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SOME ECOLOGICAL CRITERIA OF NATURAL FOCALITY OF MYCOTIC ZOONOSES

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Abstract. Mycotic zoonoses sensu stricto and mycotic infections acquired from animal polluted environment belong to diseases characterized by the phenomenon of natural focality. On a global scale they comprise 16 different diseases caused by yeast-like organisms, dermatophytes, dimorphous agents of systemic mycoses and primarily saprophytic fungi as well. Prevalence of mentioned diseases is influenced by a number of factors concerning not only biology and ecology of pathogenic agents and particular hosts, but also character of specific extra-animal substrates which make possible long-term maintenance or active propagation of agents in the environment. On the basis of their experience and published data as well, the authors present a survey and analysis of these factors, with particular emphasis on very frequent dermatophytozoonoses and some systemic mycoses. They pay attention to different conditions in urbanized and rural areas and to specific situations encountered by man and food producing animals in these areas. They note different ways of heterotrophy of particular agents and their association with vertebrate hosts which they divide into six ecologically different groups. The authors also characterize the environment in which a portion of saproparatrophic circulation of the agent takes place. They also give a survey of animal-connected human mycoses, which may arise due to occupational hazards.

The increasing frequency with which diseases caused by parasitic fungi occur, makes the specialists in human and veterinary medicine aware of the necessity to solve the problems of these infections in a comprehensive way. The ever-increasing trend of mycotic diseases reported both from the developing and industrially highly developed countries, has prompted the World Health Organisation to hold international consultations, as suggested by the resolution accepted at the 29th session of this organization in 1976 calling for a more intensive research of mycoses.

In our long-term studies on the prevalence of mycotic zoonoses we have arrived at the conclusion that dermatophytoses and deep systemic mycoses belong to diseases with natural focus character in the sense of E. N. Pavlovsky's theory (Pavlovsky 1939). This theory is based on the ecological analyses primarily dealing with the agents of virus, bacterial and protozoan diseases (e.g. tick-borne encephatilis, plague, tularemia, leptospiroses, leishmaniases), and may also be applied to some mycoses, e.g. adiaspiromycosis, coccidioidomycosis, certain dermatophytoses.

Among these diseases may be included not only mycotic zoonoses sensu stricto, but also mycoses acquired by man from particular types of extra-animal substrates, primarily from soil enriched with organic substances of animal origin (faeces, feather, particles of mammal hair etc). Today animal-associated human mycoses on a global scale include 16 different diseases caused by yeast-like organisms (e.g. *Candida parapsilosis*, *Cryptococcus neoformans*), dermatophytes (e.g. *Microsporum canis*, *Trichophyton verrucosum*), dimorphic causative agents of systemic mycoses (e.g. *Coccidioides immitis*, *Histoplasma capsulatum*) as well as primary saprophytic fungi (e.g. *Aspergillus flavus*, *Mucor pusillus*). Extra-human existence of the majority of these agents causing exogenic mycoses is governed by the regularities of natural focality of diseases. This fact was repeatedly presented in publications based on experiences of Czechoslovak

authors studying ecology of causative agents of adiaspiromycosis and some dermatophytoses.

In further ecological assessment mycotic diseases coming into consideration as zoonoses should be divided into two groups according to organic tropism of their causative agents: a) dermatophytoses and b) deep systemic mycoses.

Although the modes of heterotrophy of mycotic agents concerning the two groups have a number of common elements, unified moreover by alternation of saprophytic and paratrophic phases of existence of these causative agents, there are many differences among them in the basic ecological trivalent interactions (extra-animal environment—animal—man). These physiological and ecological differences define the rise and spread of particular mycoses. The ecological, epidemiological and epizootological aspects of these diseases, similarly as problems of their prevention and control, should be therefore discussed in both mentioned groups separately.

ECOLOGICAL SITUATION IN RURAL AREAS

Places of the incidence of diseases with natural focus character in rural areas should be considered as primary localities where natural foci manifest themselves in human cases of infection. In rural areas important sources of infection in the global aspect constitute pasture cattle breeding, large livestock units and dispersed small holder husbandry of food producing animals. Therefore, dermatophytozoonoses acquired from domestic animals, primarily cattle, play a dominant role.

As for the frequency of incidence, *Trichophyton verrucosum* afflicting both the grazed and stalled cattle in large-scale units, proved as the most important in the past decade in the Central Europe. Due to the predominant inter-animal transmission, primarily a close contact of a large number of animals concentrated in a limited area, is of epizootological importance. The long-term persistence of the causative agent in the environment inhabited by the animals is promoted by a considerable resistance of *T. verrucosum* to other influence.

Under conditions of small holder animal husbandry *T. mentagrophytes* may also occur, the primary source being probably synanthropic murine rodents.

The two above-mentioned dermatophytes in the rural situation are also most probably transmitted by blood-sucking or synbovine arthropods (lice, flies) (Hajsig and Žuković 1961, Dvořák and Otčenášek 1970, Koch 1964, Chmel et al. 1973).

In rural situation the infection of man and food producing animals is promoted by contact of exoanthropic, synanthropic to eusynanthropic mouse-like mammals which penetrate into human settlements and form populations there in rural homes. The winter concentrations of rodents in barns or ricks e.g. in Central Europe were observed to form foci from which infection of man with *T. mentagrophytes* is disseminated (Chmel et al. 1975, 1976). Consequently, agricultural workers employed in plant-growing, coming in close contact with straw, hay and grain contaminated by rodents, are afflicted primarily by the species *T. mentagrophytes* (77 %), while workers employed in animal production (cattle attendants) are infected with this agent to a lesser extent (28 %). This fact has been supported by data on the etiology of dermatophytoses afflicting agricultural workers tending cattle. These workers, on the contrary, are predominantly infected with *T. verrucosum* (72 %), while only 23 % of plant growing workers are afflicted with this dermatophyte (Chmel et al. 1977).

Apart from dermatophytozoonoses, other mycotic zoonoses also occur in rural conditions.

As an example of a special superficial mycosis occurring in rural areas connected with extensive pastures may serve dermatophilosis (streptotrichosis), caused by actinomycetic organism *Dermatophilus congolensis*. The agent is propagated primarily by interanimal transmission, while the animal —man transmission is rare. It has been found in the USA and Australia, where its hosts are carnivores, ruminants, primates and in some suspect cases also reptiles. Among domestic animals cattle, horses,

sheep, goats and pigs are afflicted by this mycotic zoonosis which is widespread primarily in the tropics and subtropics, but also occurs in the temperate zone. Prevalence of dermatophilosis is low, but in animal farms 20—30 % of animals may be afflicted. The disease is clinically characterized as exudative dermatitis, in dry crusts the organism remaining viable for a long time. The saprophytic occurrence of the agent in soil is not anticipated. In all probability the infection is also transmitted by arthropods. It has been demonstrated that lesions of dermatophilosis may originate in skin sites where ticks have fed (*Amblyomma variegatum*, *Hyalomma* sp.). The organism was also discovered on the legs of flies *Stomoxys calcitrans* and *Musca domestica*. Ticks of the genera *Boophilus*, *Haemaphysalis*, *Ixodes* and *Rhipicephalus* have been indicated as potential vectors (Richard and Pier 1966, Kaplan 1966, 1976, Kelley 1976, 1977).

Another affliction under rural conditions due to aerobic actinomycetes is nocardiosis caused by *Nocardia asteroides* in domestic animals and man (Otčenášek et al. 1971). The agent is supposed to exist in the soil and the soil is considered to be primary source of infection which is effected by transcutaneous route, by inhalation and ingestion. Exceptional cases occurred by bites of infected animals (Maddy 1967).

In rural conditions the activities associated with cattle pasturing may bring man to areas with endemic occurrence of *Coccidioides immitis*, *Histoplasma capsulatum*, or other agents causing deep systemic mycoses. Man becomes infected by inhalation. Also work associated with other forms of agricultural activities, or with the construction of industrial projects in endemic areas, belongs to this category.

ECOLOGICAL SITUATION IN URBAN AREAS

Urban areas should be unequivocally considered as secondary places of natural foci localization. Health risks associated with animal reservoir and vectors in urban areas are discussed in WHO materials (WHO 1977). Mycotic zoonoses occur both in the urban situation and in the suburban as well as semiurban situation. Their incidence in urbanized areas is essentially connected with animal reservoirs and substrates which promote the development of some pathogenic fungi.

The urban situation is favourable to the maintenance of dermatophytozoonoses associated with various pet animals, even in central parts (cities) characterized by a continuous agglomeration of buildings. Mantovani and Morganti (1977) state that dermatophytoses caused by *Microsporum canis* afflicting primarily young people reach 60 % in Rome, 65 % in Bologne and note the escalation of zoophilic dermatophytes as compared with anthropophilic and geophilic species. They also note a gradual increase in the prevalence since the beginning of this century. A similar situation is observed in other large cities. Although we do not know the precise localization accordig to topical classification of urban area into centre of town (city), pericentral part, residential areas and peripheral part (Rosický 1978), the percentage of human dermatophytoses caused by zoophilic agents in the general dermatophytoses infection rate is remarkable: 17 % (*M. canis* predominates) in Paris, 2.9 % in Philadelphia, 23.0 % in Berlin, 42.5 % (*M. canis*) in Brussels and 12—19 % in Rostock in different years (e.g. Kaben 1967).

In connection with the incidence of dermatophytozoonoses in urban situation the importance of the colonization of healthy cats' and dogs' hair with dermatophytes should be pointed out. Isolations of dermatophytes from apparently healthy hair of cats (n = 300) and dogs (n = 800) suggests that these mammals without any symptoms of infection, may be sources of dermatophytoses caused by *Microsporum canis* and *Trichophyton mentagrophytes* in Czechoslovakia. Animals also play another role in the circulation of zoophilic dermatophytes. E.g. enhancement of the virulence of zoophilic agent (*M. canis*) by the passage man—animal is considered to be well demonstrated (Kaplan 1967).

With the gradual transition of the urban situation into suburban and semiurban situation ecological factors similar to rural conditions come into consideration in the distribution of dermatophytozoonoses.

Epidemiologically not yet elucidated under urban conditions is the importance of consumption of meat products prepared without cooking; they may be contaminated with both the yeast and mycelial phases of *Sporothrix schenckii* (Adhearn and Kaplan 1969, Scharding et al. 1973). This fact requires further study and research, because the meat products may be potential source of infection with sporotrichosis. Under normal conditions the portal of entry for the saprozoonotic agent in human organism is most frequently the injured skin or mucous membrane. However, the infection may occur also by contact with infected animal (Lurie 1971).

In the peripheral parts of towns where private or industrial gardens or garden allotments exist the incidence of dermatophytoses caused by zoophilic species is increasing. These areas often serve as shelters or places of survival for small mammals (possible acquisition of *T. mentagrophytes*). Moreover, they serve as places suitable for the proliferation of geophilic dermatophytes (*M. gypseum*) known as causative agents of occupational dermatophytoses of gardeners (Otčenášek et al. 1973).

Another source of dermatophytoses in urban and suburban situation are colonies of laboratory animals or places for breeding pet animals. By contact with them man may became infected with *M. canis*, *T. mentagrophytes*, *M. equinum* etc. (Otčenášek et al. 1962, 1974, etc.).

Potential foci of dermatophytoses may be colonies of exotic animals raised in zoological gardens or animal rooms (Saëz et al. 1977).

In urban situation primarily histoplasmosis and cryptococcosis may be considered among deep systemic mycoses. Classical cases of histoplasmosis incidence in towns were observed primarily in the past 15 years in Mason City (Iowa), Mexico (Missouri), Washington, D. C. An outbreak of histoplasmosis in urban areas is connected with the so-called "point-source" of infectious agent. Point sources are influenced by the presence of droppings of domestic fowl, starlings and bats. Workers cleaning old buildings, hen houses etc. are exposed to infection. Also a connection was revealed with the nesting places of bats in houses. In recent years a number of epidemies has been observed in urban areas where people working in their gardens use bird droppings or bat guano as fertilizers.

Outbreaks of histoplasmosis in urban areas are considered to be due to interference with the original areas and to liquidation of trees and structures inhabited by birds. Such activities cause the interference with the original natural foci and to the increase of histoplasmosis cases. Urbanization consequently enhanced outbreaks of histoplasmosis in areas where it had never been observed before (Murray et al. 1957, Smith and Furcolow 1964, Larsh 1970).

The incidence of cryptococcosis is considered to be due to pigeon breeding on one hand and to the ever-increasing number of half-wild (synanthropic) pigeons in towns on the other (Littman and Borok, 1968). Pigeon droppings constitute a substrate promoting long-term maintenance of *Cryptococcus neoformans*. The concentration of pigeons and of some species of synanthropic turtle-doves as well thus becomes a potential source of human cryptococcosis for urban inhabitants.

In rural as well as urban areas occupational hazards may arise. Well-known are occupational mycotic zoonoses with proved exposure to direct animal source or occupational zoonoses caused by contact with environment enriched with animal material (less frequently by direct contact with the infected animal). They are the following professional activities:

Manipulation with laboratory animals (mice, rats, guinea pigs, rabbits) and handling these animals in breeding colonies. Agent: *Trichophyton mentagrophytes* (var. *mentagrophytes* and var. *quinckeanum*).

Activities connected with the breeding, transportation and slaughter of cattle. Agent: *T. verrucosum*. In Central European countries the dominant occupational zoonoses are trichophytoses, acquired by contact with infected animals, accounting for about 85 % of all cases of trichophytosis. Some non-occupational cases involve children and adults, and are caused by indirect contact with animal source of infection.

Activities connected with horse-breeding and use of horses in agriculture and sport. Agent: *Microsporum equinum* and *T. equinum*. Activities with working dogs. Agent: *Microsporum canis*.

Activities connected with pigeon-breeding. Agent: *Cryptococcus neoformans*.

Activities of speleologists and archeologists in contact with contaminated soil, activities of tunnelers, other labourers in contact with contaminated soil and substrates in poultry farms. Agent: *Histoplasma capsulatum*.

Contact with contaminated soil due to archeologic and geologic activities, due to work of bulldozer-operators etc. Agent: *Coccidioides immitis*.

All above-mentioned causative agents may infect laboratory workers while experimenting with infected animals.

Occasional cases of occupational infection are caused by *Sporothrix schenckii* due to animal bite (Lurie 1971).

Also exotic animals kept in zoological gardens, animal rooms and safari zoological parks may be sources of occupational dermatophytoses in man. E.g. infection caused by *Microsporum canis* spreading chain-like after the schema:

tiger —┤——→ man ——→ jaguar ——→ mule deer
       └——→ zebra —→ sheep ——→ man ——→ Persian cat

(Kuntze et al. 1967).

RESERVOIR ANIMALS

In the etiology of skin afflictions and their appendages, caused by dermatophytes transmissible from animals to man, primarily zoophilic species play an important role. Unlike geophilic dermatophytes (whose basic substrate of heterotrophy is soil), they are organisms basically adapted to parasitism on animals. They spread from animals to man by direct contact, less often through mediator. Unlike anthropophilic species closely specialized to parasitism on man, the group of zoophilic dermatophytes includes some causative agents with a relatively wide host spectrum (*Microsporum canis*, *Trichophyton mentagrophytes*). However, even dermatophytes with a wide host spectrum have a main host, representing the most frequent source of infection for man.

Zoophilic species of dermatophytes are connected with several categories of the main hosts:

1. Wild (exoanthropic) mammals inhabiting ecosystems intact by man as well as particular ecosystems associated with urban areas considerably modified by man. This group includes e.g. *Microsporum persicolor* and *Trichophyton mentagrophytes* var. *mentagrophytes*, which can be designated according to their specifity to hosts as mysophilic, or *T. mentagrophytes* var. *erinacei* from hedgehogs as echinophilic (Otčenášek, and Dvořák 1975). E.g. English and Southern (1967) reported from England that 53 % *Clethrionomys glareolus*, 25 % of *Microtus agrestis* and 19 % of *Apodemus sylvaticus* were infected with *M. persicolor*. Chmel et al. (1975) state that in Slovakia small mammals *C. glareolus* (6 %) and *Sorex araneus* (6 %) are infected with the dermatophyte *T. mentagrophytes* var. *mentagrophytes*.

Different susceptibility of small mammals to dermatophyte infection (*T. mentagrophytes*) was also demonstrated experimentally. Sharapov (1974) divides such hosts into three groups: a) susceptible and sensitive (*Arvicola terrestris*, *Microtus arvalis*, *M. oeconomus* and *Mus musculus*) b) susceptible and of low sensitivity (*Clethrionomys rutilus*, *Micromys minutus*) and c) resistant (*Apodemus agrarius*, *Citellus* sp.).

2. Synanthropic mammals, i.e. those species which regularly inhabit human settlements and houses where they form permanent or intermittent, independent or semi-independent populations. Their occurrence is associated with the same causative agents as in the group of wild mammals. The epidemiological importance consists in the close contact of synanthropic mammals (mice, rats, bats, opossums etc.) with man in his dwellings and agricultural or industrial buildings.

3. Domestic food producing animals may be a serious source of dermatophytozoonoses for man. This group includes primarily cattle afflicted with the tauriphilic dermatophyte *Trichophyton verrucosum*. The distribution of this causative agent is cosmopolitan,

promoted by frequent transportation of different breeds of cattle. Geographically much more restricted is the occurrence of the susiophilic dermatophyte *Microsporum nanum* afflicting domestic pig in some regions.

4. Companion animals with which man comes in close contact, such as recognized household pets and saddle horses. Cats and dogs are source of ailurophilic species *Microsporum canis* (Otčenášek et al. 1974) whose prevalence in some large cities tends to increase. E.g. up to 90 % of human dermatophytoses caused by *M. canis* originate by contact with infected cats (Baxter 1973). An important role in the epidemiology here is played by the carrier state (Kaplan 1967). Infection contracted from saddle horses or in some countries from draft horses is caused by hippophilic dermatophytes, *Microsporum equinum* and *Trichophyton equinum* (Otčenášek et al. 1964). Some rodents kept as pets (white mouse, guinea pig) may also become source of dermatophytes *T. mentagrophytes* var. *mentagrophytes* and *T. mentagrophytes* var. *quinckeanum.*

5. Laboratory and fur-bearing animals are an important group from the ecological aspect in the dissemination of dermatophytozoonoses. Cases of occupational infection caused by the dermatophyte *Trichophyton mentagrophytes* var. *mentagrophytes* were recorded (Alteras 1965).

6. Birds. Apart from mammals which make up the most important group among animals serving as reservoirs or shedders of causative agents of dermatophytozoonoses, also birds may play a certain role. Among them the most significant are gallinaceous birds which are a source of the ornithophilic dermatophyte *Microsporum gallinae.* Other bird hosts are also sporadically afflicted with different dermatophyte species (Alteras and Cojocaru 1970, Hubálek 1974 etc.).

The epizootology and epidemiology of a dermatophytozoonosis, however, are not only determined by the association with a particular species of animal reservoir (shedder). Complex relationships influenced by a number of factors play a role here. As main factors determining the occurrence of zoophilic dermatophytes in man may be considered as follows: a) geographic distribution of particular dermatophyte species and their hosts, b) prevalence of infection in animals, c) affinity of different dermatophyte species to man, d) possible various forms of indirect transmission, e) possible exposure of human beings and f) their immunological state with regard to the agent (English 1972).

In the ecology of deep systemic mycoses mammals and birds play a more complex role. According to their relationship to the mycotic agent causing deep systemic infections mammals and birds may be divided into two groups:

The first group is characterized by a longterm maintenance of the paratrophic phase in the host and continuous recontamination of soil promoted by the release of this phase from the host's body e.g. adiaspores of the species *Emmonsia crescens* and spherules of *Coccidioides immitis* in the wild (exoanthropic) small mammals.

The recontamination of extra-animal environment by animals is also taken into consideration, and not without reason, as regards *Blastomyces dermatitidis* (dissemination of the yeast phase by bats).

Wild small mammals afflicted with coccidioidomycosis may play a role both in the above mentioned recontamination of soil and partly in the dispersal of the causative agent. There exist exact proofs of soil contamination from dead bodies of infected animals (Maddy and Crecelius 1967). The non-infectious spherule which gets into soil, is very resistant to the conditions of fluctuating temperature and humidity. It can survive several months without nutrients and under favourable conditions it can give rise to the infectious mycelial phase.

In the epidemiological studies of American authors dealing with the regional distribution of *C. immitis* in soil, the association with the occurrence of rodents of the genera *Perognathus, Dipodomys* and *Citellus* (*P. baileyi, P. intermedius, D. penicillatus, D. meriami, C. leucurus*) is pointed out.

Specific association with biotopes inhabited by these rodents, however, is not absolute. *C. immitis* was found even in soil of regions where these mammals do not live (Maddy 1959).

Another example of the dissemination of parathropic phase of dimorphic causative agents of deep systemic mycoses in nature is the circulation of *Emmonsia crescens*, in which an important role is played by free-living mammals belonging to the orders Insectivora, Edentata, Lagomorpha, Rodentia and Carnivora. Specific here is the trophic relationship of carnivores as predators to their prey. Carnivores namely facilitate the release of the elements of parathropic phase—the adiaspores, from the lungs of the prey, into environment. In this way they play an important role in the spread of infection even over small distances. Carnivores also play an important role in the dissemination of *E. crescens* into the vicinity of human dwellings and in the rise of new elementary foci of infection (Dvořák et al. 1973).

Some small wild mammals apparently also play a role as mechanical carriers of the saprotrophic phase of the fungus. This is evidenced by findings of the mycelial (conidial) phase of *E. crescens* on the hair of voles (Sharapov 1972).

The second group of mammals and birds plays an indirect role in the ecology of agents causing deep systemic mycoses. The members of this group enrich extra-animal substrates, primarily the soil, with their droppings supplying important substances for the nutrition of the agent in question. As an example may serve the excrements of pigeons, which are important for the survival and further proliferation of *Cryptococcus neoformans*. Droppings of bats and some birds play a role in the long-term maintenance of *Histoplasma capsulatum* in extra-animal substrates. This group of "shedder animals" thus directly determines the location of point sources of these mycoses. E.g. 35 species of mammals (Marsupialia, Insectivora, Chiroptera, Primates, Rodentia, Carnivora, Perissodactyla, Artiodactyla) are known to be spontaneously infected with histoplasmosis (Otčenášek et al. 1967a).

Hence it follows that in the ecology of agents causing deep systemic mycotic zoonoses the basic role is played by wild animals (mammals and birds) which facilitate the saproparatrophic circulation of the agent by releasing elements of paratrophic phase into the environment. In the extra-animal environment the paratrophic phase is then converted into saprotrophic phase, and its active proliferation continues in the soil. On the other hand, domestic animals, e.g. pets (dogs), cattle etc. are mostly the final blind alley in the development of the mentioned causative agents. The importance of the release of elements of the paratrophic phase in their sputum and feces in the environment is not yet clear.

PATHOGENIC FUNGI IN THE ENVIRONMENT

The soil constitutes a basic substrate for the existence of some dermatophytes because both the imperfect (conidial) and perfect (sexual, ascosporic) phases of these agents develop in it. Small mammals play a role as selectors of pathogenic mutants of dermatophytes. Moreover, they promote their dissemination from free nature to human dwellings. Most cases of infection in small mammals run their course in quite inapparent forms. This carrier state, however, may change into an interaction of another type, if the agent comes in contact with a susceptible host, the food-producing animal or man. A number of isolated strains of geophilic dermatophytes in experiments on guinea pigs, proved to be fully virulent and capable of causing skin lesions (Otčenášek et al. 1967b).

The role of small mammals in the ecology of dermatophytes also consists in the fact that they enrich the soil with keratin materials during periodic shedding of hair, biting their hair off, or shedding hair while rubbing their coats in the terrain etc. This is evidenced by the mosaic-like occurrence of dermatophytes in the soil, primarily in places containing keratin material of animal origin. Samples collected from the burrows, nests and the vicinity of feeding troughs etc. contain three times as many dermatophytes than the samples taken elsewhere.

Zoophilic dermatophytes comprised in the infected particles of hair and in the epidermal scales which have passed into the environment from infected animal, may survive in the soil for a relatively long time and preserve their infectivity, but unlike the geophilic species they are not able to proliferate actively in the soil environment.

Microsporum gypseum, though a distinctly geophilic species, may also assert itself as a causative agent of zoonoses. Despite the fact that its typical natural habitat is the soil, it is rather domestic animals that are the source of human infection caused by this agent. In recent years the number of cases of human dermatophytoses caused by *M. gypseum* and acquired from animals have been increasing. They predominate over the number of cases of *M. gypseum* dermatophytoses where soil has been demonstrated as source of infection (Kelley and Mosier 1977).

The factors influencing the occurrence of agents causing deep systemic mycoses in the soil and extra-animal substrates were discussed above. Point sources of agents causing deep systemic mycotic zoonoses include the soil contaminated with bird droppings or bat guano (classic histoplasmosis), the soil contaminated with pigeon droppings (cryptococcosis), the desert soil mostly from rodent burrows (coccidioidomycosis).

In case of blastomycosis the relationship to the occurrence of causative agent in the environment is not sometimes elucidated concretely. E.g. the isolation of *Blastomyces dermatitidis* from soil samples collected from a rabbit pen, from a mule's stable and from other places serving as animal shelters (Denton and Di Salvo 1964).

The dissemination of agents causing deep systemic mycotic zoonoses may also take place without the direct participation of reservoir animals. Mycotic agents may get disseminated from the soil in relevant elements (arthrospores, aleuries etc.) by aerogenous way, less frequently by water, plant material etc. Distribution by dust and river water has been demonstrated primarily in case of *Coccidioides immitis* (Swatek et al. 1967). *Histoplasma capsulatum* is known to have been transported by river water, in which the spores can remain viable as long as 600 days (Ajello 1967). The occurrence of *C. immitis* in arid regions is associated with xerophilic plant communities with creosote bush (*Larrea tridentata*) as indicator. The association with plant communities has been also demonstrated with the species *Sporothrix schenckii*, which manifests a specific relationship to mosses of the genus *Sphagnum* (D'Alessio et al., 1965). The role of rhizosphere, which is being considered e.g. with the soil saprotrophism of the fungus *Emmonsia crescens* (e.g. Sharapov 1972) is not yet elucidated to the full.

Among environmental factors the saprophytism of pathogenic fungi in soil is affected mainly by the following components: a) macro- and microscopic soil flora and fauna, b) temperature, humidity, precipitation, direction and velocity of wind, type, pH, chemical properties of soil and content of organic substances in it (Maddy 1967).

НЕКОТОРЫЕ ЭКОЛОГИЧЕСКИЕ КРИТЕРИИ ПРИРОДНОЙ ОЧАГОВОСТИ МИКОТИЧЕСКИХ ЗООНОЗОВ

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Резюме. Микотические зоонозы в узком слова смысле и микотические инфекции приобретенные в загрязнённой животными окружающей среде имеют характер заболеваний, для которых типично явление природной очаговости. В мировом масштабе они насчитывают 16 разных заболеваний, вызываемых дрожжеобразными организмами, дерматофитами, диморфными возбудителями системных микозов и первично сапрофитными грибками. Распространённость упомянутых заболеваний обусловлена рядом факторов, касающихся не только биологии и экологии патогенных начал и отдельных хозяев, но и характера специфических внеживотных (экстраанимальных) субстратов, способствующих длительное сохранение или даже активное распространение возбудителей в окружающей среде. На основании опыта авторов и литературных данных представлены обзор и анализ этих факторов, исходя из знаний по часто встречающимся дерматофитозоонозам и некоторым системным микозам. Авторы подчеркивают различие между условиями в городских и сельских ареалах и специфичность ситуаций, в какие попадают сельско-хозяйственные животные

и сам человек. Особое внимание авторы уделяют различным способам гетеротрофии отдельных возбудителей и их приуроченности к позвоночным хозяевам, которых подразделяют на шесть экологически разных групп. Авторами затем дана характеристика окружающей среды, в которой происходит часть сапропаратрофической циркуляции патогенного начала. Представлен также обзор связанных с животными микозов человека, с риском профессионального заболевания.

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