

EFFECT OF ENVIRONMENT AND POLLUTION ON ANIMAL PERFORMANCE AND ITS HAZARD ON HUMAN HEALTH

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SUMMARY

Proper appraisal of environment is essential for life. In Animal science, the term "environment" is used to include all conditions, circumstances and influences that are not a part of the affected organism. Animal environment researchers consider environment as natural climatic conditions. Bioclimatology has been defined as a branch of ecology that studies the interrelations between chemical and physical factors of the atmospheric environment and living organism.

Environment is of major concern when attention is directed toward improving animal productivity, evaluating the effects of pollution factors on the health of animals and utilizing experimental animals for basic biological science research or in place of man in determining requirements for human health and welfare. Advances beyond current knowledge and technology will require increasingly greater understanding and control of the various elements of the environment, since physical environment factors are still poorly defined and measured. Furthermore, the combinations of bioclimatic factors are less well understood. Therefore, such knowledge could be obtained through research under carefully controlled and with complete monitoring of climatic variables. Research on the interrelationships of animals and environment serves to answer questions related to: animal welfare, human health; pollution abatement and environmental engineering.

Pollution has become threatening our life today. It comprises visible (air, water and soil) and invisible (noise, behavior, nuclear radiation .. etc). Available data on the threshold limit values for different contaminants are still limited, specially in developing countries. Similarly, the effects of pollution on animal performance and human health require more study.

INTRODUCTION

Proper appraisal of environment is essential for life. Animal environmental researchers usually utilize a narrower meaning of the word "environment",

since they refer to the natural climatic conditions. Bioclimatology has been defined as a branch of ecology that studies the interrelations between chemical and physical factors of environment and living organism.

The well-being of animals is affected by their environment including pollution factors. Environment is important when directed toward improving animal productivity, preserving rare species, evaluating the effects of pollution factors on the health and welfare of animals and utilizing experimental animals for biological research. Efficient production requires understanding for the influences of various environmental elements on the animal functions, where they are still poorly defined and measured. Even the combination of bioclimatic factors to each other aren't well understood. This knowledge could be obtained through research under controlled environment. Research on the interrelationships of animals and environment serves to answer questions related to animal welfare, human health, pollution abatement and environmental engineering.

Pollution has become threatening our life today. Environmental pollutants could be classified into visible and invisible Fig. 1. (Arnaoat, 1995). The effects of pollution on animal performance and human health require more study. In general greater emphasis on research along this line can be expected because of increasing public awareness of pollution and its associated problems (El-Halwagi, 1997).

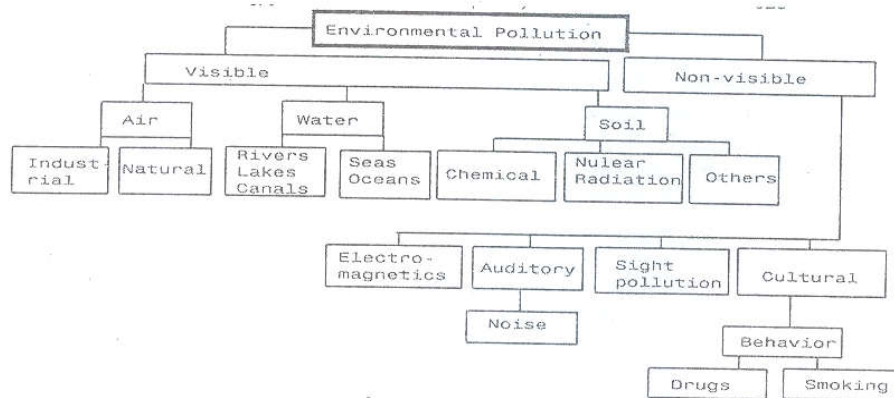


Fig. 1

This guide aims to show the importance of the following items:

- 1- Team research through the cooperation between investigators from several disciplines, with emphasis on applied research.
- 2- Research under controlled conditions to help the investigators and administrators in evaluating environmental factors and physiological responses.
- 3- Identification of some terminology differences to permit better understanding between investigators.
- 4- Paying more attention to :
 - a- physical and biochemical studies of direct cellular response or indirectly via hormones and cell substrates.
 - b- Advanced studies on the effects of environment and pollution on the incidence and susceptibility to diseases.
 - c- Further advanced studies on the interrelations between available climatic variables and livestock housing.
 - d- Protecting environment from pollution which reflects positively on animal and human health.
 - e- Sufficient operating funds required to initiate reliable research programs.

ENVIRONMENT

Environment could be simply defined as the conditions, and influences that exert some divergent effects on the organisms. In general, environment could be classified into: 1- Living components "plant, animal, human etc". and 2- Non living components "air, water, soil, rocks, weather etc" (Armaoat, 1995). It could also be classified into 1- abiotic "all physical and chemical factors" 2- biotic "all interaction between biological entities such as food, water, perdition, diseases and sexual interaction". (Yousef, 1985).

Environmental control: The manipulation and amelioration of environment reflect positively and economically on animal production. This requires evaluation the environmental effects on the animal performance under controlled conditions. For example, failure to attain/maintain thermal environments may distort an experiment or obscure a significant reaction .

Environment as a variable: With the advance of the technologies required for environment control, modification and measurement, new horizons will be opened for the separation of environmental variables which lead to better interpretation of the environmental-animal interactions. Among the environmental factors that have been studied in the laboratories are temperature, humidity, thermal radiation, air velocity, barometric pressure, photoperiodism and chemical substances including pollutants...etc. The incidence of pathogens and parasites in relation to various direct climatic factors including pollutants is one of the important environmental complexes that need more study.

Some important measurements in the development of environmental physiology and shelter engineering are body temperature, oxygen consumption, respiratory quotient, blood constituents, hormones.... etc. Physical and biochemical investigations of direct cellular response to the environmental components specially the temperature and different pollutants, or indirectly via hormones and cell substance, must receive more attention in the future.

Terminology: There are wide variations in the usage and interrelations of many terms as shown in the following examples:

1- Climatic and bioclimatic: Bioclimatic has been favored over the term climatic to differentiate between studies of climate in the meteorological science and studies involving the interaction of animals and their environment. Bioclimatology has been defined as branch of ecology that studies the interrelation between chemical and physical factors of the atmospheric environment and living organisms.

2- Stress: Among engineers, stress is defined as the load that is imposed on a subject. The reaction of the load is identified as strain. Among some animal scientists, stress is used to describe one or more environmental factors exerting an influence on an animal. The measured response is the strain.

3- Adaptive response: Adaptation is the tendency of animals to adjust to changes in their environment. Acclimatization while represents an evolutionary change that may be passed to succeeding generations. Acclimation may represent a very short-term response. However, both terms are sometimes used interchangeably.

4- Heat transfer: (conduction, convection, radiation and evaporative heat loss.

Effects of Some bioclimatic factors on animal and poultry performance.

Air composition: Normal air consists of approximately 21% O₂, 78% N, 1% argon and 0.03 % Co₂ plus trace amounts of inert gases. It may also contain dust, smoke, fumes, and gaseous combustion products. Air inside an animal building may vary than normal, composition intentionally or accidentally. Available data on the influence of air composition on animals are limited.

Air temperature : It could be considered as the most important bioclimatic factor in the animals environment. A change in temperature dictates the need for some adjustments in some physiological functions as respiration, pulse

rate, body temperature, surface temperature... etc. Cold air, in combination with wind or precipitation (liquid: rain and drizzle & solid: snow, sleet and hail), will reduce the feed conversion efficiency of most animals. The adverse effects of high temperature will considerably be declined if the animal is exposed to wind. Air with a high humidity has the effect of lowering the level at which air temperature becomes a stress factor for animals out doors. When liquid water is evaporated into air without the exchange of external energy, the humidity ratio is increased and the temperature is decreased. Data available on the effects of air temperature in combination with other bioclimatic factors are relatively limited. The choice of instruments used for measuring air temperature depends on the purpose, the accuracy required and how, when and where such measurements should be made.

Air moisture and relative humidity: Moisture in the air influences the rate of evaporative heat loss from animals through skin and lungs, the thermal conductance of the animal's coat and through condensation, it affects the properties of the surrounding environment both indoors and outdoors. The quantity of moisture per unit weight of air changes not only with temperature but also heat transfer. Animals are usually subjected to air temperature ranging from - 18? to 40? . A convenient definition for relative humidity is the ratio, expressed as a percent, of the vapor pressure of a given air sample divided by the vapor pressure of the same sample would have if it were saturated at the same temperature and pressure. It describes the feeling of dryness or dampness associated with air of a given condition. It is of much concern in dealing with plant materials or animals.

Air movement: The main effect of wind or an increase in air movement is to increase the surface heat loss by the process of convection. This would be beneficial to the animal's productiveness during hot weather, but could contribute to an unwanted loss of body heat during cold weather. A significant increase in body weight and improved feed efficiency in beef cattle were achieved through the effect of wind during summer in the empyreal valley of California (Ittner, et al., 1957). Similarly growth rate of broilers increased in a hot environment owing to the increase of air velocity (Drury, 1966). In animal laboratories, air movement from 15-30 cm/c, generally referred to as still air. Out-doors, the air movement may range from zero to many kilometers per hour. Wind seldom has steady velocity and may be highly variable and gusty. In the field studies, a high degree of measurement accuracy of wind velocity is not warranted. The most useful measure will be a value from a continuously recording instrument from which a daily or weekly average value can be obtained. For measuring wind speed, several types of anemometers are available.

Air Pressure: It varies with air temperature, humidity, and velocity. It is an important factor in the environment of livestock. The change of air pressure with elevation leads to an obvious decrease in atmospheric oxygen pressure. This is usually accompanied by changes in air and soil temperature, air moisture content, and radiation (Monge, et al., 1966). Several livestock diseases are peculiar to the higher altitudes. The fertility of chicks was decreased at high altitudes (Smith, et al., 1959).

Light (visible radiation): Light "radiation" represents the portion of energy in the spectrum of electromagnetic waves between wavelengths of 0.45 and 0.70 μ . The human eye is sensitive to the radiant energy in this range. It is presumed that the eyes of animals are generally sensitive to this range. Light is known to be an important microclimatic factor affecting reproduction efficiency of most farm livestock (Dutt, 1960). Lights have long been used to bring pullets into lay sooner as well as increase egg production of domesticated birds. (Koellabeck, et al., 1986).

In general available data on the effects of light quantity, quality and periodicity on livestock are still limited. Light can be measured by any of the methods into which the incident radiant energy is converted. These are luminosity, heating effect photoelectric effect and photochemical action.

Noise (Sound Radiation): It is defined as any unwanted or undesirable sound. The effects of noise upon human may be classified into four general categories-annoyance, disruption of activity, loss of hearing and physical or mental deterioration. The literature on the effect of loud sounds upon both humans and animals was reviewed by (Bond and Winchester, 1963). Detrimental effects upon human hearing (Glorig, 1958) and physical and mental health (Parr, 1966) have been reported. With the development of aeroplanes and machines, interest in the effects of loud noise will increase.

Concept of pollution

Natural Systems and Man - Made Systems: The universe has several systems that work, interact and intersect among each other in a homogeneous whole to keep the continuity and protection of life and environment on our planet. There is a certain type of living-organism adaptation in nature among its systems either in a separate way or in groups, while the human being in many times is the only cause of polluting and misdirecting of natural systems.

In our day life, there are different types of system's categories, but the two main types are Natural and Man-made systems.

Natural systems: The majority of systems are not made by people. They exist in nature and serve their own purpose. It is convenient to divide nature systems into two basic subcategories:

- a: Physical systems include stellar systems: galaxies, solar system etc, geological system: rivers, mountain...etc, and molecular systems: complex organizations of atoms.
- b: Living systems: Encompass all of the myriad plants, animals and human race living systems.

2- **Man-made systems.** The human-being can construct, organize, design and maintain many man-made systems such as: social, communication, manufacturing, financial and others. It is important to study the physical systems, because the human-being always try to intersect the natural system by his created artificial systems to replace or control some natural systems. Living and Man-made systems have to work in unlimited coordination to achieve the complete mechanism of the universe. In this respect cost, convenience, energy, safety and maintainability are essential factors for the existence or the convention of natural system to a man-made system.

Intersection of systems and pollution: The intersection between a man-made and a natural system disturbs the regularity of the natural system and finds sub-systems that work inefficiently with other components of the main system. This situation cause sort of pollution due to lack of integration among the components of the new and the original systems. In fact, this intersection affects not only a special natural system but also the other systems. The next example presents the "transportation system" as one of the man-made systems and its interaction relations with other natural systems as well as its adverse effects on them Fig.2. (Saiwa, 1992).

The intersection of the transportation system with the Geological, living, Molecular, and Stellar system which work within the universal set. These intersections and its relations represent the whole picture according to the (set theory), taking into consideration that every system has groups of sub-systems and components, and each system is a sub system of general the universal set.

Transportation system affected in a way or another all the other systems as follow:

1-Effect of transportation means on the geological syste: Creation of modern high speed means of transportation, such as cars ...etc; with bad roads lead to construction of a new ways net adequate to the new creation. This situation require destruction of forests, mountains and other natural elements which have adverse effects on living organisms and nature. New

roads attract people to build new communities which cause new disturbances, pollution and troubles to the natural system.

2-Effect of transportation means on the living system: All living organisms suffer from air pollution. Cars produce carbon oxides, hydrocarbons and nitrogen oxides which have detrimental effects on the respiratory and circulatory systems as well as the mental performance. Accidents of ships and petrol pipes under water cause many dangerous diseases for man and sea organisms. Loud noise, as jet aeroplanes, loudspeakers.. etc. has a stressful effect on the nervous system.

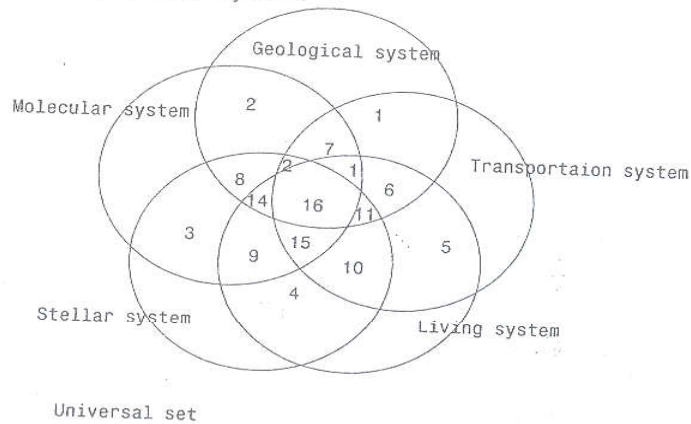


Fig. 2

3- Effect of transportation on the molecular systems: There is a close relation between the chemical composition of atmosphere and the expansion of air transportation either in inner or outer space of the earth. The great progress of the high speed means of transportation and their products of pollution destroy the layer of ozone which protects the earth from ultra violet rays and other universal rays that in turn have bad effects on the climate on the earth and all living organisms.

4- Effect of transportation means on stellar system: The universe has its set and equilibrium system, because our life is a continuous operation of birth and death and conversion of energy forms which belong mainly to the sun, the main resource of life on our planet. These conversion operations are constant and that constancy is the secret of life. As problems exist, the human-being interferes and manipulate the factors of energy in a way can construct with the

rule of constancy and the laws of environment. Thus, it could be shown that the bad use of natural resources of energy can also decrease and disturb the equilibrium in nature. In addition most of industrial products produce some types of pollution.

The second example: the carbon cycle Fig (3). Carbon is the most important single element in the biological realm and the substance that serves as the cornerstone of cell structure. Plant and microbial tissues contain 40-50% on dry weight basis, yet carbondioxide represents only 0.03% of the earth's atmosphere. Co₂ is converted to organic carbon largely by the action of photoautotrophic organisms (the higher green plants on land and the algae in aquatic habitats). Carbon is continually being fixed into organic form by photosynthetic organisms under the influence of light, and once bound the carbon becomes unavailable for use in the generation of new plant life. Therefore it is essential for the carbonaceous materials to be decomposed and returned to the atmosphere for living higher organisms. Upon the death of the plant or animal, microbial metabolism plays the dominant role in the cyclic sequence. The dead tissues undergo decay and are transformed into microbial cells and a vast, heterogeneous body of carbonaceous compounds known as humus or as the soil organic fraction. The cycle is completed and carbon made available with the final decomposition and production of Co₂ from human and the rotting tissues (Alexanser, 1961).

The third example: nitrogen cycle. Fig. (4). Nitrogen is an important element in plant nutrition. It is an essential component of protoplasm in plants, animals and microorganisms. It is also one of the soil nutrients that is lost by volatilization and leaching. Therefore, it requires continual conservation and maintenance. The nitrogen present in the protein of plant tissues is utilized by animals. In animal's body the nitrogen is converted to complex compounds such as ammonium and nitrate which escape to the atmosphere for completing the cycle. Nitrogen is utilized by certain microorganisms, sometimes in symbiosis with a higher plant, which can use it as a nitrogen source for growth. This process "nitrogen fixation" results in the accumulation of new organic compounds in the cell of the responsible organisms (Alexander, 1961).

Air pollution: It includes a wide variety of contaminants which may be classified variously as organic or inorganic, visible, or invisible, submicroscopic, microscopic or macroscopic; particulate or gaseous, and toxic or harmless (American Society of Heating, Refr., & air Condi. Engineers, 1966). Another classification based chiefly on the origin or method of formation of the material consists of: 1- Solid, particulate matter (dusts, fumes and smokes). 2- Liquid, particulate matter (mists and fogs) and 3- Non particulate (vapors and gases). Detection and measurement of air contaminate require a wide range of instrumentation and procedures.

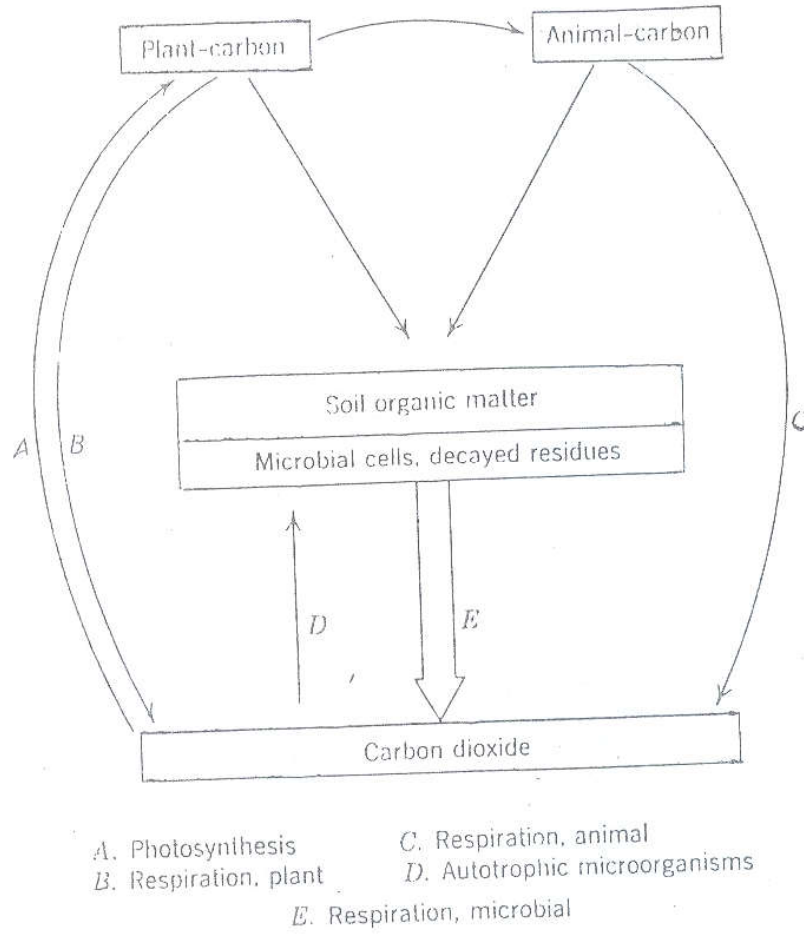


Fig. 3. The carbon cycle (Introduction to soil microbiology; Mart Alexander, 1961).

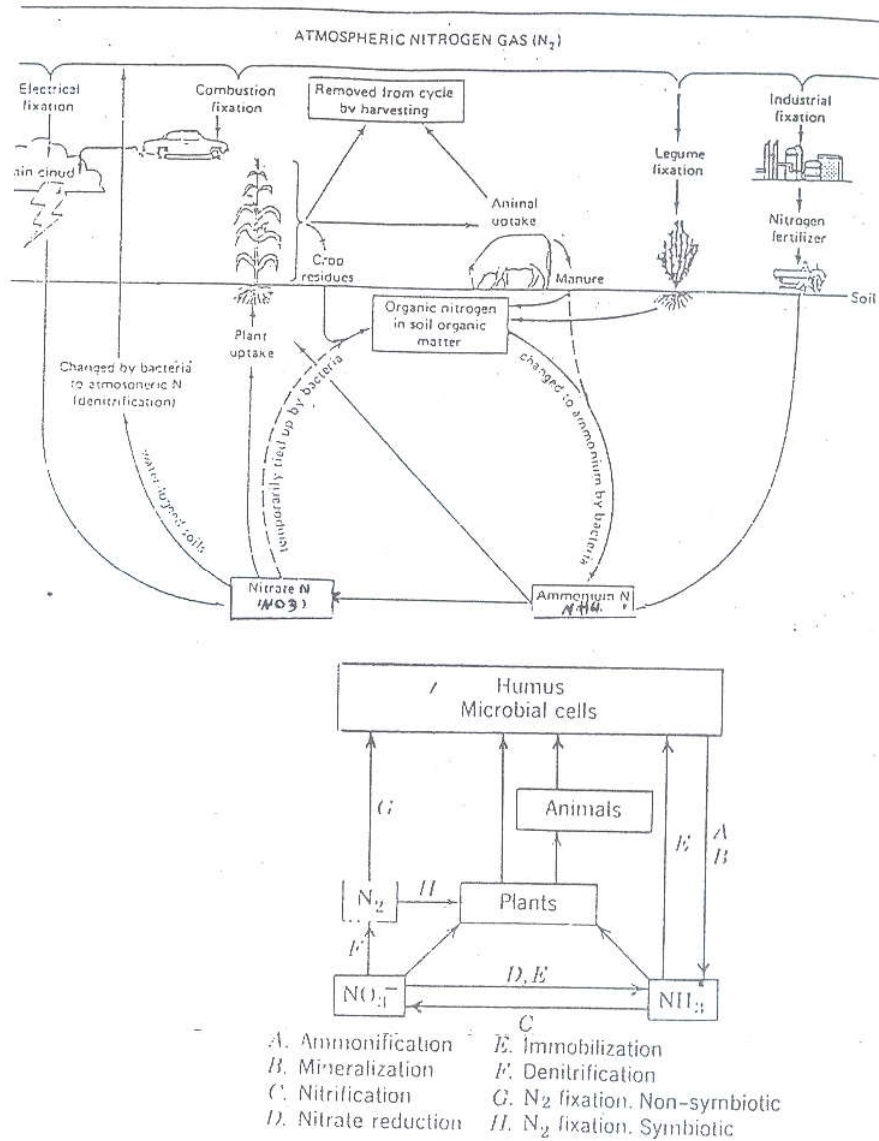


Fig. 4. The nitrogen cycle (Introduction to soil microbiology; Mart Alexander, 1961).

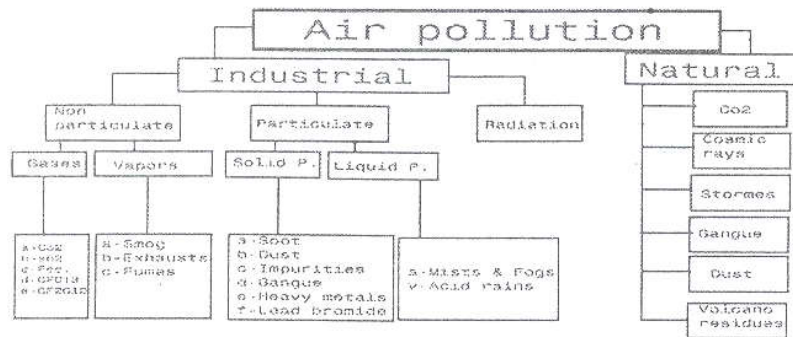


Fig.5

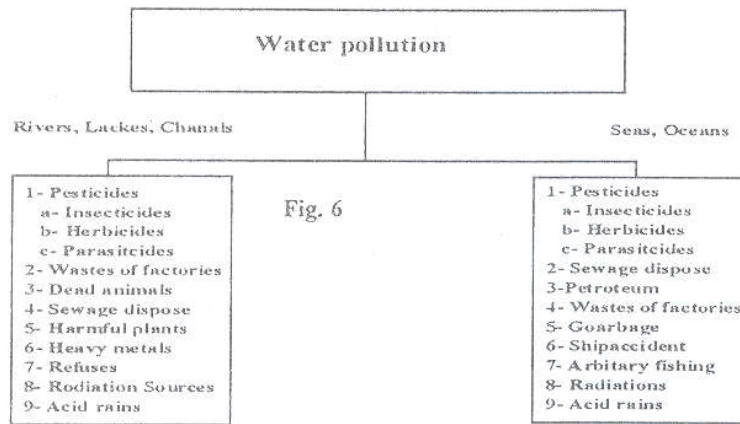
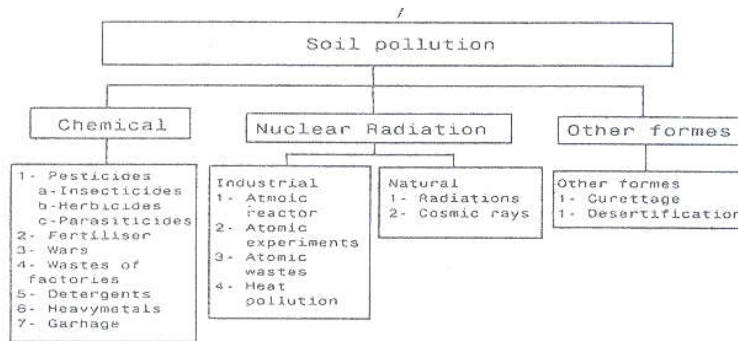


Fig. 6

Fig. 7



Measurement of the concentration may depend upon particle size, droplet size, chemical content, humidity and so on. Some values for vapors and gases that might be found in animal environment are shown in the following table.

Threshold limit concentration of gases and vapors:

Substance	Threshold limit valves (ppm)	Physiological action
Ammonia	100	Irritant
Carbondioxide	5000	Asphyxiant
Hydrogen sulfide	20	Pungent (poison)
Methane	1000	Anesthetic

Particle counters and dust monitor. Highly sophisticated measuring devices, varied in sensitivity from 0.3 μ up to 1000 μ are available to monitor the total number of particles in air or liquid flowing at an adjustable rate for a controlled length of time or to count particles of selected sizes. A dust monitor is a measuring device that collects dust from an air stream for a prescribed length of time (usually 15 min.), records the optical obscuration through a glass collection plate, automatically cleans the collection plate, and repeats the operation continuously. The device is calibrated for known weight and types of dust.

Gases and vapors: Many methods of measuring and detecting gases and vapors in an animal environment have been reported (Scott, 1939 and Day, et al., 1965). Gas chromatography (Littlewood, 1962) is a quick method for analyzing gases.

McArthur and Miltimore (1961) separated different varieties of gases in ruminant by using a thermal conductivity detector. Many of the portable gas detectors can give rapid and accurate measures of small concentration of gases.

Odors: they are the materials that excite the sense of smell; the olfactory system. For a substance to be odorous, it must be in a gaseous or vaporous state. Odor can be characterized by concentration and quality but it is difficult to be measured since the human olfactory system must be considered as the final indicator. For this reason odors-sniffing panels are the main method of measuring odors

Some diseases due to exposure to the environment and pollution:

- calves born in late autumn, winter or early spring are more likely to develop disease than calves born during the summer. (Moll, 1965).
- Cold, wet weather and unsanitary conditions being more likely to develop a dysentery in the newborn lambs. (Marsh, et al., 1938).

- Liver glycogen in the newborn piglets are lost at high (40°C) and low (14°C) environmental temperature. (McCance, et al., 1959).
- Beef and dairy cattle fed pasture during winter being more susceptible to infection by hypomagnesimic tetany disease. (McBarron, 1952).
- Prolonged exposure to high environmental temperature especially with high humidity cause obvious signs of some disorders and diseases such as panting, salivation, increased heart rate convulsion and coma-death may occur in most species after a prolonged body temperature of 41.5°C. (A Guide, 1971).
- The sensitivity of the karatoconjunctivitis (pink eye) in cattle exposed to ultraviolet light (2800-3200A) increased. (Hughes, et al., 1965).
- Exposure ruminants to direct sunlight for several hours/day may result in photosensitization disease. This disease has some side effects such as inflammatory edema, exudation and necrosis. The disease may also be inherited from generation to another as in sheep. (Klaire, et al., 1944).
- Among factors responsible for vitamin D - deficiency is the insufficient exposure of young animals to ultraviolet light (A Guide, 1971).
- Emission of fluorides from industrial operation into the air has a detrimental effect on the animal production. (Mitchel, 1942).
- Leakage of petrol oil from ships created a serious oil pollution problem causing a remarkable deterioration in fish resources. (A Guide, 1971).

Little heed about pollutants in Egypt: (Arnaoat, 1995)

From available data in the literature it could be concluded that increasing lots of different types of pollutants are produced yearly in Egypt. Some of those pollutants could be presented as follows.

- Air, water and solid pollutants were estimated in 1990 to be 32.25, 27.5 and 110 million tons/day.
- Cement factories as in Hellwan (Cairo), Beni Sweif and Beni Ghaleb (Assiut) governerates produce a lot of solid wastes disperse daily into air. For example Hellwan produces over 2 tons of these wastes. This value is four times that of the international permissible levels.
- Long time ago Hellwan was one of the most famous recreation cities in Egypt. Nowadays, it became as a huge industrial city polluted with dust, smokes, fumes ... etc, which in turn increased the incidence of respiratory diseases to about 50% of population.
- Falling dusts in Maadi-Tepeen areas increased from 145 tons/mill/month to 371 tons/mill/month in 1978.
- The average concentration of smokes blown from different factories in Cairo reached 12 µg/square meter versus 5 µg/ square meter in Dokki (Giza).
- The average fall dusts in Cairo through the fiftieth windy storm (Al-Khamasin) ranges from 1-2 tons /square meter/hour.

- Sewage and over 700 factories including trace elements are disposed in 45 drains as well as the Nile.
- Leakage of petrol oil from ships polluted and poisoned huge areas of the seas and oceans water which in turn deteriorate the fish resources.
- The use of pesticides, insecticides and chemical fertilizers resulted in soil and plant pollution.

CONCLUSION

The most important items in this guide could be presented as follows:

- Environmental pollution is one of the most serious problems facing the world.
- The improper and polluted environment has significant adverse effect on human and animal health causing pronounced economical losses especially in the developing countries.
- Protection and prevention environment from pollution become very essential. This could be achieved through applying integrative scientific programs.
- Team research under controlled environment as well as sufficient funds required for initiating integrated research programs to protect environment from pollution have to be supported.

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