and treated with local or systemic acaricides (458). There is no official report on zoonotic mange in Turkey. Ticks are obligate blood-sucking zoonotic ectoparasites belonging to the families Argasidae, Ixodidae, and Nuttalliellidae and are very important biological vectors for many pathogens of human and other animal diseases after mosquitoes (459). Ticks can cause serious direct damages to their hosts as well annoyance and “tick worry,” skin lesions, predisposition for myiasis,

loss of blood, tick paralysis, tick toxication, allergy, anaphylaxis, and meat allergy (48, 460). Tick infestations and TBDs of animals can cause huge economic losses, particularly in the cattle industry in many countries in the subtropical regions of the world, including Turkey (9, 459, 461). The current status of tick species in Turkey showed 47 species (8 argasid and 39 ixodid) in the last century (10). In addition, almost 19 TBDs have been reported in animals and men, involving 4 protozoa (babesiosis, theileriosis, cytauxzoonosis, and hepatozoonosis), 1 filarial nematode (acanthocheilonemasis), 10 bacterial agents (anaplasmosis, ehrlichiosis, aegyptianellosis, TBT, Candidatus Rickettsia vini, Lyme borreliosis, TBRF, tularemia, bartonellosis, and hemoplasmosis), and 4 viral infections (TBE, Crimean-Congo Hemorrhagic Fever (CCHF), louping ill (LI), and LSD in Turkey (20). Chiggers (larvae of Trombiculidae), bird and rodent mites (Dermanyssus gallinae and Lyponyssus bacoti), Cheyletiella spp, and house dust mites (Dermatophagoides spp) can cause rare zoonotic infestations, such as cutaneous reactions by close contact worldwide. Occasional asthma cases can be seen in children due to the inhalation of metabolites of house dust mites (462). In Turkey, a case of dermatosis caused by Cheyletiella sp. in a patient, who was a pet owner has been reported as a zoonotic mite infestation at the Sakarya University Hospital (463). Unconventional zoonotic agents: The bovine spongiform encephalopathy (BSE) or “mad cow disease” and CreutzfeldtJakop disease (vCJD) are classified among unconventional zoonotic diseases by OIE and WHO. BSE is a central nervous disease caused by an agent named “prion” or “infectious protein.” The infectious protein is transmitted to cattle via feeding of infected meat and/or bone meal, and then is found in the central nervous tissue, causing neurological disorders after an incubation period of 4–5 years (“mad cow”). The coincidence of the emergence of a variant form of vCJD in humans provides some evidence that the BSE agent might have crossed a species barrier. This is not scientifically proven but is the “precautionary principle” is suggested by OIE and WHO. There is no official report about both BSE and vCJD in Turkey.