

Chapter 7

Vertebrates as Hosts and Reservoirs of Zoonotic Microbial Agents

This chapter presents a survey of zoonotic microorganisms that have been isolated from vertebrates (*Vertebrata*), and are potentially transmissible to humans. It is intended as an aid for microbiologists, zoologists and epidemiologists, making possible better orientation among hosts (and reservoirs) of zoonoses. A great number of sources have been used in this compilation, e.g. Davis et al. (1970), Kucheruk (1979, 1989), Karabatsos (1985–1995), Hubálek (1994), etc.

The most common source of zoonoses for man are warm-blooded (endothermic, earlier called homeothermic) vertebrates, especially domestic and wild mammals, much less frequently birds, whereas only exceptionally cold-blooded (ectothermic, earlier called poikilothermic) vertebrates such as reptiles, amphibia and fishes.

A host is a vertebrate species from which a particular pathogenic agent has been isolated or detected, whereas a reservoir (host) is a vertebrate species which ensures a long-term persistence of the agent even in the inter-epizootic (inter-epidemic) period. An amplifying host is a vertebrate enabling adequate propagation (amplification) of the agent after initial infection; the pathogen then occurs in sufficient concentration and for at least several days in the blood, urine or faeces of this host. The competent host is that vertebrate species which is able not only to amplify the agent but also to transmit it to a susceptible vertebrate host or haematophagous vector (in arthropod-borne diseases). For instance in *Ebolavirus*, many primate species are amplifying and competent (but not reservoir) hosts and a source of human infection, while some species of fruit bats are the reservoir (reservoir hosts).

As long as the infected host becomes the source of infection of another vertebrate, it is considered the donor of the agent while the latter, infected vertebrate is called the recipient. The hosts are also differentiated into categories of primary (principal) host (it guarantees circulation of the agent), secondary host (it is quite often included in the epizootic process), and accidental host (does not play any role in the epizootic process). Certain vertebrates – some birds (e.g., feral urban pigeon, starling, American blackbirds) and mammalian (bat) species – can serve as so-called “lessors” (Hubálek 1994) of human-pathogenic agents (*Cryptococcus neoformans*, *Histoplasma capsulatum*) in that they provide for these pathogens an abiotic substrate (nest lining, droppings, guano) suitable for their propagation (an alternative term for a lessor could be a “tenant”).

The following survey (an annotated list) of vertebrate hosts and pathogens shows those zoonotic microbes that were in particular host species detected by isolation, microscopy or presence of specific RNA/DNA. On the other hand agents detected only indirectly, e.g. by the presence of antibodies, have been omitted from the list. Nevertheless the isolation of a microorganism is convincing evidence of its presence in a viable state in the host (“gold standard” in microbiology) whereas its sole detection with e.g. PCR, ELISA or immunohistochemistry is not.

7.1 Mammals (Class *Mammalia*)

In general, epidemiologically the most important mammals from the zoonotic point of view are domestic and synanthropic species, as well as those hunted for their fur, i.e. the species that come often into contact with humans. Common names and the system of mammals have been adopted from Wilson and Reeder (1993), and Bisby et al. (2009), with a few exceptions.

7.1.1 Order Pouched Mammals (Marsupialia)

Family *Didelphidae*

Opossum (*Didelphis marsupialis*)

Synonym *D. virginiana*. A big American mammal (size 40–50 cm plus tail 25–50 cm – about the size of cat), living preferentially in farmland, but also found in woodland. Active usually only at night. Omnivorous: plant food prevails (fruit, vegetables, nuts); eggs, meat (mice etc.), carrion, insects. VIRUSES: *Flavivirus* YF. BACTERIA: *Rickettsia rickettsii*, *R. typhi*, *Borrelia hermsii*. PROTOZOA: *Trypanosoma cruzi*, *Leishmania braziliensis*.

White-eared Opossum (*Didelphis albiventris*)

A medium-sized South-American omnivorous mammal feeding on invertebrates, small vertebrates, fruit and plants. PROTOZOA: *Trypanosoma cruzi* (Brazil – competent host and reservoir).

Linnaeus’s Mouse Opossum (*Marmosa murina*)

South American species, omnivorous. VIRUSES: alphaviruses EEE and VEE (Mucambo). PROTOZOA: *Leishmania braziliensis*.

Family *Phalangeridae*

Common Brushtail (*Trichosurus vulpecula*)

Occurs in forests of Australia and New Zealand (introduced into the latter). Size 30–60 cm plus tail 25–35 cm, weight 1.5–5 kg. Feeds on plants, leaves, fruit, insects and young birds. BACTERIA: *Mycobacterium bovis* (reservoir).

Family *Macropodidae***Agile Wallaby** (*Macropus agilis*)

Australian species. VIRUSES: *Alphavirus* Barmah Forest, Ross River.

7.1.2 Order *Insectivores* (*Insect-Eaters*) (*Insectivora*)**Family *Erinaceidae*****Four-toed Hedgehog** (*Atelerix albiventris*)

African species living largely in the savannah ecosystem. Herbivorous. VIRUSES: *Alphavirus* Semliki Forest, *Bunyavirus* Bhanja, *Nairovirus* CCHF. BACTERIA: *Borrelia duttoni*. FUNGI: *Trichophyton erinacei*.

European Hedgehog, Eastern Hedgehog (*Erinaceus europaeus*, *E. concolor*)

Familiar spiny animals. They occur in western Europe (*E. europaeus*: Photo 7.1), central and eastern Europe to Central Asia (*E. concolor*: Photo 7.2). Often suburban habitats, surface nest build from leaves and other plant materials; live solitarily. In the nest (usually full of ectoparasites) they rest during day, and also hibernate. Food: invertebrates, small vertebrates and fruit. More common in lowland areas. Usually heavily infested by ectoparasites (fleas, ixodid ticks, mites, etc.). VIRUSES: *Flavivirus* TBE, *Nairovirus* CCHF. BACTERIA: *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Staphylococcus aureus*, *Leptospira bataviae*, *L. bratislava*, *L. grippotyphosa*, *L. pomona*, *L. sorex-jalna*, *Borrelia burgdorferi* s.l., *Salmonella enteritidis*, *S. typhimurium*, *S. paratyphi* B, *Yersinia pseudotuberculosis*, *Francisella tularensis*, *Mycobacterium avium*. FUNGI: *Trichophyton mentagrophytes*, *T. erinacei*, *Microsporum persicolor*.

Family *Soricidae***Common Shrew** (*Sorex araneus*: Photo 7.3), **Pygmy Shrew** (*S. minutus*)

Small (*S. araneus*: 6–9 cm plus tail 4–5 cm; weight 5–14 g) or very small (*S. minutus*: 4–6 cm plus tail 3–4 cm; weight 2–6 g) widespread European insectivores, very active (because of rapid metabolism). Common in lowland and in mountains, nearly ubiquitous (a wide range of habitats). Feed on invertebrates. VIRUSES: flaviviruses TBE and LI, *Orbivirus* Tribeč, *Hantavirus* Puumala. BACTERIA: *Coxiella burnetii*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Leptospira grippotyphosa*, *L. hebdomadis*, *L. javanica*, *L. pomona*, *L. sorex-jalna*, *Borrelia burgdorferi* s.l., *Campylobacter jejuni*, *C. coli*, *Salmonella enteritidis*, *S. typhimurium*, *Yersinia pseudotuberculosis*, *Y. enterocolitica*, *Pasteurella multocida*, *Francisella tularensis*. FUNGI: *Microsporum persicolor*, *Trichophyton mentagrophytes*, *Pneumocystis jirovecii*. PROTOZOA: *Babesia microti*, *Toxoplasma gondii*.

Water Shrew (*Neomys fodiens*: Photo 7.4), **Miller's (Mediterranean) Water Shrew** (*N. anomalus*)

Comparatively large European shrews associated with water habitats and adapted to swimming. Occasionally found far from water (especially *N. anomalus*); feed on aquatic (and other) invertebrates, small fish and frogs. VIRUSES: *Flavivirus* TBE, hantaviruses Puumala and Dobrava. BACTERIA: *Listeria monocytogenes*, *Leptospira grippotyphosa*, *L. hebdomadis*, *L. javanica*, *L. pomona*, *L. sorex-jalna*, *Borrelia burgdorferi* s.l., *Francisella tularensis*. FUNGI: *Microsporium persicolor* (*N. anomalus*), *Pneumocystis jirovecii*. PROTOZOA: *Babesia microti*, *Toxoplasma gondii*.

Greater White-toothed Shrew (*Crocidura russula*), **Lesser White-toothed Shrew** (*C. suaveolens*)

Largely west-European (*C. russula*) and east-European (*C. suaveolens*) small-sized shrews living in xerotherm habitats (scrub, gardens, vineyards, seashore) and feeding on invertebrates. VIRUSES: hantaviruses Puumala (*C. russula*) and Dobrava, *Arenavirus* LCM (*C. russula*). BACTERIA: *Listeria monocytogenes*, *Leptospira hebdomadis*, *L. pomona*, *L. sorex-jalna*, *Francisella tularensis*. PROTOZOA: *Toxoplasma gondii*.

Asian House Shrew (*Suncus murinus*)

Asian species, feeds on invertebrates. VIRUSES: *Flavivirus* KFD, *Hantavirus* Hantaan. BACTERIA: *Orientia tsutsugamushi*, *Yersinia pestis* (Madagascar).

Family Talpidae

Common Mole (*Talpa europaea*: Photo 7.5)

Widespread in grassland and deciduous woodland in Europe (except for Ireland and Norway). Common mole lives a subterranean life and digs extensive tunnels to catch earthworms, myriapods, insects and molluscs. VIRUSES: *Flavivirus* TBE, *Hantavirus* Puumala. BACTERIA: *Francisella tularensis*. FUNGI: *Trichophyton mentagrophytes*, *T. verrucosum*. PROTOZOA: *Babesia microti*, *Toxoplasma gondii*.

7.1.3 Order Bats (Chiroptera)

Suborder FRUIT BATS (*Megachiroptera*)

Big, flying mammals eating fruit with a head similar to canids (“flying foxes”), do not contact soil. Live in Africa, Asia and Australia. During the day they rest upside down in communal roosting sites – in trees, and some species in caves and hollows. Hunted for meat in certain areas.

Family Pteropodidae

Egyptian Rousette (*Rousettus aegyptiacus*: Photo 7.6)

A medium-sized fruit bat (body 13–15 cm; weight 90–170 g). Occurs in many African countries and in parts of Asia (Turkey, the Near East and Pakistan).

Roosts in caves (colonies of up to several thousand individuals), old deserted and damaged buildings, mosques etc. At least some individuals migrate seasonally between colonies distanced up to 400–500 km apart. Nocturnal, feeds on tree fruit. VIRUSES: *Alphavirus* Chikungunya, *Flavivirus* West Nile, *Marburgvirus* (competent host and reservoir).

Wahlberg’s Epauletted Fruit Bat (*Epomophorus wahlbergi*; Photos 7.7 and 7.8)

This medium-sized fruit bat (body about 15 cm, weight c. 100 g) occurs mainly in tropical Africa, down to South Africa. Nocturnal, roosts in trees and feeds on fruit and nectar of flowers (baobab etc. – pollination). VIRUSES: *Ebolavirus* (experimental viraemia – potential reservoir), *Lyssavirus* Lagos bat.

Straw-coloured Fruit Bat (*Eidolon helvum*: Photo 7.9)

A common African fruit bat, lives in Egypt, Sudan, central and south Africa; feeds on tree fruit and nectar. VIRUSES: *Lyssavirus* Lagos bat (reservoir), *Henipavirus* similar (but different) to viruses Nipah and Hendra (Ghana), *Coronavirus* similar to human coronavirus 229E, *Orbivirus* Ife (Nigeria).

Black Flying Fox (*Pteropus* [*Aethalops*] *alecto*)

Australian and south-Asian species. Feeds on tree fruit and nectar. VIRUSES: *Lyssavirus* ABL (“Australian bat lyssavirus”), *Henipavirus* Menangle, *H. Hendra*.

Other south-Asian and/or Australian fruit bats (*Pteropus* spp.)

VIRUSES: henipaviruses Hendra, Nipah and Menangle: **Variable Flying Fox** *P. hypomelanus* (distributed in southern Asia and Australia), **Large Flying Fox** *P. vampyrus* (southern Asia), and **Indian Flying Fox** *P. giganteus* (southern Asia) are reservoirs of Nipah virus; **Spectacled Flying Fox** *P. conspicillatus* (Australia) is the reservoir of Menangle henipavirus.

Grey-headed Flying Fox *P. poliocephalus* (Australia) is natural reservoir of *Henipavirus* Hendra.

Madagascar Flying Fox (*Pteropus rufus*)

Lives in Madagascar and Africa. BACTERIA: *Salmonella typhimurium*.

Suborder BATS (*Microchiroptera*)

Flying nocturnal mammals. Most species eat insects. Do not contact the soil surface. A characteristic feature is gathering in summer and winter colonies (sometimes very extensive roosting places) in caves, buildings or tree hollows. They are infested with specific ectoparasites including ixodid and argasid ticks. VIRUSES: alphaviruses Sindbis and Chikungunya, flaviviruses JE, SLE, KFD, Dakar bat and Rio Bravo, *Bunyavirus* Keterah, *Thogotovirus* Dhori. BACTERIA: *Borrelia duttoni*. FUNGI: *Histoplasma capsulatum* (hosts and “lessors”: the fungus grows and sporulates in the bat guano in caves). PROTOZOA: *Trypanosoma cruzi*.

Family Rhinolophidae

Greater Horseshoe Bat (*Rhinolophus ferrumequinum*)

Distributed in southern (partly central) Europe, North Africa and Asia. Open woodland and pastures. Feeds on flying insects, particularly beetles. Roosts singly or in large groups in caves, cellars, attics and tunnels. Movements up to 30 km. VIRUSES: *Lyssavirus* EBL1. BACTERIA: *Borrelia persica*.

Rufous Horseshoe Bat (*Rhinolophus rouxi*)

Asian species. VIRUSES: *Flavivirus* KFD, *Coronavirus* SARS (*Rhinolophus* sp.).

Family Phyllostomidae

Gray Short-tailed Bat (*Carollia subrufa*), **Seba's Short-tailed Bat** (*C. perspicillata*)

Central and South American species. VIRUSES: *Alphavirus* VEE.

Tent-making Bat (*Uroderma bilobatum*)

Central and South American species. VIRUSES: *Alphavirus* VEE.

Jamaican Fruit-eating Bat (*Artibeus jamaicensis*)

The Caribbean. VIRUSES: *Alphavirus* VEE.

Family Desmodontidae

Vampire bats (sometimes regarded as a subfamily, *Desmodontinae*) have specialised, sharp upper incisors that enable them to cut the skin of large mammals, and to feed then on their oozing blood.

Vampire Bat (*Desmodus rotundus*: Photo 7.10)

It is detrimental to livestock. A Central and South-American species, quite common. The body is 7–9 cm (no tail), weight 20–40 g; feeds exclusively on fresh blood of big mammals (livestock and occasionally man). Nocturnal, roosts in caves (colonies consist of hundreds to thousands of individuals). VIRUSES: *Alphavirus* VEE, *Lyssavirus* s.s. (also several tens of human cases described: Trinidad, Ecuador, etc.).

Hairy-legged Vampire Bat (*Diphylla ecaudata*)

Central and North America. Roosts in caves during day. VIRUSES: *Lyssavirus* s.s.

Family Vespertilionidae

Schreber's Yellow Bat (*Scotophilus nigrita*) and **Dwarf Dog-faced Bat** (*S. temminckii*)

African and Asian species. VIRUSES: *Alphavirus* Chikungunya, *Flavivirus* Dakar bat (*S. nigrita*), *Bunyavirus* Keterah (*S. temminckii*).

Greater Mouse-eared Bat (*Myotis myotis*: Photo 7.11), **Daubenton's Bat** (*M. daubentoni*), **Pond Bat** (*M. dasycneme*)

Large (*M. myotis*) or medium-sized European bats living in open woodland, parkland, meadows, and roosting in caves, mines, tunnels, buildings (*M. myotis*: lofts, towers). *M. dasynceme* is bound to fishpond areas, its colonies are in tree hollows and in buildings. All three spp. feed on insects, and move up to 250–350 km. VIRUSES: *Lyssavirus* EBL2. BACTERIA: *Yersinia pseudotuberculosis* (*M. myotis*).

Lesser Mouse-eared Bat (*Myotis blythi*)

Southern Europe (including parts of central Europe – Hungary and Slovakia), North Africa and Asia. Feeds on insects. Movements short, up to 15 km. VIRUSES: *Bunyavirus* Keterah.

Whiskered Bat (*Myotis mystacinus*)

Eurasian species occurring in woodland, parkland, gardens and fishpond areas. Feeds on flying insects. Movements about 40–50 km. BACTERIA: *Coxiella burnetii*, *Borrelia persica*.

Long-eared Myotis (*Myotis evotis*)

Occurs in sparsely forested areas, around buildings and occasionally in caves of western North America. VIRUSES: *Lyssavirus* s.s.

Mississippi Myotis (*Myotis austroriparius*)

Colonial species distributed in southern USA; roosts in caves, also mine tunnels, hollow trees, buildings, and migrates up to 70 km. FUNGI: *Histoplasma capsulatum* (reservoir and lessor, mainly caves in Florida).

Gray Myotis (*Myotis grisescens*)

Colonial species distributed in southern and central USA; roosts in caves. Migrate up to 70 km. FUNGI: *Histoplasma capsulatum* (reservoir and lessor, mainly caves in Tennessee).

Noctule Bat (*Nyctalus noctula*: Photo 7.12)

A large Eurasian species, living in deciduous and mixed forests, and roosting in tree hollows (e.g., woodpecker holes), feeds on large insects. Migratory at least in the northern parts of its distribution range, with the movements up to 800–1,600 km. VIRUSES: *Bunyavirus* Keterah, *Lyssavirus* EBL1.

Serotine (*Eptesicus serotinus*: Photo 7.13)

Eurasian and North-African species, common in towns and villages largely in lowlands. Hunts for insects in parkland, gardens, wooded farmland. Largely a sedentary species, but movements up to 80 km (maximum of 330 km recorded in Germany). VIRUSES: *Lyssavirus* EBL1 (reservoir), *Bunyavirus* Keterah.

Big Brown Bat (*Eptesicus fuscus*)

A large, widely distributed and common American species. Roosts singly or in small clusters, in winter common in buildings. Feeds mainly on beetles, but also

other insects. Some individuals migrate. VIRUSES: flaviviruses WN and Rio Bravo, *Lyssavirus* s.s. (often).

Meridional Serotine Bat (*Eptesicus isabellinus*)

North Africa. BACTERIA: *Coxiella burnetii* (Morocco).

Parti-coloured Bat (*Vespertilio murinus*)

Eurasian species occurring in woodland, cliffs and, in northern Europe adapted to living also in cities. Feeds on insects, migratory (up to 900 km). VIRUSES: *Lyssavirus* EBL1.

Common Pipistrelle (*Pipistrellus pipistrellus*)

The smallest Eurasian and North-African bat species (3–5 cm body and head, plus tail 2–3 cm; weight 4–9 g), almost ubiquitous and widespread, also common in cities where it roosts in buildings. In Europe, it often invades living rooms during August–September. Feeds on insects. Largely sedentary, but movements up to 770 km were recorded. VIRUSES: bunyaviruses Ťahyňa (Tadjikistan) and Keterah, *Lyssavirus* EBL1. BACTERIA: *Coxiella burnetii*, *Borrelia persica*, *Yersinia enterocolitica*. FUNGI: *Microsporium persicolor*.

Red Bat (*Lasiurus borealis*), **Hoary Bat** (*L. cinereus*), **Eastern Yellow Bat** (*L. intermedius*)

North-American species occurring in woodland and roosting in trees, occasionally in caves. Migrate south in autumn. VIRUSES: *Lyssavirus* s.s.

Schreiber's Bat (*Miniopterus schreibersii*: Photo 7.14)

The most widespread bat species: Eurasia, sub-Saharan Africa, Madagascar, New Guinea and northern Australia. A highly social species, often roosts in big numbers (hundreds to thousands) in caves, usually in karst areas. Feeds on moths, beetles and diptera. Frequent movements among roosting caves, up to 350 km recorded. VIRUSES: *Lyssavirus* Duvenhage, EBL1.

Family Molossidae

Mexican Freetail Bat (Guano Bat) (*Tadarida brasiliensis*, synonym *T. mexicana*)

American species roosting in large colonies (sometimes thousands of individuals – Mexico, New Mexico, Texas) in caves and buildings, migratory (up to 1,280 km). Feeds largely on moths but also other insects. VIRUSES: *Flavivirus* Rio Bravo (reservoir), *Lyssavirus* s.s. (often). FUNGI: *Histoplasma capsulatum* (lessor).

Angolan Free-tailed Bat and Little Free-tailed Bat (*Mops* [*Tadarida*] *condylurus*, *Chaerephon* [*Tadarida*] *pumila*)

African migratory species. VIRUSES: *Flavivirus* Dakar bat (*M. condylurus*, reservoir).

7.1.4 Order Apes (Primates)

Sometimes the species of particular monkeys are not reported in the literature, and these “group records” are listed here. VIRUSES: alphaviruses Sindbis and ONN, flaviviruses YF, dengue (rarely), filoviruses Marburg and Ebola, *Bunyavirus* Oropouche, *Herpesvirus simiae* (monkeys of the Old World – reservoir), *Orthopoxvirus simiae*, *Tanapoxvirus*. BACTERIA: *Erysipelothrix rhusiopathiae*, *Campylobacter jejuni*, *Salmonella enterica*, *Yersinia pseudotuberculosis*, *Corynebacterium ulcerans*. FUNGI: *Trichophyton simii*, *Microsporium nanum*. PROTOZOA: *Trypanosoma cruzi*, *Plasmodium knowlesi*, *P. simium*, *P. cynomolgi*, *Balantidium coli*.

Family Galagonidae

Senegal Galago (*Galago senegalensis*)

A large West-African prosimian, feeds mainly on insects and small vertebrates. VIRUSES: *Flavivirus* West Nile, *F. YF*.

Family Callithricidae

White-tufted-Ear Marmoset (*Callithrix jacchus*)

A very small South-American monkey (the size of a squirrel). Feeds largely on insects. Often kept as a household pet in South America. VIRUSES: *Alphavirus* Mayaro, *Flavivirus* YF, *Bunyavirus* Oropouche, *Lyssavirus* genotype 7 (8 lethal human cases acquired from this source were described in Brazil 1991–1998).

Family Cebidae

Howler monkeys (*Alouatta* spp.) **squirrel monkeys** (*Saimiri* spp.), **spider monkeys** (*Ateles* spp.), and **sakis** (*Pithecia* spp.)

South-American monkeys living in tropical rain forest ecosystem. VIRUSES: *Alphavirus* Mayaro, *Flavivirus* YF.

Family Cercopithecidae

King Colobus (*Colobus polykomos*) and **other colobus monkeys** (*Colobus* spp.)

African monkeys of the tropical rain forest ecosystem. VIRUSES: *Flavivirus* YF.

Patas Monkey (*Erythrocebus patas*)

African species, living in tropical rain forest ecosystem. VIRUSES: *Flavivirus* YF.

Hanuman Langur (*Semnopithecus* [*Presbytis*] *entellus*)

Indian monkey, omnivorous. VIRUSES: *Flavivirus* KFD.

Greater Spot-nosed Monkey (*Cercopithecus nictitans*)

African species. VIRUSES: *Flavivirus* YF (also in *C. mitis*), *Ebolavirus*. PROTOZOA: *Trypanosoma brucei gambiense*.

Vervet (Green) Monkey (*Chlorocebus aethiops*: Photo 7.15)

Syn.: *Cercopithecus aethiops*. Common monkey species from Senegal and Ethiopia to south Africa, feeds on insects (locusts, termites etc.) and plants. VIRUSES: *Alphavirus* Chikungunya, *Flavivirus* YF, filoviruses Marburg and Ebola.

Rhesus Monkey (*Macaca mulatta*: Photo 7.16)

South-Asian species, feeds on plants and small animals. VIRUSES: *Alphavirus* Chikungunya, *Flavivirus* KFD, *Herpesvirus simiae* (reservoir). MICROSPORIDIA: *Enterocytozoon bieneusi*.

Sooty Mangabey (*Cercocebus atys*)

African species feeding on insects and plants. VIRUSES: *Flavivirus* YF, SIV (“simian immunodeficiency syndrome virus”, ancestor of HIV-2).

Olive Baboon (*Papio anubis*: Photo 7.17)

East-African species living mostly on the ground and feeding on tubers and small animals. VIRUSES: *Alphavirus* Chikungunya, *Flavivirus* YF. FUNGI: *Trichophyton simii*.

Family Pongidae

Chimpanzee (*Pan troglodytes*)

Ape living in African tropical forests, feeds on plants and animals, e.g. monkeys that are occasionally killed and eaten by chimps. VIRUSES: *Filovirus* Ebola, SIV (“simian immunodeficiency syndrome virus”, ancestor of HIV-1, in the subspecies *P. t. troglodytes*).

7.1.5 Order Carnivores (*Flesh-Eaters*) (Carnivora)

Family Canidae

Gray Fox (*Urocyon cinereoargenteus*)

North-American species living in semi-open country (open woodland, chaparral). Omnivorous: small mammals, birds, eggs, invertebrates, fruit, acorns. VIRUSES: *Flavivirus* SLE, *Lyssavirus* s.s.

Red Fox (*Vulpes vulpes*: Photo 7.18)

Distribution widely Eurasian, but possibly conspecific with the New World Red Fox (*V. fulva*). Habitat is woodland and open land (farmland), nearly ubiquitous, occurs also in urban habitats. Feeds on small mammals (largely rodents), rabbits, hares, occasionally birds (pheasants, grouse and poultry) and invertebrates (larger insects), and sometimes vertebrate carrion and fruit. Home range about 2–3 km, but longer trails in snowy winters. Young foxes can disperse up to 200 km from their birth dens. VIRUSES: *Flavivirus* TBE, *Lyssavirus* s.s. (reservoir), *Herpesvirus suis* 1. BACTERIA: *Ehrlichia* spp., *Listeria monocytogenes*, *Staphylococcus aureus*, *Borrelia burgdorferi*, *B. afzelii*, *B. garinii*, *Leptospira grippotyphosa*, *Salmonella typhimurium*, *S. infantis*, *S. derby*, *Yersinia pseudotuberculosis*, *Brucella suis* biovar 2, *B. microti* (lymphadenitis), *Mycobacterium bovis*,

Dermatophilus congolensis. FUNGI: *Trichophyton mentagrophytes*. PROTOZOA: *Leishmania infantum*, *Toxoplasma gondii*.

Corsac Fox (*Vulpes corsac*)

Central Asian species of steppe, semidesert and desert habitats. Feeds on rodents, young birds, reptiles and insects. VIRUSES: *Lyssavirus* s.s. PROTOZOA: *Toxoplasma gondii*.

Arctic Fox (*Alopex lagopus*)

Northernmost parts of North America and Eurasia, tundra and boreal forest biome. Scavenger, following the Polar Bear; also hunts for lemmings, hares, birds and eats eggs and berries. Makes very long journeys. Often bred in captivity (kept for fur). VIRUSES: *Lyssavirus* s.s. (reservoir). BACTERIA: *Listeria monocytogenes*, *Bacillus anthracis*, *Leptospira* spp. (acquired from rodents), *Brucella abortus*, *Francisella tularensis*.

Raccoon Dog (*Nyctereutes procyonoides*: Photo 7.19)

Eurasian species (originally from east Asia) about the same size as the Red Fox, with a short bushy tail. Occurring in variable habitats. Feeds on small animals, fruit and other plant components. VIRUSES: *Lyssavirus* s.s. (very susceptible), *Coronavirus* SARS. BACTERIA: *Yersinia pseudotuberculosis*, *Francisella tularensis*.

Wolf (*Canis lupus*)

Islet-like distribution in Eurasia and North America. Prefers forest habitats and tundra biome, and hunts (in packs) deer, wild boar, rabbits, hares, occasionally birds, sheep, goats, and feeds even on frogs, fruit and insects. Hunting range is up to 100 km. VIRUSES: *Lyssavirus* s.s. (reservoir). BACTERIA: *Borrelia burgdorferi*, *Leptospira grippotyphosa*, *Francisella tularensis*, *Brucella abortus*. FUNGI: *Trichophyton mentagrophytes*.

Dog (*Canis familiaris*)

VIRUSES: *Flavivirus* TBE, *Lyssavirus* s.s., *Herpesvirus suis* 1. BACTERIA: *Rickettsia conorii* (reservoir), *R. rickettsii*, *Ehrlichia ewingii*, *Leptospira interrogans*, *Borrelia duttoni*, *B. burgdorferi* s.l., *Erysipelothrix rhusiopathiae*, *Staphylococcus aureus*, *S. epidermidis*, *S. intermedius*, *Campylobacter jejuni*, *Helicobacter bizzozeronii*, *Yersinia enterocolitica*, *Y. pseudotuberculosis*, *Pasteurella multocida*, *Capnocytophaga canimorsus*, *Burkholderia mallei*, *Mycobacterium bovis*. FUNGI: *Microsporium canis*, *Blastomyces dermatitidis*, *Pneumocystis jirovecii*. PROTOZOA: *Trypanosoma cruzi*, *T. brucei rhodesiense*, *T. brucei gambiense*, *Leishmania tropica*, *L. major*, *L. donovani*, *L. infantum* (reservoir), *Giardia lamblia*, *Cryptosporidium parvum*. MICROSPORIDIA: *Encephalitozoon cuniculi*, *Enterocytozoon bieneusi*.

Dingo (*Canis dingo*)

Australian wild dog living in dry bushland and semidesert. Hunts different mammals, birds, reptiles and insects, also feeds on carrion. BACTERIA: *Rickettsia australis*.

Jackal (*Canis aureus*)

Steppe, semi-open and wetland ecosystems of south-eastern Europe, Asia and north Africa, often around towns and villages. Feeds mostly on carrion, also on some small animals including insects, and fruit. VIRUSES: *Lyssavirus* s.s. (reservoir in many parts of south Asia, north Africa, Ethiopia). PROTOZOA: *Leishmania infantum* (reservoir).

Coyote (*Canis latrans*)

North-American species, the size of a medium dog, living in open woodland, bushland or prairies – very adaptable. Omnivorous, feeding on rodents, rabbits, often on carrion (scavenger), but also vegetables. Occasionally can kill sheep or calves. Extensive home range (usually up to 15 km, occasionally 160 km recorded). VIRUSES: *Lyssavirus* s.s. BACTERIA: *Mycobacterium bovis*.

Family Ursidae**Brown Bear** (*Ursus arctos*)

Fragmentary distribution in forest ecosystem of mountainous areas in Europe and North America (Alaska). A huge mammal, with a usual weight of 150–250 kg, but sometimes up to 450 kg. Omnivorous: eating berries, insects, honey, smaller vertebrates and carrion. VIRUSES: *Lyssavirus* s.s. BACTERIA: *Campylobacter jejuni*. FUNGI: *Trichophyton mentagrophytes*.

Black Bear (*Ursus americanus*)

Forest, swamps and mountainous habitats in North America. Feeds on berries, nuts, tubers, insects, honey, small mammals, eggs, carrion, and garbage. Long movements (up to about 25 km). VIRUSES: *Lyssavirus* s.s.

Family Procyonidae**Raccoon** (*Procyon lotor*: Photo 7.20)

North-American, medium-sized (about that of a small dog) species living near wooded areas, closely to streams and lakes, rock cliffs, but also in urban areas. Rests in tree hollows, ground burrows or rock crevices. Activity is largely nocturnal. Omnivorous: feeds on fruit, nuts, grain, rodents, frogs, carrion of larger mammals, eggs, insects, crayfish and other invertebrates. Home range 1–3 km, but young animals disperse up to 50 km from the birth place (one record of 260 km). Raccoon was introduced into Europe for its fur and now is spreading in Germany, the Baltic states, and NW Russia. VIRUSES: *Lyssavirus* s.s. (reservoir). BACTERIA: *Listeria monocytogenes*, *Leptospira autumnalis*, *L. grippotyphosa*, *L. hebdomadis*, *L. pomona*, *L. icterohaemorrhagiae*, *L. australis*, *Borrelia burgdorferi* s.s., *Yersinia pseudotuberculosis*, *Pasteurella multocida*, *Francisella tularensis*. PROTOZOA: *Trypanosoma cruzi*.

Family Mustelidae**Weasel** (*Mustela nivalis*: Photo 7.21)

This is the smallest Eurasian carnivore (11–25 cm, tail 15–85 cm; weight about 100 g, maximum 200 g); also occurs in north-western Africa and North America. Lives usually in open country in varied habitats, and normally nests in rodent burrows. Hunts small mammals, largely rodents – even in their burrows. BACTERIA: *Staphylococcus aureus*, *Leptospira grippotyphosa*, *Yersinia pseudotuberculosis*, *Francisella tularensis*. PROTOZOA: *Toxoplasma gondii*.

Stoat (Ermine) (*Mustela erminea*: Photo 7.22)

Eurasian and North-American species, nearly ubiquitous but usually in open country. It nests in burrow or in rocks. In their diet prevail small mammals (up to the size of small rabbit). BACTERIA: *Staphylococcus aureus*, *Leptospira grippotyphosa*, *Yersinia pseudotuberculosis*, *Francisella tularensis*. PROTOZOA: *Toxoplasma gondii*.

Polecat (*Mustela putorius*: Photo 7.23), **Steppe Polecat** (*M. eversmanni*: Photo 7.24)

European and NW African (*M. putorius*) and Eurasian (*M. eversmanni*) species of medium-sized mustelids, closely related to the domestic ferret. They occur mostly in woodland (*M. putorius*) or in grassland and steppe habitats (*M. eversmanni*). They rest above ground (*M. putorius*) or in burrows (*M. eversmanni*), hunting small vertebrates (rodents and birds), and occasionally feeding on insects. VIRUSES: *Lyssavirus s.s.*, *Herpesvirus suis* 1. BACTERIA: *Staphylococcus aureus*, *Leptospira grippotyphosa*, *Francisella tularensis.*, *Yersinia pestis* (*M. eversmanni*, during epizootics in Central Asia and the Caucasus). PROTOZOA: *Toxoplasma gondii*.

American Mink (*Mustela vison*), **European Mink** (*Mustela lutreola*)

Medium-sized mustelids living along streams, lakes and in wetlands (excellent swimmers). Mainly nocturnal and solitary species. They feed on small vertebrates (mammals, birds and their eggs, frogs and fish). Hunted or bred for valuable fur. The American Mink was introduced to Eurasia, where it has occasionally escaped from captivity (domesticated mink) and lives in the wild now. The population of European Mink has been reduced markedly and the species is endangered, while feral American Mink is expanding in Europe and is considered a pest. BACTERIA: *Bacillus anthracis*, *Erysipelothrix rhusiopathiae*, *Pasteurella multocida*, *Yersinia pseudotuberculosis*.

Black-footed Ferret (*Mustela nigripes*)

A large “ornamental weasel” with light brown body and dark face mask. It occurs in prairies of midwestern US states, often close to prairie dog towns, feeding on prairie dogs and other small mammals and birds. BACTERIA: *Yersinia pestis*.

European Pine Marten (*Martes martes*: Photo 7.26), **Beech (Stone) Marten** (*Martes foina*: Photo 7.25)

Medium-sized Eurasian mustelids living in woodland, forests, and the Beech Marten also in dry and more open scrub, rocky habitats and close to human habitation. They hunt small mammals and birds (*M. foina* also hunts chickens). VIRUSES: *Lyssavirus* s.s., *Herpesvirus suis* 1. BACTERIA: *Erysipelothrix rhusiopathiae*, *Listeria monocytogenes*, *Salmonella enteritidis*. PROTOZOA: *Toxoplasma gondii*.

Wolverine (*Gulo gulo*)

North Asian and North American medium-sized to large mammal (about 85 cm plus bushy tail 30 cm; 15–30 kg). Habitat: mountains near the timberline, and tundra biome. Solitary and omnivorous (often including carrion), with a considerable home range. BACTERIA: *Brucella abortus*.

Badger (*Meles meles*: Photo 7.27)

The largest mustelid species (70–90 cm plus tail about 12–20 cm; weight c. 10–20 kg, sometimes up to 30 kg). Lives in Eurasian woodlands where it builds quite extensive burrows. Nocturnal and omnivorous (small mammals, carrion of large mammals, bird eggs, earthworms and other invertebrates, seeds, fruit). VIRUSES: *Lyssavirus* s.s., *Herpesvirus suis* 1. BACTERIA: *Bacillus anthracis*, *Leptospira grippotyphosa*, *Salmonella enteritidis*, *Mycobacterium bovis* (reservoir: England). FUNGI: *Trichophyton mentagrophytes*. PROTOZOA: *Babesia microti*.

Chinese Ferret-Badger (*Melogale moschata*)

Southeastern Asian species, omnivorous. VIRUSES: *Coronavirus SARS*, *Lyssavirus* s.s.

Striped Skunk (*Mephitis mephitis*)

A medium-sized (about the same as a cat) North-American species of semi-open country (mixed wood, bushland and prairie). Largely nocturnal. Dens in ground burrows or tree hollows. Omnivorous: rodents, eggs, invertebrates, carrion and fruit. VIRUSES: *Lyssavirus* s.s. (reservoir), *Coltivirus CTF*. BACTERIA: *Listeria monocytogenes*, *Leptospira autumnalis*, *L. grippotyphosa*, *L. hebdomadis*, *L. pomona*, *L. icterohaemorrhagiae*, *L. australis*, *Yersinia pseudotuberculosis*, *Pasteurella multocida*, *Francisella tularensis*.

Otter (*Lutra lutra*)

This Eurasian and NW African species lives along streams, fishponds, lakes and wetlands as largely an aquatic animal, but can travel several kilometres overland to reach another river. Feeds mainly on fish, also frogs, crayfish and other aquatic invertebrates, and vertebrate carrion. VIRUSES: *Lyssavirus* s.s. BACTERIA: *Erysipelothrix rhusiopathiae*, *Yersinia pseudotuberculosis*.

Family *Herpestidae***Egyptian Mongoose** (*Herpestes ichneumon*: Photo 7.28)

Predominantly African species (also lives in Spain and Portugal) in scrub and woods. Mainly nocturnal. VIRUSES: *Lyssavirus* s.s. (often, also human cases).

Indian Mongoose (*Herpestes javanicus* [*auropunctatus*])

South Asian species (also introduced into the Caribbean in 1870). VIRUSES: *Lyssavirus* s.s. (often, also human cases).

Yellow Mongoose (*Cynictis penicillata*)

South African social species. VIRUSES: *Lyssavirus* s.s. (often).

Family *Viverridae***Genet** (*Genetta genetta*)

African, south Asian and south-west European (Spain, France) nocturnal species living in moist, dark woods. VIRUSES: *Lyssavirus* s.s.

Masked Palm Civet (*Paguma larvata*)

South-Asian, medium sized (50–75 cm plus tail 50–60 cm; weight 3.5–5 kg) species. Lives mostly on trees, and feeds on small vertebrates, insects and fruit. It rests usually in tree hollows. VIRUSES: *Coronavirus* SARS (competent host).

Family *Hyaenidae***Striped Hyena** (*Hyaena hyaena*)

African and south-Asian species (size 90–120 cm) living in the savannah ecosystem and around human habitation. Feeds on carrion, refuse and small vertebrates. VIRUSES: *Lyssavirus* s.s. (also human cases). BACTERIA: *Bacillus anthracis*. PROTOZOA: *Trypanosoma brucei rhodesiense*.

Family *Felidae***Lynx** (*Lynx lynx*)

Fragmented distribution in Eurasia and North America in forest habitats (and scrub). Hunts birds and mammals (including cat, fox, up to the size of roe deer). VIRUSES: *Lyssavirus* s.s. PROTOZOA: *Toxoplasma gondii*.

Bobcat (*Lynx rufus*)

North American lynx living in chaparral, swamp and forest habitats. Feeds on small mammals and birds. Home range usually 3 km, but can move up to 50 km. VIRUSES: *Lyssavirus* s.s. PROTOZOA: *Toxoplasma gondii*.

Domestic Cat (*Felis catus*), **Wild Cat** (*Felis silvestris*: Photo 7.29)

Wild cat lives in fragmented woodland areas in Europe, and feeds on small mammals, birds and other small animals. VIRUSES: *Lyssavirus* s.s. (also human cases), *Henipavirus* Nipah, *Herpesvirus suis* 1. BACTERIA: *Rickettsia typhi*,

R. felis, *Bartonella henselae* (reservoir), *Chlamydomyces felis*, *Staphylococcus aureus*, *Campylobacter jejuni*, *Helicobacter felis*, *Leptospira interrogans*, *Yersinia pestis*, *Y. pseudotuberculosis* (reservoir), *Y. enterocolitica*, *Francisella tularensis*, *Pasteurella multocida*, *Streptobacillus moniliformis*, *Burkholderia mallei*, *Mycobacterium bovis*. FUNGI: *Microsporium canis*, *Sporothrix schenckii*. PROTOZOA: *Trypanosoma cruzi*, *Giardia lamblia*, *Toxoplasma gondii* (reservoir, final host), *Cryptosporidium felis*. MICROSPORIDIA: *Enterocytozoon bieneusi*.

Mountain Lion (Cougar) (*Felis concolor*)

A large, tawny to grayish cat, living in rugged mountains, forests and swamps of western North America and in Central America. Feeds on deer, hares, rodents, and domestic animals. BACTERIA: *Yersinia pestis*.

Lion (*Panthera leo*)

African steppe habitats (savannah). BACTERIA: *Bacillus anthracis*. PROTOZOA: *Trypanosoma brucei rhodesiense*.

7.1.6 Order Sloths and Armadillos (Xenarthra)

Family Bradypodidae

Pale-throated (Three-toed) Sloth (*Bradypus tridactylus*: Photo 7.30)

Large mammal (50–60 cm; weight about 4 kg) living in the South-American tropical forest ecosystem. Specialized feeding on leaves and fruit of the tree *Cecropia lyratifolia*. VIRUSES: *Bunyavirus Oropouche*. BACTERIA: *Borrelia hermsii*.

Family Dasypodidae

Armadillo (*Dasypus novemcinctus*)

Medium-sized (40 cm plus tail 40 cm, weight 4–8 kg) American (including southern US states) mammal species occurring in bushland, woods and on cliffs. Largely insectivorous, less frequently feeds on fruit and avian eggs. The body is “armoured” – covered with a protective horny substance. Den is situated in deep burrows. BACTERIA: *Borrelia hermsii*. FUNGI: *Paracoccidioides brasiliensis*. PROTOZOA: *Trypanosoma cruzi*.

7.1.7 Order Elephants (Proboscidea)

Family Elephantidae

African (Savannah) Elephant (*Loxodonta africana*: Photo 7.31)

The largest terrestrial mammal (up to 7.5 m long, weight up to 6,000 kg). Distributed in sub-Saharan Africa in savannah with bushes and in woodland. Herbivorous (leaves, grasses, fruit). PROTOZOA: *Trypanosoma brucei rhodesiense*.

7.1.8 Order Hyracoidea

Family Procaviidae

Rock Hyrax (*Procavia capensis*: Photo 7.32)

Medium-sized mammal (30–60 cm long; weight up to 4 kg), lives on rocks in southern Africa and Angola. Herbivorous and social (up to 100 individuals in a colony) species. PROTOZOA: *Leishmania tropica*.

7.1.9 Order Rodents (Rodentia)

Rodents are, together with domestic mammals (namely ruminants and carnivores), epidemiologically the most important group of vertebrates as a source of human zoonotic infections (Davis et al. 1970, Kucheruk 1979, 1989, Blood et al. 2007, Hubálek and Halouzka 1996, etc.).

Family Sciuridae

Woodchuck (*Marmota monax*)

The “groundhog” is an approximately 50 cm long marmot living in North-American open woodland and rocky ravines. It hibernates, and builds extensive ground burrows. Feeds on plants. VIRUSES: *Flavivirus* Powassan, *Orthobunyavirus* SSH. BACTERIA: *Rickettsia rickettsii*, *Leptospira* spp., *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Yersinia pestis* (reservoir), *Y. pseudotuberculosis*, *Pasteurella multocida*.

Tarbagan Marmot (*Marmota sibirica*), **Himalayan Marmot** (*M. himalayana*), **Long-tailed Marmot** (*M. caudata*), **Bobak Marmot** (*M. bobak*)

Big stocky herbivorous rodents living in steppe and grassland often at higher elevations (up to alpine) in eastern Europe (*M. bobak*) and central Asia. They form colonies and build extensive burrow systems where they also hibernate (Photo 5.41). Hunted for their fur. BACTERIA: *Rickettsia sibirica* (*M. sibirica*), *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Bacillus anthracis* (*M. caudata*), *Leptospira* spp., *Yersinia pestis* (all 4 spp. are a significant reservoir in Asia, and the source of human infection with plague in Mongolia and China), *Y. pseudotuberculosis*, *Pasteurella multocida* (an epizootic in Mongolia), *Francisella tularensis*. PROTOZOA: *Toxoplasma gondii*.

Blacktail Prairie Dog (*Cynomys ludovicianus*: Photo 7.33)

Comparatively large (25–40 cm long plus tail 7–12 cm; weight about 1 kg) rodent, living in steppe habitat (dry upland prairies) of central and southern areas of USA, and forming extensive colonies (“towns”) with deep burrows. Related to marmots in its bionomics. Eats plants (grasses), and occasionally insects (e.g. locusts). VIRUSES: *Orthopoxvirus simiae* (lesions) – via import of African rodents to USA in 2003. BACTERIA: *Yersinia pestis* (reservoir), *Francisella tularensis*

(interestingly, several infected captive prairie dogs from Texas imported *Francisella t. tularensis*, i.e. the highly virulent type A, as pets into the Czech Republic in 2002, but fortunately the spread of infection was controlled).

California Ground Squirrel (*Spermophilus* [= *Citellus*] *beecheyi*)

About 25 cm long rodent (with a bushy tail about 20 cm long) living in western North-American pastures, cornfields and rocky ridges. Builds long burrows, and eats plants, seeds, acorns, fruit, mushrooms, insects, and even small birds and eggs. BACTERIA: *Yersinia pestis*, *Francisella tularensis*.

Golden-mantled Grand Squirrel (*Spermophilus lateralis*), **Richardson Ground Squirrel** (*S. richardsoni*: Photo 7.34), **Columbian Ground Squirrel** (*S. columbianus*), and **other American ground squirrels**

North-American species of grassland steppe ecosystem, herbivorous. VIRUSES: *Alphavirus* WEE, *Flavivirus* Powassan, *Orthobunyavirus* LaCrosse, SSH and other viruses of California group (*S. lateralis*), *Coltivirus* CTF (*S. lateralis*, *S. columbianus* – reservoir hosts). BACTERIA: *Rickettsia rickettsii*, *Yersinia pestis* (competent hosts and reservoirs, as well as many other ground squirrel spp. in North America, e.g. *S. columbianus*, *S. beldingi*, *S. armatus*, *S. washingtoni*, *S. townsendi*, *S. brunneus*, and *S. variegatus*), *Francisella tularensis* (*S. richardsoni*, *S. townsendii*, *S. columbianus*, *S. armatus*), *Pasteurella multocida*.

European Ground Squirrel (Souslik) (*Spermophilus citellus*: Photo 7.35)

Xerotherm habitats (steppes, meadows, pastures, scrub) in Eurasia. Lives in colonies in simple burrows where it also hibernates. Herbivorous (seeds of grasses, grain, green herbage), occasionally feeds on insects. BACTERIA: *Coxiella burnetii*, *Listeria monocytogenes*, *Leptospira pomona*, *Yersinia enterocolitica*, *Y. pestis*, *Pasteurella multocida*, *Francisella tularensis*. PROTOZOA: *Leishmania infantum*.

Long-tailed Ground Squirrel (*Spermophilus undulatus*), **Little G. S.** (*S. pygmaeus*), **Caucasian Mountain G. S.** (*S. musicus*), **Daurian G. S.** (*S. dauricus*)

East-European and Asian species of steppe habitats, herbivorous. VIRUSES: orthobunyaviruses of California group (*S. undulatus*). BACTERIA: *Rickettsia sibirica* (*S. undulatus*), *Coxiella burnetii*, *Listeria monocytogenes* (*S. undulatus*, *S. dauricus*), *Erysipelothrix rhusiopathiae*, *Bacillus anthracis* (*S. undulatus*), *Leptospira grippotyphosa*, *L. icterohaemorrhagiae* (*S. undulatus*), *Yersinia pestis* (reservoir: *S. pygmaeus* around Caspian Sea; *S. musicus*, the Caucasus; *S. undulatus*, Mongolia; *S. dauricus*, eastern Asia), *Y. pseudotuberculosis* (*S. pygmaeus*), *Y. enterocolitica* (*S. undulatus*), *Francisella tularensis*, *Brucella abortus* (*S. pygmaeus*, *S. undulatus*), *Pasteurella multocida*. PROTOZOA: *Toxoplasma gondii* (*S. pygmaeus*).

Yellow Ground Squirrel (*Spermophilus fulvus*), **Russet G. S.** (*S. major*), **Red-cheeked G. S.** (*S. erythrogegensys*), **Tien Shan G. S.** (*S. relictus*)

East- and Central-Asian species of steppe habitats, herbivorous. BACTERIA: *Rickettsia sibirica* (*S. erythrogenys*), *Coxiella burnetii* (*S. relictus*), *Bacillus anthracis* (*S. fulvus*), *Yersinia pestis* (*S. fulvus*, *S. major*), *Y. pseudotuberculosis* (*S. fulvus*), *Francisella tularensis* (*S. major*, *S. erythrogenys*). PROTOZOA: *Toxoplasma gondii* (*S. fulvus*, *S. erythrogenys*).

Whitetail Antelope Squirrel (*Ammospermophilus leucurus*)

A smaller (*c.* 15 cm long) semidesert rodent similar to both squirrel and ground squirrel, living in southwestern parts of North America. Feeds on seeds, insects and even meat. BACTERIA: *Yersinia pestis* (New Mexico).

Red (Spruce) Squirrel (*Tamiasciurus hudsonicus*: Photo 7.36)

Coniferous and mixed forests of North America, also swamps. Feeds on seeds, nuts, eggs, and fungi (the latter sometime stored). Nests in tree hollows or outside in tree branches. VIRUSES: *Alphavirus* WEE, *Flavivirus* Powassan, *Bunyavirus* LaCrosse and other viruses of the California group, *Coltivirus* CTF. BACTERIA: *Leptospira grippotyphosa*.

Long-clawed Ground Squirrel (*Spermophilopsis leptodactylus*)

Lives in deserts of central Asia. Feeds on grasses and subterrestrial parts of plants. Often contacts with *Rhombomys opimus*. BACTERIA: *Rickettsia sibirica*, *Coxiella burnetii*, *Borrelia persica*, *Yersinia pestis*. PROTOZOA: *Leishmania major*, *Toxoplasma gondii*.

Striped Ground Squirrel (*Xerus erythropus*)

A big (body size 30 cm plus long tail up to 28 cm; weight 350–650 g) squirrel, living in bushland and woodland of sub-Saharan Africa, builds underground burrows. VIRUSES: *Bunyavirus* Bhanja.

Congo Rope Squirrel, Thomas's Rope Squirrel, Red-legged Sun Squirrel (*Funisciurus congicus*, *F. anerythrus*, *Heliosciurus rufobrachium*)

African tropical forest herbivorous inhabitants. Occasionally feed on invertebrates. VIRUSES: *Orthopoxvirus simiae* (reservoir).

American chipmunks (*Tamias striatus*, *T. minimus* – Photo 7.37, *T. ochrogenys*, *Tamias* spp.)

North-American species building ground burrows, herbivorous and insectivorous (occasionally meat, eggs). *T. striatus* occurs in deciduous forests while the species of the genus *Eutamias* prefer coniferous forests and woods. VIRUSES: bunyaviruses of California group (LaCrosse etc.), *Coltivirus* CTF (*T. minimus*). BACTERIA: *Rickettsia rickettsii*, *Anaplasma phagocytophilum* (competent host), *Yersinia pestis* (USA – during epizootics), *Francisella tularensis*, *Pasteurella multocida*. PROTOZOA: *Toxoplasma gondii*.

Siberian Chipmunk (*Tamias sibiricus*: Photo 7.38)

A small (about 15 cm, tail of the same length) North-Asian ground squirrel species (also called “burunduk”), building burrows. Occurs in coniferous and mixed forests. Herbivorous (seeds of trees and herbs), occasionally insectivorous. VIRUSES: *Flavivirus* TBE. BACTERIA: *Rickettsia sibirica*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Yersinia pseudotuberculosis*, *Francisella tularensis*. PROTOZOA: *Toxoplasma gondii*.

(European) Red Squirrel (*Sciurus vulgaris*: Photo 7.39)

Widespread in Eurasian forests, woods and parks. Nests on tree branches or in tree hollows. Feeds on seeds (coniferous cones, nuts and fruit), the bast of trees, mushrooms, insects, bird eggs and nestlings. This mammal is usually heavily infested with ectoparasites (fleas etc.). VIRUSES: *Flavivirus* TBE, *Orthobunyavirus* Ťahyňa, *Hantavirus* Puumala, *Lyssavirus* s.s. BACTERIA: *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Leptospira hebdomadis*, *Borrelia burgdorferi* s.l. (competent host), *Pasteurella multocida*, *Francisella tularensis*. FUNGI: *Trichophyton mentagrophytes* (skin lesions). PROTOZOA: *Toxoplasma gondii*.

Western Gray Squirrel (*Sciurus griseus*)

Distributed in the westernmost part of North America, in semi-open oak and pine-oak habitats. Feeds largely on acorns and seeds of conifers. VIRUSES: *Lyssavirus* s.s. (1 case, California). BACTERIA: *Borrelia burgdorferi* s.s. (competent host with a persistent infection up to 14 months).

Eastern Gray Squirrel (*Sciurus carolinensis*: Photo 7.40)

Widespread in hardwood forests in the whole eastern part of North America. Feeds mainly on nuts and other seeds, also fruit, mushrooms, phloem under bark of trees. Nests in tree holes or builds a leaf nests in branches high above ground. VIRUSES: *Alphavirus* WEE, *Flavivirus* Powassan, *Orthobunyavirus* LaCrosse and other viruses of California group, *Coltivirus* CTF. BACTERIA: *Leptospira grippotyphosa*, *Clostridium tetani*.

Eastern Fox Squirrel (*Sciurus niger*)

Open broad-leaved and pine woods in the whole eastern part of North America. Spends much time on the ground. Feeds mainly on nuts and other seeds, also bird eggs, mushrooms, phloem under bark of trees. Nests in tree holes or builds a twig and leaf nest in branches high above ground. VIRUSES: *Orthobunyavirus* LaCrosse and other viruses of the California group, *Coltivirus* CTF. BACTERIA: *Leptospira grippotyphosa*, *Francisella tularensis*, *Borrelia burgdorferi* s.s.

Southern Flying Squirrel (*Glaucomys* [*Pteromys*] *volans*)

North-Eurasian species of flying nocturnal squirrel. Lives in mixed or deciduous forests, gregarious in winter. Feeds on seeds, nuts, insects, and avian eggs. Nests in tree holes or on tree branches. BACTERIA: *Rickettsia prowazekii*, *Yersinia pseudotuberculosis*.

Family *Castoridae*

European Beaver (*Castor fiber*), **Canadian Beaver** (*C. canadensis*: Photo 7.41)

A very big European and North-American rodent (c. 70 cm long, plus tail 25 cm, weight up to 30 kg). Bound to water ecosystem (streams, lakes and swamps with trees on banks). Feeds on aquatic vegetation, tree bark and small twigs. Builds a lodge in water or burrows into banks along streams. BACTERIA: *Salmonella typhimurium*, *Francisella tularensis* (*C. canadensis* – epizootics, but not in *C. fiber*). PROTOZOA: *Toxoplasma gondii*, *Giardia lamblia*.

Family *Heteromyidae*

Trinidad Spring Pocket Mouse (*Heteromys anomalus*)

South-American and Caribbean species. Feeds on seeds, other plant parts, and also arthropods. VIRUSES: *Alphavirus VEE* (Mucambo). PROTOZOA: *Leishmania mexicana*.

Great Basin Pocket Mouse (*Perognathus parvus*)

North-American species (size about 7 cm plus tail 8–10 cm), living solitarily in sagebrush, chaparral and pine stands. Herbivorous (mainly seeds). BACTERIA: *Francisella tularensis*.

Family *Pedetidae*

Springhare (*Pedetes capensis*)

Central- and South-African species with long legs living in deserts and semideserts, herbivorous. Hunted for the skin and meat. BACTERIA: *Yersinia pestis* (human cases at contact).

Family *Dipodidae*

Great Jerboa (*Jaculus jaculus*: Photo 7.42)

Small, jumping rodent living in deserts and semideserts in Egypt and Asia. Feeds on roots, seeds, leaves of succulent plants. BACTERIA: *Coxiella burnetii*, *Yersinia pestis*, *Y. pseudotuberculosis*, *Francisella tularensis*.

Severtzov's Jerboa, Five-toed Jerboa, Mongolian Five-toed Jerboa (*Allactaga severtzovi*, *A. elater*, *A. saltator* [=sibirica])

Small, jumping Asian rodents living in deserts and semideserts. Feed on roots, seeds, leaves of succulent plants. BACTERIA: *Erysipelothrix rhusiopathiae* (*A. saltator*), *Salmonella enteritidis* (*A. saltator*), *Borrelia caucasica* (*A. elater*), *Yersinia pestis* (*A. elater*, *A. saltator*), *Y. pseudotuberculosis*. PROTOZOA: *Leishmania major* (*A. severtzovi*).

Northern Three-toed Jerboa (*Dipus sagitta*)

Small, jumping Asian rodent living in deserts and semideserts. Herbivorous. BACTERIA: *Erysipelothrix rhusiopathiae*, *Salmonella typhimurium*, *Yersinia pestis*.

Small Jerboa (*Pygerethmus platyurus*) **and other jerboas** (*Alactagulus acontion*, *Scirtopoda telum*, *Paradipus ctenodactylus*, *Eremodipus lichtensteini*)

Small and jumping Asian rodents living in deserts and semideserts. Herbivorous.

BACTERIA: *Yersinia pestis*, *Y. pseudotuberculosis* (*P. platyurus*).

Northern Birch Mouse (*Sicista betulina*)

Northern Eurasian species widely, but sporadically distributed. In central Europe a glacial relict at higher mountain levels in humid coniferous forests. Nest on the ground or in tree hollows close to the ground, hibernates underground. Omnivorous (seeds, berries, insects). VIRUSES: *Flavivirus* TBE. BACTERIA: *Erysipelothrix rhusiopathiae*, *Leptospira hebdomadis*, *Francisella tularensis*.

Family Cricetidae

Common Hamster (*Cricetus cricetus*: Photo 7.43)

European species living in dry habitats of steppe character and in farmland in colonies and building deep burrows with stored food, where it also hibernates. Largely herbivorous, feeding on all agricultural crops, grain, seeds, roots, and occasionally on invertebrates. Irregular mass overpopulation events (e.g., east Slovakia 1971/1972). VIRUSES: *Alphavirus* Sindbis, *Flavivirus* OHF, *Lyssavirus* s.s. BACTERIA: *Rickettsia sibirica*, *Coxiella burnetii*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Leptospira grippotyphosa*, *L. pomona*, *L. sejroe*, *L. icterohaemorrhagiae*, *Yersinia pestis* (one isolation in Kazakhstan), *Francisella tularensis* (an important host in steppe habitats; 160 infected persons during the 1971/1972 east-Slovakian overpopulation of the hamster; a number of human infections at hunting hamster for the skin in eastern Europe). FUNGI: *Microsporum persicolor*.

Golden Hamster (*Mesocricetus auratus*: Photo 7.44)

Origin in the Near East. Feeds on grasses and grain. Often in captivity as pet or laboratory animal. VIRUSES: *Arenavirus* LCM (reservoir).

Ciscaucasian Hamster (*Mesocricetus raddei*)

Occurs in Ciscaucasian steppes, hibernates. Feeds on grasses, seeds, and roots. BACTERIA: *Francisella tularensis* (very susceptible, outbreaks).

Brandt's Hamster (*Mesocricetus brandti*)

Asia Minor, Transcaucasia. BACTERIA: *Francisella tularensis*, *Erysipelothrix rhusiopathiae*.

Greater Long-tailed (Rat-like) Hamster (*Cricetulus [Tscherskia] triton*), **Striped Dwarf Hamster** (*Cricetulus barabensis*: Photo 7.45), **Gray Hamster** (*C. migratorius*)

Small, mainly East-Asian (but *C. migratorius* also lives in the Balkans and Asia Minor) hamsters living mainly in grass steppe and brush habitats. They feed on seeds, and build burrow systems, where they store seeds for winter, and hibernate. BACTERIA: *Rickettsia sibirica*, *Orientia tsutsugamushi* (*C. triton*), *Coxiella*

burnetii (*C. migratorius*), *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae* (*C. barabensis*), *Leptospira* spp., *Borrelia persica* (*C. migratorius*), *Yersinia pestis* (*C. barabensis*: China, *C. migratorius*: the Urals, Transcaucasia), *Y. pseudotuberculosis* (*C. triton*), *Pasteurella multocida* (*C. triton*, *C. barabensis*), *Francisella tularensis* (*C. migratorius*).

Dzhungarian Hamster (*Phodopus sungorus*)

Distributed in steppes of Central Asia. Feeds on seeds, less on insects. Also in captivity as pet. BACTERIA: *Rickettsia sibirica*, *Erysipelothrix rhusiopathiae*, *Yersinia pestis*, *Francisella tularensis*.

White-footed Mouse (*Peromyscus leucopus*: Photo 7.46)

One of the most common rodent species in North America (in eastern and central parts). Body size about 10 cm (plus the tail *c.* 10 cm). It lives in forest ecosystem, but also in bushland and open land, and in the human environment (gardens etc.). In winter it invades human dwellings. It feeds mainly on fruit, seeds and nuts, but also on insects. It nests in diverse places (old avian or squirrel nests, buildings, etc.). VIRUSES: *Alphavirus* EEE, VEE. BACTERIA: *Anaplasma phagocytophilum*, *Borrelia burgdorferi* (reservoir). FUNGI: *Microsporum persicolor*. PROTOZOA: *Babesia microti*.

Deer Mouse (*Peromyscus maniculatus*)

Widely distributed over the whole of North America in moist, cool, coniferous and other forests, but also grassland. It nests in ground burrows or in trees and even buildings. It feeds on fruit, seeds, nuts, acorns, and occasionally insects. VIRUSES: *Alphavirus* VEE, *Flavivirus* Powassan, *Hantavirus* Sin Nombre (reservoir), *Coltivirus* CTF. BACTERIA: *Yersinia pestis* (California). FUNGI: *Microsporum persicolor*. PROTOZOA: *Cryptosporidium parvum*, *Babesia microti*.

Piñon Mouse (*Peromyscus truei*)

It lives in western and central North-American rocky habitats with scattered pines and junipers. Feeds on seeds and nuts. VIRUSES: *Hantavirus* Sin Nombre.

Long-tailed Pygmy Rice Rat (*Oligoryzomys longicaudatus*)

South-American species, called *raton colilarge* (in Spanish). VIRUSES: *Hantavirus* Andes (reservoir), *Arenavirus* Whitewater Arroyo.

Fulvous Pygmy Rice Rat (*Oligoryzomys fulvescens*)

Central-American species. VIRUSES: *Hantavirus* Choclo (reservoir).

Yellow Pygmy Rice Rat (*Oligoryzomys flavescens*)

South-American species (Argentina). VIRUSES: *Hantavirus* Lechiguana (reservoir).

Azara's grass mouse (*Akodon azarae*)

South-American species (Argentina). VIRUSES: *Hantavirus* Lechiguana (reservoir).

Eastern Woodrat, Bushytail Woodrat, Dusky-footed Woodrat, White-throated Woodrat, Southern Plains Woodrat (*Neotoma floridana*, *N. cinerea*, *N. fuscipes*, *N. albigula*, *N. micropus*, respectively)

Big North-American mouse-like species (about 20–22 cm, plus tail 15–20 cm). *N. floridana* lives in diverse habitats: rocky cliffs, swamps, gardens, or in semidesert. Builds nest houses from various material, and feeds on seeds, fruit and vegetables. *N. cinerea* lives in high mountains of western North America on cliffs and pine stands where it usually does not build nest houses and feeds on green vegetation. VIRUSES: *Coltivirus* CTF (*N. cinerea*), *Arenavirus* Whitewater Arroyo (*N. albigula*). BACTERIA: *Anaplasma phagocytophilum* (*N. fuscipes*). PROTOZOA: *Trypanosoma cruzi* (*N. micropus*).

Hispid Cotton Rat (*Sigmodon hispidus*)

A small rat (13–20 cm, tail 11–20 cm), lives in southern USA and in Mexico on humid meadows, nests on surface or in burrow, and feeds on green vegetation and eggs of birds. VIRUSES: *Hantavirus* Black Creek Canal (reservoir). PROTOZOA: *Trypanosoma cruzi*.

Rice rat (*Oryzomys palustris*) and related rats (*O. laticeps*, *O. capito*)

American semi-aquatic and nocturnal species, *O. palustris* occurs in USA (south-western), 12–13 cm plus tail 11–18 cm. They live in humid habitats, sedges or marshes, and feed on green vegetation and seeds. They nest under vegetation litter close to the upper level of the water. VIRUSES: alphaviruses EEE a VEE (Mucambo), *Hantavirus* Bayou (*O. palustris*, reservoir).

Short-tailed Cane Mouse (*Zygodontomys brevicauda*)

This nocturnal, terrestrial species is abundant in grassland, clearings, marshy areas, second growth, and agricultural areas of South America. Its diet includes seeds, fruit, and green plant material. It makes short burrows in banks or under tree roots, leading to nests made of grasses and plants. VIRUSES: *Hantavirus* Calabazo, *Arenavirus* Guanarito.

Family Microtidae

Norway Lemming (*Lemmus lemmus*), **Black-footed Lemming** (*L. sibiricus*), **Brown Lemming** (*L. trimucronatus*)

Scandinavian, north-Siberian and Canadian species, respectively, of higher mountain levels (tundra and sub-alpine meadows). Nests either in burrows or aboveground. They feed on vegetation. Overpopulation every 3–4 years, followed by emigration southwards. VIRUSES: *Hantavirus* Topografov (*L. sibiricus* reservoir). BACTERIA: *Listeria monocytogenes* (in *L. trimucronatus*), *Leptospira grippotyphosa* (*L. sibiricus*), *Francisella tularensis* (outbreaks in *L. sibiricus*, *L. lemmus* – waterborne cases of human tularaemia have been described from this source).

Bering's (Tundra) Collared Lemming (*Dicrostonyx rubricatus*), **Greenland Collared Lemming** (*D. groenlandicus*), **Collared (Arctic) Lemming** (*D. torquatus*)

North-Palaearctic species – *D. rubricatus* and *D. groenlandicus* are Nearctic. VIRUSES: *Bunyavirus* SSH (*D. rubricatus*). BACTERIA: *Listeria monocytogenes* (disease: *D. groenlandicus*), *Francisella tularensis* (disease: *D. torquatus*, *D. groenlandicus*).

Steppe Lemming (*Lagurus lagurus*)

Central-Asian and east-European species living in steppe habitats. Body size about 10 cm (tail absent), maximum weight 40 g. Herbivorous. BACTERIA: *Rickettsia sibirica*, *Coxiella burnetii*, *Yersinia pestis*, *Francisella tularensis* (epizootics in south Russia).

Sagebrush Vole (*Lagurus curtatus*)

Eastern states of USA. Size about 11 cm, tail only 2–3 cm + weight 20–40 g. Habitat is arid scattered sagebrush. Feeds on green vegetation. BACTERIA: *Francisella tularensis*.

Indian Gerbil (*Tatera indica*)

South-Asian species of steppe habitats. BACTERIA: *Orientia tsutsugamushi*, *Yersinia pestis*. FUNGI: *Trichophyton simii*.

Great Gerbil (*Rhombomys opimus*: Photo 7.47)

Asian species of big mouse with bushy tail, associated with desert, semidesert and steppe habitats. It usually builds systems of burrows (Photo 5.44), and feeds on roots, grasses and invertebrates. BACTERIA: *Coxiella burnetii*, *Yersinia pestis* (principal host in Central Asia, reservoir), *Borrelia duttonii*, *B. persica*, *Pasteurella multocida*, *Borrelia latyshevi*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Bacillus anthracis*. PROTOZOA: *Leishmania tropica* and *L. major* (reservoir), *Toxoplasma gondii*.

Fat Sand Rat (*Psammomys obesus*: Photo 7.48)

African species of big mouse with bushy tail, living in desert and semidesert habitats. Feeds on roots, grasses and invertebrates. BACTERIA: *Coxiella burnetii*, *Yersinia pestis* (reservoir), *Borrelia duttonii*, *B. persica*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*. PROTOZOA: *Leishmania tropica* and *L. major* (reservoir).

Libyan Jird, Persian J., Shaw's J. (*Meriones libycus*, *M. persicus*, *M. shawi*)

African and Asian species of big mice with bushy tail, associated with desert, semidesert and steppe habitats. They usually build systems of burrows, and feed on roots, grasses and invertebrates. VIRUSES: *Arenavirus* LCM (*M. shawi*). BACTERIA: *Coxiella burnetii*, *Yersinia pestis* (reservoir), *Borrelia duttonii*,

B. persica, *Francisella tularensis* (*M. libycus*), *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Bacillus anthracis* (*M. libycus*). PROTOZOA: *Leishmania major* (reservoir).

Mid-day Jird, Tamarisk J., Vinogradov's J., Mongolian J. (*Meriones meridianus*, *M. tamariscinus*, *M. vinogradovi*, *M. unguiculatus*)

Asian species of mice with bushy tail, associated with desert, semidesert and steppe habitats. They feed on roots, grasses and invertebrates. BACTERIA: *Orientia tsutsugamushi* (*M.t.*), *Coxiella burnetii* (*M. meridianus*), *Yersinia pestis* (reservoir – all spp.), *Leptospira* spp. (*M. tamariscinus*), *Borrelia persica* (*M. meridianus*), *Francisella tularensis* (*M. meridianus*, *M. tamariscinus*), *Listeria monocytogenes* (*M. meridianus*), *Erysipelothrix rhusiopathiae* (*M. meridianus*, *M. vinogradovi*, *M. unguiculatus*). PROTOZOA: *Leishmania major* (*M. meridianus*, *M. tamariscinus*).

Silver Mountain Vole, Flat-headed Vole (*Alticola argentatus*, *A. strelzowi*)

Central-Asian (Kazakhstan and Mongolia) and North-Asian species of high rocky mountains. Herbivorous; they store hay between stones. BACTERIA: *Yersinia pestis* (Mongolia), *Y. pseudotuberculosis* (*A. strelzowi*).

Bank Vole (*Myodes* [*Clethrionomys*] *glareolus*: Photo 7.49)

A widespread Eurasian species living in deciduous and mixed forests, woods, coppices and parks. Builds a system of shallow runs and burrows in the soil. Mainly herbivorous (seeds, nuts, fruit, roots and bast), but occasionally feeds on invertebrates (mainly insects). Active also in winter. Cyclic overpopulations every 3–5 years. VIRUSES: flaviviruses TBE and LI, *Hantavirus Puumala* (principal reservoir), orbiviruses Tribeč and Kemerovo, *Arenavirus LCM*, *Parechovirus Ljungan*, *Orthopoxvirus bovis*. BACTERIA: *Coxiella burnetii*, *Anaplasma phagocytophilum* s.l., *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Borrelia afzelii*, *B. garinii*, *Leptospira australis*, *L. grippityphosa*, *L. hebdomadis*, *L. jalna*, *L. pomona*, *Campylobacter jejuni*, *C. coli*, *Salmonella typhimurium*, *S. enteritidis*, *Yersinia pseudotuberculosis*, *Y. enterocolitica*, *Pasteurella multocida*, *Francisella tularensis*, *Mycobacterium microti*. FUNGI: *Microsporium persicolor* (skin lesions), *Trichophyton mentagrophytes* (skin lesions), *Pneumocystis jirovecii*. PROTOZOA: *Babesia microti* (splenomegaly), *Toxoplasma gondii*, *Cryptosporidium parvum*. MICROSPORIDIA: *Encephalitozoon cuniculi*.

Red-backed (Ruddy) Vole (*Myodes* [*Clethrionomys*] *rusticus*), **Gray-sided Vole** (*M. rufocanus*)

Asian species living in forest habitats, birch woodland, tundra biome; *M.rut.* occurs also in Alaska and northernmost Europe. They feed on seeds, berries and other plant components, and nest in burrows. VIRUSES: *Flavivirus* TBE (RSSE), *Hantavirus Puumala*. BACTERIA: *Rickettsia sibirica* (*M. rufocanus*), *Orientia tsutsugamushi* (*M. rufocanus* – possible reservoir in the Primorye region, Siberian Russia), *Coxiella burnetii*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Leptospira*

grippytyphosa, *L. javanica*, *Salmonella typhimurium* (*M. rutilus*), *Yersinia pseudotuberculosis* (*M. rufocanus*), *Francisella tularensis*. FUNGI: *Microsporium persicolor*. PROTOZOA: *Toxoplasma gondii*.

Common Vole (*Microtus arvalis*: Photo 7.50)

An abundant Eurasian species; cultivated steppe is the typical habitat (meadows and arable fields). Lives in colonies, builds extensive burrows and runs, active also in winter. Herbivorous (mainly green parts of plants, in winter also roots, etc.). Overpopulation usually every 3–4 years (up to 1,500 ind./ha), and the stressed animals are often affected with fatal infectious and non-infectious diseases and, at the same time, serve as an easy source of food for predators like foxes, raptors and owls. VIRUSES: *Flavivirus* TBE, hantaviruses Tula (reservoir) and rarely Puumala, *Arenavirus* LCM, *Parechovirus* Ljungan. BACTERIA: *Rickettsia slovaca*, *Coxiella burnetii*, *Borrelia afzelii*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Bacillus anthracis*, *Borrelia burgdorferi* s.l. (competent host), *Leptospira grippytyphosa* (reservoir), *L. bataviae*, *L. hebdomadis*, *L. pomona*, *Campylobacter jejuni*, *C. coli*, *Salmonella enteritidis*, *S. paratyphi* B, *Yersinia pseudotuberculosis*, *Y. enterocolitica*, *Y. pestis* (mountainous Transcaucasia), *Brucella suis* biotype 2, *B. microti* (systemic disease), *Pasteurella multocida* (epizootics), *Francisella tularensis* (often human aerogenic infections during tularaemia epizootics of voles in agroecosystems), *Mycobacterium microti*. FUNGI: *Microsporium persicolor* (skin lesions), *Trichophyton mentagrophytes*, *T. erinacei*, *Pneumocystis jirovecii*. PROTOZOA: *Babesia microti* (splenomegaly), *Giardia lamblia*, *Toxoplasma gondii*, *Cryptosporidium parvum*, *Encephalitozoon cuniculi*.

Field (Short-tailed) Vole (*Microtus agrestis*: Photo 7.51)

Eurasian, very widespread and abundant species. Lives in grassland (usually humid), moorland, also arable fields in colonies, builds extensive runs and burrows, and is active also in winter. Feeds on grasses and other vegetation (mainly green parts, but in winter also roots, bast etc.). Populations are cyclic, and during the overpopulation peak the voles serve as rich source of food for foxes and birds of prey. VIRUSES: *Flavivirus* TBE, *Hantavirus* Tula (and rarely Puumala), *Orthopoxvirus bovis*. BACTERIA: *Listeria monocytogenes*, *Borrelia burgdorferi* s.l. (competent host), *Leptospira grippytyphosa* (reservoir), *Yersinia enterocolitica*, *Francisella tularensis*, *Mycobacterium microti*. FUNGI: *Microsporium persicolor*, *Trichophyton mentagrophytes*, *T. erinacei*, *Pneumocystis jirovecii*. PROTOZOA: *Babesia microti* (splenomegaly), *Toxoplasma gondii*, *Cryptosporidium parvum*.

Root (Tundra) Vole (*Microtus oeconomus*)

Distributed in north-eastern Europe, northern Asia and Alaska. There are also some places in central Europe where smaller populations thrive as a glacial relict (Neusiedler See in Austria and Hungary, and south Slovakia). The normal habitat is humid tundra, or wetlands in central Europe. Feeds on green vegetation, roots, and nests usually under plant litter or in shallow burrows. VIRUSES: *Flavivirus*

OHF. BACTERIA: *Rickettsia sibirica*, *Coxiella burnetii*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Leptospira grippotyphosa* (reservoir), *L. javanica*, *L. pomona*, *L. hebdomadis*, *Francisella tularensis*. FUNGI: *Microsporium persicolor*.

Maximovicz's Vole (*Microtus maximowiczii*)

Occurs in open taiga ecosystem of the Russian Far East. Herbivorous. VIRUSES: *Flavivirus* TBE (RSSE), *Hantavirus* sp. BACTERIA: *Rickettsia sibirica*, *Orientia tsutsugamushi*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Leptospira grippotyphosa* (reservoir), *L. hebdomadis*, *Yersinia pseudotuberculosis*, *Francisella tularensis*.

Middendorf's Vole, North Siberian V., Sakhalin V. (*Microtus middendorffi*, *M. hyperboreus*, *M. sachalinensis*)

These herbivorous vole spp. occur largely in tundra of North Siberia or in the Russian Far East. BACTERIA: *Orientia tsutsugamushi* (*M. sachalinensis*), *Erysipelothrix rhusiopathiae* (*M. hyperboreus*), *Francisella tularensis* (*M. middendorffi*).

Social Vole (*Microtus socialis*)

Steppe habitats in southeastern Europe, Caucasus, Israel, and Kazakhstan. BACTERIA: *Coxiella burnetii*, *Leptospira hebdomadis*, *Erysipelothrix rhusiopathiae*, *Yersinia pestis*, *Francisella tularensis*.

Narrow-headed Vole (*Microtus gregalis*)

Asian (and Israeli) herbivorous species of steppe habitats. VIRUSES: *Flavivirus* TBE (RSSE). BACTERIA: *Rickettsia sibirica*, *Leptospira hebdomadis*, *L. grippotyphosa*, *L. pomona*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Yersinia pestis*, *Francisella tularensis*.

Major's Pine Vole (*Microtus majori*)

Occurs in meadow habitats and woodland at high altitudes in Asia Minor and Caucasus. BACTERIA: *Leptospira pomona*, *L. grippotyphosa*, *Erysipelothrix rhusiopathiae*, *Francisella tularensis*.

Meadow Vole (*Microtus pennsylvanicus*)

North-American vole living in lowland moist habitats or in high grassland near streams or lakes, much less often in forests. It can swim, feeds on grasses, seeds, grain and bark. Population fluctuates considerably, with spikes every 3–4 years. BACTERIA: *Francisella tularensis*.

California Vole (*Microtus californicus*)

It only occurs in the westernmost part of North America in marshes (even with brackish water) and on wet meadows, but also on grassy hills. Feeds on green vegetation (grasses, sedges). VIRUSES: *Alphavirus* WEE.

Mountain Vole (*Microtus montanus*)

Distributed in western North America in mountain areas. Feeds on grasses and other green vegetation. VIRUSES: *Parechovirus* Ljungan.

Common Pine Vole (*Microtus [Pitymys] subterraneus*)

Eurasian less abundant species occurring usually in humid forests and woods (alder stands), meadows, or banks of brooks. Herbivorous (grasses, seeds and roots). VIRUSES: *Hantavirus* Tula, *Orbivirus* Tribeč. BACTERIA: *Leptospira grippotyphosa*, *L. jalna*, *Campylobacter jejuni*, *C. coli*, *Yersinia pseudotuberculosis*, *Francisella tularensis*. FUNGI: *Pneumocystis jirovecii*. PROTOZOA: *Babesia microti*, *Toxoplasma gondii*, *Giardia lamblia*.

Water (Ground) Vole (*Arvicola terrestris*: Photo 7.52)

A large vole (the size of a rat: up to 20 cm long, plus tail about 10 cm; weight up to 200 g), occurring in Eurasian aquatic habitats; some populations occur in humid sites far from water (gardens and orchards). Mainly subterranean pattern of life. Nests underground. Feeds on root vegetables, roots of fruit trees (pest), occasionally fish, carrion. Active also in winter. VIRUSES: *Flavivirus* OHF (reservoir) and TBE, *Hantavirus* sp. BACTERIA: *Rickettsia sibirica*, *Coxiella burnetii*, *Listeria monocytogenes* (disease – reservoir), *Erysipelothrix rhusiopathiae* (reservoir), *Bacillus anthracis*, *Leptospira bataviae*, *L. grippotyphosa* (probable reservoir), *L. icterohaemorrhagiae*, *L. hebdomadis*, *Salmonella enteritidis*, *S. paratyphi* B, *S. typhimurium*, *Yersinia pseudotuberculosis*, *Y. enterocolitica*, *Y. pestis*, *Pasteurella multocida*, *Brucella abortus*, *Francisella tularensis* (reservoir in flood-plain forest ecosystem; disease, also many human cases). FUNGI: *Trichophyton mentagrophytes*. PROTOZOA: *Babesia microti*, *Toxoplasma gondii*.

Muskrat (*Ondatra zibethicus*: Photo 7.53)

Medium-sized (25–40 cm, tail 20–25 cm, the weight of adults 1–2.5 kg) water rodent occurring in North America and, since nineteenth century, has been introduced into Eurasia (first bred in captivity for the fur) where it has spread widely. Burrows in banks of streams, and in reed stands of fishponds, marshes and lakes it builds big houses (up to 1 m high). Feeds on aquatic vegetation, occasionally on water invertebrates (snails, mussels, etc.) or frogs and rarely fish. Seasonally it moves overland. In some countries (e.g. Russia) it is hunted for its fur. VIRUSES: *Flavivirus* OHF (epizootics), *Hantavirus* Puumala, *Lyssavirus* s.s. BACTERIA: *Rickettsia sibirica*, *Coxiella burnetii*, *Chlamydophila abortus* (an epizootic), *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Fusobacterium necrophorum*, *Staphylococcus aureus*, *Leptospira bataviae*, *L. grippotyphosa*, *L. hebdomadis*, *L. icterohaemorrhagiae*, *L. pomona*, *L. tarassovi*, *Salmonella enteritidis*, *S. typhimurium*, *Yersinia pseudotuberculosis*, *Y. enterocolitica*, *Pasteurella multocida*, *Francisella tularensis* (human infections during hunting muskrats for skins), *Actinomyces bovis* (fatal disease of muskrats). FUNGI: *Trichophyton mentagrophytes* (lesions), *Microsporium cookei*. PROTOZOA: *Toxoplasma gondii*, *Cryptosporidium parvum*, *Giardia lamblia*.

Northern Mole Vole (*Ellobius talpinus*)

A species specialized for subterranean life in steppe, semidesert, desert and mountain habitats from Ukraine and Central Asia to west China. Feeds mainly on roots of herbs, but also on insects and worms. BACTERIA: *Rickettsia sibirica*, *Coxiella burnetii*, *Yersinia pestis*, *Francisella tularensis*.

Transcaucasian Mole Vole (*Ellobius lutescens*)

A species specialized for subterranean life in mountainous meadow and steppe habitats in Asia Minor, Caucasus and Central Asia. Feeds mainly on roots of herbs. BACTERIA: *Yersinia pestis* (Iran, Kurdistan).

Family Muridae**Giant Rat** (*Cricetomys emini*), **Gambian Rat** (*C. gambianus*)

Big omnivorous rats (up to 40 cm plus bicoloured tail 35 cm in *C. gambianus*) of African tropical forests. VIRUSES: *Nairovirus* Dugbe (*C. gambianus*), *Orthopoxvirus simiae* (lesions).

Drylands Vesper Mouse (*Calomys musculinus*), **Large Vesper Mouse** (*C. callosus*)

South-American species of agrocenoses. VIRUSES: arenaviruses Junin (*C. musculinus*, reservoir) and Machupo (*C. callosus*, reservoir).

Striped Field Mouse (*Apodemus agrarius*: Photo 7.54)

Occurs mainly in northern Eurasia in more humid habitats with dense vegetation but in winter it approaches human settlements and isolated buildings. Feeds on seeds, but animal component (insects) makes up about one-third of the diet. VIRUSES: *Flavivirus* TBE, hantaviruses Hantaan (reservoir), Dobrava (reservoir in SE. Europe), Saaremaa and Puumala, *Arenavirus* LCM. BACTERIA: *Rickettsia sibirica*, *R. slovaca*, *Orientia tsutsugamushi*, *Coxiella burnetii*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Bacillus anthracis*, *Leptospira grippotyphosa*, *L. australis*, *L. bataviae*, *L. hebdomadis*, *L. pomona* (mozdok – reservoir), *L. sejroe*, *L. javanica*, *L. icterohaemorrhagiae*, *Borrelia burgdorferi* s.l. (competent host), *Salmonella typhimurium*, *Yersinia pseudotuberculosis*, *Y. pestis*, *Brucella abortus*, *Francisella tularensis*. FUNGI: *Trichophyton mentagrophytes*. PROTOZOA: *Babesia microti*, *Toxoplasma gondii*.

Korean Field Mouse (*Apodemus peninsulae*)

Distributed in eastern-Asian brush and woodlands. In winter season attracted to human habitations. Feeds on seeds and vegetation. VIRUSES: *Flavivirus* TBE, *Hantavirus* Hantaan. BACTERIA: *Orientia tsutsugamushi*, *Leptospira autumnalis* (reservoir), *Yersinia pseudotuberculosis*, *Francisella tularensis*, *Erysipelothrix rhusiopathiae*. PROTOZOA: *Toxoplasma gondii*.

Yellow-necked Mouse (*Apodemus flavicollis*: Photo 7.55)

A common European species, living in woodland (less in open country habitats). Feeds on seeds (acorns etc.) and invertebrates (insects etc.). VIRUSES: *Flavivirus* TBE, hantaviruses Dobrava (reservoir), Saaremaa, Hantaan and Puumala, *Arenavirus* LCM, *Orthopoxvirus bovis*. BACTERIA: *Rickettsia slovacica*, *Orientia tsutsugamushi*, *Anaplasma phagocytophilum* s.l., *Listeria monocytogenes*, *Borrelia burgdorferi* s.l., *B. afzelii*, *Leptospira australis*, *L. bataviae*, *L. bratislava*, *L. grippotyphosa*, *L. hebdomadis*, *L. jalna* (reservoir), *L. pomona*, *L. saxkoebing* (reservoir), *L. sejroae*, *Campylobacter jejuni*, *C. coli*, *Salmonella* spp., *Yersinia enterocolitica*, *Francisella tularensis*. FUNGI: *Trichophyton mentagrophytes*, *Pneumocystis jirovecii*. PROTOZOA: *Babesia microti*, *Toxoplasma gondii*.

Wood Mouse (*Apodemus sylvaticus*)

A very common Eurasian mouse species, living usually in small woods and wooded habitats of open country (coppices, windbreak tree lines, brush, etc.). Feeds on seeds (acorns, etc.) and invertebrates (up to a quarter of the diet – insects, etc.). VIRUSES: flaviviruses TBE and LI, hantaviruses Hantaan and Puumala, *Arenavirus* LCM. BACTERIA: *Rickettsia sibirica*, *Coxiella burnetii*, *Orientia tsutsugamushi*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Bacillus anthracis*, *Borrelia burgdorferi* s.l., *B. afzelii*, *B. caucasica*, *Leptospira australis*, *L. bratislava*, *L. grippotyphosa*, *L. hebdomadis*, *L. jalna*, *L. pomona*, *L. saxkoebing*, *L. sejroae*, *L. icterohaemorrhagiae*, *Campylobacter jejuni*, *C. coli*, *Salmonella typhimurium*, *S. enteritidis*, *Yersinia enterocolitica*, *Y. pseudotuberculosis*, *Francisella tularensis*, *Brucella abortus*, *Mycobacterium microti*. FUNGI: *Trichophyton mentagrophytes*, *T. erinacei*, *T. verrucosum*, *Microsporium persicolor*, *Pneumocystis jirovecii*. PROTOZOA: *Babesia microti*, *Toxoplasma gondii*.

Pygmy Field Mouse (*Apodemus uralensis* [syn. *A. microps*])

Associated with dry steppe-like habitats. Feeds on grain, seeds, grasses. BACTERIA: *Leptospira bataviae*, *L. pomona*, *L. sejroae*, *L. grippotyphosa*.

House Mouse Western (*Mus domesticus*) and **Eastern** (*Mus musculus*: Photo 7.57)

Synanthropic species with a cosmopolitan distribution. However, *M. domesticus* is distributed in western (partly also central) Europe and the Americas, while *M. musculus* in central and eastern Europe and in Asia. The dividing line between these two similar species goes across Europe from southern Sweden through Denmark, eastern Germany, western Czechland to Italy. Both species are associated with human habitation but in the summer some populations also live in fields. They feed on plant and animal remnants, seeds (grain – often considered a pest), small roots and insects. Epidemiologically very important rodent species. Many zoonotic and saprotoxic agents have also been recorded in laboratory mice, which are bred forms of wild house mouse. VIRUSES: hantaviruses Puumala, Leakey, Seoul, Sin Nombre, arenaviruses LCM (reservoir) and Junin, *Cardiovirus* EMC, murine *Orthopoxvirus*, *Orthopoxvirus bovis*. BACTERIA:

Rickettsia akari (reservoir), *R. typhi*, *R. sibirica*, *Orientia tsutsugamushi*, *Coxiella burnetii*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Bacillus anthracis*. *Borrelia persica*, *Leptospira sejroe* (reservoir), *L. grippityphosa*, *L. icterohaemorrhagiae*, *L. pomona*, *L. javanica*, *L. hebdomadis*, *Salmonella typhimurium*, *S. enteritidis*, *S. paratyphi* B, *Yersinia pestis* (Ural and Volga rivers during epizootics in 1937–1938, 1946, and 1958), *Y. pseudotuberculosis*, *Y. enterocolitica*, *Y. pestis*, *Pasteurella multocida*, *Francisella tularensis*, *Brucella abortus*, *Streptobacillus moniliformis*. FUNGI: *Trichophyton mentagrophytes*, *T. quinckeanum*, *T. verrucosum*, *T. erinacei*, *Microsporum canis*, *Histoplasma capsulatum*, *Pneumocystis jirovecii*. PROTOZOA: *Babesia microti*, *Trypanosoma cruzi*, *Leishmania major*, other *Leishmania* spp., *Toxoplasma gondii*, *Cryptosporidium parvum*.

Harvest Mouse (*Micromys minutus*)

A small (5–8 cm plus tail 4–7 cm; weight 5–12 g) Eurasian species living close to water (reed beds, meadows, ditches) and building typical spherical grassy nests woven in vegetation 40–80 cm above the ground while in winter it uses ground nests. Feeds on seeds and insects (30%). The population density is usually low, and the epidemiological role therefore decreased. VIRUSES: *Flavivirus* TBE, hantaviruses Hantaan and Puumala, *Arenavirus* LCM. BACTERIA: *Orientia tsutsugamushi*, *Erysipelothrix rhusiopathiae*, *Leptospira bataviae* (reservoir), *L. pomona*, *Yersinia enterocolitica*, *Y. pestis* (China), *Francisella tularensis*. PROTOZOA: *Babesia microti*.

Nile Grass Rat (*Arvicanthis niloticus*: Photo 7.58)

Synanthropic omnivorous African species, widely distributed. VIRUSES: *Flavivirus* West Nile. BACTERIA: *Yersinia pestis*. PROTOZOA: *Leishmania tropica*, *L. major*.

Black Rat (*Rattus rattus*: Photo 7.59)

A synanthropic species with cosmopolitan distribution but rare in colder areas. The Black Rat has a tail longer than its body plus head and also longer ears (when bent they reach to the eye) than the Brown Rat. Contrary to the Brown Rat, the Black Rat prefers drier and warmer sites in buildings (attics), granaries, storehouses etc. (often in seaports). Omnivorous (crops, foodstuffs, refuse, fruit, etc.). Epidemiologically a very important rodent. VIRUSES: *Flavivirus* KFD, *Hantavirus* Seoul, *Cardiovirus* EMC, *Arenavirus* LCM, *Orthopoxvirus* bovis. BACTERIA: *Rickettsia akari* (reservoir), *R. typhi*, *R. conorii*, *Orientia tsutsugamushi*, *Coxiella burnetii*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Leptospira grippityphosa*, *L. icterohaemorrhagiae*, *L. pomona*, *L. javanica*, *Borrelia burgdorferi* s.l., *B. duttonii*, *Spirillum minus* (reservoir), *Streptobacillus moniliformis* (reservoir), *Burkholderia mallei*, enteropathogenic *Escherichia coli*, *Salmonella typhimurium*, *Yersinia pestis*, *Y. pseudotuberculosis* (reservoir), *Francisella tularensis*, *Brucella abortus*, *Mycobacterium bovis*, *M. avium*. FUNGI: *Microsporum canis*, *Trichophyton mentagrophytes*. PROTOZOA: *Leishmania infantum*, *Trypanosoma cruzi*, *Toxoplasma gondii*.

Brown Rat (*Rattus norvegicus*: Photo 7.60)

A synanthropic species with a nearly cosmopolitan distribution. The Brown Rat has a shorter tail and ears than the Black Rat. The Brown Rat often lives in the cellars of urban buildings and farmyards near water (sewers etc.), and is extremely adaptable. Omnivorous – the animal component of the food (e.g., offal) is substantial, and it feeds commonly on rubbish, fodder for domestic animals (sometimes directly in the manger). It is found regularly in farm buildings and in slaughterhouses. Epidemiologically a very important rodent, especially at an enhanced population density when control by rat extermination is necessary. Many zoonotic agents have also been reported in the laboratory rat (which is, in fact, a bred albino form of the Brown Rat). VIRUSES: *Hantavirus* Seoul (reservoir), *Lyssavirus* s.s., *Cardiovirus* EMC, *Herpesvirus suis* 1 (pseudorabies). BACTERIA: *Rickettsia akari* (reservoir), *R. typhi*, *R. sibirica*, *Orientia tsutsugamushi*, *Coxiella burnetii*, *Bartonella quintana*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae* (reservoir), *Bacillus anthracis*, *Leptospira icterohaemorrhagiae* (reservoir), *L. pomona*, *L. copenhageni*, *Helicobacter heilmannii* (gastritis), *Borrelia burgdorferi* s.l., *Spirillum minus* (reservoir), *Streptobacillus moniliformis* (reservoir), *Burkholderia mallei*, enteropathogenic *Escherichia coli*, *Salmonella enteritidis*, *S. typhimurium*, *S. dublin*, *S. paratyphi* B, *Yersinia pestis* (in epizootics), *Y. enterocolitica*, *Y. pseudotuberculosis* (reservoir), *Y. pestis*, *Pasteurella multocida*, *Francisella tularensis*, *Brucella abortus*, *B. melitensis*, *B. suis* (biotype 2), *Mycobacterium bovis*, *M. avium*, *M. paratuberculosis*. FUNGI: *Microsporium canis*, *Trichophyton mentagrophytes*, *T. erinacei*, *T. simii*, *Pneumocystis jirovecii*. PROTOZOA: *Trypanosoma cruzi*, *Toxoplasma gondii*, *Giardia lamblia*, *Balantidium coli*.

Turkestan Rat (*Rattus turkestanicus*)

Deciduous forests of mountainous Central and southern Asia and China, also synanthropic species. BACTERIA: *Rickettsia typhi*, *R. sibirica*, *Orientia tsutsugamushi*, *Coxiella burnetii*.

Polynesian Rat (*Rattus exulans*)

Indonesian, Australian and Oceanic species, not strictly synanthropic. Omnivorous. BACTERIA: *Leptospira australis*, *Yersinia pestis*. PROTOZOA: *Toxoplasma gondii*.

Natal Multimammate Rat (*Mastomys natalensis*: Photo 7.56)

A widely distributed rat of sub-Saharan Africa. It occurs in savannah, in agroecosystems and in human habitation including houses. Sometimes serves as food for local humans. VIRUSES: *Arenavirus* Lassa (reservoir). BACTERIA: *Yersinia pestis*. PROTOZOA: *Leishmania* spp.

Great Bandicoot Rat (*Bandicota indica*), **Lesser Bandicoot Rat** (*B. bengalensis*), **Short-tailed Bandicoot Rat** (*Nesokia indica*)

Common, omnivorous species of Indian rats. VIRUSES: *Hantavirus* Thailand (*B. indica* reservoir). BACTERIA: *Orientia tsutsugamushi*, *Leptospira* spp.,

Yersinia pestis, *Francisella tularensis* (*N. indica*). FUNGI: *Trichophyton simii*. PROTOZOA: *Leishmania major* (*N. indica*).

Family *Rhizomyidae*

Large Bamboo Rat (*Rhizomys sumatrensis*), **Lesser Bamboo Rat** (*Cannomys badius*)

R. sumatrensis occurs in south-east Asia, feeds on stems and leaves of bamboo; *C. badius* is an Indian species. FUNGI: *Penicillium marneffeii* (reservoir).

Family *Ctenodactyliidae*

Common Gundi (*Ctenodactylus gundi*)

A guinea pig-like stocky rodent (body size 16–20 cm, tail very short), occurs in desert rocky habitats of north Africa (Maghreb), feeds on plants. PROTOZOA: *Toxoplasma gondii* (very first observed and described from this host in 1908 – but the gundis were from captivity).

Family *Gliridae*

Edible Dormouse (*Glis glis*: Photo 7.61)

Eurasian species living in warm deciduous forests, scrub, gardens, orchards. Feeding on fruit and seeds. Hibernating. VIRUSES: *Cardiovirus* EMC (disease). BACTERIA: *Borrelia burgdorferi* s.l. (competent host).

Forest Dormouse (*Dryomys nitedula*)

Eurasian species living in woods with thick undergrowth, often in hills and mountains. Omnivorous, but the animal component forms about 80% of the diet (insects, snails, avian eggs and nestlings, small mammals). Hibernating. VIRUSES: *Flavivirus* TBE. BACTERIA: *Leptospira pomona*, *Francisella tularensis*.

Garden Dormouse (*Eliomys quercinus*: Photo 7.62)

European, largely a woodland species but also occurs in orchards, gardens and scrub. Feeds on invertebrates, nestling birds (a good tree climber), small mammals, and in autumn on fruit (berries), nuts, and seeds. Hibernates in common nests. VIRUSES: *Flavivirus* TBE. BACTERIA: *Borrelia burgdorferi* s.s., *B. spielmanii*. FUNGI: *Microsporium persicolor*.

Hazel Dormouse (*Muscardinus avellanarius*)

A small, nocturnal European dormouse, occurring in deciduous and coniferous woodland and coppices from lowland to mountains. Omnivorous, feeds on fruit, seeds, nuts and invertebrates. Hibernating. BACTERIA: *Erysipelothrix rhusiopathiae*. PROTOZOA: *Babesia microti*.

Family *Hystriidae*

Porcupine (*Hystrix cristata*)

African herbivorous mammal with long spiny quills, digging burrows and occurring in bushland, farmland and arid rocky areas. BACTERIA: *Borrelia duttonii*, *B. persica* (reservoir).

Indian Crested Porcupine (*Hystrix indica* [=*H. leucura*])

Central and southern Asia, herbivorous. BACTERIA: *Borrelia persica* (reservoir). PROTOZOA: *Leishmania infantum*.

Family Erethizontidae**(Canadian) Porcupine** (*Erethizon dorsatum*)

A big (about 50 cm long plus tail 20 cm; weight 5–12 kg) North-American species resembling African porcupine but it lives mostly on trees (or in bushland) and feeds on bark, twigs and buds. VIRUSES: *Coltivirus* CTF. BACTERIA: *Rickettsia rickettsii*, *Coxiella burnetii*, *Francisella tularensis*.

Family Chinchillidae**Chinchilla** (*Chinchilla laniger*)

Living in rocky habitats in high mountains (the Andes) in Chile and Bolivia, feeds on roots, rootstocks, tubers and green plants. Bred for its excellent fur. BACTERIA: *Listeria monocytogenes*.

Family Caviidae**Guinea Pig** (*Cavia aperea porcellus*)

Originally a wild South-American herbivorous species living in open lowland. As domesticated animal, it serves as pet and an important laboratory animal. In South America also used for human food. BACTERIA: *Chlamydophila caviae*, *Leptospira pomona*, *L. grippotyphosa*, *Leptospira* spp., *Yersinia pestis*, *Y. pseudotuberculosis*. FUNGI: *Trichophyton mentagrophytes*. PROTOZOA: *Trypanosoma cruzi* (reservoir).

Cavy (*Microcavia australis*)

Mountainous areas of Argentina, also close to human habitation. Hunted for food. BACTERIA: *Yersinia pestis* (human cases after contact).

Family Echimyidae**Cayenne Spiny Rat** (*Proechimys cayennensis*)

Central- and South-American medium-sized rat-like rodent species in wooded habitats and scrub. VIRUSES: alphaviruses VEE (Mucambo) and EEE, bunyavirus group C, *Arenavirus* Machupo. PROTOZOA: *Leishmania mexicana* (competent host).

Spiny Rat (*Proechimys semispinosus*)

A common rat-like rodent of Central and South America. BACTERIA: *Leptospira* spp. (incl. *L. icterohaemorrhagiae*, *L. pomona*), *Salmonella* spp.

Punaré (*Trichomys apereoides*)

A caviomorph rodent living in South America (Brazil). PROTOZOA: *Trypanosoma cruzi* (reservoir), *Leishmania braziliensis* (competent host, possibly reservoir).

Family *Hydrochaeridae*

Capybara (*Hydrochaeris hydrochaeris*)

A huge South-American rodent (the largest rodent: 100–130 cm long; weight about 50 kg). Forest and grassland areas close to water. Feeds on aquatic plants. BACTERIA: *Rickettsia rickettsii*.

Family *Myocastoridae*

Coypu (Nutria) (*Myocastor coypus*: Photo 7.63)

A large South-American (Argentina) rodent (about 60 cm long plus tail 30–40 cm, weight 7–9 kg), living in marshes, ponds and lakes. Herbivorous (aquatic plants). Kept for its fur and meat in Eurasia; occasionally some individuals escape from captivity. VIRUSES: *Lyssavirus* s.s. BACTERIA: *Leptospira hebdomadis*, *L. australis*, *L. icterohaemorrhagiae*, *L. autumnalis*, *L. australis*, *L. bataviae*, *Listeria monocytogenes*, *Salmonella typhimurium*, *Yersinia enterocolitica*, *Y. pseudotuberculosis*, *Francisella tularensis* (susceptible). FUNGI: *Trichophyton mentagrophytes* (skin lesions). PROTOZOA: *Toxoplasma gondii*.

7.1.10 Order *Lagomorphs* (*Rabbits, Hares, and Pikas*; **Lagomorpha**)

Family *Ochotonidae*

Daurian Pika (*Ochotona dauurica*), **Pallas's (Mongolian) Pika** (*O. pallasii* [= *O. pricei*])

Small central Asian and east Asian mammals, quite abundant in grassland or rocky steppe habitats in foothills and at higher mountain elevations. Exclusively herbivorous (grasses), they store large quantities of hay for winter periods. They are very often massively infested by fleas of many species (mainly *Ctenophyllus* spp., but also *Citellophilus tesquorum*, a known vector of plague). BACTERIA: *Rickettsia sibirica*, *Erysipelothrix rhusiopathiae*, *Yersinia pestis* (Mongolia, Altai Mts.: reservoir – mainly *O. pallasii*, epizootics), *Y. pseudotuberculosis*, *Francisella tularensis*.

Afghan Pika (*Ochotona rufescens*), **Alpine Pika** (*O. alpina*)

Small Asian species of mountain or foothill (*O. rufescens*) steppes, rocks (*O. alpina*); exclusively herbivorous and storing hay. BACTERIA: *Coxiella burnetii*, *Erysipelothrix rhusiopathiae* (*O. alpina*).

Family *Leporidae*

Rabbit (*Oryctolagus cuniculus*: Photo 7.65)

Wild and domestic rabbit. The wild rabbit lives in scrub and grassland on lighter (sandy) soil where it builds a system of burrows (colonies). This originally European

species was introduced to Australia where it is a pest. Obligately herbivorous (grass, herbage; bark and twigs in winter), with an extraordinary reproduction rate. Free living populations may nearly reach the density of rodent populations, but are periodically and drastically reduced by epizootics of myxomatosis. VIRUSES: *Coltivirus* Eyach, *Herpesvirus suis* 1, *Orthopoxvirus bovis*. BACTERIA: *Rickettsia conorii*, *Orientia tsutsugamushi*, *Coxiella burnetii*, *Staphylococcus aureus*, *Listeria monocytogenes*, *Yersinia pseudotuberculosis*, *Pasteurella multocida*, *Francisella tularensis*, *Fusobacterium necrophorum*, *Mycobacterium paratuberculosis*. PROTOZOA: *Trypanosoma cruzi*, *Toxoplasma gondii*, *Giardia lamblia*. MICROSPORIDIA: *Encephalitozoon cuniculi*, *Enterocytozoon bieneusi*.

Eastern Cottontail (*Sylvilagus floridanus*)

A small rabbit distributed widely in central, eastern and southern North America in brushland, small woods with open areas, coppices, farmland, edges of marshes. It was introduced into Europe (France, Italy, Switzerland). Herbivorous (grasses, herbs, in winter also feeds on bark and twigs). VIRUSES: *Coltivirus* Eyach. BACTERIA: *Coxiella burnetii*, *Yersinia pseudotuberculosis*, *Francisella tularensis*.

Brown (European) Hare (*Lepus europaeus*: Photo 7.64)

Well-known European mammal, most often occurring in farmland (agrocoenoses in lowlands and warmer hilly land) or open woodland, but also appears in suburban woody areas and gardens. Herbivorous: grasses, herbs, leaves; bark and twigs in winter. It does not build burrows like the rabbit but rests in shallow depressions in the ground. VIRUSES: *Flavivirus* TBE, *Flavivirus* WN (Volga Delta), *Orthobunyavirus* Tahyňa, *Nairovirus* CCHF (southern Russia), *Herpesvirus suis* 1. BACTERIA: *Rickettsia slovaca*, *Coxiella burnetii*, *Chlamydophila abortus*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Bacillus anthracis*, *Staphylococcus aureus*, *S. intermedius*, *Streptococcus* spp., *Bacteroides fragilis* (necrobacillosis), *Leptospira grippityphosa*, *Borrelia burgdorferi* s.l., *Campylobacter jejuni*, *C. coli*, *Salmonella typhimurium*, *S. enteritidis*, *Yersinia pseudotuberculosis* (disease), *Y. enterocolitica*, *Pasteurella multocida* (disease), *P. haemolytica*, *Brucella suis* var. *leporis* (biotype 2 – chronic disease; carriership; reservoir), *Francisella tularensis*, *Mycobacterium bovis*. FUNGI: *Trichophyton mentagrophytes*, *Pneumocystis jirovecii*. PROTOZOA: *Babesia microti*, *Toxoplasma gondii*. MICROSPORIDIA: *Encephalitozoon intestinalis*, *E. hellem*.

Mountain (Blue) Hare (*Lepus timidus*)

Northern parts of Eurasia and North America. Habitat is tundra, heathland, and farmland. Sociable, forming herds of up to 50 individuals. Feeds on grasses, heather and twigs of willow, birch, etc. VIRUSES: flaviviruses LI and TBE. *Orthobunyavirus* SSH. BACTERIA: *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Salmonella typhimurium*, *Yersinia pseudotuberculosis*, *Francisella tularensis*. PROTOZOA: *Toxoplasma gondii*.

Snowshoe Hare (*Lepus americanus*)

This species is widely distributed in northern parts of North America, occurring in forests, coppices, swamp areas; it is herbivorous and largely nocturnal. VIRUSES: *Orthobunyavirus* SSH. BACTERIA: *Rickettsia rickettsii*, *Listeria monocytogenes*, *Yersinia pseudotuberculosis*, *Francisella tularensis*.

Blacktail Jackrabbit, Whitetail Jackrabbit (*Lepus californicus*, *L. townsendii*)

North-American hare species living in open areas (grassland, prairies, semidesert); herbivorous. VIRUSES: *Orthobunyavirus* California encephalitis (*L. californicus*), *Coltivirus* CTF (*L. californicus*). BACTERIA: *Rickettsia rickettsii*, *Coxiella burnetii* (*L. californicus*), *Listeria monocytogenes* (*L. californicus*), *Yersinia pseudotuberculosis* (*L. californicus*), *Francisella tularensis*, *Brucella suis* (*L. californicus*).

Tolai Hare (*Lepus tolai*)

Central-Asian species. BACTERIA: *Rickettsia sibirica*, *Listeria monocytogenes*, *Burkholderia pseudomallei*, *Salmonella typhimurium*, *Yersinia pseudotuberculosis*, *Pasteurella multocida*, *Brucella suis* var. *leporis*, *Francisella tularensis*. PROTOZOA: *Toxoplasma gondii*.

7.1.11 Order Odd-Toed Ungulates (Perissodactyla)**Family Equidae****Horse** (*Equus caballus*) and other equids (**donkey, mule**)

VIRUSES: alphaviruses EEE, WEE and VEE, flaviviruses JE and WN, *Nairovirus* CCHF, *Vesiculovirus* VSV, *Lyssavirus* s.s., orthomyxoviruses Dhori and influenza A, *Paramyxovirus* Hendra, *Aphthovirus* FMDV. BACTERIA: *Streptococcus equi* ssp. *zooepidemicus*, *Bacillus anthracis*, *Clostridium tetani*, *C. botulinum*, *Salmonella enterica*, *Burkholderia mallei*, *B. pseudomallei*, *Fusobacterium necrophorum*, *Corynebacterium pseudotuberculosis*, *C. ulcerans*, *Arcanobacterium pyogenes*, *Rhodococcus equi*, *Dermatophilus congolensis*. FUNGI: *Trichophyton equinum*.

Family Rhinocerotidae**Black Rhinoceros** (*Diceros bicornis*: Photo 7.66)

Huge African (mainly eastern and southern Africa) herbivorous mammal (body length about 3.5 m; weight 1,400 kg). PROTOZOA: *Trypanosoma brucei rhodesiense*.

7.1.12 Order Even-Toed Ungulates (Artiodactyla)**Family Suidae****Domestic Pig and Wild Boar** (*Sus scrofa*: Photo 7.67)

Eurasian and North-African wild species, also introduced into North America, common in deciduous humid forests (oak and beech) and visits neighbouring fields.

Extensive home range. Can swim well (also in great rivers). Omnivorous: acorns, beechmast, roots, field vegetables, maize, rodents, bird eggs and nestlings, molluscs, insects and other invertebrates, carrion of large mammals etc. The food is collected from the ground or dug from the soil. A very dangerous infectious disease of wild boars and domestic pigs is swine pest (not transmissible to man); for pigs it is highly contagious and lethal. VIRUSES: *Flavivirus* JE (amplifying host), *Vesiculovirus* VSV, *Orthomyxovirus* influenza A, *Henipavirus* Nipah, *Cardiovirus* EMC, *Aphthovirus* FMDV, *Hepevirus* hepatitis E, *Herpesvirus suis* 1 (reservoir), *Parapoxvirus bovis* 2. BACTERIA: *Orientia tsutsugamushi*, *Chlamydomphila abortus*, *Leptospira pomona* (reservoir), *L. australis*, *L. tarassovi*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae* (reservoir), *Streptococcus suis* (reservoir), *Bacillus anthracis*, *Clostridium difficile*, *C. botulinum*, *Campylobacter jejuni*, *C. coli*, *Helicobacter bizzozeronii*, *Brachyspira pilosicola*, *Salmonella enteritidis* and other serovars, enteropathogenic *Escherichia coli*, *Yersinia enterocolitica*, *Y. pseudotuberculosis*, *Brucella suis* (biotypes 1–3), *Pasteurella multocida*, *Francisella tularensis*, *Burkholderia pseudomallei*, *Fusobacterium necrophorum*, *Rhodococcus equi*, *Mycobacterium bovis*, *M. avium*. FUNGI: *Trichophyton mentagrophytes*, *Microsporium nanum*. PROTOZOA: *Trypanosoma cruzi*, *T. brucei rhodesiense*, *T. brucei gambiense*, *Toxoplasma gondii*, *Sarcocystis suihominis*, *Giardia lamblia*, *Balantidium coli*. MICROSPORIDIA: *Enterocytozoon bieneusi*. OTHER EUKARYOTA: *Blastocystis*.

Warthog (*Phacochoerus africanus*: Photo 7.68)

African species of savannah, omnivorous. Male weights up to 150 kg. BACTERIA: *Mycobacterium bovis*. PROTOZOA: *Trypanosoma brucei rhodesiense*.

Family Hippopotamidae

Hippopotamus (*Hippopotamus amphibius*)

A huge (up to 3,200 kg) African hydrophilic species, herbivorous. PROTOZOA: *Trypanosoma brucei rhodesiense*. BACTERIA: *Bacillus anthracis*.

Family Camelidae

Dromedary, Bactrian Camel (*Camelus dromedarius*, *C. bactrianus*)

Origin of *C. bactrianus* is in Central Asia, in *C. dromedarius* unknown. Today distributed in arid areas in Africa and Asia (central, southern, the Near East). Herbivorous. VIRUSES: *Flavivirus* WN, *Phlebovirus* RVF, orthomyxoviruses Thogoto and Dhori, *Orthopoxvirus bovis*. BACTERIA: *Mycobacterium bovis*.

Family Cervidae

Elk (Moose) (*Alces alces*)

The greatest deer-like ruminant (weight up to 800 kg), distributed in northern Eurasia and America. Lives in semi-open humid to marshy forests. Feeds on herbage, grasses, shoots, leaves, twigs and bark of trees, brushes and aquatic plants. Migrates or travels for long distances. BACTERIA: *Erysipelothrix rhusiopathiae*,

Bacillus anthracis (brucellosis, with abortus), *Staphylococcus aureus*, *Brucella abortus* (causing problems in the Greater Yellowstone Ecosystem, Wyoming), *B. suis* (biotype 4), *Mycobacterium bovis*.

White-tailed Deer (*Odocoileus virginianus*)

North-American species (but introduced into Finland), occurring in humid forests and open bush in their environment. Feeds on twigs, acorns, mushrooms, grasses and other plants. In Europe kept in deer farms. VIRUSES: bunyaviruses Jamestown Canyon and SSH, *Vesiculovirus VSV*, *Herpesvirus suis* 1. BACTERIA: *Anaplasma phagocytophilum* (competent host), *E. chaffeensis*, *Erysipelothrix rhusiopathiae*, *Listeria monocytogenes*, *Bacillus anthracis*, *Fusobacterium necrophorum*, *Leptospira pomona*, *Pasteurella multocida*, *Yersinia pseudotuberculosis*, *Y. enterocolitica*, *Brucella abortus*, *Mycobacterium bovis*, *M. paratuberculosis*, *Dermatophilus congolensis*. FUNGI: *Trichophyton mentagrophytes*.

Reindeer (*Rangifer tarandus*), **Caribou** (*R. tarandus caribou*: Photo 7.69)

North of Eurasia and America, occurring in woodland and tundra biome. Feeds on grasses, herbage, twigs of trees and shrubs. Reindeer live in great herds and migrate twice a year, up to hundreds of kilometres, whereas the Caribou migrates short distances (usually up and down mountains). BACTERIA: *Brucella abortus*, *B. suis* (biotype 4, also in *R. t. caribou*).

Fallow Deer (*Cervus [Dama] dama*)

The original distribution area of this deer species is the Mediterranean and SW Asia, but since Middle Ages it has been introduced into central Europe – game reserves situated in deciduous forest and parkland. Feeds on leaves, herbage, shoots, grasses, acorns and chestnuts. VIRUSES: *Lyssavirus* s.s. BACTERIA: *Anaplasma phagocytophilum* s.l., *Bacillus anthracis*, *Pasteurella multocida*, *Yersinia pseudotuberculosis*, *Brucella abortus*, *Mycobacterium bovis*, *M. paratuberculosis*.

Red Deer (*Cervus elaphus*: Photo 7.70)

A large (weight 70–250 kg) Eurasian, North-American and North-African deer, occurring in lowland to mountain forests. Feeds on leaves, twigs, shoots, grasses, herbage, acorns, beechmast, mushrooms etc. VIRUSES: *Flavivirus LI*, *Lyssavirus* s.s., *Vesiculovirus VSV*, *Herpesvirus suis* 1. BACTERIA: *Anaplasma phagocytophilum* s.l., *Listeria monocytogenes*, *Bacillus anthracis*, *Staphylococcus aureus*, *Leptospira grippotyphosa*, *L. pomona*, enteropathogenic *Escherichia coli*, *Yersinia pseudotuberculosis*, *Pasteurella multocida*, *Brucella abortus*, *Mycobacterium bovis*, *M. a. paratuberculosis*. FUNGI: *Trichophyton mentagrophytes*. PROTOZOA: *Toxoplasma gondii*, *Cryptosporidium parvum*.

Sika Deer (*Cervus nippon*)

Eastern Asiatic deer species of woodland and parkland, in the twentieth century introduced into Europe where it thrives in a number of game parks. Herbivorous (grasses, leaves, shoots). VIRUSES: *Hepevirus hepatitis E*. BACTERIA: *Ehrlichia chaffeensis*, *Anaplasma phagocytophilum* s.l., *Yersinia pseudotuberculosis*.

Roe Deer (*Capreolus capreolus*: Photo 7.71)

Eurasian species living in forests and woods of all types, lately also in agrocoenoses. Feeds on grasses, herbage, leaves, shoots, bark, mushrooms and fruit. VIRUSES: *Lyssavirus* s.s., *Vesiculovirus* VSV, *Herpesvirus suis* 1. BACTERIA: *Anaplasma phagocytophilum* s.l., *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Bacillus anthracis*, *Clostridium tetani*, *Staphylococcus aureus*, *Salmonella enteritidis*, *S. typhimurium*, *Yersinia pseudotuberculosis*, *Y. enterocolitica*, *Brucella abortus*, *B. melitensis*, *Pasteurella multocida*, *Mycobacterium bovis*, *M. avium*, *M. paratuberculosis*. PROTOZOA: *Toxoplasma gondii*.

Family Bovidae**Red Lechwe** (*Kobus leche*)

A gazelle living in wetlands, largely in southern Africa. Herbivorous (aquatic plants). BACTERIA: *Mycobacterium bovis*.

Greater Kudu (*Tragelaphus strepsiceros*), **Gray (Bush) Duikker** (*Sylvicapra grimmia*)

Mammals of African savannah ecosystem. BACTERIA: *Mycobacterium bovis* (*T. strepsiceros*). PROTOZOA: *Trypanosoma brucei rhodesiense*.

Chamois (*Rupicapra rupicapra*)

Isolated populations occur in the alpine zone of some mountains in Europe, Asia Minor and the Caucasus. Feeds on grasses, herbage, and bark. Can move for longer trails. VIRUSES: *Parapoxvirus ovis*. BACTERIA: *Brucella melitensis* (biotype 3), *B. abortus*, *Mycobacterium bovis*, *Dermatophilus congolensis*.

Goat (*Capra hircus*)

VIRUSES: *Flavivirus* TBE (transmission to man by milk), *Phlebovirus* RVF, *Nairovirus* CCHF, *Bunyavirus* Bhanja, *Orbivirus* Tribeč, *Lyssavirus* s.s., *Parapoxvirus ovis*. BACTERIA: *Coxiella burnetii*, *Chlamydophila abortus*, *Salmonella enterica*, enteropathogenic *Escherichia coli*, *Brucella melitensis* (reservoir), *Fusobacterium necrophorum*, *Listeria monocytogenes*, *Mycobacterium paratuberculosis*. PROTOZOA: *Trypanosoma brucei rhodesiense*, *Leishmania tropica*, *Toxoplasma gondii*.

Sheep (*Ovis aries*)

Domestic (and feral) sheep has a cosmopolitan distribution. It is a grazing herbivore. VIRUSES: flaviviruses LI and TBE (transmission to man by milk products), *Phlebovirus* RVF, *Nairovirus* CCHF, *Bunyavirus* Bhanja, *Lyssavirus* s.s., *Parapoxvirus ovis*, *P. bovis* 2. BACTERIA: *Coxiella burnetii* (competent host, reservoir), *Ehrlichia chaffeensis*, *Chlamydophila abortus* (enzootics of abortion), *Leptospira interrogans*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Campylobacter jejuni*, *C. foetus*, *Salmonella enterica*, enteropathogenic

Escherichia coli, *Bacillus anthracis*, *Brucella melitensis* (reservoir), *Francisella tularensis*, *Pasteurella multocida*, *Burkholderia pseudomallei*, *Fusobacterium necrophorum*, *Corynebacterium pseudotuberculosis*, *C. ulcerans*, *Arcanobacterium pyogenes*, *Mycobacterium paratuberculosis*, *Dermatophilus congolensis*. FUNGI: *Trichophyton verrucosum*. PROTOZOA: *Trypanosoma brucei rhodesiense*, *T. brucei gambiense*, *Toxoplasma gondii*, *Giardia lamblia*, *Cryptosporidium parvum*.

Mouflon (*Ovis musimon*)

The original area of this European species is Corsica and Sardinia (mountain grasslands), but the mouflon has been introduced into other European countries where its herds live in many game reserves and on deer farms. Herbivorous. BACTERIA: *Mycobacterium paratuberculosis*. PROTOZOA: *Toxoplasma gondii*.

African (Cape) Buffalo (*Syncerus caffer*)

Huge (up to 170 cm high; male weights up to 900 kg) herbivorous mammal living in sub-Saharan African savannah. BACTERIA: *Mycobacterium bovis*. PROTOZOA: *Trypanosoma brucei rhodesiense*.

Cattle (*Bos taurus*)

Big herbivorous domesticated ruminants with a cosmopolitan distribution. PRIONS: prion vCJD. VIRUSES: *Flavivirus* TBE (transmission to man by milk), *Phlebovirus* RVF, *Nairovirus* CCHF, *Nairovirus* Dugbe, *Bunyavirus* Bhanja, *Vesiculovirus* VSV, orthomyxoviruses Thogoto and Dhori, *Lyssavirus* s.s., *Aphthovirus* FMDV, *Orthopoxvirus* bovis, *Herpesvirus* suis 1, *Parapoxvirus* bovis 1 and 2. BACTERIA: *Rickettsia sibirica*, *Coxiella burnetii*, *Chlamydomphila abortus*, *Leptospira tarassovi*, *L. hardjoe*, *L. interrogans*, *Listeria monocytogenes*, *Bacillus anthracis*, *Clostridium difficile*, *C. botulinum*, *Staphylococcus aureus*, *Streptococcus zooepidemicus*, *Campylobacter jejuni*, *C. foetus*, enteropathogenic *Escherichia coli* (reservoir), *Salmonella enterica*, *Yersinia pseudotuberculosis*, *Brucella abortus*, *Pasteurella multocida*, *Burkholderia pseudomallei*, *Fusobacterium necrophorum*, *Corynebacterium pseudotuberculosis*, *C. ulcerans*, *Arcanobacterium pyogenes*, *Mycobacterium bovis*, *M. avium*, *M. paratuberculosis*, *Dermatophilus congolensis*. FUNGI: *Trichophyton verrucosum* (reservoir). PROTOZOA: *Trypanosoma brucei rhodesiense*, *T. brucei gambiense*, *Toxoplasma gondii*, *Sarcocystis bovihominis*, *Cryptosporidium parvum*, *Babesia divergens*. MICROSPORIDIA: *Enterocytozoon bieneusi*.

American Bison (*Bison bison*: Photo 7.72), **European Bison** (*Bison bonasus*: Photo 7.73)

The American Bison lives on the open plains of North America, while European bison in forests in Poland, Belarus, Russia, the Caucasus, and Romania. Both species are gregarious, long living (up to 30 years) and herbivorous (mostly grazing on grasses, but also feeding on the leaves of trees, twigs and other vegetation). BACTERIA: *Fusobacterium necrophorum* (Poland – lesions in male bisons), *Brucella abortus* (brucellosis – abortions) and *Mycobacterium bovis*

(bovine tuberculosis) – the latter two causing big epizootiological problems in North America, e.g. in the Greater Yellowstone Ecosystem (Wyoming), *Bacillus anthracis*.

7.2 Birds (*Aves*)

Domestic and free-living birds may be involved in the circulation of zoonotic and sapronotic microorganisms in nature generally as:

- (1) biological amplifying hosts of zoonotic microorganisms (the pathogen multiplies in/on the avian body) with an acute, chronic or latent infection, and in some cases as carriers shedding the agent for a prolonged period – such bird species may be characterized as a reservoir of infection when they ensure a long-term reproduction or survival of the agent, especially in the inter-epizootic periods;
- (2) “lessors” (Hubálek 1994) or “tenants” of some sapronotic microorganisms, by providing a substrate (droppings) suitable for reproduction of an agent. Such microbes are, e.g., fungi *Cryptococcus neoformans* or *Histoplasma capsulatum*. These fungi utilize uric acid, the main component of avian excreta, and other low-molecular nitrogen compounds in the bird droppings for their growth. Most often the lessors are bird species congregating in communal roosting sites where they produce considerable amounts of droppings.

In addition, some birds can host and disseminate ectoparasite vectors (ixodid ticks or fleas) infected with zoonotic agents such as tick-borne viruses (TBE, CCHF, Kemerovo viruses etc.) and bacteria (*Borrelia burgdorferi* s.l., *Anaplasma phagocytophilum*).

Nevertheless, domestic and free-living birds have a substantially lower significance than mammals as a primary (direct) source of human infection. Therefore they are not given here as particular species, but mostly in blocks of avian groups and only some species are listed in more details.

Colonial ardeids: egrets and herons (family *Ardeidae*; Photo 7.74)

VIRUSES: Flaviviruses JE (competent hosts, reservoir) and MVE. BACTERIA: *Chlamydophila psittaci*.

Storks (*Ciconiidae*)

VIRUSES: *Flavivirus* West Nile (White Stork *Ciconia ciconia* is a competent host: Photo 7.75).

Domestic and wild waterfowl (ducks, geese, swans; Photo 7.76)

VIRUSES: *Flavivirus* WN, *Orthomyxovirus* avian influenza A (H5N1). BACTERIA: *Chlamydophila psittaci*, *Clostridium botulinum*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Salmonella enterica* serovar Enteritidis (reservoir), *Listeria monocytogenes*, *Mycobacterium avium*. PROTOZOA:

Cryptosporidium meleagridis. OTHER EUKARYOTA: *Blastocystis hominis*, *Encephalitozoon intestinalis*, *E. hellem*.

Domestic chicken and turkey

VIRUSES: *Orthomyxovirus* avian influenza A (H5N1, H7N1), *Paramyxovirus* NDV, *Hepevirus* E. BACTERIA: *Chlamydophila psittaci*, *Campylobacter jejuni* (reservoir), *Salmonella enterica* serovar Enteritidis (reservoir), enteropathogenic *Escherichia coli*, *Pasteurella multocida*, *Clostridium difficile*, *C. botulinum*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Mycobacterium avium*. FUNGI: *Microsporium gallinae*, *Trichophyton simii*. PROTOZOA: *Cryptosporidium meleagridis*. OTHER EUKARYOTA: *Blastocystis hominis*, *Enterocytozoon bieneusi*.

Pheasant (*Phasianus colchicus*)

VIRUSES: alphaviruses EEE and WEE. BACTERIA: *Mycobacterium avium*.

Red grouse (*Lagopus lagopus scoticus*)

VIRUSES: *Flavivirus* LI.

Gulls (*Larus* spp.; Photos 7.78 and 7.79)

BACTERIA: *Chlamydophila psittaci*, *Campylobacter jejuni*, *Salmonella enterica* serovars Typhimurium and less often Enteritidis, enteropathogenic (and multiresistant) *Escherichia coli*, *Campylobacter laridis*, *Listeria monocytogenes*, *Mycobacterium avium*.

Puffin and Guillemots (*Fratercula arctica*, *Uria lomvia*, *U. algae*; Photos 7.77, 5.37).

BACTERIA: *Borrelia garinii*.

Feral pigeon (*Columba livia* f. *domestica*: Photo 7.80)

Especially feral pigeons (*Columba livia* f. *domestica*) can present a risk as hosts or lessors of several human pathogenic microorganisms. VIRUSES: *Flavivirus* SLE. BACTERIA: *Chlamydophila psittaci* (source of human ornithosis), *Coxiella burnetii* (at least 5 human cases have been described), *Salmonella enterica* serovar Typhimurium, *Mycobacterium avium*. FUNGI: *Cryptococcus neoformans* (urban pigeons as a lessor, worldwide). MICROSPORIDIA: *Enterocytozoon bieneusi*.

Wood Pigeon (*Columba palumbus*)

BACTERIA: *Mycobacterium avium* (Great Britain).

Guacharo (oilbird, *Steatornis caripensis*)

Communal breeding and roosting sites in caves, Central America. FUNGI: *Histoplasma capsulatum* (lessor).

Thrushes (family *Turdidae*)

VIRUSES: *Alphavirus* Sindbis. BACTERIA: *Borrelia garinii*, *Mycobacterium xenopi* (European blackbird).

Red-winged Blackbird (*Agelaius phoeniceus*), **Common Grackle** (*Quiscalus quiscula*), **Brown-headed Cowbird** (*Molothrus ater*)

Common North-American birds with communal roosting sites in woods and tree groves, often in urban parks. FUNGI: *Histoplasma capsulatum* (lessors).

Starling (*Sturnus vulgaris*)

Communal roosting sites in trees or in reeds, often in urban parks.

VIRUSES: *Orbivirus* Tribeč. FUNGI: *Histoplasma capsulatum* (lessor – probably only in North America).

House Sparrow (*Passer domesticus*: Photo 7.82)

VIRUSES: Alphaviruses EEE, WEE. *Flavivirus* SLE. BACTERIA: *Salmonella enterica* serovar Typhimurium, *Mycobacterium avium*, *M. xenopi*.

House Finch (*Carpodacus mexicanus*)

VIRUSES: Alphaviruses EEE and WEE, *Flavivirus* WN.

Corvids (family *Corvidae*)

VIRUSES: *Flavivirus* WN (American crow – Photo 7.81, blue jay – competent hosts). BACTERIA: *Listeria monocytogenes*, *Mycobacterium avium* (rook).

Other birds

VIRUSES: alphaviruses Sindbis (various passerines), EEE and WEE (mainly passerines), Semliki Forest, Mayaro, Ross River and Barmah Forest, flaviviruses JE (bitterns, passerines), WN (sporadically passerines, turtle dove etc.), SLE, MVE (cormorants), Bagaza, Rocio (passerines), Usutu, TBE (forest birds) and KFD, *Orthobunyavirus* Oropouche, orbiviruses Kemerovo (redstart) and Tribeč (chaffinch), *Paramyxovirus* NDV (cormorants in Canada).

BACTERIA: *Chlamydophila psittaci* (reservoir: wild birds of many species and orders), *Staphylococcus aureus*, *Borrelia garinii* (ground-foraging forest birds and sea birds), *Campylobacter jejuni*, *C. coli*, *C. laridis*, *Salmonella enterica* different serovars, *Yersinia pseudotuberculosis*, *Y. enterocolitica*, *Pasteurella multocida*.

FUNGI: *Cryptococcus neoformans* (some pet birds are “lessors”).

PROTOZOA: *Giardia lamblia*, *Toxoplasma gondii*.

MICROSPORIDIA: *Encephalitozoon hellem* (parrots, water birds), *E. intestinalis* (water birds).

7.3 Reptiles (*Reptilia*)

Ectothermic (poikilothermic) vertebrates. Their role as hosts of zoonotic agents is relatively very low.

VIRUSES: alphaviruses WEE (snakes of three genera), VEE, and Mayaro (varan *Ameiva ameiva*, iguana *Tropidurus torquatus*), *Flavivirus* OHF (lizards) and WN (alligators, *Natrix natrix*).

BACTERIA: *Salmonella enterica* – some serovars (snakes), *Borrelia hermsii* and related species (agama), *B. lusitaniae* (lizards), *Listeria monocytogenes*, *Salmonella enterica* (some serovars pathogenic for humans), *Yersinia enterocolitica*, *Mycobacterium haemophilum*.

FUNGI: *Basidiobolus* (crocodiles).

PROTOZOA: *Trypanosoma brucei rhodesiense*.

7.4 Amphibians (*Amphibia*)

Ectothermic (poikilothermic) vertebrates. Their role as hosts of zoonotic agents is very low.

VIRUSES: alphaviruses WEE (*Rana pipiens*) and Sindbis (*Rana ridibunda*), *Flavivirus* OHF (frogs) and WNV (*Rana ridibunda*).

BACTERIA: *Yersinia enterocolitica*.

FUNGI: *Basidiobolus ranarum*.

PROTISTA: *Rhinosporidium seeberi*.

7.5 Fishes (*Pisces*)

Their role as hosts of zoonotic agents is relatively very low.

BACTERIA: *Neorickettsia sennetsu*, *Yersinia enterocolitica*, enterotoxigenic *Escherichia coli*, *Salmonella* spp., *Vibrio cholerae*, *V. parahaemolyticus*, *V. vulnificus*, *V. metschnikovii*, *V. alginolyticus*, *V. harveyi*, *V. furnissii*, *V. mimicus*, *Grimontia hollisae*, *Photobacterium damsela*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Streptococcus iniae*, *Clostridium botulinum* types E and F, *C. perfringens*, *Mycobacterium marinum*, *M. haemophilum*, *M. abscessus*, *M. ulcerans*.

PROTISTA: *Rhinosporidium seeberi*.