

HEALTH PROBLEMS ASSOCIATED WITH TRANSPORT AND USE OF NONDOMESTICATED ANIMALS: AN OVERVIEW¹

Edwin H. Lennette, M.D., Ph.D.,² and
Richard W. Emmons, M.D., Ph.D.³

This article reviews the dangers arising from importation of nondomestic animals and actions needed to cope with the problem. It was first presented at the II International Symposium on Health Aspects of the International Movement of Animals as an introductory overview for that meeting.

It is a privilege and a pleasant responsibility to open this first session of the II International Symposium on Health Aspects of the International Movement of Animals by presenting a brief overview of health problems associated with the transportation and use of nondomesticated animals. Such problems are unquestionably of increasing importance and interest to us in the public health field, and it is particularly appropriate that the various disciplines represented here today are joining forces for a further evaluation of the problems at hand—and for a search for solutions to them.

Presentation of an overview is made easier because of the careful review and attention given this subject just three years ago at the First Symposium (I) in San Antonio, Texas, in which many of you participated. At that symposium an excellent and comprehensive analysis of the problems emerged, and it seems unnecessary to recount in detail the specific points covered there. Our task in the next three days is to evaluate how well we have progressed in the past three years in implementing the

proposals previously made. As Dr. William H. Stewart (2) stated at the First Symposium, "humanity possesses the knowledge and skill to relieve its suffering: science and technology have given us the tools to combat the ancient ills of poverty, ignorance, disease, hunger, and overpopulation. We must now seek the wisdom to exploit our achievements properly and to control the unwanted by-products of progress." The keynote for us today is to put to more effective use the knowledge and the tools we possess to control or to elucidate the problems that will be raised at this Symposium and to utilize this armamentarium at the local, national, and international levels.

We might well ask whether, in the short interval between August 1968 and this meeting, enough progress has been made in the development and implementation of the scientific, legal, institutional, and governmental means for anticipating, preventing, and dealing with these "unwanted by-products of progress" on which we will focus our attention at this symposium. The answer, obviously, is no; otherwise, this conference, called for a further sharing of ideas, for achieving a better understanding of the multiplicity of problems, and for taking concerted international action, would not be in session today.

Philosophic Approach

It is desirable that we approach our subject rationally and put it in proper perspective,

¹Paper presented at the II Symposium on Health Aspects of the International Movement of Animals (Mexico City, 11-13 August 1971). Also published in Spanish in *Boletín de la Oficina Sanitaria Panamericana*, Vol. LXXIII, No. 2 (August 1972), pp. 124-131, and in English in *Scientific Publication PAHO 235* (1972), pp. 3-9.

²Chief, Viral and Rickettsial Disease Laboratory, Department of Public Health, Berkeley, California.

³Viral and Rickettsial Disease Laboratory, Department of Public Health, Berkeley, California.

avoiding simple reflex responses to specific microorganisms of an especially virulent or "exotic" nature or highly fatal zoonotic diseases, approaching the subject pragmatically from an ecological standpoint. Although the term "ecology" has been so misused and abused as to become a cliché, the concept is nevertheless pertinent to our long-term objectives. Our ultimate goal is not just the immediate well-being of the human species but the long-term well-being of the entire planet and, in fact, of that part of the universe that we can affect and influence. Even in the lunar exploration program we have recognized the possible inherent dangers, as regards infectious diseases, from suddenly transporting life forms into totally new environments.

We acknowledge the positive values of various wild animal species to society—as experimental models in medical or technical research and in certain aspects of agriculture or industry—and also the educational and aesthetic values of animals to man, as exemplified by zoological gardens and the harboring of animals as pets. We recognize particularly the importance of a critical, realistic evaluation of the risks involved in keeping wild animals as pets and of balancing such risks to the owners and other exposed persons against many persons' wish to keep "exotic" species as pets. We take special note of the conservationist plea that species not be endangered or eliminated from the earth needlessly, or for careless or selfish reasons. We must learn to use the world's resources wisely and to avoid exhausting irreplaceable species as well as irreplaceable materials and energy sources.

We should support careful investigative efforts, scientific research, and evaluations of potential and actual health hazards associated with various animal species. Opportunities to learn from past animal-associated disease events have too often been missed because epidemiologic and laboratory investigations were not available or were not utilized as they might have been. It is obvious that we need better recording, summarizing, and retrieving of accurate information about animal transport, as well as about animal sources, uses, character-

istics, states of health, and susceptibility to disease. This means we also need better diagnostic laboratories to identify disease problems and to support field investigations, and better epidemiologic investigation of the epidemic and sporadic occurrences of zoonotic diseases as well as of endemic and latent disease problems.

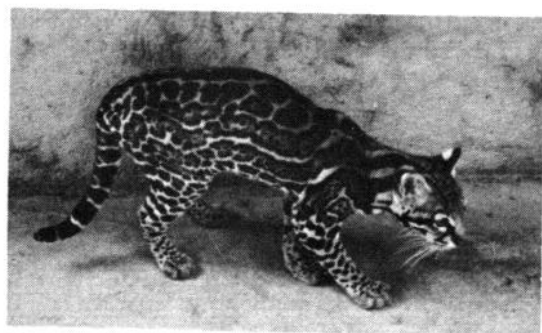
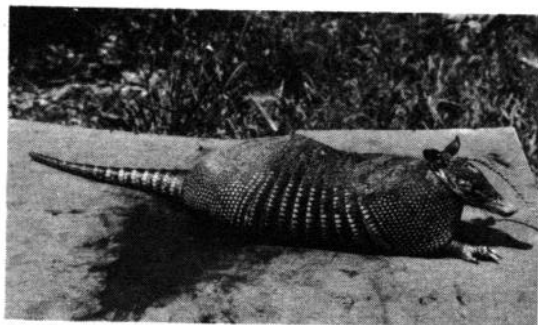
We should emphasize education of the general public, consumers, scientific organizations, legislative bodies, industries, and all groups involved in the use of imported animal species—education as to disease potential, mechanisms of disease transmission, and methods of prevention. We will then be in a better position to plan, to obtain the needed cooperation and support, and to respond appropriately to public health needs.

In this effort the need for good teamwork is obvious. The health problems associated with animals are so diverse and involve so many disciplines and divisions of government that it is not possible to devise one central, overall organizational scheme to deal with them. Therefore, the kind of interdisciplinary international cooperative effort represented by this symposium is all the more important. Effective collaboration, joint planning, mutual assistance in laboratory and epidemiological studies, information exchange, and adequate financial support are vitally important in achieving our goals.

Scope of the Problem and some Recent Experience

It is difficult to summarize the size and complexity of the potential health problems associated with the use of nondomesticated animals. The sources, numbers, and uses of wildlife species or animal products—for research in medicine, industry, and agriculture, or as zoological specimens or pets—are extremely diverse, and much of the information is poorly recorded or not easily collected. Obviously, the general deficiency in centralized information makes it more difficult to establish the baselines from which to assess specific risks to human health.

There is no need to list or review in detail



A few of the animals swept up in the rushing stream of international commerce: (1) upper left—howler monkey (*Alouatta palliata*); (2) center left—nine-banded armadillo (*Dasypus novemcinctus*); (3) lower left—ocelot (*Felis pardalis*); (4) upper right—small grey fox (*Urocyon cinereoagustus*); (5) lower right—hog-nosed skunk (*Conepatus tropicalis*).

here the specific zoonotic diseases and methods for their control, since many excellent reviews have already been published (3-9). Instead, a discussion of the general categories of health problems with which we are concerned, illustrated by a few specific examples, will set the stage for the papers to follow. It should be emphasized that although our records and experience mainly involve animals imported into the United States, this does not mean that health problems are associated only with animals foreign to this country. There are many zoonotic diseases and health hazards we must claim as our own. Diseases, like wildlife species, are not respecters of international boundaries. As sharers of a single planet, we all owe the same careful attention to safeguarding the world against exportation of disease from one area and importation of disease into another.

Direct Disease Transmission

The first and most obvious category of health problems is that of overt diseases directly affecting man which occur as a result of contact with "exotic" animals brought into an area. Direct trauma from bites or scratches is a frequent result, particularly from simians or *Felidae*, and these pose a significant risk aside from the possibilities of secondary infection.

Rabies, though hardly an "exotic" disease in the United States, must be included because of the greater opportunity of exposing many individuals to bites from captive animals than to bites from animals in the wild. For example, in California during the past 30 years, four monkeys were found positive for rabies after having exposed many persons by bite. Other examples of simian rabies are well-known in the

literature. An ocelot imported as a pet into California from Peru in April 1968 exposed five persons by bite shortly before it died of rabies (10). An episode involving the interstate shipment of approximately 70 young skunks for pets, one of which was found to be rabid, resulted in at least 72 bite exposures among some 343 persons at risk (11). A rabid coatimundi kept as a pet at a tourist hotel in Jalisco State, Mexico, exposed over 80 local residents and foreign visitors during Christmas 1970 before the risk was recognized, causing an extensive international search to locate persons in need of treatment (12). Although these two latter episodes did not involve international transport of diseased animals, the problems created by exposing many individuals to captive wild animals are identical. Such cases as those cited above are reported all too frequently.

Herpesviruses of primates are of special concern, in particular *Herpesvirus simiae* (B virus). Human cases are rare, but when they do occur they are usually fatal. It should be re-emphasized that our own experience and that of others (13) indicate that transmission can occur not only via monkey bite (which actually accounts for a minority of the reported cases) but also through contact with animal tissues, blood, or cell cultures—and possibly via aerosols or other indirect mechanisms not yet understood. Other herpesviruses of primates, such as *Herpesvirus tamarinus* (herpes T), spider monkey herpesvirus, SA-8, SA-15, *Herpesvirus saimiri*, *Herpesvirus aotus*, *Herpesvirus saguinus*, and herpesviruses causing exanthematous diseases of *Erythrocebus patas* and *Cercopithecus aethiops*, are not firmly established as pathogenic for man; nevertheless, they must be considered as potentially so and certainly warrant extensive study. The number of recognized herpesviruses indigenous to primates will undoubtedly continue to increase.

Tuberculosis transmitted from primates to man is a well-known hazard, and numerous episodes (including many in California) have been documented. The continuing importance of this problem is shown by the expensive and extensive testing and quarantine programs carried out by major institutions which use

primates; yet, despite these preventive methods, episodes continue to occur.

A fatal infection with *Shigella sonnei* occurred in 1962 in Alameda County, California, in a woman exposed to two gibbons (*Hylobates lar*) imported a short time earlier from Southeast Asia (14). Undoubtedly many other significant (though less serious) episodes of salmonellosis, shigellosis, or other enteric illnesses occur among persons exposed to primates, but are not reported to health authorities.

Infectious hepatitis is a well-recognized hazard of contact with chimpanzees. For example, in four recent episodes in the United States (15) there were eight cases (December 1970–January 1971) among 16 humans exposed to two chimpanzees in Culver City, California; two cases occurred in May 1970 in San Francisco, California, from exposure to two chimpanzees; at least eight cases occurred in Connecticut; and 14 cases occurred in St. Louis, Missouri.

Psittacosis (ornithosis) is a hazard from imported psittacine birds as well as from native pigeons, turkeys, and other avian species. The greater hazard of imported species lies in the fact that they are usually acquired as pets and thereby involve the owners in close household exposure.

These few cases of direct disease transmission are but some of the more dramatic examples in an extensive list of viral, bacterial, protozoal, and other diseases well known to the scientific world. It should not be forgotten that at any time new and unknown pathogenic agents may surface unexpectedly, e.g., the recent dramatic appearance of the Marburg virus among *Cercopithecus aethiops* monkeys and laboratory workers exposed to them.

Fear of Disease

A second category of health problems to be considered—that of acute anxiety, fear, or stress—is well illustrated by some of the examples given above. It includes the concern of public health officials, the anxiety—at times approaching hysteria—of the particular individuals involved, and the community problems

relating to the suspicion or fear of disease hazards, even though the animals in question are ultimately shown to have been free of the disease suspected. For example, of a group of 20 gibbons imported into Los Angeles from Thailand in 1968, 8 died with oral lesions suspected to have been due to *Herpesvirus simiae* (herpes B). Five persons were bitten by the ill gibbons and three of these individuals were given treatment with anti-*Herpesvirus simiae* immune serum (equine origin). Subsequent laboratory studies indicated that the viral agent involved was not *Herpesvirus simiae* but *Herpesvirus hominis* (16). Other documented episodes of *Herpesvirus hominis* (herpes simplex virus) infection of primates have occurred (17-20), but this information was not widely available at the time. Although *Herpesvirus hominis* is apparently highly fatal for certain primate species, it probably does not represent a hazard to exposed humans. However, the difficulty in obtaining rapid isolation and identification of the agents responsible for an animal's illness creates a period of considerable anxiety and uncertainty about individual and community action to be taken.

Similarly, in any bite exposure of man to primates, carnivores, or bats a period of anxiety and concern is unavoidable until appropriate laboratory tests can be obtained to rule out rabies. These situations are frequently complicated by the fact that animals from a suspected shipment may have been sold or widely distributed to other areas of the country before the possibility of rabies, herpesvirus infection, or other diseases has arisen. Considerable difficulty may then be encountered in locating all the animals, some of which may even have died and been destroyed.

Establishment of New Diseases

A third category of health problems to be considered is that of the introduction and establishment of disease agents in geographic areas where the agent has never existed or has previously been eradicated. Domestic or feral species—imported for agricultural purposes, for exhibition in zoos, or as pets—imported

animal products such as hides, bone meal, and even cell cultures or frozen sperm for breeding purposes, have been implicated as potential or actual sources of devastating epizootics in the native fauna. Aside from the possibility of direct immediate disease transmission—the establishment of enzootic disease in an area previously free of involvement—the effect on food supplies and on the agricultural economy of the area, and the more general adverse effects on the ecologic “balance” of the environment are well-recognized hazards. Most examples of these problems (rinderpest, blue-tongue, foot-and-mouth disease, myxomatosis, and anthrax) relate to domestic animals rather than to wildlife; because they are well-known historically and in modern times, they need not be further elaborated upon here.

Establishment of New Disease Reservoirs and Vectors

A fourth category to consider covers situations in which imported animal species, though free of disease agents themselves, become established in a new geographic area as potential reservoirs and vectors of indigenous diseases. In some instances these new hosts are more efficient amplifying hosts for the disease agent than are many of the indigenous species. The newly introduced species may fill a niche which results in close contact with man and thus bring about a more direct hazard than that previously encountered with indigenous species.

Classic examples of this type of potential problem include the introduction of foxes for sport hunting purposes or of mongooses for rat control, these animals then becoming important hosts for rabies. Other examples are the introduction of tree squirrels into parks and urban areas, with the establishment of an abnormal cycle of bubonic plague that results in unexpected urban transmission to humans; the introduction of susceptible species such as gerbils (as pets or laboratory animals) into a new area such as the United States, with the chance that they might escape captivity and become established in the wild, then serving as amplifying hosts for bubonic plague; and the

accidental or purposeful introduction of bird species, such as English sparrows or pheasants, which then become efficient amplifying hosts for mosquito-transmitted encephalitis viruses, thereby increasing in some measure the risk of infection to man.

Introduction of New Ectoparasites

Brief mention might be made of a fifth problem, concerned not with the imported animals themselves but with the undesirable ectoparasites inadvertently imported along with them. As is well known, an extensive effort is made by the Agricultural Research Service of the United States Department of Agriculture and cooperating agencies to detect and prevent the importation of exotic ectoparasites, particularly ticks, into the United States. The potential problems, such as the introduction of diseases endangering economically important livestock or of disease agents of direct hazard to man

(e.g., plague-infected fleas on rats), are clearly of immediate concern for human health and welfare.

Adverse Environmental Effects

Finally, a rather indirect adverse effect on the ecosystem might be mentioned to complete the picture. The inadvertent or purposeful introduction of some species of game animals, for example, may result in the replacement of normal faunal species because of competitive advantages of the new species. A chain of subsequent adverse effects on the indigenous fauna and flora may develop, with potential influences on disease cycles, resulting in increased direct threat of disease to man and domestic animals. The need to be cognizant of this possibility and to study and carefully document examples, rather than merely to play the alarmist, has been increasingly recognized in recent years.

SUMMARY

Regarding the hazards posed by non-domestic animals, the tasks which face us are to achieve better education of the professional and lay community; more intensive field and laboratory investigations; better information gathering, recording, and dissemination; and a better legal, organizational, and financial framework to support our efforts. On such a foundation we can then put into practice more effectively the control and preventive methods which have been found to work.

Control programs should be designed not only to prevent direct transmission of disease to man or his economically important livestock, but also to reduce or eliminate the fear of

disease, to prevent the introduction of disease agents, reservoirs, or vectors into new areas, and to avoid long-term adverse effects on the ecosystem which might alter disease cycles unfavorably.

Most important of all, our control programs must be designed not just to keep out disease but also to permit acquisition of knowledge and insight into the epidemiology and pathogenesis of the diseases in question—so that we will be prepared at all times to adapt control measures to the inevitably changing characteristics of society, the environment, and the disease agents themselves.

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