

Zoonoses as occupational diseases

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Summary

Zoonoses are discussed as occupational diseases, with special reference to animal husbandry and related activities. After quoting some historical references, occupational zoonoses are examined in relation to the evolution of the concept of occupational zoonosis, the involvement of the World Health Organization in this field, their socio-economic significance, the principal working activities, zoonoses of greatest importance (with special reference to the Mediterranean region), the evaluation of damage and risks. An outline is made of the transmission of zoonoses from farm workers to animals and the biological hazards from the environment. The present situation of occupational zoonoses and related risks in industrialised and traditional farming activities are presented and the importance of some emerging and re-emerging zoonoses for the health of workers is highlighted. The author concludes by stressing that the prevention of occupational zoonoses must be implemented jointly by both veterinary and medical services through preventive measures and epidemiological surveillance of human and animal health, risk evaluation, diagnosis of infections and prompt reporting. It is hoped that the future will offer better inter-disciplinary collaboration and that legislation will be timely and better tailored to safeguard working health and safety.

Keywords

Animal, Animal husbandry, Disease, Health, Occupational disease, Public health, Veterinary public health, World Health Organisation, Zoonosis.

Le zoonosi come malattie occupazionali

Riassunto

Vengono discusse le zoonosi come malattie occupazionali, con particolare riferimento alle attività zootecniche e correlate. Dopo alcuni riferimenti storici, le zoonosi occupazionali vengono trattate nei seguenti punti: l'evoluzione del concetto di zoonosi occupazionale; il coinvolgimento dell'Organizzazione Mondiale della Sanità sull'argomento; la loro importanza socio-economica; le attività lavorative maggiormente interessate; le zoonosi di maggiore interesse (con particolare riferimento al Mediterraneo); la valutazione dei danni e dei rischi. Vengono presi in rassegna brevemente anche la trasmissione di zoonosi dagli addetti degli allevamenti agli animali ed i pericoli di natura biologica di origine ambientale. Vengono sottolineate la situazione attuale delle zoonosi occupazionali e dei rischi correlati in attività zootecniche di tipo intensivo e in quelle di tipo tradizionale, nonché la possibile importanza di alcune zoonosi emergenti e riemergenti per la salute dei lavoratori. L'autore conclude sottolineando che la prevenzione delle zoonosi occupazionali deve essere condotta congiuntamente dai servizi veterinari e dai servizi medici, attraverso la prevenzione e la sorveglianza epidemiologica della sanità animale ed umana, la valutazione dei rischi, la diagnosi delle infezioni e la loro rapida segnalazione. Per il futuro, si auspica che migliori la collaborazione interdisciplinare e che la legislazione si adegui prontamente alle necessità di tutelare la salute e la sicurezza del lavoro.

Parole chiave

Animale, Malattie, Malattie occupazionali, Organizzazione Mondiale della Sanità, Sanità, Sanità pubblica, Sanità pubblica veterinaria, Zoonosi, Zootecnia.

Introduction

Humans must have very soon become aware of the dangers linked to contacts with animals. The first known form of activity, hunting, especially of large mammals as practised in the Palaeozoic era, was certainly a hazardous occupation. In addition, the harvesting of crops and the exploitation of animals for food were also hazardous and those involved in these activities would surely have individually or collectively experienced the risks connected with obtaining such food. It can be hypothesised that any form of human occupational relationship with animals has been associated with specific diseases. Traumas of varying degrees of severity (sometimes even fatal) could result from hunting and pasture activities with the first partially domesticated animals. It should be remembered that in those early times, hunters and breeders were also consumers in that they ate hunted or reared animals and this involved the handling of (i.e. contacts with) the food that was prepared. One of the factors considered when selecting animals to be domesticated was certainly docility, i.e. the limited risk in the human-animal relationship and one of the goals of domestication was the taming of the animal, diminishing (and, if possible, eliminating) the risks involved. As activities developed, so did specialisations and surely also diseases connected thereto. No documentation is available in this specific area.

Occupational zoonoses

A glance at the past

Even before the concepts of *infection* and *zoonosis* were clarified, the possibility of transmitting diseases from animals to humans was confirmed by the observation that diseases affected people who tended animals or those who had contact with animals and animal products (4, 8).

It is possible that a link was established between the type of work and contacts with animals and diseases, but such records were probably lost or destroyed in time. Some authors suggest that humans approached cattle for food in the Neolithic era and that the first evidence of human tuberculosis can be traced back right to this period.

The first recognised zoonoses with an occupational relationship were those with apparent skin lesions and short incubation periods, such as ringworm infections (dermatomycoses, defined as 'scabies'), cutaneous anthrax and glanders. An obstacle to the identification of some occupational zoonoses could have been their long incubation periods (e.g. tuberculosis and cystic echinococcosis) and/or the fact that the lesions caused are internal and evolve slowly (e.g. cystic echinococcosis, tuberculosis and deep mycoses). Another obstacle might have derived from the fact that contacts with animals were part of everyday life, thus making it difficult to classify them as a risk factor. Some zoonoses were probably included in a category of diseases now defined as 'malaria complex' and 'flu complex' (e.g. brucellosis and Q fever) and others confused with leprosy (e.g. erysipelas, cutaneous anthrax and dermatomycosis by *Trichophyton verrucosum*).

Anthrax, glanders and scabies (dermatomycoses?) are the infections most cited in historical references, and in the 19th century they were recognised as being occupational disease. It should be pointed out that the first case of compensation for an occupational zoonosis was in 1828, when Francis Bourbon I, King of the Two Sicilies, granted a life pension to a stableman who contracted scabies along with another two stablemen while tending infected dromedaries.

The two diseases that first led to the concept of occupational zoonosis (and, together with rabies, to the concept of 'zoonosis') are anthrax and glanders. The categories of workers that have historically been reported as being at higher risk of contracting such infections are listed below.

Anthrax

Anthrax (especially linked to direct contact with sick animals, carcasses, hides, horsehair and wool) affected workers processing hides, hairs and wool (tanners, manufacturers of related products, shearers, carders, furniture makers, etc.), sellers of products of animal origin, butchers, skinners, ragmen, coachmen, paper manufacturers, shepherds and veterinarians.

Glanders

Glanders (especially linked to activities with infected, dead or live equine animals) affected butchers, carters, farmers, farriers, riding instructors, stablemen, soldiers serving in the cavalry or in contact with equines and veterinarians.

Evolution of the concept of zoonosis

The interest in occupational zoonoses was initially devoted to modes and routes of infection and only later to control measures and to workers exposed to greater risk (sometimes also involving their families). Only later was the focus extended from zoonoses, identified in time in ever-increasing numbers, to all diseases connected with activities linked to animals (domestic, wild, synanthropic, experimental), to their living and breeding environments and to the processing of their products. These pathologies include allergies (e.g. to environmental dusts, mites and moulds of foods and feeds), intoxication (e.g. contact with or ingestion of chemicals, etc.), traumas and wounds.

Over the years, the conviction has gained ground, at least at the ideological level, that animal health, human health and economics represent three fundamental, inseparable pillars of a modern, efficient and 'healthy' animal husbandry. Working places physically, chemically and biologically unfit for humans are also unfit for farm animals, with negative (often serious) socio-economic consequences for the individual, industry and consumers. Accordingly, the prevention of occupational diseases (among which those of veterinary

interest, such as zoonoses) is not only an instrument designed to safeguard workers but is also a indicator of the preservation of quality-quantity in relation to animal production and of a balanced and healthy human-animal-environment relationship. Only recently, at least in Italy, was the prevention of occupational risks taken into account by legislation (5), despite the fact that some zoonoses of livestock are of noticeable socio-economic importance.

Occupational zoonoses and the World Health Organization

The involvement in veterinary public health (VPH) by the World Health Organization (WHO) commenced when the organisation was founded in 1948 and has developed over the years in cooperation with other international organisations. Among the many initiatives, documents and expert meetings promoted by the WHO, mention must be made of some events that are believed to be fundamental in the field of occupational diseases in animal husbandry and related activities, since they have strongly fostered the assignment of prevention and surveillance of these pathologies to the competence of VPH.

In 1975, a meeting of VPH experts, organised by the WHO and Food and Agriculture Organization (FAO) WHO (12) recognised zoonoses and traumas caused by different species of animals as occupational risks and stressed the need for specific knowledge to ensure they were prevented and controlled.

In 1977, the WHO convened an expert consultation on some VPH problems at the *Istituto Superiore di Sanità* (ISS) in Rome, during which occupational diseases were discussed and a recommendation on the 'protection of workers at special risk to zoonoses' was made (6).

In 1982, a WHO meeting on bacterial and viral zoonoses (13), following the suggestion made by Calvin W. Schwabe (9), classified the occupational groups and populations at high risk of zoonotic infection and the zoonotic infections that represented a high risk to different occupational groups and populations.

In 1988, an international conference organised to celebrate the 900th anniversary of the University of Bologna, with the participation of many WHO members, devoted a section to problems associated with occupational hazards, especially those linked to cattle farming in the Mediterranean region (2).

A chapter on the control of occupational disease hazards in animal industry was included in the guiding principles for VPH programmes published by the ISS, WHO, FAO and the *Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise 'G. Caporale'* in Teramo in 1990 (7).

A more recent event is the meeting of the WHO expert group convened in Teramo in 1999 to discuss the future of VPH in the 21st century, with the participation of the FAO and the World Organisation for Animal Health (*Office International des Épizooties*: OIE). The issue of occupational diseases in relation to work with animals and their products is included both in the final document (15) and in the working contributions, since it is considered an emerging component of the VPH competences and activities.

The WHO/OIE *Manual on echinococcosis* (14) discusses occupational risks and dedicates a special chapter to people and animals involved in transhumance (seasonal movement of livestock to new pastures).

Socio-economic significance

In 1975, the FAO/WHO Expert Committee on VPH classified zoonoses as follows (12):

- zoonoses that have serious effects on animal production
- zoonoses that have serious consequences both for humans and for economically important animals
- zoonoses that have serious consequences for humans, but which are much less serious in economically important animals.

This classification indicates both the health and the economic significance of zoonoses, thus stressing the fundamental importance that some of these may have upon farm management and economics. Many zoonoses that are possibly associated with occupational

activities (e.g. brucellosis, bovine tuberculosis, anthrax, dermatomycoses and leptospirosis) belong to the first two categories.

Humans

In humans, zoonoses (in general occupational diseases) may have various consequences, including the following:

- cost for diagnosis of the disease
- medical fees and costs of hospitalisation, nursing and drugs
- loss of working days or 'production'
- mortality
- suffering and social consequences of disability
- abandonment of farming or agricultural activities by affected or at-risk persons.

It should be noted that some of the above consequences are difficult to evaluate from an economic point of view and others can be mainly or exclusively evaluated in social terms. It has been observed that some zoonoses (e.g. cystic echinococcosis) may negatively affect the 'quality' of life and that the affected patients have a higher unemployment rate in comparison to the general population (11).

Livestock

In livestock, the following negative consequences of zoonoses must be considered:

- reduced yield and quality of animal production (meat, milk, wool, eggs, labour)
- reduced birth rate and fertility
- delayed performance and growth
- in some cases, condemnation of organs and costs for destruction of viscera and/or carcasses.

There are also other possible indirect detrimental consequences, such as bans on the export of animals and their products if these are required to be free of certain infections. In livestock, the importance of the above-mentioned economic consequences will depend, to a large extent, on the characteristics of the animals or on the farming or livestock industry, and on the legislative rules of each country (e.g. compulsory condemnation and destruction of organs at slaughter).

In some cases, occupational zoonoses and related problems may exert a heavy impact on

the social status of individual families and communities, especially in areas where they are highly endemic in animals, where the prevention of occupational hazards is underestimated or completely ignored and where technical assistance to farmers and stockholders and control plans are insufficient or even absent.

Work and risks

Several occupational diseases exist that possibly involve staff working in animal husbandry and related activities (1, 3). Figure 1 shows breeding and related activities, with special reference to those exposed to biological hazards. Regarding proper (*sensu stricto*) zoonoses, they may affect many occupational categories, first of all farmers, personnel working in abattoirs and those processing products of animal origin (5, 9, 10, 13). The same applies to some workers who do not work directly in the above sectors but who share frequent contacts with living animals or their carcasses (e.g. firemen) or those who come into contact with faeces or urine present in the environment (e.g. tyre repairers). Some hundreds of such diseases are known, but those of primary importance, at least in countries equipped with efficient health services and plans, are far less numerous. Table I lists the main zoonotic diseases

involved in animal husbandry and related activities. Table II provides a list of the occupational zoonoses of major socio-economic importance in the Mediterranean region, with reference to farming and slaughter activities. It must be remembered that, occasionally, the use of live vaccines (e.g. brucellosis strain 19 and Newcastle disease) may prove infectious for the operators.

The probability of coming into contact with zoonotic agents during work depends on a large variety of different factors, such as the health status of the animals (dependent on control programmes), the type of activity of the worker, the frequency of contacts with live animals, their carcasses and organs, the type of individual and environmental preventive measures taken and the level of professional training/information on risks. The consequences of such contacts may be different and can essentially depend on the immunological status and general health conditions of the person, on the timeliness and accuracy of diagnosis in case of disease and on the therapeutic and rehabilitative activities implemented. Special attention has to be given to immunocompromised workers given their higher risk of contracting occupational infections (e.g. toxoplasmosis and cryptosporidiosis).



Figure 1
Animal husbandry and related activities, with special reference to those exposed to biological hazards

Table I
Principal zoonoses encountered in animal husbandry and related activities (in alphabetic order)

Agent	Zoonosis	
Viruses and prions	Avian flu (in particular farming conditions)	
	Bovine spongiform encephalopathy and other animal transmissible spongiform encephalopathies	
	Contagious ecthyma	
	Newcastle disease	
	Rabies	
	Rift Valley fever	
	Tick encephalitis (tick-borne encephalitis)	
	Bacteria	Anthrax
		Bovine tuberculosis
		Brucellosis
Chlamydiosis (avian strains)		
<i>Helicobacter pylori</i> infection		
Leptospirosis		
Tetanus		
Q fever		
Salmonellosis		
<i>Streptococcus suis</i> infection		
Swine erysipelas		
Fungi	Cryptococcosis	
	Dermatomycoses	
	Histoplasmosis	
Protozoa and metazoa	Cystic echinococcosis (<i>Echinococcus granulosus</i>)	
	Cryptosporidiosis	
	Larval ascariidosis (<i>Toxocara canis</i>)	
	Toxoplasmosis	

It is important to note that epidemiological data needed to evaluate the occupational risks posed by many zoonoses, despite the importance attributed to them, are most often insufficient. For instance, the data on notified cases are often very different from those on cases that have really occurred or have been diagnosed.

It should be remembered that risk (R) is considered as the product of the probability (p) an infection has of occurring (incidence) within a given period of time by the negative consequences, i.e. the damage (D) associated with it ($R = p \times D$). If the probability cannot be

Table II
Occupational zoonoses of major socio-economic importance in the Mediterranean region, with reference to farming and slaughter activities (in alphabetic order)

Disease	Main sources of occupational infection
Anthrax	Hides, wool, infected carcasses
Bovine tuberculosis	Live cattle and their organs
Brucellosis	Live ruminants and their viscera
Cystic echinococcosis	Dogs, pastoral environment
Dermatomycosis	Live rabbits, beef cattle, cats, dogs
Leptospirosis	Live pigs and their viscera, biological refuse from farms
Q fever	Live sheep and goats, environment in which infected animals and ticks are present
Tetanus	Environment in which animals are present

evaluated, the risk cannot be assessed either. This means that workers are not correctly informed about the probability of coming into contact with different transmissible and potentially dangerous agents. They need to be familiar with the application of specific defence measures. In the majority of cases, therefore, only information can be provided on 'dangers' rather than on 'risks' of a biological nature. Furthermore, when cases of zoonoses occur in humans (that are often not diagnosed), the causative agent must be recognised as being associated with the execution of the working activity so that the diseases can be shown to be linked to the profession and, hence, to deserve insurance compensation. The demonstration of this association is often complex and verifiable (not always) only through very accurate epidemiological investigations. As a result, in the absence of recognition of many zoonoses as work-associated infections, their number will certainly be underestimated. It may sometimes be difficult to prove if an infection is occupational in workers who own their own animals.

In some countries, occupational diseases are covered by special legislation and are considered by insurance company policies.

Transmission of zoonoses from farm workers to animals

Farm workers may be carriers of disease agents which can be transmitted to animals. For instance, human tuberculosis may be caused by *Mycobacterium bovis* or by *M. tuberculosis*. In the first case, farm workers with open tuberculosis can transmit the disease to cattle. In the second case, a farm worker with open tuberculosis may cause tuberculin sensitisation in cattle. In both cases, the disease of farm workers interferes with control programmes by introducing the infection or simply by sensitising the animals. If farm workers with *Taenia saginata* or *T. solium* defecate in places accessible to cattle or pigs, respectively, may infect the animals with cysticercosis. The problem of transmission of diseases to animals by farm workers requires further research. Agents that may be involved in this form of transmission are, for example, staphylococci, streptococci and salmonellae.

Biological hazards from the environment

Some environmental conditions may influence the presence and spread of biological agents. Some animal husbandry and para-husbandry industries can pollute waters and other environmental elements with by introducing various materials, thus causing the creation of cultural media that are suitable for the growth of microbes, possibly including pathogens. It was observed that the dispersal in the environment of debris, such as hair, skin scales, droppings and other organic matters is necessary for the growth in the environment of certain pathogens (e.g.: *Clostridium tetani*, *Cryptococcus neoformans*, *Histoplasma capsulatum* and *Microsporium gypseum*); it may also establish conditions that might be suitable for the growth of other pathogens that find their site of natural development in animals and/or humans (e.g. *Salmonella* spp., *Escherichia coli*).

Other agents (e.g. *Bacillus anthracis*) develop in animals and may be spread in environment which, in turn, may infect humans or animals. The metabolites of some species of mould, often present in dust on farms, cause typical lung diseases (e.g. 'farmer's lung') which can, in some cases, lead to lung fibrosis, a serious disease that creates a pre-cancerous condition.

Conclusions

The application of preventive veterinary medicine, such as abattoir inspections, diagnostic tests, prophylaxis using vaccines, farm hygiene and control programmes, has largely modified the occurrence of biological hazards in animals and their impact on humans.

In countries with industrialised farming activities, changes have occurred in the role played by animals, in farming techniques and in the types of animal-human contacts; these have influenced the epidemiology of occupational pathology and have led to the gradual decrease in the number of diseases associated with traditional animal and food production cycles and techniques. As a result, they have contributed to the reduction or disappearance of some biological risks for workers involved in farming or related activities. Relevant examples include the almost total disappearance of exploitation of animals for work (draught, etc.), the introduction of machine milking or the marginalisation of horses to sporting activities due to the advent of agricultural, military and transport motorisation. As an example, glanders has become extinct in many areas not only due to the enforcement of veterinary police regulations but also to the disappearance of large concentrations of equines in the army and in civil transport.

New activities and technologies have generated new zoonotic and occupational risks. Examples are sensitisation to certain drugs, allergic alveolitis due to organic dust, transmissible encephalopathies, dermatomycoses in intensive farming, mainly of beef cattle and rabbits.

In countries that exercise traditional/family farming activities, these changes have not generally been observed and many social reasons favour the occurrence of some endemic zoonoses and occupational hazards, including accidents. For instance, some reasons are as follows:

- many rural families have small lots of lands and/or live in close proximity with their flocks (this is especially true for pastoralists and nomadic people)
- the practice of gathering groups of animals that belong to different owners and leading them to common pastures is an occasion for the circulation of animal infections, including zoonoses
- home slaughter is practised extensively or numerous small abattoirs exist which are insufficiently equipped
- professional training of farm and animal industry workers and health education are often inadequate (this is also true in many industrialised countries and in intensive systems).

Scientific research still needs to clearly define the importance of some emerging zoonoses (transmissible encephalopathies, *E. coli* O157:H7 infection, avian influenza, etc.) for the health of workers and to evaluate the risks they run from becoming infected. Emerging (and re-emerging) zoonoses may derive from alterations of an ecological balance, natural or artificial mutations of infectious agents, wildlife migrations, introduction of allochthonous species, globalisation of trade, movements of people from distant areas of the planet and changes in human-animal relationships. Some are re-emerging in countries where drastic changes of the type of animal husbandry (from intensive to family management) have occurred as a consequence of policy changes (e.g. cystic echinococcosis in the former Soviet Republics of Central Asia). They may also derive from changes in working conditions or workplaces, lifestyles and resistance capabilities of people to infections. However, the 'classic' zoonoses, often wrongly considered to be a problem of the past, affect people in many areas of the world. Bovine tuberculosis, brucellosis, anthrax and cystic

echinococcosis are not only often neglected but remain strong examples of this. In the Mediterranean region, the above diseases are real (not only occupational) risks.

Present challenges include safeguarding the laboriously attained social services and extending them to areas in need, adequate instruction of staff involved in animal husbandry and related activities and the monitoring of such activities in order to identify all existing or emerging diseases involved. Attention must be paid to the health status and education of guest (imported) workers (who are now numerous in many countries in animal husbandry and related activities). In addition, it should be stressed that the fight against occupational diseases coincides with the application of rational farming techniques and that human and animal health and the economics of husbandry are three fundamental pillars of modern farming. To meet this goal, it is also indispensable to maintain a strong focus on animal health, the implementation or strengthening of control programmes for animal diseases of socio-economic relevance, improvements to the training of physicians and veterinarians in the field of the control of zoonoses and animal related diseases and the provision of medical services with adequate facilities for the diagnosis of zoonoses.

The prevention of occupational hazards, with special reference to the biological risks, must be implemented by official veterinary services throughout the whole production chain, using appropriate tools for control, diagnosis, epidemiological surveillance and evaluation of health interventions. The following should receive particular attention:

- identification of the hazards
- surveillance, diagnosis and control of hazards
- verification of prevention measures and hygiene
- notification of diseases
- health education and information.

Medical services must be given the responsibility for the prevention of risks for workers in the workplace, as follows:

- prevention of risks in the workplace

- verification of measures taken by the employer and by individual workers
- diagnosis and therapy of human pathologies
- notification of diseases
- health education and information.

Occupational diseases linked to animals, to their living and breeding environments and to the processing of their products represent

shared fields of interest, competences and activity between a large variety of different professions and only interdisciplinary collaboration will lead to the rational resolution of many of the problems faced today. Labour and health laws must follow this process and be tailored to the needs of current times.

References

1. Alborghetti F., Battelli G., Benvenuti F.L., Cancellotti F.M., Cazzagon R., Chiumenti R., Clonfero E., Da Borso F., De Marzo N., Ghinzelli M. & Loli Piccolomini L., Mantovani A., Mezzadri M. 2000. Definizione dei rischi di esposizione e misure di sicurezza e di tutela della salute nei settori: allevamento, macellazione, trattamento, distribuzione delle carni. Monografico di Fogli d'informazione ISPESL N. 2/99. Istituto Poligrafico e Zecca dello Stato, Rome, 303 pp.
2. Anon. 1988. Atti della Conferenza internazionale su sanità e produzione bovina nell'area del Mediterraneo, 3-5 May, Bologna. University of Bologna, Bologna, 784 pp.
3. Battelli G., Biocca M., Fara G. & Mantovani A. 1984. Interventi sanitari di primo livello per la prevenzione della patologia occupazionale connessa con le attività zootecniche e para-zootecniche. *Ann Ist Super Sanità*, **20**, 367-372.
4. Battelli G., Ghinzelli M. & Mantovani A. 2005. Historical notes on zoonoses as occupational diseases. *In Proc. 35th International Congress of the World Association for the History of Veterinary Medicine* (A. Veggetti, I. Zoccarato & E. Lasagna, eds), 8-11 September 2004, Grugliasco. Fondazione Iniziative Zooprofilattiche e Zootecniche, Brescia, 285-293.
5. Battelli G., Baldelli R., Ghinzelli M. & Mantovani A. 2006. Occupational zoonoses in animal husbandry and related activities. *Ann Ist Super Sanità*, **42**, 391-396.
6. Bellani L., Mantovani A. & Ravaioli L. (eds) 1978. Proceedings of the WHO expert consultation on some veterinary public health problems. *Ann Ist Super Sanità*, **14**, I-XIV, 185-410.
7. Istituto Superiore di Sanità (ISS)/World Health Organisation (WHO)/Food and Agriculture Organization (FAO)/Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise (IZS A&M) 1990. Guiding principles for planning organisation and management of veterinary public health programmes. *Veterinary Public Health Reports* (K. Bögel, R.B. Griffiths, A. Mantovani & Z. Matyas, eds). ISS/WHO/FAO-CC/IZS A&M/ 90.11, Teramo, 143 pp.
8. Mantovani A., Baldelli R., Battelli G., Benvenuti F., Cancellotti F.M., Catalano A., Ghinzelli G., Loli Piccolomini L., Marabelli R., Musti M. & Seimenis A. 1999. A historical overview of occupational diseases connected with animals. *In Contributions to the history of occupational and environmental protection* (A. Grieco, S. Iavicoli & G. Berlinguer, eds). International Congress Series No. 1189, Elsevier Science B.V., Amsterdam, 239-246.
9. Schwabe C.W. 1984. *Veterinary medicine and human health*, 3rd Ed. Williams and Wilkins, Baltimore, 680 pp.
10. Seimenis A. 1995. Zoonoses as occupational hazards. *In Joint MZCP/NPI-Bari/WHO/FAO-CC/ISS/MZCP-Athens workshop on occupational hazards in animal farming and related industries*, 23-27 October, Heraclion, Crete. MZCC, Athens.
11. Torgerson P. R., Karaeva R. R., Corker N., Abdyjaparov T.A., Kuttubaev O.T. & Shaikenov B.S. 2003. Human cystic echinococcosis in Kyrgystan: an epidemiological study. *Acta Trop*, **85**, 51-61.
12. World Health Organisation (WHO) 1975. The veterinary contribution to public health practice. *In Report of a Joint FAO/WHO Expert Committee on veterinary public health*. Technical Report Series No. 573, WHO, Geneva, 79 pp.
13. World Health Organisation (WHO) 1982. Bacterial and viral zoonoses: report of a WHO Expert Committee with the participation of FAO. Technical Report Series No. 682, WHO, Geneva, 146 pp.
14. World Health Organization (WHO)/World Organisation for Animal Health (Office International des Épidémiologies: OIE) 2001. Manual on echinococcosis in humans and animals: a public health problem of global concern (J. Eckert, M.A. Gemmell, F.-X. Meslin & Z.S. Pawlowski, eds). OIE, Paris, 265 pp.
15. World Health Organization (WHO) 2002. Future trends in veterinary public health: report of a WHO study group. Technical Report Series No. 907, WHO, Geneva, 85 pp.