Chapter 1

INTRODUCTION

Fungi, most of which usually known as plant pathogens, are also found to be pathogenic to animals. Reports of fungi as pathogens of animals have appeared at infrequent intervals since Bassi (1935) first called attention to the muscardine disease of silkworms caused by a fungus, now known as *Beauveria bassiana*. Gruby (1941) showed that different types of human favus were fungal infections and that the thrush was caused by a fungus, *Candida albicans*. Their work gradually led to recognition of fungi as animal pathogens. Mycoses in animals has been stressed by different workers viz., Bennett (1842), Robin (1855), Rivolta (1884, 1885), Renon (1897), Pallin (1904), Neumann (1909), Sabouraud (1910), Beurmann & Gougerot (1912), Meyer (1913), Smith (1920) and others.

Sabouraud's (1910) researches have shown the importance of fungi as dermatophytes common both to man and animals and also that animals can act as foci of infection in the epidemiology of human ringworm.

(1972), Sarkisov et al. (1972), Hajsig et al. (1972), Baxter (1973), Taylor et al. (1973), Maestrone et al. (1973), Abdallah et al. (1973), Vries and Jitta (1973), Beemer and Kuttin (1973), Reyes (1973), Young (1974), Buchvald (1974), Pascoe (1974), Haufe and Zimmermann (1975), Scott (1975), Abu-Samra et al. (1975), Hajsig et al. (1975), are some of the workers who have contributed much towards the problem of animal mycoses, more precisely of dermatomycoses in recent years.

Smith (1884) gives the earliest Indian record of a fungus as the casual organism of lesions in Bursatte, which is considered as a phycomycoses by Bridge and Emmons (1961). Dutta (1953) cited Homes (1914) who reported that the casual organism of Bursatte was a species of *Sporotrichum* but subsequently the aetiological factor was reported to be agent other than a fungus. Earlier Mahon (1918) reviewed the aspergillosis of birds, man and animals.

Gupta et al. (1970), Singh et al. (1970), Singh and Singh (1970), Mohapatra and Mohajan (1970), Singh and Singh (1972), Gupta and Singh (1971), Das and Sambamurti (1973), Gugnani and Randhawa (1973) have contributed towards understanding of the different aspects of animal mycoses in India.

Fungi, have assumed new importance in veterinary medicine: While the beneficial antibiotic producing activities of some fungi has been exploited, the disease producing
potentialities of some others have occupied an increasingly important place. It may be that these two divergent phenomena are casually related. The use of antibacterial drugs and antibiotics has been very extensive in livestock and poultry. These drugs are used professionally by veterinarians and non-professionally by laymen for medical and non-medical purposes in attempts to increase the rate of growth and to improve feed efficiency. It has been found that more than half of the antibiotics produced in the U.S.A. are used for agricultural purposes and the extent of drug usage is extensive. These agents lower the resistance of animals tissues and have stimulated or at least permitted the rapid growth of pathogenic fungi in animal body.

Saunders (1948), Gordon (1951) and Ajello (1953) have briefly reviewed the aspect, and Ainsworth (1950) has recorded fungus diseases in animals in England. Ainsworth and Austwick (1955), in their survey of fungi associated with the diseases of farm animals, found more than 1200 isolates of fungi from nearly 700 cases of mycotic or suspected mycotic infections. The infecting agents were grouped into 125 species of which 25 species were considered pathogenic. They also showed that more than half of the isolates were distributed in 5 genera, viz., Aspergillus, Absidia, Candida, Penicillium, and Trichophyton.

McPherson (1956), in a survey of cattle in Northern Britain, found 133 herds out of 518 to have been infected by
Trichophyton verrucosum. Ford (1956), Sellars et al. (1956), investigated this problem at Leeds. Gentles et al. (1957) have found Trichophyton mentagrophytes as a casual organism of ring worm in cattle.

Austwick and Venn (1957) recorded fungi associated with bovine abortions. Of the 601 foetuses and 52 placentas examined, 41 were diagnosed as cases of mycotic abortion and isolates included Aspergillus fumigatus, Absidia ramosa and Candida sp. Baruah and Ahmed (1963) isolated Aspergillus fumigatus, Geotrichum candidum, and Mucor sp. from aborted foetuses of cattle.

Walker (1958) critically surveyed mycoses of animals and man and the epidemiology of fungal diseases. Grin and Ožegovick (1958) have recorded dermatomycoses in Yugoslavia. Dawson (1968), dealing with ringworm in animal, found that fungi as dermatophytes parasitise non-keratinised layer of the skin but are normally incapable of invasion of the underlying living tissues.

Fungi are known to cause deep seated mycoses also, apart from being dermatophytes. Bora and Baruah (1965-66), while surveying animal mycoses in Assam, found Aspergillus sp. constituting 36.90% of the total isolates, Penicillium sp. 13.37%, Trichophyton sp. 9.9% and others being Blastomyces sp. Candida sp., Cladosporium sp., Herminthosporium sp., Mucor sp., Histoplasma sp., Nocardia sp., occurring in different
proportions. Out of these, *Trichophyton*, *Microspora*, *Epidermophyton* and *Helminthosporium* constitute the dermatophytes.

**Foci of Infection**

The means by which a pathogenic fungus reaches its host have some bearing on pathogenicity. The medium in which the propagule is borne may determine its mode of transport - (i) airborne spores; (ii) animal feed; and (iii) unhygienic conditions. The sources are of special importance since they are known to survive well in moist conditions and multiply in the presence of a minimal amount of nutrient.

**Airborne Spores**

The air is regarded as a reservoir of spores, pollengrains and other particles, their number and types depending upon the time, weather, season and geographical location (Gregory, 1961, 1973). Spores may not directly cause harm but are implicated in causing infections or provoking allergic responses due to toxic properties. Another important attribute of a spore is its retention of the power to germinate. For that reason, it is a matter of concern to the medical mycologist studying epidemiology of animal diseases.

Pasteur (1862), Cunningham (1873), Miquel (1883), Durham (1942), Hyde and Williams (1946) and Gregory (1945)
studied in detail air borne diseases and made considerable contribution to the study of aerobiology.

Aerobiological studies by Ahmed (1959), Baruah (1961), Lacey and Lacey (1964) and Sreeramula (1967) for understanding animal mycoses, respiratory mycoses and other allergic diseases showed very high concentrations of *Mucor*, *Penicillium* and *Aspergillus*-type spores, in the indoor air of cowsheds, potentially pathogenic to man and animals. Baruah and Chetia (1966), analysing the aerospores present in the atmosphere and in rooms of asthmatic patients, found predominance of fungal spores of *Cladosporium*, *Aspergillus*, *Penicillium*, *Curvularia* and *Alternaria*. Kimura and Yamamoto (1972) investigated into the relationship between the occurrence of airborne spores and allergic respiratory diseases in San-in district of Japan.

Animal Feed

As fungal spores are ubiquitously distributed, it is natural that foodstuffs and feeds are contaminated with a wide variety of fungi. Christensen (1965) has described a wide variety of fungi that invade the seeds of cereal grains and their products. He has grouped these organisms into categories like field fungi, storage fungi and advanced decay fungi according to the stage at which invasion and growth occur. If an equally complex fungal flora is assumed to be present in other feeds like grasses and hay, it is apparent that the
majority of food materials of animals are liable to influences of contaminating fungi. This may happen during their harvest, storage, transport or processing.

It has been customary to regard mould damaged foodstuff as acceptable for use in animal feeds, for which purpose they have been generally regarded harmless. A substantial literature has developed on the deleterious effects of feeding mouldy diets to a variety of domestic animal species. These findings are compatible with the currently available evidences which indicate that probably a small proportion of moulds found on food and feedstuffs are capable of producing toxic metabolites.

Unhygienic Conditions

Health and disease are in direct proportion to the purity or otherwise of the atmosphere; inadequate drainage, sewerage, want of good water supply and poor management and feeding that are practised in farms contribute to unfavourable environment. Inadequacies and errors in these aspects constitutionally weaken the animals especially the young, pregnant and the nursing ones and making them more susceptible to infections. Overcrowding and faulty ventilation are also factors effecting animal health.

Fungal presence may cause disease by (i) provocation of an allergic reaction; (ii) infection (mycoses and actinomycoses); and (iii) poisoning (mycotoxicoses). All these
disease reactions may sometimes have a common source in mouldy feed.

Allergy has been defined as altered reactivity, and is now used synonymously with hypersensitivity. An antigen responsible for an allergic disease is an allergen. It has long been known that air-borne pollen grains are allergens to sensitized persons and cause distressing symptoms called hay-fever.

Inhalation is probably the greatest factor in enabling fungal diseases to become established. Aspergillosis, Histoplasmosis, Coccidioidomycosis, Cryptococcosis, Adiaspiromycosis, Blastomycosis are all considered to be primary mycoses, whilst allergic Asthma, Hayfever and Farmers' lung also follow this event. Feinberg (1946) listed 24 different fungi showing different types of skin reactions which are allergenic to man. Infections caused by *Histoplasma capsulatum*, *Coccidioides immitis*, *Blastomyces dermatitidis*, *Aspergillus fumigatus* etc. are the main respiratory diseases of animal of fungal origin.

The quantity and quality of inoculum are important factors in mycoses and allergies, so also in the toxicosis by the amount of toxic substance available.

In man, the role of Type I hypersensitivity to inhaled fungal spores in the aetiology of asthma is well recognised but there is little information about this type of disease in
livestock. The most important development has been the discovery that the type III allergy known as Farmer's Lung, a disease not confined to atopic, allergy-prone subjects, is caused by certain thermophilic actinomycetes prevalent on hay and sometimes on other stored feedingstuffs (Pepys et al., 1963; Gregory et al., 1964). The organism responsible was described as *Micropolyspora faeni* (Cross, Maciver and Lacey, 1968). *Thermoactinomyces* was also shown to be responsible (Pepys et al. 1963).

The serum precipitins which are a feature of Farmer's Lung have been demonstrated in cattle, and in a high proportion of a group suffering from 'fog-fever'. 'Fog-fever' was described as an acute respiratory disorder in cattle in autumn in Great Britain by Begg and Whiteford (1948). 'Fog-fever' does not appear to be a clearly defined disease and a number of conditions of differing aetiology may be included within this diagnosis. Nothing is known of the intake of actinomycete spores necessary to sensitize the lung; they were observed in the lungs of 7 abattoir cattle out of 18 examined at Kohima.

Fungal spores have also been known to induce conditions analogous to Farmer's Lung and there appears to be scope for the investigation of pulmonary diseases in cattle along these lines. Exceedingly high concentration of fungal and actinomycete spores can occur in the atmosphere of buildings in which mouldy hay is handled or fed, and in the air of silos containing mouldy grain (Baruah, 1961).
Mycoses: Superficial Infections

The epidemiology of mycoses due to endogenous and exogenous infections was shown by La Touche (1952), Vanbreuseghem (1952), English (1966, 1967) and by Pugh and Evans (1970).

The superficial infections commonly encountered are streptotrichosis and ringworm. The former, an actinomycete infection, occurs most frequently in sheep and can diminish the value of both wool and pelts. Skin diseases have plagued domestic animals since antiquity. Interestingly enough, a few successful remedies have survived for hundreds of years and are in use today.

Attempts have been made to classify animal skin diseases. Schneidemuhl (1898) described the skin diseases of men that also occur in animals such as Eczema, cutaneous pruritus, pemphigus, ichthyosis, hyperhidrosis, chromidrosis, acne, furunculosis, congenital alopecia, favus, impetigo, scabies, tumors and other diseases.

Although Schneidemuhl and others made contributions, the real beginning of veterinary dermatology occurred at the turn of this century when Schindelka (1853-1913) published the first book on skin diseases of domestic animals (1903). Heller (1910) evaluated the veterinary aspects of animal skin diseases from the point of view of the dermatologist. He surveyed the entire literature to that date and gave many original histopathologic descriptions.
According to Heller (1910) "Skin diseases are comparatively more frequent in animals than in civilized man, especially in regard to the endless number of parasites that cause skin disease. Epidemics of scabies not only destroy farm animals, but also cause local extinction of wild animals (such as foxes). Fungal diseases routinely cause death in certain species (such as mice). Molluscum contagiosum is a harmless illness in man but causes systemic illness in domestic fowl. While Demodex folliculorum is a harmless parasite of man, demodectic mange is often incurable in animals. On the other hand, many human dermatoses are seen only seldom in animals or are seen in a different form (psoriasis, lupus erythematosus, lichen planus etc.)."

Kral and Schwartzman revised, enlarged and rewrote Kral's textbook 'Veterinary and Comparative Dermatology' (1964). It covers skin diseases of horses, cattle, swine, sheep, rabbits, poultry, dogs, cats and other animals.

Mycoses: Systemic Infections

All endogenous mycoses have their origin from the internal environment. This has been borne out by the findings of van Uden and Carmo Sousa (1957a, 1957b), Clarke and DiMenna (1961), Munch Petersen (1963), Kawatika and van Uden (1965) and Al-Dorry (1969).
Infections by yeasts, particularly by Candida species, are well known in a number of hosts affecting the intestinal tract or the udder. The infection appears to be essentially endogenous but often assumes an epidemic form in which it behaves as a contagious disease. Predisposing factors appear to be important but the pathogenesis is obscure.

Bovine mycotic abortion is invariably one of the most important endogenous mycoses. It is caused by one of a few thermophilic fungi of which Aspergillus fumigatus is the most frequent. These fungi are amongst the potentially pathogenic species occurring in overheated hay and other materials. No survey has been made and the incidence is unknown.

Mycotoxicoses

The growth of fungi on feedstuff is a common phenomenon but it can inevitably bring about changes in its physical and chemical composition effecting palatability and nutritive value. In many instances, there may be no apparent ill effect and, indeed, an improvement is conceivable in some circumstances; for example breakdown of the lignin. However, an increasing number of fungi have been found to produce toxic substances, mycotoxins, when growing upon dead, moribund, dormant or even living and active plant tissues.

Mycotoxicoses is the toxicity syndrome in man and animals due to ingestion of contaminated foodstuffs.
Mycotoxicoses have caused significant losses in animals used for food and thereby decreasing available animal protein sources.

Probably the first mycotoxicoses to have been recognised was ergotism, a syndrome due to ingestion of grains infected with *Cle viceps purpurea*. In 1959 Percival reported the toxin sporidesmin, produced by the fungus *Pithomyces chartarum*, to be the cause of facial eczema in sheep in New Zealand.

In 1960 more than 100,000 young turkeys and many thousands of ducklings died in England of unknown reason. The syndrome was referred to as 'Turkey-X' disease because the etiologic agent was not known. In 1961 groundnut meal containing aflatoxin was shown to be responsible for the deaths of large number of turkey poults and ducklings (Allcroft et al., 1961). The toxin was produced by certain isolates of *Aspergillus flavus* and *A. parasiticus*. Sarkisov (1954) has collated the Russian work on these disorders and a review of mycotoxicoses was published by Forgaes & Carl (1962). Similar diseases were reported in ducklings and chickens (Asplin and Carnaghan, 1961), in young cattle (Loosmore and Markson, 1961) and also in swine (Harding et al., 1963). Gopal et al. (1968) described an outbreak of aflatoxicoses in a dairy herd in India; of 126 animals, 58 died.

Significant levels of aflatoxins have been recorded in samples of soybeans, cotton seed, maize, rice, wheat, barley, sorghum, millet, peas, beans and cowpeas from various parts of
the world (Allcroft and Carnaghan, 1963; Wogan, 1968). The factors attributed for contamination are high moisture content and methods of harvest and storage. (Austwick and Ayerst (1963), cited by Wogan (1969) showed that the conditions for growth of toxin producing *A. flavus* include an ambient temperature of 10° to 45°C and relative humidity of 75% or greater.

Meyer (1955) isolated *Hymenopsis*, *Macrosporium*, *Aspergillus*, *Cladosporium*, *Phoma* sp., *Fusarium* sp. from various samples of toxic grains. Joffe (1965) has summarised findings of his toxicological study on 950 grain samples collected from different homes. *Fusarium poae*, *F. sporotrichioides* and *Cladosporium epiphyllum* were dominant in frequency of occurrence and in preponderance of toxin-producing isolates.

*Fusarium*, *Rhizopus*, *Aspergillus* and *Penicillium* are the genera capable of producing toxic metabolites on rice and other substrates (Kinosita & Shikata, 1965; Brook & White, 1966; Christensen, 1965; Ciegler & Lillehoj, 1968; Goldblatt, 1969; Hesseltine, 1969; Detroy et al., 1971; Purchase, 1971; Scott, 1973; Wogan, 1965, 1969; Mateles & Wogan, 1967 and Ciegler et al., 1971).

It appears that — (1) cereal products contain aflatoxin B₁ and B₂. (2) both toxigenic and nontoxigenic strains of *Aspergillus flavus* occur on cereal products. (3) aflatoxin is found in sunflower seeds (4) *Aspergillus candidus*, *Penicillium piceum* and *P. oxalicum* produce
mycotoxins, aflatoxin is also present in infected tapioca samples, sorghum grains, copra, maize samples, cotton seed cake and groundnut cake.

Food of animal origin represents the most important part of human diet in many parts of India and this is particularly so in Nagaland as all the protein need for 516,449 people in this state is supplied by meat (cattle, buffalo, goats, sheep, swine), milk and egg (Table 1 & 2); total quantity of meat marketed in Nagaland was estimated at 21,348 quintals approximately per year.

Table 1: Total number of animals distributed by species in Nagaland (1975)*

<table>
<thead>
<tr>
<th>Animals</th>
<th>Heads</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Milch cow</td>
<td>1,97,798</td>
</tr>
<tr>
<td>2. Buffalo</td>
<td>11,778</td>
</tr>
<tr>
<td>3. Sheep and goats</td>
<td>17,446</td>
</tr>
<tr>
<td>4. Poultry</td>
<td>18,19,576</td>
</tr>
<tr>
<td>5. Swine</td>
<td>1,95,161</td>
</tr>
</tbody>
</table>

*(Source: Department of Veterinary and Animal Husbandry, Nagaland)
Table 2: Total quantity of meat, milk and eggs marketed in Nagaland in the year 1975*

<table>
<thead>
<tr>
<th>Animal</th>
<th>Slaughter estimate (Heads)</th>
<th>Total Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cattle and Buffalo</td>
<td>..</td>
<td>13,906</td>
</tr>
<tr>
<td>2. Goats and Sheep</td>
<td>..</td>
<td>10,295</td>
</tr>
<tr>
<td>3. Swine</td>
<td>..</td>
<td>6,633</td>
</tr>
<tr>
<td>4. Chicken and Ducks</td>
<td>3,30,323</td>
<td>21,248 quintal</td>
</tr>
<tr>
<td>5. Milk production</td>
<td>..</td>
<td>1,41,843.25 litres</td>
</tr>
<tr>
<td>6. Egg production</td>
<td>..</td>
<td>4,00,235 Nos.</td>
</tr>
</tbody>
</table>

*(Source: Department of Veterinary and Animal Husbandry, Nagaland)

The health of livestock is of considerable importance in view of the need for modern animal husbandry and to reduce the loss due to infection of cattle and eliminate risk to mycotoxicoses.

The aim of the present investigation has, therefore, been to -

(a) determine the fungus flora associated with skin lesions of different animals in Nagaland putting stress on dermatophytes, and their characters and physiological reactions.
(b) investigate the aerospora of animal sheds, silo and field and their effect on farm animals,

(c) determine the fungus flora of different animal feedstuffs and to find out if aflatoxins are produced.