

ROLE OF ECOLOGICAL DISTURBANCES IN EMERGENCE OF SYLVATIC ZONOSSES AND NIDAL DISEASES

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INTRODUCTION:

Wild animals may be free living (*in situ*) or captive (*ex situ*), but nowhere are they absent the influence of humans. Everywhere on the earth's surface there is evidence of the presence of 6.35 billion (World POP Clock 2004) humans and in practical terms, there no longer is any "wild" (Ullrey 2005). Although we claim this earth as our own, we share it with myriad other creatures, many of which have not been identified. It is estimated that there exists 5-30 million of living forms on our earth but only 1.5 million have been identified, out of which number of animal species 1.2 million (Agrawal 1999). While the world's zoos contain thousands of individuals, out of which only somewhat more than 3000 species of mammals, birds, reptiles, and amphibians are represented (Ullrey 2005). The emergence of new infectious diseases in humans and other animals has been highlighted recent years. Infections and diseases such as Australian bat lyssavirus, Hanta virus, Nipah virus, West Nile virus, monkey pox, avian influenza, Pilchard herpes virus, severe acute respiratory syndrome(SARS), rabbit haemorrhagic disease, canine distemper in lions and seals etc. to name a few, have had a devastating impact on animal and human population (Larry *et al.* 2008). Wildlife populations play an important role in initiating and maintaining many of these diseases (Bunn *et al.* 2005).

SYLVATIC ZONOSSES AND NIDAL DISEASES :

Those diseases and infections that are naturally transmitted between vertebrate animals and man are defined as Zoonoses by WHO Expert Committee in 1959. Rudolf Virchow stated that there was no dividing line - nor should be between animal and human medicine; the object was different but the experience obtained constitute the basic of all medicine. The experience of zoonoses was one of the foundations of this comment because the agents of approximately 80% of all described human infections are shared in nature by other vertebrate animals (Bachhil *et al.* 2000).

Sylvatic Zoonoses (Zoonoses involve wild animals): Those diseases having reservoirs among the wild or feral animals, free living and captive are known as Sylvatic Zoonoses (Joshi 1991). To check the spread of sylvatic zoonoses in man, the study of ecology of natural foci of those infections is important.

Natural foci of diseases: A natural focus is defined as an area where the disease tends to have a habitat in a defined ecosystem in which the definitive host or parasitic vectors and the pathogen are parts of a biocenose in which the pathogen circulates (Shegal 1981).

Nidal diseases: there are certain diseases (or agents of infectious diseases) which occur in nature in hidden, localized foci, away from the civilization.

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They are contracted by susceptible host or transmitting agents(vectors) when they invade those infected areas(foci) or when the vectors or reservoir species of animals are forced to come out of their natural habitat in search of food or shelter as a result of natural or man made ecological changes. These are called "Nidal Diseases" (Shankar *et al.* 1984).

The concept of nidal diseases was brought by a noted Russian academician, E. Pavlovsky (erstwhile USSR). He and his student Prof. P.A. Petrischieva, a malariologist identified the ticks (*Orthodorous papillipes*) infected with a spirochaet, *Borrelia recurrentis* as transmitting agent(vector) for the relapsing fever of man who entered in a haunted cave in Turkman (erstwhile USSR). They noticed that those ticks were living in crevices in the cave and feeding on porcupines and other small mammals sheltering or living there and whoever went in side came down with fever. In fact, that haunted cave was the natural focus of spirochaet causing relapsing fever in man.

Infection present in wild life cycle forms enzootic foci under certain favourable set of conditions; it may spill among the domestic animals including humans. When man becomes involve in ecosystem that consists of the foci of zoonotic infections, he is liable to infection (Joshi 1991). Alteration of the environment for the human welfare *e.g.* construction of dams, canals, deforestation and tiling of the grass lands for agricultural development etc. may enhances the chance of human contact with the nidal diseases. Deforestation in Shimoga District in Karnataka State (of India) resulted in the break out of Kyasanur Forest Disease (KFD) in humans due to migration of carrier monkeys from their natural habitat to the populated areas through monkey-tick-bird epidemiological cycle in 1955 (Joshi 1991).

Emergence and persistence of disease nidi in nature: As a part of biotic community, pathogenic microorganisms and other parasites along with their vertebrate and invertebrate hosts form identifiable ecosystems. During ecological climax, a succession

of different species of animals, plants and microorganisms in a geographical area have evolved an environmental homoeostasis in their relationship to one another. In this evolving climax each animal, plant or microorganism comes to occupy a well defined ecological niche or "Slot" with respect to its competitors, enemies and food.

The emergence and persistence of natural foci of an infection need a variety of essential environmental factors which favour the circulation of a pathogenic organism (*eg.* bacteria, viruses, fungi, rickettsia etc.), or parasites (*eg.* protozoa, worms, insects etc.), in a suitable vertebrate host(s) living in a biotope. The important characteristics of natural nidus of infection is that the organism or parasite adopts itself in the host or vector species through reciprocal evolution that it does not produce disease either of them, but may be virulent (disease producing capacity) for human or domestic animals who venture into the area (Shankar *et al.* 1984).

Influence of human civilization on the evolution of disease nidi: The evolution of disease nidi in nature had to change its direction with the advent of man as a social phenomenon. Landscapes in which natural nidi could and did exist from ancient time were more or less changed by the different forms of man's activity such as:

□ First taming and breeding of wild animals by primitive man.

□ Taking out of wild animals out of their usual habitats for its domestic use and bringing them into new ecosystem in which the new disease agents prevailed.

□ The disease agent that existed in wild animals in forest got introduces and exposed to man through domestication.

□ Practice of cattle breeding and agriculture in virgin lands which disturbs the natural nidi that turns to disease nidi to domestic animal and man.

□ The driving away of wild cloven footed animals and other mammals by man's cultivation of forests

might have resulted (a) dropping out of those animals from their natural habitat to new areas and (b) bringing new disease agents in new areas with them.

□ Living of many wild animals (like rodents, insectivores and birds etc.) nearby human habitats for availability of foods. So primitive ecosystem to which they belong, were thus disturbed and the profile of life and the ways in which agents circulated also changed giving rise to new ecosystem, the structure and the topology of which depended wholly on the socio-economic activity and culture of man.

□ Newly formed disease foci became more prone for exposure to new species by the recent industrial development resulting in increasing encroachment by man on natural resources (Shankar *et al.* 1984).

Escape of disease agents from their natural foci: The disease agents generally produce symptomless infection in one or more than one species of animals residing in natural ecosystem, but it may be escaped from their natural foci and/or become virulent to human beings and/or for their animals also when:

□ The area is invaded by them accidentally or with some purpose (like Relapsing fever).

□ Most people do so for occupational reasons *e.g.* workers for gigantic project like dam construction, canal digging, road building, railway tract laying, deforestation etc. (like KFD, Yellow fever, Cutaneous Leishmaniasis etc.).

□ Foresters, hunters, trappers, soldiers or persons (as holiday makers) entering into the area for recreation, exploration while camping, bathing or hunting may also become exposed to new disease agent (like Leptospirosis).

□ The infectious agents travel from their niche boundaries to urban foci or even to research laboratories handling experimental animals or their tissues and infected people far away from their original source (like Marburg virus disease,

Haemorrhagic fever virus disease etc.).

□ In nature the change in physical factors and climate may also affect animal and plant communities resulting in fluctuation in number of vertebrate hosts and invertebrate vectors. This in turn affects the survivability and spread of the infectious agents (like Rabies, Russian spring summer disease etc.) (Shankar *et al.* 1984).

The zoo and wildlife veterinarians, biologist, naturalists and zoo garden personnel and laboratory workers dealing with the feral animals must be aware of the risks of those diseases so that appropriate preventive or curative measures may be taken to check on the spread of these infections (Joshi 1991).

Mechanisms of escape of disease agents from their natural boundaries of niche: For alteration of usual host range of infectious disease agents and its escape from its niche boundaries, a number of possible mechanisms are may be as follows:

□ Introduction of new susceptible host species into an ecosystem where the infectious agent is a part.

□ Introduction of infected host species into a new ecosystem.

□ Changes in the population dynamics of a usual host, a potentially new host or an intermediate host.

□ Ecological changes that bring to previously separated ecosystems into contact.

□ Changes in the habits (especially food habits) of a host.

□ Technological changes brought about by man.

□ Change in genotype *i.e.* mutation or genetic recombination of an infectious agent (Shankar *et al.* 1984).

Biosecurity measures for sylvatic zoonoses (*in situ* and *ex situ*) and nidal diseases: According to possible nature of exposure and spectrum of sylvatic zoonoses (*in situ* and *ex situ*) and nidal diseases the following steps may be taken as biosecurity

measures:

(A) Animal health and disease risk assessment and protective measures for rescue, treatment, rehabilitation and release of wild animals *in situ*:

In wildlife management during rescue, treatment, rehabilitation and release of wild animals *in situ*:

□ A number of risk factors and processes have been identified, including geographic translocations of hosts and pathogens, new and/ or intensified contacts between hosts and pathogens, genetic change and environmental change (Larry *et al.* 2008).

□ The rescue, rehabilitation and release of wildlife, if not done properly, may contribute to these processes and lead to the disruption and disturbance of the natural balance between the host, environment and pathogens.

□ When releasing rehabilitated wild animal, the health of the wild population and the ecosystem into which that animal is being released must take precedence over the welfare of the individual animal (IUCN 2000).

□ Great care must be taken to maintain the balance of organisms naturally found within an animal and not introduce foreign organisms during the rehabilitation process.

□ Appropriate measures must be taken to reduce the risk of disease during the rehabilitation and release of wild animals, including initial and ongoing clinical assessment, laboratory tests (haematology, biochemistry, serology, faecal examination, microbiology etc.), screening tests for specific diseases (*e.g.* Tuberculin testing), prophylactic procedures and treatments, quarantine, enclosure design and husbandry (Viggers *et al.* 1993, Kirkwood *et al.* 1995, IUCN 1998).

(B) Assessment for natural nidal diseases of wild animals *in situ* and its protective measures:

With the advancement of civilization, essential human activity in the modern age, expose the human being and their domestic animals to hidden foci of

infection in nature. To protect these host and control such infections the following measures to be adopted:

(1) Determination of the structure of disease nidi in nature(in a particular ecosystem) by:

□ Identifying the areas of risk.

□ Knowing exactly the components of those nidi such as donor, recipient and the vector species involved in the perpetuation of infectious agent.

□ Application of "Landscape epidemiology" concept.

□ Usual field and laboratory examination.

(2) Destruction of vectors by:

□ Direct or indirect attach on flying or crawling vectors.

□ Manual or aerial dusting on forest and other areas to kill non-flying vectors.

□ Spraying dusting or dipping by acaricides to the domestic animals.

□ Destruction of burrows of rodents etc.

(3) Reduction in the number of donor animals of the disease agents in specified areas:

(4) Cleanliness of external environment and adoption of proper hygienic measures to keep away such infections in a given biotope:

(5) Measures to protect man with search for possible foci of infection should be included in planning of any large development projects, new settlements and deforestation. If hazardous conditions are noted, following are essential to protect their workers:

□ Protective clothing, gum boots, nets etc.

□ Self inspection, brushing off and proper treatment of clothing after works.

□ Screening of the crevices in the house, doors and windows for possible presence of infected vectors.

□ Specific vaccination (against Viral encephalitis, Plague, Tularemia etc.), if possible.

(C) Disease risk assessment and protective

measures for zoonoses of wild animals and humans *ex situ* (in zoos, wild animal rescue / rehabilitation centers etc.): It is important to establish sound principles regarding correct sanitation and disinfection in the animal enclosures. Wild animals and their associated human beings are supposed to be clinically assessed regularly and steps to be taken accordingly as follows:

(1) Regular clinical assessment of diseases in zoo personnel closely associated to zoo animals-such as:

(i) Pre-employment physical check up of animal keepers, attendants etc. which includes:

□ Serological test for viral or chlamydial zoonoses.

□ Tuberculin tested by skin test to identify positive reactors.

□ Fecal examination for protozoa and helminthes and fecal culture for salmonella and shigella organisms.

□ Review of each prospective employee's immunization history (As per Guidelines for personnel preventive medicine program in Zoological Parks and Aquarium, AAZPA News Letter 1981).

(ii) Annual health status review of all employees to establish their (a) Current immunization status (*e.g.* for measles and flu in contact with non human primates) and (b) Tuberculosis status (should be skin tested at least once but twice in a year when animal TB cases have been identified).

(iii) Protocol should be developed for co-ordination of administration, attending physicians and zoo veterinarians in disease outbreak, which assures the cooperative interaction of all three parties in case of a suspected or possible zoonoses.

(iv) Prophylactic vaccination against rabies to employees in areas where the disease is endemic or unusual risk.

(v) Routine fecal examination. Fecal examination of individual employees who develop persistent

recurrent diarrhea.

(vi) Annual collection of reference serum for storage.

(vii) Limiting contact between high risk personnel (like pregnant, immunosuppressant workers etc.) and non-human primates.

(viii) Counseling pregnant workers on the potential risks (like Toxoplasmosis, Viral hepatitis etc.) of working with animals during pregnancy.

(2) Regular clinical assessment of diseases in captive wild animals: Clinical assessment of zoo animals' diseases is necessary which includes:

□ Physical examination.

□ Serology, haematology and serum biochemistry analysis.

□ Fecal examination for parasites and bacteria.

□ Urine examination for bacteria (*eg.* for Leptospirosis).

□ Evaluation of the blood smear for parasites and other sampling or testing as appropriate to the species (*eg.* for Trypanosomiasis in big cats, Tuberculosis in primates and deer etc.)

Once the disease status of an incoming rehabilitation/ zoo animal has been assessed and a disease is diagnosed, a decision must be made as to whether the disease can or should be treated or the animal may pose a risk to other animals and/or human beings. If the risk is assessed as too high taking into account the conservation of the animal, the animal should be euthanased. If the treatment option is chosen, it would be carried on accordingly (Larry *et al.* 2008).

CONCLUSION:

Influence of human civilization along with disturbance of ecology has an important role on the evolution and emergence of new sylvatic zoonoses as well as nidal diseases. The evolution of these diseases in nature had to change its direction with

Table 1 : Some important zoonotic diseases related to wild animals (Source: Bachhil *et al.* 2000, Joshi 1991)

Disease/ infection	Etiologic Agent(s)	Principal mode(s) of transmission
Bacterial Zoonoses:		
Anthrax	<i>Bacillus anthracis</i>	Contact, food borne
Leptospirosis	<i>Leptospira interrogans</i>	Vehicle, contact
Listeriosis	<i>Listeria monocytogenes</i> (Type 1a,1b,4a,4b)	Food borne, nosocomial
Lyme disease	<i>Borrelia burgdorferi</i>	Tick bite
Plague	<i>Yersinia pestis</i>	Flea bite, airborne
Relapsing fever	<i>Borrelia recurrentis</i>	Louse borne
Tuberculosis	<i>Mycobacterium bovis</i>	Inhalation, vector, ingestion
Tularemia	<i>Francisella tularensis</i> (Type A & B)	Inhalation, vector, ingestion
Yersiniosis	<i>Yersinia enterocolitica</i> , <i>Y. pseudotuberculosis</i>	Ingestion
Fungal Zoonoses:		
Histoplasmosis	<i>Histoplasma capsulatum</i>	Airborne
Aspergillosis	<i>Aspergillus spp.</i>	Airborne
Rickettsial and Chlamydial Zoonoses:		
Murine typhus	<i>Rickettsia typhi</i> (mooseri)	Flea bite (<i>Xenopsylla cheopis</i>)
Psittacosis (Ornithosis)	<i>Chlamydia psittaci</i>	Ingestion, inhalation
Q fever	<i>Coxiella burnetii</i>	Contact, vehicle, vector
Scrub typhus	<i>Rickettsia tsutsugamushi</i>	Mite bite
Viral Zoonoses:		
Hepatitis A	Hepatitis A virus	Food, vehicle, faecal-oral
Herpes B-virus infection	Herpes simiae virus	Contact bite, scratch, droplet
Influenza	Influenza A virus	Airborne
Japanese B encephalitis	Japanese encephalitis virus	Mosquito (<i>Culex spp.</i> mainly)
Kyasanur forest disease	Kyasanur forest disease virus	Tick bite (<i>Haemaphysalis spinigera</i>)
Rabies (Hydrophobia)	Rabies virus	Contact, bite, scratch
Monkey pox	Monkey pox virus	Contact, inhalation
Haemorrhagic fever	Hantavirus	Inhalation, broken skin, conjunctiva
West Nile fever	West Nile virus	Mosquito bite (<i>Culex spp.</i>)
Yellow fever	Yellow fever virus	Mosquito bite (<i>Aedes, Haemagogus</i>)
Protozoal Zoonoses:		
Trypanosomiasis	<i>Trypanosoma brucei, T. cruzi</i>	Tse-tse fly bite, Reduviid bug bite
Toxoplasmosis	<i>Toxoplasma gondii</i>	Meat, soil, Transplacental
Leishmaniasis (Kalaazar)	<i>Leishmania donovani</i>	Sand fly bite
Babesiosis	<i>Babesia microti, B. bovis, B. divergens</i>	Tick bite (<i>Ixodes, Ixodes etc.</i>)
Simian malaria	<i>Plasmodium brasilianum, P. simium etc.</i>	Mosquito bite (<i>Anopheles</i>)
Helminthic Zoonoses:		
Fascioliasis	<i>Fasciola hepatica, F. gigantica</i>	Ingestion, contaminated herbage
Schistosomiasis	<i>S. haematobium, S. japonicum etc.</i>	Waterborne
Hydatidosis	<i>Echinococcus granulosus, E. vogeli etc.</i>	Ingestion
Taeniasis & Cysticercosis	<i>Taenia saginata, T. solium</i>	Ingestion of meaty beef & pork
Diphyllobothriasis	<i>Diphyllobothrium latum, D. pacificum</i>	Ingestion of raw or undercooked fish/ copepod crustacean
Trichinosis	<i>Trichinella spiralis</i>	Meat vehicle
Filariasis	<i>Dirofilaria immitis, D. tenuis etc.</i>	Mosquito bite
Cutaneous / Visceral larvae migrans	Larva of <i>Ancylostoma brasiliense, A. caninum/Larva of Toxocara canis, T. cati</i>	Contact with infected larvae/ Ingestion of soil

advent of man as a social phenomenon. Careful study of different causes and mechanisms of escape of disease agents from their natural boundaries of niche and taking of suitable biosecurity measures for those diseases *in situ* and *ex situ* should be ensured prior to any developmental and welfare activities of human which are responsible for any kind of ecological disturbance.

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