CHAPTER III. SOIL HYGIENE

3.1. THE SOIL

3.1.1. SOIL AND ITS IMPORTANCE

The soil is at the interface between the atmosphere and lithosphere (the mantle of rocks making up the Earth's crust). It also has an interface with the hydrosphere. The soil sustains the growth of many plants and animals, and so forms part of the biosphere. A combination of physical, chemical and biotic forces acts on organic and weathered rock fragments to produce soils with a porous fabric that contain water and air. We consider soil as a natural body of mineral and organic material that is formed in response to many environmental factors and processes acting on and changing soil permanently.

Because soil is important for cultivation and agricultural production, soil fertility and productivity are important issues to address. Soils are an integral part of landscape and the knowledge of the distribution of different soils helps to preserve a high standard in environmental quality. Soil surveys furnish basic inputs to soil conservation planning and provide information used in equations for predicting soil loss and water pollution under various management practices on different soils.

3.1.2. SOIL PROFILES

A description of a soil profile developed in a temperate humid environment is given showing all of the principle soil horizons:

- The *upper layer,* from which materials are generally washed downwards, is described as *eluvial.*
- *Lower layers* in which these materials accumulate are called *illuvial.*
- The *unconsolidated parent material* in which the soil is formed.
- If *consolidated material* exists below the parent material.
- *Organic litter* on the surface, which is not incorporated in the soil.

3.1.3. COMPONENTS OF THE SOIL

Soils are made of four main components:

- mineral matter (40-60%);
- soil water (20-50%);
- soil air (0-40%);
- organic material (small percentage)

The relative proportions of the four major components may vary widely.

3.1.4. ORGANISMS ON/IN SOIL

The soil and the organisms living on and in it comprise an ecosystem. The active components of the soil ecosystem are the vegetation, fauna, including microorganisms, and man.

- **Vegetation**

The primary succesion of plants that colonize a wethering rock culminates in the development of a climax community, the species composition of which depends on the climate and parent material, but which, in turn, has a profound influence on the soil that is formed. Differences in the chemical composition of leaf leachates can partly account for a divergent pattern of soil formation. For example acid litter of pines or heather favors the development of acid soils with poor soil structure, whereas litter of decidious trees for development of well structured soils.

- **Mezo-/Macrofauna**

Earthworms are the most important of the soil forming fauna in temperate regions, being supported to a variable extent by the small arthropods and the larger burrowing animals (rabbits, moles). Eartworms are also important in tropical soils, but in general the activities of termites, ants, and beetles are of greater significance, particularly in the subhumid to semiarid savanna of Africa and Asia. Earthworms build up a stone-free layer at the soil surface, as well as intimately mixing the litter with fine mineral particles they have ingested. The surface area of the organic matter that is accessible to microbial attack is then much greater. Types of the mesofauna comprise arthropods (mites) and annelids (earthworms).

- **Microorganisms**

The organic matter of the soil is colonized by a variety of soil organisms, most importantly the microorganisms, which derive energy for growth from the oxidative decomposition of complex organic molecules. During decomposition, essential elements are converted from organic combination to simple inorganic forms (mineralization). Most of the microorganisms are concentrated in the top 15-25 cm of the soil because unconsolidated parent material substrates are more plentiful there. Estimates of microbial biomass unconsolidated parent material range from 500 to 2000 kg/ha to 15 cm depth. Types of microrganisms comprise bacteria, actinomycetes, fungi, algae, protozoa, and soil enzymes. All of these microorganisms we met in the chapter about water.

- **Man**

Man influences soil formation through his impact to the natural vegetation (agricultural practices, urban and industrial development). Heavy machinery compacts soils and decreases the rate of water infiltration into the soil, thereby increasing surface runoff and erosion. Land use and site specific management (application of fertilizer, lime) also act on soil development.

3.1.5. PARENT MATERIAL

The nature of parent material has a decisive effect on the properties of soils. Properties of the parent material that exert a profound influence on soil development include texture, mineralogical composition, and degree of stratification. Soil may form directly by the weathering of consolidated rock in situ (a residual soil), saprolite (weathered rock), or it may develop on superficial deposits, which may have been transported by ice, water, wind or gravity. These deposits originated ultimately from the denudation and geologic erosion of consolidated rock. Consolidated material is not strictly parent material, but serves as a source of parent material after some physical and/or chemical weathering has taken place. Soils may form also an organic sediments (peat, muck) or salts (evaporites). The chemical and mineralogical compositions of parent material determine the effectiveness of the weathering forces. During the early stages of soil formation, rock disintegration may limit the rate and depth of soil development. The downward movement of water is controlled largely by the texture of the parent material. Furthermore, parent material has a marked influence on the type of clay minerals in the soil profile.

3.2. CONTROL OF SOIL-BORNE DISEASES

3.2.1. NATURAL CONTROL OF SOIL/BORNE DISEASES

- **BALANCE OF SOIL ORGANISMS**

Soil with good texture and good organic matter content also tend to have a healthy balance of soil organisms, from earthworms to bacterial and fungal microorganisms that cycle nutrients. These will coexist with other soil microorganisms that can cause plant problems, such as disease-causing root-rotting fungi. All these organisms exist in the soil in a precarious balance, which can go haywire when major environmental stresses change the equation.

- **NATURAL CONTROL OF THIS BALANCE**

The best balance will be achieved by developing soils that have good overall texture and *drainage* and good organic matter content, which will optimize microbial activity.

Adding *compost* to soil will help they to achieve these goals. They add at least an inch of compost over all growing areas in the spring, and work the compost into the top several inches of soil.

People in climates with prolonged sunny streches can *solarize* soils, i.e. use the heat of the sun to eliminate pathogens. Cultivate the soil to a depth of at least 4 inches. Water the soil well, then cover with clear plastic at least 1,5 mm thick and bury and anchor the edges in a trench around the bed. At least 6 weeks of abundant sunshine are needed for effective solarization, which kills not only pathogens, but also beneficial organisms. That's not the only drawback. The technique will eliminate pathogens in only the top few inches of soil, probably not to the full depth of plant roots. And solarized soil is easily recontaminated. However, beneficial organisms such as Trichoderma species tend to prefer solarized soil for recolonizing, and biocontrol agents can be mixed with seeds or added to the soil when transplanting to maximize benefits.

3.2.2. PREVENTION

- **UNDERSTAND THE MECHANISM OF INFECTION**

The first step in prevention is to have a good understanding of infectious disease.

The simple but extremely useful concept of the disease triangle is fundamental to that understanding. Diseases can occur only when the following three components are present at the same time:

- A pathogen capable of causing disease
- An environment conducive to disease
- A susceptible host

The disease triangle is also a creative way to remind oneself of the different ways to prevent disease: break the links in the triangle at any point and disease will not occur. A way is do not provide a susceptible host; other way is to exclude pathogens; or can adopt cultural practices that make the environment less conducive to infection.

Sanitation for disease control is important today.

- **CHEMICAL SOIL DISINFESTATION**

A. Fumigants

- *Metam-sodium (Vapam)*

This product, which is formulated as a water-soluble solution, is a broad-spectrum biocide and may be used to control soil fungi, nematodes, soil insects, and weeds. Metam-sodium applied to moist soil will decompose to methyl isothiocyanate (MIT), which is the biocidal ingredient.

- *Dazomet (Basamid)*

This compound is like metam-sodium a precursor to the formation of the biocidal ingredient MIT. Upon contact with the moist soil, dazomet also converts to MIT.

- *1,3-D (e.g., Telone)*

1,3-D has two isomers: cis- and trans dichlopropene. The cis- izomer is more volatile and is considered more active biologically than the trans-izomer. This fumigant has no potential to deplete ozone layer and has a short life of 7 to 12 hours in air.

- *Chloropicrin (e.g., Tear gas)*

Chloropicrin may be used for the control of nematodes, bacteria, fungi, insects, and weeds. The product is also used as a warming agent for odorless fumigants such as MB.

- *Dichloroisopropyl eter (Nemamort)*

This product is not registered and may only be used in Japan and Taiwan. Nemamort may be effective in the management of nematodes in fruit crops, citrus, vegetable crops and ornamentals.

- *Bromonitromethane*

This product is still under development and will require several years of research before registration is possible.

- *Enzone*

Enzone is a new compound that may control nematodes, soil-borne diseases and insects, but may not be as effective as MB for weed control. The active ingredient of Enzone is sodium tetrathiocarbonate that releases the biocide carbon disulfide.

B. Nonfumigants

- *Systemic nemastat/insecticides*

The following systemic compounds can be used as a pre- and postplant nemastat/insecticide treatments. They may be used for shallow rooted crops or to treat the upper soil fraction in combination with soil fumigants. A wet, cold climate and soils with high organic content may limit the efficacy of soil fumigation.

These compounds are: Ethoprop (Mocap), Aldicarb (Temik), Carbofuran (Furadan), Oxamyl (Vydate), Fenamiphos (Nemacur)

Nemastats do not kill nematodes but typically work by delaying hatching, impeding migration of invazive larvae to host roots, impairing feeding behaviour, or disorienting males toward females. A loss in eficacy due to microbial degradation was reported for carbofuran, fenamiphos and oxamyl.

- *Formaldehyde*

Formaldehyde effectively controls soil-borne fungi, bacteria and weeds. This product is used as a seed, soil, and space disinfectant in some countries. Formalin is also used as an additive to enhance the efficacy of hot water treatments to kill nematodes in plant tissues.

- *Furfuraldehyde*

The chemical properties of 2-furfuraldehyde, also known as furfural, resemble those of formaldehyde and benzaldehyde, which suggests the possibility of its use as a fungicide. It may control nematodes and soil borne fungi. However, this compound may not control soil insects and weeds.

- *Inorganic azides (Na or K- azides)*

Azides are enzyme inhibitors, which affect the activity of peroxidases, oxidases, and other metal-containing enzymes. Thus, azides may be expected to affect a broad-spectrum of microbiological activities. Hydrozoic acid is considered the biocidal ingredient and is formed after azide hydrolysis.

- *Systemic fungicides*

The following compounds are systemic fungicides and can be used as a pre- and postplant treatment to control plant pathogenic fungi:Beromyl (Benlate), Metalaxyl (Ridomil). The development of resistant or tolerant strains after frequent application of these compounds is a major limitation in their use; their use should thus be restricted to integrated programs.

- **NON-CHEMICAL SOIL DISINFESTATION**

A. Steam

Steam at 80-100^{0}C effectively controls most soil-borne pathogens and weeds. Aerated steam (air-steam mixture) selectively kills plant pathogens at 50-60^{0}C in 30 minutes and could be used in nurseries as an alternative to soil fumigation.

B. Soilless culture systems for greenhouses

Soilless culture of crops can be accomplished by using artificial substrates such as rockwool, rock, clay granules, and flexible polyurethane foam-blocks to allow plant roots to absorb nutrients and water. Soilless culture of tomatoes, strawberries, cucumbers, peppers, eggplants, and some flowers are grown in greenhouses using artificial substrates as a replacement to MB soil fumigation.

- **BIOLOGICAL CONTROL METHODS**

Antagonistic microorganisms established in the infection site in advance of the pathogen may be used to prevent infection or as colonists of the infected tissues to arrest disease development. They may have the potential to increase crop yield without adverse effects to the environment.

Releasing the antagonistic microorganisms with the seed at time of planting is considered an effective way of using these microorganisms. The antagonistic Trichoderma and Gliocladium spp., used as seed treatments, have shown potential to control soil-borne plant pathogens.

Soil microorganisms also may be used to turn on plant defense genes in the plant. Inoculative release of beneficial bacteria at the beginning of the disease cycle may function as the equivalent of host-plant "resistance" to the largest root disease.

When introduced into the soil, microbial agents are less successful than MB in the control of soil-borne diseases and pests. Often, these agents do not persist in high numbers for a sufficient length of time to protect plants adequately, and multiple applications are needed.

CHAPTER IV. HABITATION HYGIENE

4.1. MICROCLIMATE

The microclimate of a site can have a profond effect on how people use its outdoor spaces, and on how readily and efficiently its buildings can provide confortable and attractive environments. A site's microclimate can be altered by design to warm, cool, shelter, expose, and reduce unwanted pollution and sound. The wind, temperature, sunlight and nocturnal radiation, humidity, noise, vegetation, and built objects action on microclimate and on human comfort.

A microclimate is any small, local area within which the effects of weather are both relatively uniform and easily modified. Microclimate modification involves the best use of structural and lanscape design elements to maximize or limit sunlight, shade and air movement. Structural modifications involve the design of the house and associated construction (walkways, fences, patios). Landscape modifications (enviroscaping) involve the use of plants to further increase or decrease the impact of sun and wind upon the local environment.

4.1.1. STRUCTURAL ELEMENTS OF MICROCLIMATE MODIFICATION

When choosing a new home, several decisions strongly influence the degree to which interior comfort requires energy inputs for heating of air conditioning. The homeowner should incorporate effective insulation in ceilings and walls, and weather strip around windows and doors, even if local ordinances do not require such practice. Total energy savings of 50 percent to 60 percent can be realized if conservation practices are followed in new home construction.

ORIENTATION

In a hot and humid climate, a house is more energy efficient if it is oriented with the long axis running east-west. With this orientation, the short walls of the house receive most of the direct morning and afternoon sun, thereby reducing the total heat load on the structure. In the winter, when the sun is lower in the sky, the south facing long wall receives the heating benefits of solar radiation. Divergence of up to 10^0F, in either direction from this orientation, is allowable to compensate for the prevailing wind direction.

ROOFS AND WALL COLORS

Light-colored materials reflect sunlight; dark materials absorb the radiation. A house with dark walls and roof is less expensive to heat in winter, but more costly to cool in summer. Light-colored walls and roofs lower cooling costs but increase the need for winter heating.

FENCING

Fencing is primarily used around homes to ensure privacy or mark boundaries. Fencing also directly influences air-circulation patterns. Air movement can affect the energy efficiency of the home, depending on the season of the year. Air movement around the home may raise home energy consumption by increasing conductive heat loss (in winter) and heat gain (in summer) through walls and windows, and the infiltration of outside air around the edges of windows and doors.

OTHER STRUCTURAL FEATURES

In summer, large roof overhangs can help shade windows and walls, as well as walkways adjacent to the house. Arbors and trellises over outdoor living areas increase comfort and shade nearby walls. Decks should be built with bottom clearance to allow air to circulate below the structure. If possible, driveways should be located on the cast or north side of the house to reduce heat buildup during warm afternoons.

Solid surfaces such as concrete and asphalt, which reflect a great deal of heat, should be kept to a minimum. Brick driveways build up less heat than either asphalt or concrete and produce less glare than concrete. Ground covers offer a cooling effect and are not energy intensive. Organic mulches reduce runoff, are inexpensive and an attractive alternative to pavements.

4.1.2. LANDSCAPE ELEMENTS OF MICROCLIMATE MODIFICATION

Plants provide the most economical means of modifying microclimate around a home and represent an investment in future energy savings. Plants in the landscape interact directly with the two primary factors: sun and wind.

Summertime heat gain in a home can be reduced by using plants to:

1. shade the residence from direct solar radiation;
2. either divert or channel air movement away from or towards the house;
3. create cooler temperatures near the home by evaporation of water from their leaves (transpiration).

Heating costs in winter, can be decreased by selecting and properly locating plants so that:

1. the amount of direct solar radiation received by the home is maximized;
2. the effects of cold winter winds are minimized.

Leaving too many trees around buildings, however, contributes to mildew, mold and other moisture problems in and outside the structures.

4.2. BUILDING - ASSOCIATED ILLNESSES

Recent studies confirm that concentrations of pollutants inside buildings may greatly exceed standards established for outdoor concentrations.

Indoor air contamination has been linked to a wide variety of building materials and consumer products. The problem is exacerbated by concerns about energy conservation that have led to decreasing air turnover in homes, offices, and other buildings.

4.2.1. TYPES OF BUILDING-ASSOCIATED ILLNESSES AND HEALTH CONCERNS

It is possible to divide building-associated illnesses into two categories:

1. acute short-latency illnesses
2. potential chronic long-latency illnesses.

The nature of the exposures that may give rice to each type differs substantially. The term building-associated illnesses is reserved for health problems that develop in setting customarily considered nonhazardous.

Short-latency illnesses include sick building syndrome, mass psychogenic illness, specific illnesses resulting from identifiable sources of noxious materials, certain infectious diseases, and building-associated hypersensitivity pneumonitis.

In contrast, sick building syndrome refers to the occurrence, in more than 20% of work population, of a variety of nonspecific symptoms, wherein it is not possible to make a specific diagnosis.

These conditions are characterised by a relatively acute onset, closely related in time to the individual's presence within the building and often relieved by removal from further exposure. Some of the building-related illnesses do not resolve promptly upon the building.

In contrast, the long-latency illnesses include cancer and chronic pulmonary diseases, which may result from long-term, low-level exposure to contaminate of indoor air.

Because of the long induction-latency periods for these conditions and their multifactorial origin, it is much more difficult to establish a causal link to the building exposure.

Agents in indoor air that may be responsible for such illnesses include cigarette smoke, asbestos, radon gas, polycyclic aromatic hydrocarbons, and chlorinated hydrocarbons insecticides.

CIGARETTE SMOKE

Tabacco smoke is a complex mixture of chemical substances in the form of gases and particulates.

Toxic gases include carbon monoxide, which binds hemoglobin preferentially to oxygen and results in reduced oxygen delivery to tissues. Other gases such as nitrogen oxides are oxidising agents or irritants and may contribute to chronic obstructive lung disease. Hydrogen cyanide impairs ciliary function in the lung, which may predispose to pulmonary infection. Volatile nitrosamines and other gaseous substances such as formaldehyde may contribute to cancer formation.

The particulate phase of tabacco smoke includes the alkaloids - chiefly nicotine - and tar. Aside from its central nervous system actions, nicotine is a sympathetic nervous system stimulant that increases heart rate, blood pressure, and myocardial contractility and causes release of free fatty acids. Nicotine causes release of stress hormones such as cortisol and grouth hormone as well as vasopressin and b-endorphin. As a consequence of the cardiovascular effects of nicotine, myocardial oxygen demand increases.

Exposure to nicotine and carbon monoxide results in reduced exercise tolerance in patients with angina pectoris and enhances the risk of acute myocardial infarction and sudden death in persons with coronary heart disease. Nicotine induces vasoconstriction and may contribute to coronary spasm as well.

Tar is a complex mixture of chemicals that includes most of the suspected carcinogens, cocarcinogens; and tumor promoters in tabacco smoke. These include benzo (a) pyrene and other polynuclear aromatic hydrocarbons; nicotine - derived nitrosamines β-naftylamine, polonium - 210, and metals such as nickel, arsenic, and cadmium.

PASSIVE SMOKING

On average, 75% of the smoke generated in smoking a cigarette is released into the environment.

Concentrations of various toxic chemicals, including polycyclic aromatic hydrocarbons are higher in sidestream compared to mainstream smoke.

Sidestream condensate is more carcinogenic than mainstream smoke condensate. Irritant gases such as formaldehyde, ammonia, and volatile nitrosamines are present in far greater concentration in sidestream than in mainstream smoke.

From urinary cotinine data, it is estimated that nonsmokers with exposure to environmental tabacco smoke (ETS) typically absorb a dose of nicotine equivalent to one sixth to one third of a cigarette, however, with heavy ETS exposure, the amount of nicotine may be equivalent to as much as one to two cigarettes per day. There is overlap in the intake of heavily passively exposed nonsmokers and light primary smokers.

Indoor asbestos exposure occurs at very low levels unless the insultation materials are disturbed or properly removed. Exposure to low levels of radioactivity occurs in the form of radon gas from building materials and soil underlying basements or foundations.

Polycyclic aromatic hydrocarbons are released into indoor air from wood-burning fireplaces and other sources.

Based on the increased risk of lung cancer in much more heavily exposed asbestos workers, uranium miners, and coke oven workers, respectively, there is some concern about the impact of these agents on lung cancer incidence in the general population.

Certain products of combustion, such as oxides of nitrogen from unvented gas appliances, may pose long-term health risks. There is limited epidemiologic evidence suggesting increased respiratory infections and reduced performance on pulmonary function testing associated with exposure to gas stove emissions.

NATURE, SOURCES, CONCENTRATIONS OF EXPOSURES

Potential sources of indoor air contaminants can be classified as follows:

1. contaminants released from the building or its contents, including asbestos, formaldehyde, and radon;
2. contaminants generated by such diverse human activities as cooking, heating, cigarette smoking, and cleaning;
3. infiltrated contaminants-agents that enter the house or building along with the outside air, but in lower concentration (typically 25-75%).

The concentration of contaminants is influenced not only by the source of exposure but also by the exchange rate between indoor air into a home or building occurs either by implemented ventilation or by infiltration. Infiltration occurs through cracks or other leaks in the structure or through open doors or windows. The amount of infiltration is dependent on the type of building, the amount of insulation and other weather-proofing, and climatic conditions. Implemented ventilation (e.g., forced-air heating or air conditioning systems) may provide substantial amounts of outdoor air but may also be designed to recirculate preconditioned air with minimal fresh air intake.

The amount of fresh air exchange is often expressed in air changes per hour (ACH). ACH may vary from 0.2 in tightly sealed homes to 0.7 in an average home to 60 or more in some industrial settings with implemented ventilation.

Alternatively, with implemented ventilation, the amount of outdoor air supplied may be expressed in cubic feet per minute (cfm) or cfm per occupant.

The concentration of contaminants at any location within a building will be influenced by the location of the source and the degree of air mixing. In the case of reactive or particulate contaminants, the concentration will be affected by rate of chemical reaction or the rate of deposition, respectively.

RESULTS OBTAINED FROM BUILDING INVESTIGATIONS

Investigators at the National Institute for Occupational Safety and Health have reported the results of their evaluations, through December, 1996, of 446 buildings with indoor air quality problems.

Although they recognised that some of the problems may have had multiple causes, they were able to classify the result by the primary identified cause.

In 32% of the evaluations, building ventilation was found to be inadecvate, as evidenced by inadequate fresh air intake, poor air distribution and mixing, draftiness, poor temperature and humidity control, pressure differences between office spaces, or air filtration problems.

Inside sources accounted for 17% of the problems, and included contaminants from various types of wet copiers, improper use of cleaning agents such as shampoo, tabacco smoke, improper pesticide application, and combustion gases.

Such contaminants were present at levels above the normal background but far below any permissible exposure limits.

Outside contamination sources were the primary factor in 11% of the investigations, generally due to entrainment of contaminated outside air as a result of improperly located exhaust and intake vents or contaminant generation near intake vents.

One of the most common identified sources was the entrainment of vehicle exhoust fumes from parking garages into the air intake vent.

Other contaminants included boiler gases, previously exhausted air, and asphalt from roofing operations.

Microbiologic contamination accounted for 3% of the problems, resulting from standing water in ventilation system components or from water damage to carpets or other furnishings. A variety of disorders - hypersensitivity pneumonitis, humidifier fever, allergic rhinits and possibly allergic asthma, infrequently, and conjunctivitis -can arise from microbial contaminants.

Building materials were the source of contaminants in 3% of the investigations, including materials such as particle board, plywood, ureaformaldehyde foam insulation, and some glues and adhesives. In 12 % of the investigations, the factor or factors involved remained unknown.

Though they did not list it as a primary cause, the NIDSH investigators indicated that *tabacco smoke* may be a major contributor to indoor air quality problems, largely because it contains numerous irritant compounds.

The significance of environmental tabacco smoke may be a major contributor to indoor air quality problems, largely because it contains numerous irritant compounds. The significance of environmental tabacco smoke in the induction of closed-building syndrome or other building-related illness remains a hotly debated subject.

There is no question that heavy cigarette use, when combined with poor ventilation, can result in high levels of environmental tabacco smoke that may result in irritant symptoms in crowded areas such as cafeterias or lobbies. In the more typical office building environment, the extent to which tabacco smoke contributes to indoor air quality problems is less clear and probably depends on ventilation and fresh air intake rates as well as on smoker density.

Some investigators have demonstrated significant increases in respirable particulate concentrations in building where smoking is permitted relative to comparable nonsmoking buildings.

Urinary levels of cotinine, a metabolite of nicotine, increase in a clear dose-response relationship with increasing exposure to environmental tabacco smoke in a variety of settings.

4.2.2. SHORT-LATENCY ILLNESSES

4.2.2.1. SICK BUILDING SYNDROME

The term sick building syndrome denotes a characteristic set of symptoms, typically headache and mucous membrane irritation, recognised among occupants of nonindustrial buildings, such as offices and schools. In most cases, the syndrome has occurred in relatively new buildings with centrally controlled ventilation systems and without operable windows.

OCCURRENCE AND ETIOLOGY

The incidence of sick building syndrome is unknown, but reported outbreaks of illnesses consistent with this diagnosis have increased dramatically in recent years.

Outbreaks have occurred chiefly in government offices business offices, and schools or colleges.

The contaminants responsible for these syndrome have not been identified.

One common feature present in virtually all afflicted buildings is a central ventilation system that depends on a significant proportion of recirculated air.

Once of the more widely held theories is that this ventilation design permits the accumulation of low levels of many contaminants-volatile organic compounds, aldehydes, cigarette smoke, etc - which together induce the symptoms.

There are a number of potential sources for air contaminants in the office environment. Formaldehyde is present in and evaporates from resins in particle-board and plywood (used in furniture and construction materials) and furnishings (including carpets and draperies).

Other sources include cigarette smoke and unvented gas appliances. Volatile organic compounds may evaporate from carpet glues and drying paints. Releases from photocopiers and other office equipment may also contribute to the symptoms.

Dryness of indoor air may contribute to some of the symptoms of sick building syndrome. Blinded experimental studies of office workers and hospital workers have demonstrated a reduction in symptoms of dryness of mucous membranes (eye and throat dryness or irritation) and skin (dryness, irritation, and itching) with air humidification of up to 35-45% compared to control conditions of about 25-35%.

There was also a reduction in perceived air dryness.

An allergic symptom score (considering nasal congestion and excretion and sneezing) was also significantly reduced during humidification for the office workers. Given that relative humidity often falls in indoor environments during the heating season, low humidity may play a significant role in the induction of symptoms of sick building syndrome in some situations.

Jaakkola also point out that two studies have suggested that room temperatures greater than 22^{0}C may be associated with increased prevalence of the symptoms of sick building syndrome.

Skow and Valbjorn, in their Danish Town Hale Study, related irritation of the mucous membranes and work-related general symptoms (headache, abnormal fatigue, or malaise).

Symptom of mucosal irritation were significantly correlated with area of the office, number of workplaces in the office, floor dust, organic floor the fleece and shelf factor. The fleece factor is the area of all textile floor covering, curtains and seats devided by the volume of the room. General symptoms were significantly correlated with area of the office, organic floor dust, and the fleece and shelf factor.

Women had a higher prevalence of both mucosal irritation and general symptoms.

Individuals with hay fever had a higher risk for work-related mucosal irritation, while individuals with a history of migraine headaches were more likely to report general symptoms.

They found that a variety of psychosocial work characteristics, including absence of varied work, dissatisfaction with the supervisor, job satisfaction diminished by the quantity of work, little influence on the organization, and high work speed, were associated with the prevalence of symptoms, both mucosal irritation and general symptoms.

However, the indoor climate factors noted above remained strongly associated with the symptoms.

Jaakkola studied the impact of textile and other soft fiber wall materials (SWM) by evaliating the occurance of symptoms in two similar buildings, one of which did not use textile wall materials.

They found that workers in offices with SWM reported significantly more mucosal irritation symptoms (eye sps, nasal dryness, nasal congestion, pharyngeal irritation) than those workers in the reference offices.

Symptoms considered to reflect an allergic reaction (nasal excretion and sneezing) were also more prevalent in the exposed group.

The study postulates that it may be the capability of these materials to absorb (and release) volatile organic compounds and to accumulate (and release) organic and inorganic particulates that may lead to an influence on indoor air quality.

Incidences in wich the occupants relate symptoms to the building are common, even in buildings without recognised problem.

While these studies have revealed a number of buildings work, and occupant factors that are statistically associated with occurrence of symptoms of sick building syndrome, they have not, as yet, established causal relationship. For example, relative to the consistent excess of symptoms observed in women.

CLINICAL FINDINGS

The most common symptoms are those associated with mucous membrane irritation and headaches. Eye irritation, difficulty in wearing contact lenses, nasal and sinus irritation and congestion, throat irritation, chest tightness or burning, nausea, headache, dizziness, and fatigue are common complaints. Some symptoms may be psychophysiologic in origin.

PREVENTION

Wood apear to require balancing energy conservation concerns with the need to provide adequate fresh air intake rates when designing ventilation systems.

4.2.2.2. MASS PSYCHOGENIC ILLNESS

Mass psychogenic illness is an illness of psychophysiologic origin occuring simultaneously in a group of individuals. Less satisfactory terms include "mass hysteria" and "behavioural contagion".

OCCURRENCE AND ETIOLOGY

Episodes felt to represent building-associated mass psychogenic illness have occurred in office buildings, light industrial facilities, and electronics plants.

The incidence of these illnesses is unknown.

The precise cause, though unknown, would appear to involve the occurrence of un appropriate stimulus or trigger in a psychologically susceptible population.

The trigger is often un unexplained odor, concern about which may initiate psychophysiologic symptoms in some individuals.

Since the trigger may be low levels of a respiratory irritant or an irritating odor, symptoms of sick building syndrome may occur concurently.

Thus, sick building syndrome and mass psychogenic illness may occur simultaneously or sequentially in the same building incident.

Episodes of mass psychogenic illness have occurred in groups of workers in low-paying jobs they perceive as stressfull, often with repetitive work and physical stress from such factors as poor lighting.

CLINICAL FINDINGS

Mass psychogenic illness have included headache, dizziness, lightheadness, drowsiness, nausea, dry mouth and throat; eye, nose, and throat irritation; chest tightness; and weakness, numbness, and tingling. Headache, dizziness, nausea, and numbness tend to predominate over symptoms of mucous membrane irritation in mass psychogenic illness when compared with symptom profiles in sick building syndrome. Some subjects may be observed to hyperventilate.

In contrast to sick building syndrome, symptoms usually do not resolve promptly when the individual leaves the bulding.

Certain features strongly suggest the diagnosis of mass psychogenic illness. The symptoms are difficult to explain on an organic basis and are not consistent with the toxicologic properties of any suspected contaminants. There is a visual or auditory chain of transmission. In other words, subjects typically do not become ill unless they see or hear that others are becoming ill.

The illness in the index cases may be due to actual exposure to an unpleasant odor or noxious substance or to a nonoccupational cause (eg. a viral syndrome). Despite severity and sudden onset of illness, the illnesses are consistently benign without sequelae.

4.2.3. POTENTIAL CHRONIC LONG-LATENCY ILLNESSES

4.2.3.1. BUILDING-ASSOCIATED HYPERSENSITIVITY PNEUMONITIS

Hypersensitivity pneumonitis is a form of interstitial lung disease characterized pathologically by lymphocyte and granulomatous infiltration of alveolar walls that results from inhalation of bacterial spores and antigens from stored moist hay.

However, hypersensitivity pneumonitis has been reported in a number of individual homes or offices where mold has been allowed to grow on humidifiers or air conditioners.

OCCURRENCE AND ETIOLOGY

Hypersensitivity pneumonitis is an immunologic disorder triggered by repeated inhalation exposures to a foreign antigen, which probably results from a combination of immunopathogenic mechanism.

There is evidence to suggest a type III immunologic (immune complex-mediated) reaction with precipitating or complement-fixing antibodies to the offending antigen. Some antigens may be capable of direct complement activation.

Type IV T cell-mediated immune response probably play a role in disease development, particularly in chronic hypersensitivity pnemonitis.

In building-associated hypersensitivity pneumonitis, a number of agents and antigens have been implicated, including bacteria (thermophilic actinomycetes such as thermoactinomyces vulgaris or Micropolyspora faeni), fungi (Aspergillus, Penicillium, Alternaria, or others) and perhaps amebas (Naegleria and Acanthameba).

The source of antigens has usually been contaminated ventilation systems. Less commonly, carpets, furnishings, and surgaces persistently moist from water leaks in occupied areas have been implicated.

CLINICAL FINDINGS

There are both acute and chronic forms of hypersensitivity pneumonitis. The acute form typically presents with fever, chills, shortness of breath, nausea, myalgia, malaise, and cough without wheezing, usually developing 4-6 hours after exposure to the antigen.

The chronic form of hypersensitivity pneumonitis is typically manifested by the insidious onset of fatigue, progressive dyspnea, nonproductive cough, and weight loss.

TREATMENT

Avoidance of further exposure by removal from the environment usually results in resolution of symptoms and abnormalities.

4.2.4.OTHER BUILDING-ASSOCIATED ILLNESSES

Certain noncommunicable infectious diseases may be transmitted in indoor air. Legionnaires' disease, a multisystem disease dominated by pneumonia, is caused by the bacterial organism Legionella pneumophila. Legionella species can be cultured in up to 40% of cooling towers, although infections stemming from exposure to the aerosols are uncommon.

Finally, Q fever, caused by rickettsial organism Coxiella burnetii, has been responsible for several building-associated outbreaks. The animal reservoirs for this infection are sheep, goats, and cattle. Airborne transmission of organisms from animal excreta to humans has occurred via ventilation systems in animal handling and medical research facilities.

Carbon monoxide in buildings may be the cause of mild symptoms, such as headache and nausea, or more severe, potentially life-threatening intoxication.