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Editorial

This journal provides a forum for innovative trends and issues connected to science education. Focuses on advancing new visions, understanding, and is at the forefront of the field is found in this journal. Accordingly, authoritative works based on empirical research and writings from disciplines external to science education, including historical, philosophical, psychological and sociological traditions, are represented here. It requires students to engage in and appreciate how contemporary social debates are informed by scientific and technical knowledge. IJCS, as one of the premier journal in the field, fosters that understanding by publishing the latest significant findings of research, the description of new techniques, and up-to-date authoritative and critical reviews over the whole field of science and its applications.

We are very pleased to have very good editorial board and advisory board which provide the IJCS an edge over other journal in the same filed. We invite you to embark on this journey by prompt publication in all fields of sciences. We hope that you will learn as much from this issue as we did from each other in creating it.

—*Editors*

Contents

Ecology and Taxonomy of the Wall Flora of Chapra Town, Bihar, India

Anurag Kumar and H.K. Verma

(PG Dept. of Botany JPU, Chapra)

Introduction

The usual substratum of flora is soil from which the plants derive their nutrients. It has been noticed in the present work that flora used to grow on different walls of Chapra town with the scarcity of water and soil. It has also been noticed that annual plants growing on walls have short vegetative as well as reproductive periods while that of perennial plants growing on walls have short vegetative and reproductive phase but long dormant phase. The permeating plants i.e. trees growing on walls have short shoot system due to scarcity of water and nutrients, while long root system suggests search of water and firm anchorage of plants (permeating). The present paper deals with the study of ecology and taxonomy' of the wall flora of chapra town.

The chapra town is the headquarters of Saran district of Bihar state in India. It has an area of 184.87 Sq km and has population of 27,570 (2001 census). It is located in between 25° 39' N to 26° 30' N latitude to 85° 24' E to 85° 15'E longitude in north western part of Bihar (India). Muzaffarpur and Vaishali surround it on the north, Bhojpur and Patna on the south, Vaishali and Patna on the east while Balia (U.P.) and Siwan on the west. It shows higher altitude on the west (61.5m height from sea level) and shows gradual slope from west to east:

The climate of Chapra town is of monsoon type. Chapra town has three distinct and consecutive seasons

(i) Hot season (from March to Mid June) (PRM)

(ii) Rainy Season (from mid June to early October) (M)

(iii) Cold season (from early October to February) (PM).

Annual average rainfall has been recorded as 1000 mm/Hg average . It's temp, varies from 23.1°c to 35.2°c. The three main rivers of this area are the Ganga, the Saryu and the Gandak. During the present study walls of Chapra town have been classified or, the basis of their age

(a) Walls built by old house building materials and are more than 100 years old e.g. temples mosque etc. (O.W.)

(b) Walls built by modern building materials which are less than 100 years old e.g. houses, bridges colleges etc. (M.W.)

(c) Walls built by mud and non standard materials e.g. mud walls, hut, embankment brick dumps etc. (N&W)

For the sake of convenience Chapra town has been divided into following zones:

1. Gudari-Nabiganj area
2. Bhagwan Bazar area
3. Daroga Rai Chowk area

4. Katra-Daulatganj area
5. Dahiyawan-Gandak Colony Area
6. Roopganj-Karim Chowk Area
7. Bara-Chota Telpa area
8. Bhikhari Thakur Chowk- Airstrip Area
9. GarkhaDhala-Mohan Nagar Area.
10. Sadha-Prabhunath Nagar area
11. Salempur-Sadhanapuri area.

Regarding wall flora, several workers like Pavlova & Tonkov (2005), Willis and Burkill (1893) have given significant records of wall flora of developed countries. In India, Several workers like Varshney (1964 -1966,1967, 1968), Bimal et. al. (1991) have given significant records in this field. Still information on wall flora is rather meagre. Therefore, the present work may serve as a basic source data for future ecological and taxonomic work on the wall flora of Chapra town.

Materials and Methods

From the 11 zones of chapra town plants were collected between 1999 to 2006 with critical notes on habit, habitat, seasonal variation, nature of substratum, vegetational zone mode of dispersal, life forms and types of formation.

Results and Discussion

During present study 72 species of 66 genera under 41 families have been studied using various parameters used in following table. During present study ten dominant families having 2 or more genera are as follows:

Asteraceae (7)

Amaranthaceae (4)

Euphorbiaceae (4)

Poaceae (4)

Malvaceae (3)

Solanaceae (3)

Menispermaceae (2)

Vitaceae (2)

Verbenaceae (2)

Lamiaceae (2)

Families having 2 or more species are as follows:

Moraceae (4)

Cyperaceae (3)

Cleomaceae (2)

The most common species found on walls of Chapra town are *Lindenbergia macrostachya, Amaranthus viridis, Oxalis corniculata, Azadirachta indica, Mollugo pentaphylla, Catharanthus roseus, Boerhavia diffusa, Achyranthus aspera, Ficus religiosa etc.*

With the advent of monsoon many flora have been found growing on the walls of Chapra town. Some of them continue their life cycle during post monsoon period. Some of pre monsoon flora continue its life cycle during monsoon period. Hence monsoon period shows a large variety of vegetation on walls, some of them are in vegetative stages while some are in flowering and fruiting condition & rest are in dormant phase.

Most of the plants have been found growing throughout the year on the walls. These are *Calculus hirsutus, Argemone mexicana, Azadirachta indica, Ficus religiosa etc. Pentapetes phoenicea* have been found growing only after monsoon period. While *Tinospora cordifolia, Pulicaria crispa, Ruellia tuberosa* have been found growing during pre monsoon period and remain up to monsoon period. *Cleome gynandra, Bombax ceiba, Corchorus aestuens, Vitis vinifera* etc. have been re-stricted to premonsoon period only while *Impatiens*

balsamina, Ammania baccifera, Tridax procumbens etc. have been found growing even after monsoon period.

Out of 72 species 6 species are trees found growing on walls and rest 66 species are herbs found growing on walls. The trees have long root system for want of water and nutrients, as wall is not the usual substratum for growth of plants. It's shoot system is stunt due to lack of nutrients even then they are found permeating on walls. Most of the wall flora are weeds and some are agricultural or garden escapes.

It has been found that 68 plants are growing on OW and constitute 94.44 %, 40 plants have been found growing on MW and constitute 55.56%, while 24 plants are found growing on NSW and Constitute 33.33% of the flora.

On the basis of vegetational zone 65.28% plants have been found growing on HT and 50% plants have been found on VF while 51.39% plants have been noticed growing on WB.

In the present work 50% plants were found disseminating by wind, 34.72% plants were found disseminating by birds, 11.11% autonomously, 2.78% by animals and 1.39% by men..

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Evaluation of the Success of Herbal Extracts in Sand Fly (Phlebotomus Argentipes) Control Over DDT. (Dichlorodiphenyl Trichloroethane)

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Abstract

Phlebotomus argentipes (Sand flies) are the vector of Leishmania Donovan. It is causative organism of visceral Leishmaniasis which is one of the most dreadful disease in west Bengal and Bihar.

DDT. has been extensively used in the pest for insect control, in house hold, community & agriculture. DDT has also been proved very toxic and hazardous for the ecosystem.

Extracts of four plants viz. Azabirachta indica, Ocimum sanctum. Alium sativum and Aloe-vera have been sprayed independently on the various life-stages of sand flies in natural and laboratory conditions.

The results regarding the insecticidal and larvicidal properties of these herbal extracts have been found every enthusiastic as the LC50 of these extracts have been recorded more effective than that of DDT. in context with the Phlebotomus Sand flies.

These herbal extracts are even ecofriendly with lowest probability of any type of resistance development in sand flies.

Key words

Phlebotomus argentipes, resistance, residual effects, ecosystem, DDT.

Introduction

Through Phlebotomus argentipes, the vector of Kala-azar, has been found in different states in all over India, this disease remains to be endemic in Bihar and West Bengal mainly.

Mass spraying of DDT has been used to control the sand flies collaborated with National Malaria control programme as the vector has been found highly susceptible to indoor spraying of DDT. earlier. However continued spraying of DDT. has been seen to result in the precipitation of DDT resistance in sand flies in various areas of Bihar and West Bengal. All over DDT. is universally marked as a hazardous chemical for ecosystem.

In the past two decades, various indigenous plants and its extracts in addition of A. indica have been tested as mosquito repellent and insecticidal values against life stages of mosquitoes. Extracts of Mentha piperita (Ansari et.al. 1999), Solarium nigrum) Singh et.al., 2001). A indica (Batra et.al., 1998), 0 sanctum have provided more than 95% positive results against Culex and Anopheles larvae and adults.

In the present piece of research work, some of these plants have been used for

monitoring the insecticidal properties against the phlebotomous sand flies.

The residual effect of DDT indoor spray has been found remaining only for two weeks (Vyokov, 1980) but the residual effects of these herbal extracts last even for more than one month. These parameters clearly prove the supremacy of herbal insecticides over DDT.

Materials and Methods

Phlepotomus argentipes were collected from the endemic districts in North Bihar by using suction tubes. The collected sand flies were transferred into the special container mode of plastic and then put into the wooden cage covered with fine organdy cloth.

In every cage random mating of sand flies were facilitated and eggs were collected in separate containers. Similarly all the four larval instars were kept in separate containers high humidity over 80% was maintained artificially.

The larvae were fed with special mixture made by mixing sand, rabbit feaces, yeast powder with few drops of rabbit blood. Larval food was autoclaved & before application. Thus a good colony of all the life stages of sand flies was maintained in the laboratory.

Fresh leaves and soft shoots were selected for the preparation of extracts. These parts were cut and washed thoroughly in distilled water first and dried for few minutes and then crushed inside the juicer and filtered.

This extract was treated as N and normal distilled water was added to change its concentration. Similarly for obtaining the essential oil, soft parts of the selected plants were crushed in presence of alcohol and centrifuged.

The supernant was then put water bath maintaining the temperature up to 50^0C so that alcohol was evaporated leaving the essential oil normal glycerol was added in the essential oil to obtain various concentrations.

Various concentrations of DDT. were also maintained with help of distilled water. All these extracts were sprayed on separate containers for further observation LC5o of different extracts were calculated indoor spraying of these extracts and DDT. were also used the houses of selected endemic areas for monitoring the residual effects of these extracts as well as DDT.

Results and Discussions

Through the table it is very clear that the strengths of larvicidal and insecticidal properties of aqueous extracts of A indica 0 Sanctum and Aloevera are more than that of DDT although the strength of A. sativum is somewhat less than DDT, but very near to it.

Essential oils of all these plants have been found more effective than DDT., First and second larval instars but the degree of affectivity has been monitored more or almost equal of the DDT.F-test and test of significance also show the superiority of plant extracts over DDT.

In case of adults the scenario is some what different and here DDT. has been recorded more effective than any aqueous extracts of plants but the essential oils project almost similar strength as DDT. In this case again test of significance and test result prove the strength of plant extracts and DDT almost equal.

Table 1. Mean LC5o for different spraying materials.

Spraying Material	*Mean Value of LC 50*				
	Ist Larval in Star	*2nd Larval in Star*	*3rd Larval in Star*	*4th Larval in Star*	*Adult*
DDT	24.26% (v/V)	24.58% (v/V)	26.34% (v/V)	26.45% (v/V)	21.96% (v/V)
A. indica (Aqu Ext)	22.18% (v/V)	23.24% (v/V)	25.54% (v/V)	26.05% (v/V)	20.47% (v/V)
A indica (Ess. Oil)	14.22% (v/V)	16.27% (v/V)	20.17% (v/V)	20.84% (v/V)	19.02% (v/V)
O. sanctum (Aqu ex)	21.84% (v/V)	21.21% (v/V)	23.50% (v/V)	24.21% (v/V)	27.24% (v/V)
O. sanctum (Ess.oil)	12.25% (v/V)	11.26% (v/V)	14.08% (v/)—	14.76% (v/V)	21.49% (v/V)-
A. sativum (Aqu. Ext)	26.34% (v/V)	28.11% (v/V)	28.92% (v/V)	30.42% (v/V)	28.84% (v/V)
A. sativum (Ess. Oil)	15.47%(v/V)	17.84% (v/V)	19.43% (v/V)	21.01% (v/V)	20.05% (v/V)
Aloe-vera (Aqu. Ext)	18.25% (v/V)	22.48% (v/V)	24.42% (v/V)	24.47% (v/V)	29.84% (v/V) J
Aloe-vera (Ess. Oil)	11.43% (v/V)	13.05% (v/V)	15.62% (v/V)	16.2 1% (v/V)	19.22% (v/V)

Table-2: Days of residual effects in indoor sprying of various effects.

Sprayed Materials	*Days of residual effects*
DDT	14-17 days
A. indica (Aqu. Ext)	32-37 days
A. indica (Essnt Oil).	41-45 days
O. sanctum (Aqu. Ext)	21-24 days
O. sanctum (Essnt. Oil)	26-31 days'
A. sativum (Aqu.Ext)	22-27 days
A. sativum (Essnt. Oil)	24-28 days
Aloe-vera (Aqu. Ext.)	30-34 days
Aloe-vera (Essnt. Oil)	35-42 days

Residual effects are showing the time of the strength of sprayed materials even after the day if indoor spray on the walls of dwellings of insects in naturals condition.

The quality of any insecticide is not only depending over the LC 50 but is also depends on the residual effects. Through the above table, it has been clear that on the account of residual effect, extracts of A. indica are found having maximum strength followed by aloe-vera, O. sanctum and A. sativum.

It is strongly proved that the various extracts of these selected plants are for more effective than DDT in respect to the residual effect value.

Above all there is not any single evidence of toxicity of these selected plant extracts against aqueous and terrestrial for flora and fauna including human.

These extracts have been found toxic mostly in case of harmful insects come under Diptera.

These extracts have no hazard on the ecosystem and environment so on account of their effects and eco-friendly nature these herbal insecticides are boon for the area of insect control. No doubt the future integrated insect control programs would revolve around these herbal extracts and their will be no space for DDT in such areas.

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Chemical Fertilizer or Organic Fertilizer

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A chemical fertilizer is defined as any inorganic material of wholly or partially synthetic origin that is added to the soil to sustain plant growth. Many artificial fertilizers contain acids, such as sulfuric acid and hydrochloric acid, which tend to increase the acidity of the soil, reduce the soil's beneficial organism population and interfere with plant growth.

Generally, healthy soil contains enough nitrogen-fixing bacteria to fix sufficient atmospheric nitrogen to supply the needs of growing plants. However, continued use of chemical fertilizer may destroy these nitrogen-fixing bacteria. Furthermore, chemical fertilizers may effect plant health. For example, citrus trees tend to yield fruits that are lower in vitamin C when treated with high nitrogen fertilizer. Fungus and bacterial disease resulting from the lack of trace elements in soil regularly dosed with chemical fertilizers is not uncommon. This lack of vital micronutrients can generally be attributed to the use of chemical fertilizers.

On the other hand organic fertilizer such as manure treated with CBPA adds nutrients to soil, increases soil organic matter, improves soil structure and tilth, improves water holding capacity, reduces soil crusting problems, reduces erosion from wind and water, improves water holding capacity and improves buffering capacity against fluctuations in pH levels.

Chemical Fertilizer

An Overview

Agriculture is an empowered arena nowadays. With advancement of technology, new machines related to cultivation, harvesting , etc. are being introduced to enhance the productivity. Now that everything has been taken care of, how can one remain behind to promote the real growth.

Today when the whole life cycle of every plant is in human hands, each step of growth is studied deeply and no one is ignorant of the rising nutrient demands of the plants. Science has evolved with each progressive day and the agricultural front has not been left untouched. New synthetic degradable and non degradable fertilizers have been duly introduced looking at the hastened demands of food.

Today productivity has been increased by a major proportion and the entire credit goes to fertilizers. Fertilizers are a superior and advanced means to promote and enhance productivity. All the fertilizers have been categorized into several types depending on their constituents, strength and various other features. However each fertilizer contain adequate amounts of the needed chemicals, minerals and elements to ensure a healthy and fast growth.

A fertilizer is essentially a blended mixture of one or more organic or inorganic compounds or chemicals needed by the plants for enhanced and nourished growth. Based on these constituent components, fertilizers have been divided in the following categories:

Organic Fertilizers

Organic fertilizers constitute of decayed or partially decayed organic material which

is to a great extent bio degradable. It includes animal waste and rotten green manure or also any natural elements which adds to the humus content of the soil and nourishes it is termed manure or fertilizer. It is used by the plants with the help of the microorganisms in the soil which decompose the matter releasing the nutrients and thus making it soluble and ready to be taken in by the plants.

Certain examples of organic fertilizers are: Compost, Manure, fish and bone meal, etc.

Inorganic Fertilizers

A chemical Fertilizer is known as inorganic fertilizer when its constituents are originated through synthetic means making them non-degradable. To sustain reliable and hastened growth, these fertilizers are added to the soil. Generally these fertilizers are manufactured keeping in mind the natural elements needed by the plants for healthy and convenient growth. They contain one or more of the essential growth nutrients such as nitrogen, phosphorus, and potassium and various others. Once added to the soil, these nutrients fulfil the required demands of the plants and provide them the nutrients they naturally lacked or helps them retain the lost nutrients.

How does the Chemical Fertilizer work?

Unlike the longer time-period taken by organic fertilizers to work on the growth of the plants, Chemical fertilizers work in a hastened manner and work their appropriate actions on the plants in the required time-frame.

Trusted for their fastened and sure action, these chemical fertilizers are formulated and churned in precisely measured concentrations and combined with suitable elements and acids meant for different crops and plants. The suitable quantities ensure a well formulated action on the plant growth in the estimated time. Various other factors are also kept in mind while using these fertilizers. These factors include:

- The type of crop
- Growing condition
- Soil texture
- Season, etc.

Listed below are a few of the most prominently used chemical fertilizers:

- Anhydrous ammonia: A gas which contains 82% nitrogen.
- Urea: A solid compound containing 46% nitrogen gas.
- Superphosphate: Proportioned amounts of nitrogen and phosphate
- Diammonium phosphate: Contains 18% nitrogen and 46% phosphate.

How to apply the chemical fertilizers?

As these constitute of several measured quantities therefore it is essential to keep in mind the correct procedure of applying the fertilizers so that not even a little amount goes wasted and also to ensure that sufficient quantities reach the roots of the plants. Following are a few tips that can be taken care of:

- Spread the fertilizer over the soil surface or apply it while plowing the land to enable it go underground and get deeply dissolved in the soil
- Apply it where the seeds will be sown or spread it once the plants sprout up and repeat the same procedure twice before harvesting.

Caution: the fertilizers are harmful therefore avoid any physical contact and tie your mouth with a clean cloth and wear gloves in case of applying it with hands. Inhalation or consumption might cause severe injuries , allergies and death also.

- Advantages of Chemical Fertilizers over organic fertilizers
- Chemical fertilizers provide measured quantities of required nutrients.

They work faster than the organic fertilizers. The elements are in the easily soluble form and thus are taken in by the soil immediately while organic fertilizers wait for the microorganisms to work on them and thus takes time.

Disadvantages

- Eutrophication: Overgrowth of aquatic vegetation and degradation of water quality due to extra nitrogen accumulation
- Increased acidity: Many chemical fertilizers are composed of acids like sulphuric acid and hydrochloric acid and these acids decrease the soil's quality and heightens the acidity which further registers a bad impact on the plant growth.
- Loss of bacteria: The natural nitrogen fixing bacteria, rhizobium suffers great blows from the excessive usage of chemical bacteria.

Certain plants are hampered due to excessive dozes of the chemical fertilizers so much so that they also tend to cease growing and yield fruits.

However, organic fertilizer might work slower but they leave an everlasting impact on the soil texture and improves the water holding capacity of the soil, regains its fertility and prevents soil erosion.

What is an Organic Fertilizer?

Organic fertilizers are made from naturally occurring substances, and include by-products or waste remains of the animals. Dead plants and dead animal remains are also often used as fertilizers in organic farming. They are naturally chemical-rich and contain high amounts of nitrogen, phosphorus and potassium (NPK).

What is a Chemical Fertilizer?

The main difference between a chemical fertilizer and an organic fertilizer is that the chemical ones come out of a lab and the organic one comes from living beings. A chemical fertilizer is synthetically prepared to include the vital nutrients that are necessary for the plant growth process. All chemical fertilizers contain the normal NPK requirement and any other nutrients as required.

Chemical Fertilizer vs Organic Fertilizer

What are the benefits of Organic Fertilizers?

Production: Chemical fertilizers are man-made and organic fertilizers are made by natural processes.

Effect on Biological Activity: Chemical fertilizers kill the microorganisms in the soil. It is one of the advantages of organic fertilizers that they boost microbial activity in the soil. These microbes help in degenerating the complex compounds present in the organic fertilizers.

Effect on Soil: Overuse of fertilizers is often a problem as excess nutrients are neither good for the overall composition of soil nor are they good for the plant. Organic fertilizers may also have a problem of overuse, but it is a slow nutrient releasing material, so the nutrients will anyway take some time to get absorbed.

Effect on Environment: It is one of the greatest advantages of organic fertilizers that they are easily available in nature, in plenty and with almost no adverse effect on the environment. Chemical fertilizers on the other hand might have the problem of nitrogen components seeping into groundwater streams or otherwise into the nearest lake or river and causing pollution.

Price: Organic fertilizers are much cheaper compared to their chemical counterparts as they are easily available in

nature and only require packaging. Chemical fertilizers need extensive research and production work making them much more expensive.

What are the Benefits of Chemical Fertilizers?

Composition: One of the benefits of chemical fertilizers is that it is custom-made for your requirement. Now if your soil is rich in nitrogen and potassium, what you need is a fertilizer that will take care of the phosphorus deficiency. Chemical fertilizers will give you the option of using phosphorus-rich fertilizers.

Fertility: While organic fertilizers have a low NPK ratio, the chemical ones enjoy a very high ratio of the same. So if you have a very unproductive soil, chemical fertilizers are what you need as they have an NPK ratio of nearly 60% while the most fertile of organic fertilizers can give only about 14%.

Release time: Organic fertilizers may take more time to release the nutrients as they need some microbial activity to get them working. Chemical fertilizers get cracking instantly and release the essential nutrients into the soil.

Thus we now know the advantages and disadvantages of organic fertilizers and chemical fertilizers. This will help us solve the old chemical fertilizer vs. organic fertilizer dilemma once and for all.

Using Chemical Fertilizer

There are many different types of chemical fertilizer. They are made with a mixture of different chemicals, designed to be strong and powerful as a way of helping our garden. However, this mix can be quite toxic, which is what began to fuel the chemical fertilizer vs organic fertilizer debate.

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The New Technological Advances of Reproduction in Mammals

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Production of new individuals along a leaf margin of the air plant, *Kalanchoë pinnata*. The small plant in front is about 1 cm tall. The concept of "individual" is obviously stretched by this asexual reproductive process.

Reproduction is the biological process by which new individual organisms are produced. Reproduction is a fundamental feature of all known life; each individual organism exists as the result of reproduction. The known methods of reproduction are broadly grouped into two main types: sexual and asexual.

In asexual reproduction, an individual can reproduce without involvement with another individual of that species. The division of a bacterial cell into two daughter cells is an example of asexual reproduction. Asexual reproduction is not, however, limited to single-celled organisms. Most plants have the ability to reproduce asexually.

Sexual reproduction requires the involvement of two individuals, typically one of each sex.

Asexual Reproduction

Asexual reproduction is the process by which an organism creates a genetically-similar or identical copy of itself without a contribution of genetic material from another individual. Bacteria divide asexually via binary fission; viruses take control of host cells to produce more viruses; Hydras (invertebrates of the order *Hydroidea*) and yeasts are able to reproduce by budding. These organisms do not have different sexes, and they are capable of "splitting" themselves into two or more individuals. Some 'asexual' species, like hydra and jellyfish, may also reproduce sexually.

For instance, most plants are capable of vegetative reproduction—reproduction without seeds or spores—but can also reproduce sexually. Likewise, bacteria may exchange genetic information by conjugation. Other ways of asexual reproduction include parthogenesis, fragmentation and spore formation that involves only mitosis. Parthenogenesis is the growth and development of embryo or seed without fertilization by a male.

Parthenogenesis occurs naturally in some species, including lower plants (where it is called apomixis), invertebrates (e.g. water fleas, aphids, some bees and parasitic wasps), and vertebrates (e.g. some reptiles, fish, and, very rarely, birds and sharks). It is sometimes also used to describe reproduction modes in hermaphroditic species which can self-fertilize.

Sexual Reproduction

Sexual reproduction is a biological process by which organisms create descendants that have a combination of genetic material contributed from two (usually) different members of the species. Each of two parent organisms contributes half of the offspring's genetic makeup by creating haploid gametes. Most organisms form two different types of gametes. In these

anisogamous species, the two sexes are referred to as male (producing sperm or microspores) and female (producing ova or megaspores). In *isogamous species* the gametes are similar or identical in form, but may have separable properties and then may be given other different names.

For example, in the green alga, *Chlamydomonas reinhardtii*, there are so-called "plus" and "minus" gametes. A few types of organisms, such as ciliates, have more than two kinds of gametes. Most animals (including humans) and plants reproduce sexually.

Sexually reproducing organisms have two sets of genes for every trait (called alleles). Offspring inherit one allele for each trait from each parent, thereby ensuring that offspring have a combination of the parents' genes. Having two copies of every gene, only one of which is expressed, allows deleterious alleles to be masked, an advantage believed to have led to the evolutionary development of diploidy (Otto and Goldstein).

Allogamy

Allogamy is a term used in the field of biological reproduction describing the fertilization of an ovum from one individual with the spermatozoa of another.

Autogamy

Self-fertilization (also known as autogamy) occurs in hermaphroditic organisms where the two gametes fused in fertilization come from the same individual. They are bound and all the cells merge to form one new gamete.

Mitosis and Meiosis

Mitosis and meiosis are an integral part of cell division. Mitosis occurs in somatic cells, while meiosis occurs in gametes.

Mitosis The resultant number of cells in mitosis is twice the number of original cells. The number of chromosomes in the daughter cells is the same as that of the parent cell.

Meiosis The resultant number of cells is four times the number of original cells. This results in cells with half the number of chromosomes present in the parent cell. A diploid cell duplicates itself, then undergoes two divisions (tetraploid to diploid to haploid), in the process forming four haploid cells. This process occurs in two phases, meiosis I and meiosis II.

Same-sex Reproduction

In recent decades, developmental biologists have been researching and developing techniques to facilitate same-sex reproduction. The obvious approaches, subject to a growing amount of activity, are female sperm and male eggs, with female sperm closer to being a reality for humans, given that Japanese scientists have already created female sperm for chickens. More recently, by altering the function of a few genes involved with imprinting, other Japanese scientists combined two mouse eggs to produce daughter mice.

Reproductive Strategies

There are a wide range of reproductive strategies employed by different species. Some animals, such as the human and Northern Gannet, do not reach sexual maturity for many years after birth and even then produce few offspring.

Others reproduce quickly; but, under normal circumstances, most offspring do not survive to adulthood. For example, a rabbit (mature after 8 months) can produce 10–30 offspring per year, and a fruit fly (mature after 10–14 days) can produce up to 900 offspring per year. These two main strategies are known as K-selection (few offspring) and r-selection (many offspring). Which strategy is favoured by evolution depends on a variety of circumstances. Animals with few offspring can devote more resources to the nurturing

and protection of each individual offspring, thus reducing the need for many offspring. On the other hand, animals with many offspring may devote fewer resources to each individual offspring; for these types of animals it is common for many offspring to die soon after birth, but enough individuals typically survive to maintain the population.

Other Types of Reproductive Strategies

Polycyclic animals reproduce intermittently throughout their lives.

Semelparous organisms reproduce only once in their lifetime, such as annual plants. Often, they die shortly after reproduction. This is a characteristic of r-strategists.

Iteroparous organisms produce offspring in successive (e.g. annual or seasonal) cycles, such as perennial plants. Iteroparous animals survive over multiple seasons (or periodic condition changes). This is a characteristic of K-strategists.

Asexual vs. Sexual Reproduction

Organisms that reproduce through asexual reproduction tend to grow in number exponentially. However, because they rely on mutation for variations in their DNA, all members of the species have similar vulnerabilities. Organisms that reproduce sexually yield a smaller number of offspring, but the large amount of variation in their genes makes them less susceptible to disease. Many organisms can reproduce sexually as well as asexually. Aphids, slime molds, sea anemones, some species of starfish (by fragmentation), and many plants are examples.

When environmental factors are favourable, asexual reproduction is employed to exploit sui conditions for survival such as an abundant food supply, adequate shelter, favorable climate, disease, optimum pH or a proper mix of other lifestyle requirements. Populations of these organisms increase exponentially via asexual reproductive strategies to take full advantage of the rich supply resources.

When food sources have been depleted, the climate becomes hostile, or individual survival is jeopardized by some other adverse change in living conditions, these organisms switch to sexual forms of reproduction. Sexual reproduction ensures a mixing of the gene pool of the species.

The variations found in offspring of sexual reproduction allow some individuals to be better suited for survival and provide a mechanism for selective adaptation to occur. In addition, sexual reproduction usually results in the formation of a life stage that is able to endure the conditions that threaten the offspring of an asexual parent. Thus, seeds, spores, eggs, pupae, cysts or other "over-wintering" stages of sexual reproduction ensure the survival during unfavourable times and the organism can "wait out" adverse situations until a swing back to suitability occurs.

Life Without Reproduction

The existence of life without reproduction is the subject of some speculation. The biological study of how the origin of life led from non-reproducing elements to reproducing organisms is called abiogenesis. Whether or not there were several independent abiogenetic events, biologists believe that the last universal ancestor to all present life on earth lived about 3.5 billion years ago.

Today, some scientists have speculated about the possibility of creating life non-reproductively in the laboratory. Several scientists have succeeded in producing simple viruses from entirely non-living materials.

The virus is often regarded as not alive. Being nothing more than a bit of RNA or DNA in a protein capsule, they have no metabolism and can only replicate with the

assistance of a hijacked cell's metabolic machinery.

The production of a truly living organism (*e.g.*, a simple bacterium) with no ancestors would be a much more complex task, but may well be possible according to current biological knowledge.

Lottery Principle

Sexual reproduction has many drawbacks, since it requires far more energy than asexual reproduction and diverts the organisms from other pursuits, and there is some argument about why so many species use it.

George C. Williams used lottery tickets as an analogy in one explanation for the widespread use of sexual reproduction. He argued that asexual reproduction, which produces little or no genetic variety in offspring, was like buying many tickets that all have the same number, limiting the chance of "winning"-that is, producing surviving offspring. Sexual reproduction, he argued, was like purchasing fewer tickets but with a greater variety of numbers and therefore a greater chance of success.

The point of this analogy is that since asexual reproduction does not produce genetic variations, there is little ability to quickly adapt to a changing environment. The lottery principle is less accepted these days because of evidence that asexual reproduction is more prevalent in unstable environments, the opposite of what it predicts.

Natural Vegetative Structures

The rhizome is a modified underground stem serving as an organ of vegetative reproduction, e.g. Polypody, Iris, Couch Grass and Nettles. Prostrate aerial stems, called runners or stolons are important vegetative reproduction organs in some species, such as the strawberry, numerous grasses, and some ferns. Adventitious buds form on roots near the ground surface, on damaged stems (as on the stumps of cut trees), or on old roots. These develop into above-ground stems and leaves.

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Revolution in Genetics Embryology of Fishes

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Embryology is the branch of developmental biology that studies the beginning and early growth of sexually reproducing organisms. This life science speciality focuses primarily on *embryogenesis* (the formation and development of embryos). In humans, the term embryo is traditionally reserved for the first two months of development. After that point, the term "embryo" is replaced by the term "fetus," which then applies until birth. At the beginning of the individual's development, the entity is a single cell. After two months, it has limbs, distinct fingers and toes, internal development, and countless cells. So the term "*embryo*" applies to an individual throughout a vast range of developmental change.

Since the time Charles Darwin published *The Origin of Species*, embryology has been used to support common descent. In fact, Darwin referred to embryological homology as the *strongest single class of facts* that existed to support his theories. A theory later put forth by Ernst Haeckel, known as the biogenetic law, asserted that the evolutionary history of an organism was recapped during embryo development.

Although the biogenetic law is now discredited, in recent years, embryology has reemerged as a tool used by evolutionary biologists that attempt to establish phylogenetic relationships by identifying developmental similarities between taxonomic groups. *Evolutionary Developmental Biology* is a merging of developmental biology and evolutionary biology that is commonly known as "*evo-devo*".

Embryogenesis

Embryogenesis begins when a sperm fertilizes an egg and creates a single cell that has the potential to form an entire organism. In the first hours after fertilization, this cell divides into identical cells. Approximately 4 days after fertilization and after several cycles of cell division, these cells begin to specialize, forming a hollow sphere of cells, called a blastocyst. The blastocyst has an outer layer of cells, and inside this hollow sphere, there is a cluster of cells called the inner cell mass. The cells of the inner cell mass will go on to form virtually all of the tissues of the human body.

Although the cells of the inner cell mass can form virtually every type of cell found in the human body, they cannot form an organism.

Therefore, these cells are referred to as pluripotent, that is, they can give rise to many types of cells but not a whole organism. Pluripotent stem cells undergo further specialization into stem cells that are committed to give rise to cells that have a particular function. Examples include blood stem cells that give rise to red blood cells, white blood cells, and platelets, and skin stem cells that give rise to the various types of skin cells. These more specialized stem cells are called multipotent—capable of giving rise to several kinds of cells, tissues, or structures.

Cleavage

After fertilization, the zygote proceeds immediately to the first cleavage (cell division) and subsequent cell divisions follow rapidly. The zygote is a very large cell, but the first waves of rapid cell division occur without increase in cell volume. The result is a closely bound mass of cells each of more typical cell size. At this stage the cells are called blastomeres, and the organism as a whole is called a morula from the time it has 16 blastomeres to the next stage. As it is undergoing this very rapid cell division, the organism is also migrating down the uterine tube toward the uterus.

Vertebrates, such as humans, have bilateral symmetry and therefore polarity in three dimensions (head-tail, or back-front, and left-right). Establishing polarity is one of the most basic manifestations of emerging specialization. But the egg is roughly spherical, and it is not readily apparent how polarity is established. Although it had been shown long ago that the point of sperm entry determines the plane of first cleavage (and thus subsequent ones) in amphibian eggs, mammals were believed until recently to remain spherically symmetrical until later in development.

Recent data on mammalian zygotes, however, suggests that the point of sperm entry may similarly determine the cleavage plane. Even the first two cells resulting from the first cleavage may have different propensities, which persist through the next divisions as the progeny of one cell tend to become the body of the offspring and progeny of the other cell become the embryo's contribution to the placenta and other supporting structures. The word "fate," however, might be too strong, because the cells of such very early embryos are resilient to perturbations—if one cell is removed, the remaining ones can compensate.

Gastrulation

Gastrulation begins when fluid starts to accumulate between the blastomeres of the morula. The fluid-filled spaces run together, forming a relatively large fluid-filled cavity. At the point when the cavity becomes recognizable, the organism is called a blastocyst. The outer cells of the blastocyst, especially those around the blastocyst cavity, assume a flattened shape. The flattened cells of the exterior blastocyst are the trophoblast. They become the embryo's contribution to the placenta and other supporting structures. On one side of the blastocyst is a group of cells that project inside into the blastocyst cavity; this is the inner cell mass, or embryoblast, and its progeny form the body of the new offspring.

The cells of the inner cell mass can give rise to progeny differentiating into all the types of cells in the adult body, so they are called pluripotent. They have not usually been described as totipotent because, the inner cell mass having already differentiated from trophoblast, the cells of the inner cell mass were believed to be no longer able to give rise to the cells of the trophoblast. Recent work, however, describes culture conditions under which human embryonic stem cells can differentiate to trophoblast cells. Although the new offspring itself develops only from the inner call mass, the trophoblast is not just passive padding. Its progeny are the essential and specialized connection between the embryonic and maternal systems. Embryonic stem cells can be isolated from the inner cell mass.

Organogenesis

The basic structures and relations of all the major organ systems of the body emerge during the fourth through the eighth weeks of embryonic development. First, the embryo folds in several ways so that the flat linear structure distinguished by neural tube

flanked by somites become roughly C-shaped.

The effect of this is to bring the regions of the brain, gut, and other internal organs into their familiar anatomical relations. During the fourth week the neural pores, the ends of the neural tube "zipper," close. First the one at the cranial or head end, which is called the anterior or rostral pore, closes, and later the caudal or tail-ward pore closes. Closure of the neural pores completes the closure of what will become the central nervous system. Also during the fourth week, limb buds become visible, first buds for arms and later for legs. Further, two accumulations of cells along the neural tube become distinguishable: the alar plate and the basal plate.

Cells of the alar plate go on to become mostly sensory neurons, while basal plate cells give rise mostly to motor neurons. Already while the neural tube is closing, its walls along the cranial area are thickening to form early brain structure. Cranial nerves, for example the nerves for the eye and for the muscles of the face and jaw, also are beginning to develop at this time. The embryonic brain develops rapidly in both size and structure especially during the fifth week, and the optic cup that will form the retina of the eye becomes visible as well.

The Rise of Fish Embryology in the Nineteenth Century

It is particularly appropriate to write about the history of fish embryology at this time. History is often said to move in cycles, and this seems to be true of the study of fish development. After a period of prominence during the nineteenth and early twentieth centuries, the study of fish development, except in the hands of a stalwart few such as Oppenheimer and Trinkaus working with Fundulus and Ballard and Devillers working with the trout and other fishes, was overshadowed by developmental studies of other organisms, such as amphibians, the domestic fowl, sea urchins, and assorted invertebrates. For obvious reasons, the study of fish development continued to be pursued by fisheries biologists. With the popularization of the zebrafish Danio rerio as a "model of vertebrate development" and a revival of interest in the relationship between development and evolution, the cycle has come full turn and the study of fish development again has a place in the sun.

My objective is to present an outline of the historical development of the science of fish embryology in the nineteenth century, broadly defined as 1789-1914. My plan is to assess the state of knowledge at the outset of the period, to document the advancement of descriptive embryology of teleosts and elasmobranchs, to consider the rise of comparative embryology of fishes associated with evolutionary studies, and to search out the beginning of experimental, physiological, and biochemical analyses of fish development.

When discussing the development of fishes, it is prudent to recall that fishes are the most diverse group of vertebrates. They should not be treated as a distinct, relatively homogeneous taxonomic unit. Rather, the term "fishes" applies to a grade of ectothermic, aquatic craniates and vertebrates and not to a distinct taxonomic group (Atz, 1985; Bruton, 1990; Nelson, 1994). Extant fishes are divided into five classes, namely Myxini (hagfish), Cephalaspidomorphi (lampreys), Chondrichthyes (cartilaginous fishes), Sarcopterygii, and Actinopteryg. Chondrichthyes contains two taxa, namely the subclass Elasmobranch (living sharks, rays, and skates) and the Holocephal (ratfishes or chimaeras) that diverged at a relatively early time, i.e., the Devonian-

Carboniferous boundary. The class Sarcopterygii (flesh-finned fishes) contains the Actinistia (the living coelacanth), the Dipnoi (lungfishes) and the tetrapod vertebrates. The class Actinopteryg (ray-finned fishes) comprises five groups, namely Cladistia (bichir and reedfish), Chondrostei (sturgeons and paddlefish), Ginglymodi (gars), Halecomorphi (Amia calva, the bowfin), and the Teleostei (teleost fishes). Thus, the five classes of fishes contain eleven major taxonomic groups with an estimated total of 25,000 species. Each class is as distinct from the others as it is from the four other classes of vertebrates. The theme of eleven major taxonomic groups of fishes that is used in the ensuing presentation to emphasize the broad phylogenetic relationships of fishes and other vertebrates, tends, however, to obscure the extraordinary phylogenetic diversity within the teleosts. Teleostei, a monophyletic group, contains 24,000 species in 38 orders and 126 families compared to the 1,000 species, 19 orders, and 56 families in the ten other groups of fishes and the 25,000 species of tetrapods.

Not only are fishes the most diverse group of craniates, but they also display the greatest diversity of life history styles. Most fishes are oviparous, but viviparity is estimated to have independently evolved 42 times in five of the eleven major groups of fishes, all within the Chondrichthyes and Osteichythes. The phylogenetic diversity of fishes is reflected in the diversity and variability of their developmental patterns. Craniate development based on cleavage and subsequent patterns of gastrulation and embryogenesis is holoblastic, meroblastic, or transitional between the two. In holoblastic eggs, cleavage of the ooplasm is complete by the blastula stage. The morphogenetic movements of gastrulation occur in the three-dimensional space of the entire egg and involve most of the embryonic mass. They often lead to the occlusion of the blastocoele. Neurulation is synchronous in time and space. Holoblastic development is considered the less specialized and more primitive craniate developmental pattern because it is characteristic of most echinoderms and non-craniate chordates as well as the more primitive representatives of various craniate lineages, namely lampreys, sturgeons, bichirs, lungfish, and most amphibians.

In the meroblastic egg, most of the yolk mass remains uncleaved at the blastula stage. Morphogenetic movements are confined to a portion of the egg volume, i.e., the blastoderm, and involve only a portion of the embryonic mass. Gastrulation and neurulation tend to be spatially and temporally asynchronous. Evolution of the meroblastic pattern appears to have involved qualitative and quantitative changes in the ooplasm and yolk components of the egg, namely an increase in total yolk content, an increase in the amount of yolk relative to ooplasm, a change in the type of yolk, and a change in the relative disposition of ooplasm and yolk. Not only did the changes in yolk-cytoplasm relationships of the egg affect cleavage patterns, but they also imposed a set of physical or physiological constraints on the morphogenetic movements of embryo formation, the so-called holoblastic-meroblastic barrier. Consequently, new or highly modified patterns of gastrulation and embryogenesis co-evolved with the evolution of the meroblastic egg.

The meroblastic pattern of development appears to have independently evolved in six craniate lineages, namely hagfish, sharks and chimaeras, teleost fishes, the living coelacanth (?), one group of amphibians (the caecilians) and amniotes. In each instance, different morphological patterns of gastrulation and embryogenesis have evolved. Thus, although

meroblastic cleavage is superficially similar in hagfish, elasmobranchs, and teleosts, the morphological events of embryo formation differ considerably. These points and others are summarized in part by Collazo et al. (1994) who present a phylogenetic perspective and an evolutionary scenario for teleost gastrulation. Paradoxically, whether development proceeds according to a holoblastic or meroblastic pattern, the end product is a stereotypic craniate embryo. Recent advances in the study of the molecular basis of embryogenesis should help resolve this paradox.

Moreover, as museum or natural history collections of fishes were made during the course of explorations, specimens of curious, new species of gravid viviparous fishes became available for study, e.g., the four-eyed fish Anableps. In contrast, the eggs of oviparous teleosts are small and not easily collected in the wild. Artificial fertilization of teleost eggs did not begin until the late eighteenth century and the regulated spawning of captive fish species and the rearing of their eggs under "controlled" conditions for scientific purposes was first used only toward the mid-nineteenth century.

In addition, the technology for maintaining fishes in aquaria and the possibility of spawning them under aquarium conditions did not emerge until the mid-late nineteenth century. In passing, one should recall that the Chinese have been rearing captive goldfish, including mutant strains, for over a thousand years. Other factors also influenced decisions to study certain viviparous instead of oviparous fishes. Viviparity in fishes, especially when there is a placental relationship, is an intrinsically interesting process. Finally, as a subject for the general study of development, oviparous teleosts have been secondary to the chicken egg ever since the Renaissance because of the greater size of the chicken's egg and its ready availability as an article of food.

Development of Teleostean Fishes

As the nineteenth century dawned, the foundations had been laid for the study of fish development, and the stage had been set for the extraordinary progress that would soon be made. The rise of fish embryology was vitally linked to the origins of embryology as a formal science and its subsequent growth, diversification, and interaction with other branches of biology. Scientific embryology is generally considered to begin with the publication of the first volume of von Baer's comparative studies of animal development. As Oppenheimer (1936) has pointed out, even though von Baer's work codified embryology as a science and profoundly influenced its future directions, nonetheless, it was the culmination of a course that had been pioneered by Dollinger (1770-1841) and Rathke (1793-1860). Oppenheimer (1936) states that Dollinger "was the originator of the appreciation of comparative development by working out carefully the succession of steps in the developmental processes in various vertebrate forms." Dollinger not only influenced von Baer (1792-1876) but also guided Pander's (1793-1860) revolutionary studies of chick development and inspired in Louis Agassiz (1807-1873) a life-long commitment to a program of comparative embryological research. Dollinger's approach to embryology had its origins in the influence of German Naturphilosophie on the study of comparative anatomy. Thus influenced, anatomists attempted to systematize, describe, and classify all organisms or parts of organisms as variations of a single type. Dollinger, who was a proponent of Naturphilosophie, thus accepted and extended suggestions of the anatomist

Meckel (1781-1833) that a unity of plan manifests itself in development as well as in structure. For reasons of convenience and also because their study progressed at different rates and in different ways, I have chosen to treat teleosts and chondrichthyans separately.

In retrospect, it is amazing to contemplate the almost explosive increase in knowledge of teleostean development that took place in the period 1819-1842. The first major work from this period was Forchhammer's (1819) dissertation on the development of the viviparous blenny Zoarces. He described no stages younger than pre-motile embryos. The main body of the work comprises descriptions of older embryos and organ formation. He was the first to describe the embryonic shield, the region in which the embryo forms. His observations on the contractility of the excised embryonic heart constitute one of the earliest attempts to study isolated embryonic organs. He also observed that yolk ultimately is absorbed into the liver. Rathke (1833) also published a monograph on the development of the viviparous blenny, as part of a much larger serial work on the development of animals and humans. Conceptually, Rathke's studies parallel those of Dollinger and von Baer (Oppenheimer, 1936). Although he described and analysed early stages of development, he was primarily concerned with older stages. His observations on the developmental anatomy of the brain, heart, gut, and other organs established a new standard of excellence in the field.

The first volume of von Baer's three-volume treatise on embryology appeared in 1828 but fishes were not dealt with until the second volume. In the interim, he published a separate communication devoted to the development of fishes based on his studies of species of Cyprinus. He made several fundamental observations such as the sharp distinction between the pattern of development in large-yolked and small-yolked teleostean eggs and the great differences in the duration of development, viz. three months in trout, a few weeks in Zoarces and a few days in Cyprinus. His choice of Cyprinus, an egg-laying species, made it possible to obtain newly fertilized eggs, thus giving him access to the early, i.e., cleavage-epiboly, stages of development and providing a chronological base for the consecutive stages of development. von Baer (1835) was the first to describe clearly and illustrate one of the most characteristic features of teleostean development, viz. epiboly or overgrowth of the yolk by the blastoderm. Not only did he describe it, but also he provided a timetable for the process.

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Use of DNA in Forensic Entomology

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Forensic entomology contains three aspects: medicocriminal entomology, urban entomology, and stored product entomology. This article focuses more on the medicocriminal aspect and how DNA is analysed with various blood feeding insects.

Blood Meal Extraction

To extract a blood meal from the abdomen of an insect to isolate and analyse DNA, the insect must first be killed by placing it in 96% ethanol. The killed insect can be stored at -20°C until analysis.

When it is time for analysis, the DNA must then be extracted by dissecting the posterior end of the abdomen and collecting 25mg of tissue. The cut in the abdomen should be made with a razor blade as close to the posterior as possible to avoid the stomach. Using a DNA extraction kit, the DNA is extracted from the tissue. If the DNA is mixed with samples from more than one individual, it is separated using a species specific primer. Once extracted and isolated, the DNA sample goes through a polymerase chain reaction (PCR), is amplified and identified.

PCR works by analysing species specific mitochondrial DNA. PCR is currently the most commonly used method of species identification. This results from the fact that it is very sensitive in that it requires only a small amount of biological material, and can also utilize material that is not particularly fresh. The sample can be frozen and stored while still remaining usable for later PCR.

DNA requires one hour to reach the abdomen of an insect, so DNA can be amplified one to forty-four hours after an insect feeds. Some research suggests that the source of a blood meal can be determined up to two months post feeding.

To amplify DNA, it must first be denatured by exposing it to a 95°C temperature for one minute, followed by thirty cycles of thirty-second 95°C exposures. Then denatured DNA is mixed with a specific primer. A chromatograph is conducted on 2% agarose gel, stained, and viewed with UV fluorescence. The DNA is identified by looking for genome specific repetitive elements and by comparing it with known examples.

Haematophagous Insects of Forensic Importance

Humans are constantly fed on by haematophagous insects. The ingested blood can be recovered and used to identify the person from which it was taken. Bite marks and reactions to bites can be used to place a person in an area where those insects are found.

Order Diptera

The following among the flies (Diptera) have been utilized:

- Mosquitoes, Family Culicidae : Due to erratic feeding habits, mosquitoes could potentially provide DNA evidence to many people in one area at a certain time. PCR analysis shows that

identification of bitten individuals is possible with a low error rate, although multiple mosquitoes would be needed. The insects would need to be collected as soon as possible due to the insect's high mobility and constant feeding. Research is centred on the mosquito due its widespread presence and affinity for feeding on humans.

- Biting midges, Family Ceratopogonidae
- Tsetse flies, Family Glossinidae
- Sheep keds, Family Hippoboscidae
- Stable and horn flies, Family Muscidae
- Sand flies, Family Psychodidae, Subfamily Phlebotominae
- Snipe flies, Family Rhagionidae
- Black flies, Family Simuliidae
- Horse flies, Family Tabanidae.

Order Siphonaptera

Listed here are fleas commonly encountered by humans that could potentially be used for DNA identification.

- Sticktight and chigoe flea, Family Hectopsyllidae (formerly Tungidae)
- Cat flea (*Ctenocephalides felis*)
- Northern rat flea (*Nosopsyllus fasciatus*)
- Human flea (*Pulex irritans*)
- Oriental rat flea (*Xenopsylla cheopis*).

Order Hemiptera

- Bedbug (*Cimex lectularius*): *Cimex lectularius* is an obligate parasite of humans. Testing a sample of a residence's bed bug population and screening for bites could reveal possible recent visitors to the structure, as they have been observed to feed approximately once a week in temperate conditions. A recent re-emergence of bedbug populations in North America as well as growing interest in the field of forensics may prove bedbugs to be useful investigative tools. Recent studies have revealed that human DNA can be recovered from bed bugs for up to 60 after feeding, thus demonstrating the potential use of this insect in forensic entomology
- Assassin bugs, Family Reduviidae

Order Phthiraptera

Lice can be indicators of contact with another person. Many species closely associated with humans can be easily transferred between individuals. DNA identification of multiple individuals using blood meals from body and head lice has been demonstrated in laboratory settings.

Suborder Anoplura

- Head louse (*Pediculus humanus capitis*)
- Body louse (*Pediculus humanus humanus*)
- Pubic louse (*Phthirus pubis*).

Other Arthropods

Order Ixodida

Due to the low probability of a tick detaching and falling to the ground at the scene of the crime, these may not be highly useful regardless of the large amount of blood and lymph they ingest. However, should an engorged tick be found in an area of interest, it would likely contain sufficient genetic material for identification.

Analysis of Collected DNA

DNA identification of species can be a very useful tool in forensic entomology. Although it does not replace conventional identification of species through visual identification, it can be used to differentiate between two species of very similar or identical physical and behavioural

characteristics. A thorough identification of the species through conventional methods is needed before an attempt at DNA analysis. This DNA can be obtained from practically any part of the insect, including the body, leg, setae, antennae, etc.

There are about one million species described in the world and many more that have still not been identified. A project termed "the barcode of life" was launched by Dr. Paul Herbert, where he identified a gene that is used in cell respiration by all species, but is different in every species. This difference in sequence can help entomologists easily identify two similar species.

DNA sequencing is basically done in three steps: polymerase chain reaction (PCR), followed by a sequencing reaction, then gel electrophoresis. PCR is a step that cleaves the long chain of chromosomes into much shorter and workable pieces. These pieces are used as patterns to create a set of fragments. These fragments are different in length from each other by one base which is helpful in identification. Those sets of fragments are then separated by gel electrophoresis. This process uses electricity to separate DNA fragments by size as they move through a gel matrix. With the presence of an electric current the negative DNA strand marches toward the positive pole of the current. The smaller DNA fragments move through the gel pores much more easily/faster than larger molecules. At the bottom of the gel the fragments go through a laser beam that emits a distinct colour according to the base that passes through.

Forensic entomology is a very important aspect for law enforcement. With the magnitude of information that can be gathered, investigators can more accurately determine time of death, location, how long a body has been in a specific area, if it has been moved, and other important factors. Because of this range of uses, forensic entomology is an extremely significant tool used by law enforcement officials to aid in numerous cases. As this branch of entomology progresses it will become a key facet in all investigations due to its steadily rising popularity and usefulness.

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Significance of Photosynthesis in Plant Growth

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Photosynthesis is the only process which produces enormous quantities of organic matter for sustaining the life on this globe. It is the only known method of manufacture of organic food from inorganic raw materials. Animals including man are directly or indirectly dependent on photosynthetic plants for their food. All flesh is grass.

Photosynthetic products not only build up the bodies of organisms but also provide energy for carrying out metabolic activities and different types of movements. The chemical energy present in the organic food is the converted form of radiant or solar energy. All life is bottled sunshine.

Coal, petroleum and natural gas represent the photosynthetic capital of the past geological ages. They have been formed by the application of heat and compression over the plant and animal bodies in the deeper layers of earth. Along with wood they provide a sufficient portion of energy required for domestic, industrial and transport needs.

Several materials derived from the organic world (and hence photosynthesis) are in our daily use.

Examples: Natural fibres, drugs, vitamins, gums, tannins, turpentine, furniture, etc.

Oxygen is being constantly consumed and carbon dioxide evolved by the respiration of animals and plants and by the burning of wood, coal, petroleum or natural gas. High carbon dioxide content of the atmosphere is toxic. Lower concentrations of oxygen are equally harmful. Luckily, green plants keep the concentration of the two gases almost constant by absorbing carbon dioxide and evolving oxygen during photosynthesis.

Site of Photosynthesis

Leaf Structure

Photosynthesis occurs only in the green parts of the plant. For efficient photosynthesis the leaf should be thin and have a large surface area. This helps in absorption of light and gaseous diffusion, and a means of preventing excessive water loss through stomata and epidermis. Large number of chloroplasts in palisade mesophyll cells provide the main photosynthetic tissue.

The spaces between the irregularly shaped spongy mesophyll cells within leaf permit free diffusion of gases. Turgor changes into guard cells permit gaseous exchange with the atmosphere. Cuticle on the single layered transparent upper and lower epidermis protects the leaf from desiccation and infection.

Chloroplasts

These biconvex organelles, containing many flattened, fluid filled membranous sacs called thylakoids and a gel like stroma are enclosed by the two membranes of the chloroplast envelope. Stacks of circular thylakoids called grana linked together by intergranal lamellae, are formed at intervals throughout the chloroplast.

Photosynthetic Pigments

Molecules of chlorophyll-a, chlorophyll-b, carotene and xanthopyhll are situated in

the thylakoid membranes. For light energy to be used by living systems, it must first be absorbed. A pigment is any substance that absorbs light. Chlorophyll, the pigment that makes leaves green, absorbs light in the violet and blue wavelengths and also in the red because it reflects green light, it appears green. Different pigments absorb light energy at different wavelengths. The absorption pattern of a pigment is known as the absorption spectrum. The absorption spectrum of chlorophyll is between 400 nm and 700 nm. This portion of the spectrum is known as photosynthetically active region (PAR). The action spectrum shows how effective these pigments are in stimulating photosynthesis.

In plants, chlorophyll a is the pigment directly involved in the transformation of light energy to chemical energy.

Structure of Chlorophyll

Structurally all types of chlorophyll resemble one another. All of them contain four pyrrole rings which are linked together by methane bridges (-CH=). The skeleton of each pyrrole ring is made up of five atoms-four carbon and one nitrogen with magnesium in the centre as nucleus. One pyrrole ring is esterified with a long chain alcohol-phytol. This side chain-phytol is long and is composed of insoluble carbon and hydrogen atoms which helps to anchor the chlorophyll molecules with the thylakoids. In plants, there are 2 types of chlorophyll-namely chlorophyll a and b. Chlorophyll molecule looks like a tadpole with porphyrin head and phytol tail. Chlorophyll a has methyl group (-CH_3) at position and aldehyde (CHO) group in chlorophyll b.

Chlorophyll a is the major pigment involved in trapping light energy and converting it in to electrical and chemical energy. It acts as a reaction centre.

Chlorophyll b constitutes about 1/4th of the total chlorophyll content. It acts as an accessory pigment and helps broaden the spectrum of light absorbed during photosynthesis. Chlorophyll b absorbs a different wavelength of light other than that absorbed by chlorophyll a. On absorbing light, it becomes excited and transfer its to chlorophyll a molecule.

Another group of pigments are called carotenoids. The carotenoids are red, orange or yellow pigments. In the green leaf, their colour is masked by the chlorophylls, which are more abundant.

Carotenoids like chlorophyll are embedded in the thylakoid membrane of the chloroplasts. They are accessory pigments and harvest light from different regions of the spectrum. The light captured by these pigments are channelled it to the reaction centre, where light energy is converted into electrical energy.

The Action Spectrum

The Action Spectrum is the curve plotted on a graph paper representing the amount of oxygen evolved or the amount of carbon dioxide fixed or any other action of photosynthesis at different wavelengths of light. It has been observed that the photosynthesis occurs maximum in blue and red regions of visible light. Action spectrum of photosynthesis determined by T.W.Englemann in 1882 using green alga. The scientist measured rate of photosynthesis as the amount of O_2 released, which he detected by using bacteria that are attracted by O_2

The Absorption Spectrum

The Absorption Spectrum is the curve plotted on a graph paper representing the amount of light absorbed at each wave length by that pigment.

Relation of the Visible Colour of Leaf to Absorption Spectrum

The leaf is green because wavelengths in this region of the spectrum, 550 nm are less strongly absorbed by leaf. These wavelengths are reflected.

Activity to Extract the Chloroplast Pigments and Separate them by Paper Chromatography

Materials Required

Spinach leaves, pestle and mortar, 80% acetone, calcium carbonate, Buchner funnel, beaker, measuring cylinder, glass jar with a tight cork. Whatmann No.1, filter paper, petroleum ether, acetone, hook, micropipette.

Procedure

Take 50 g of fresh spinach laves in a pestle and mortar. Crush them with 20 ml of 80% acetone. Add a pinch of calcium carbonate and again crush. Filter the extract on a Buchner filter. The deep green coloured filtrate containing chlorophylls and carotenoids is obtained. Evaporate the extract to concentrate.

Take a glass jar (about 45cm high) with a tight cork fitted in it. The cork should have a hole in the centre. Fit a small glass rod having a small hook, in the hole of cork. Now prepare the solvent by mixing 25ml petroleum ether and 3ml acetone. Pour the solvent into the jar and allow the jar to become saturated. Cut a strip of filter paper of the size which can easily be hung on the hook. Apply a circular spot of pigment extract about 3cm from the base of strip with the help of a micropipette. Now hang the strip inside the jar to the hook of cork and close the cork. Care should be taken that the spot is not dipped in the solvent. Make the apparatus air tight and observe.

Observation

The solvent will run on the filter paper. After few hours, the chloroplast pigments will be separated in the form of different spots on the paper. Take out the paper when the solvent reaches upto the upper level. After drying the paper, identify the different pigments with the help of their specific colours. Carotene is yellow, xanthopyhll is yellow-brown, chlorophyll-a is blue-green and chlorophyll-b is olive green in colour.

Demonstration of Fluorescence by Chlorophyll

Materials Required

Spinach leaves, pestle and morter, 80% acetone, calcium carbonate, Buchner funnel, test tube, source of light

Procedure

Take 25g of fresh spinach leaves in a pestle and morter. Crush them with 10 ml of 80% acetone. Add a pinch of calcium carbonate and crush again. Filter the extract on a Buchner funnel. The drop green coloured filtrate containing chlorophylls is obtained. Pour the filtrate in a test tube. Place the test tube before the source of light and observe.

Observation

The solution appears green when placed between the source of light and eyes of observer is in transmitted light. The solution appears red when source of light is placed behind the observer and solution is placed in front of observer is in reflected light. The phenomenon is called fluorescence.

Photochemical and Biosynthetic Phases

Light Phase consists of photochemical reactions which are carried out by two different photo systems, PS-I and PS-II. In the thylakoids, chlorophyll and other molecules are packed into units called photo systems.

Each photosystem unit contains from 250 to 400 molecules of pigment, which serve as light trapping antennae. Once light energy is absorbed by one of the antenna pigments, it is bounced around among the other pigment molecules of the photosystem until it reaches a special form of chlorophyll-a which is the reaction centre.

In photosystem-I, the reactive chlorophyll-a molecule is known as P_{700} (P stands for pigments) because one of the peaks of its absorption spectrum is at 700 nm. It is located in the stroma regions of the thylakoid. The reactive chlorophyll a molecule of

photosystem-II is P_{680}. They are located in the appressed regions of the grana in the thylakoid.

It is believed that these chlorophyll molecules have unusual properties because of their association with special proteins in the membrane. The main function of these two photosystems is to trap lightenergy and convert it into chemical energy (ATP) which is used by living cells.

The photochemical phase was explained by Arnon and his co-workers in 1958. Whenever a chlorophyll molecule absorbs a photon of light, it is said to move from the ground state to the excited state. The added energy lifts the electrons from the chlorophyll molecule (as given below in the equation) and is ultimately used to reduce $NAPH_2$. The excited state is unstable and the chlorophyll molecule regains its lost electron from the water molecule through an electron transfer system and gets back to the ground state. The P_{680} chlorophyll molecule having lost its electron, is avidly seeking replacement. It finds it in the water molecules, which dissociates into protons and oxygen gas.

The P_{700} chlorophyll molecule is oxidized and an electron is boosted to a primary electron acceptor from which it goes downhill to NADP.

Electron Transport System

Electron transport chain refers to the light driven reactions of photosynthesis. They were first formulated in 1939 by Robert Hill. The two photosystems are connected in series with each other by the components of electron transport system. The reaction centres become so excited that they escape high energy electron (e^-) which move to nearby electron acceptor molecules. The electrons move through two pathways-non-cyclic and cyclic. The non-cyclic electron transport system involves participation of both PS-II and PS-I, whereas cyclic electron transport chain involves only PS-I.

Non-cyclic Electron Transport System

The light energy of specific wavelengths is absorbed by chlorophylls and accessory pigments of PS-II. These pigments transfer their absorbed energy to PS-II reaction centre-P_{680} (chlo 680). This centre become photo excited and exudes an electron with a gain of energy (23 K Cal/mol).

Photolysis of Water (Photo Oxidation of Water)

The PS-II reaction centre (P_{680}) by transferring electron to primary acceptor becomes oxidised.

$$2H_2O \rightleftharpoons 4H^+ + 4e^- + O_2$$

The overall process is called photo-oxidation of water. It requires the presence of Mn^{++}, Ca^+ and Cl^-, a water oxidising enzyme and an unknown substance Z. It is believed that oxygen evolves as oxygen gas. Electrons are accepted by PS-II reaction centre through unknown substance Z and H^+ temporarily stay in the thylakoid space (loculus).The high energy electrons that leave PS-II are captured by Q which sends them to an electron transport system consisting of PQ, cytochrome complex, PC. Every time electron passes from donor to acceptor, the reduced donor id oxidised and the acceptor is reduced. The electrons of plastocyanin are picked by PS-I.

Simultaneously, the pigment molecules of PS-I complex absorb solar radiation and transfer their absorbed electronic excitation (energy) to PS-I reaction centre-P_{700}. P_{700} gets excited and exudes an electron, which goes to reduce an electrons acceptor A. The oxidised reaction centre of PS-I takes electron from plastocyanin and comes to ground state. The electron emitted from the P_{700} is accepted by an unknown acceptor A which transfers its electron to ferredoxin an iron containing protein positioned at the outer surface of thylakoid membrane. The reduced ferredoxin donates its electrons to $NADP^+$

(Nicotinamide Adenine Dinucleotide Phosphate). The $NADP^+$ takes electrons from ferredoxin, protons from the medium and gets reduced to $NADPH_2$ in presence of enzymes, Ferredoxin-NADP-reductase.

Sequenced Genome of Chlorobium Tepidum

When early microbes evolved, some species developed ways to convert sunlight into cellular energy and to use that energy to capture carbon from the atmosphere. The origin of this process, known as photosynthesis, was crucial to the later evolution of plants. The publication today of the analysis of the complete genome sequence of an unusual photosynthetic microbe provides important insights into studies of how that light harvesting mechanism evolved and how it works today. The bacterium, Chlorobium tepidum, was originally isolated from a hot spring in New Zealand. It is a member of the green-sulfur bacterial group, so known because of the microbes' colour and their dependence on sulfur compounds to carry out photosynthesis. Biologists say green-sulfur bacteria are important because they perform photosynthesis in a different way from that of other bacteria and that of plants.

For example, instead of the choloroplasts found in plants, green-sulfur bacteria have organelles called chlorosomes that help generate energy through an electron-transport chain in the microbe's cytoplasmic membrane. Inside the chlorosomes, the chlorophyll and carotenoid molecules that capture light differ from the molecules that other species use to perform photosynthesis. Also, green-sulfur bacteria carry out photosynthesis in the absence of oxygen and do not produce oxygen as a byproduct as plants do. "Because of their unusual mechanisms of harvesting and using the energy of light, the green-sulfur bacteria are important to understanding the evolution and the mechanisms of both photosynthesis and cellular energy metabolism," said Jonathan A. Eisen, an evolutionary biologist at The Institute for Genomic Research (TIGR) in Rockville, Maryland. "The ability to carry out photosynthesis in the absence of oxygen is particularly important to evolutionary studies since it is believed that the early atmosphere of Earth had little oxygen. That is why some scientists have suggested the green-sulfur bacteria were the first photosynthetic organisms."

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Manures for Organic Crop Production

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Livestock manure is traditionally a key fertilizer in organic and sustainable soil management. It is most effectively used in combination with other sustainable practices. These include crop rotation, cover cropping, green manuring, liming, and the addition of other natural or biologically friendly fertilizers and amendments. In organic production, manure is commonly applied to the field in either a raw (fresh or dried) or composted state. This publication addresses the advantages and constraints of using manure in either form, but with particular focus on raw manure; it does not discuss the specific circumstances and challenges associated with handling and applying slurry manure. There are clear restrictions on the use of raw manure in organic farming. These restrictions are detailed in the National Organic Program (NOP) Regulations, which constitute the federal standard for organic production.

Raw Manure Use: Problems and Solutions

Raw manure is an excellent resource for organic crop production. It supplies nutrients and organic matter, stimulating the biological processes in the soil that help to build fertility. Still, a number of cautions and restrictions are in order, based on concerns about produce quality, food contamination, soil fertility imbalances, weed problems, and pollution hazards.

Contamination

Some manures may contain contaminants such as residual hormones, antibiotics, pesticides, disease organisms, and other undesirable substances. Since many of these can be eliminated through high-temperature aerobic composting, this practice is recommended where low levels of organic contaminants may be present. Caution is advised, however, as research has demonstrated that *Salmonella and E. coli* bacteria appear to survive the composting process much better than previously thought. The possibility of transmitting human diseases discourages the use of fresh manures (and even some composts) as preplant or sidedress fertilizers on vegetable crops—especially crops that are commonly eaten raw. Washington State University suggests that growers:

- Apply animal manures at least 60 days prior to harvest of any vegetable that will be eaten without cooking. (Note: The NOP's specific requirements on the timing of manure applications are discussed later in this publication.) If possible, avoid manuring after planting. Fall spreading is advised.
- Do not use dog, cat, or pig manures (fresh or composted). These species share many parasites with humans.
- Wash all produce from manured fields thoroughly before use. Persons especially susceptible to food-borne illnesses should avoid uncooked produce.

In February 2000, the issue of manure use on organic farms was highlighted on the television news program *20/20*. The segment suggested that fertilization with livestock manures made organic foods more dangerous than other food products in the marketplace. The show's producers arranged for a sampling of various organic and

nonorganic vegetables from store shelves and tested for the presence of *E. coli*. The samples of both organic and nonorganic produce were generally free of serious contamination. The exceptions were bagged sprouts and mesclun salad mix. Of these, more *E. coli* contamination was observed on the organic samples. It was largely on this basis that the news program challenged organic farming.

The attack was embarrassing to the organic industry and forced its membership to undertake a lot of "damage control," despite the fact that the allegations were contrived and based on poor science. The sampling was not statistically significant. The show failed to point out that the specific test used does not distinguish between pathogenic and benign forms of *E. coli*. Also ignored was the obvious fact that conventional farmers use manure, too! Furthermore, the reporter failed to disclose the vested interests of the individual bringing the charges (Dennis Avery of the Hudson Institute—a "think tank" heavily funded by conventional agriculture interests), presenting him instead as a former official with the Agriculture Department. John Stossel—the journalist responsible for the *20/20* report—subsequently issued an apology and a correction. Unlike conventional farmers, who have only safety guidelines regarding manure use, certified organic farmers must follow stringent protocols. Raw manure may NOT be applied to food crops within 120 days of harvest where edible portions have soil contact; it may NOT be applied to food crops within 90 days of harvest where edible portions do not have soil contact. Such restrictions do not apply to feed and fibre crops.

Organic substances are not the only contaminants found in livestock manures. Heavy metals can be a problem, especially where industrial-scale production systems are used. Concerns over heavy-metal and other chemical contamination have dogged the use of poultry litter as an organically acceptable fertilizer in Arkansas, where it's readily and cheaply available. Heavy-metal contamination is also a concern with composted sewage sludge (biosolids)—a major reason for its being prohibited from certified organic production. Under federal organic standards, certifiers may require testing of manure or compost if there is reason to suspect high levels of contamination.

Produce Quality Concerns

It has long been acknowledged that improper use of raw manure can adversely affect the quality of such vegetable crops as potatoes, cucumbers, squash, turnips, cauliflower, cabbage, broccoli, and kale. As it breaks down in the soil, manure releases chemical compounds such as skatole, indole, and other phenols. When absorbed by the growing plants, these compounds can impart off-flavours and odours to the vegetables. For this reason, raw manure should not be directly applied to vegetable crops; it should instead be spread on cover crops planted the previous season. In the Ozark region, for example, poultry manure is sometimes used to fertilize winter cover crops that will be incorporated ahead of spring vegetable planting.

Fertility Imbalances

Raw manure use has often been associated with imbalances in soil fertility. There are several causal factors:

- Manure is often rich in specific nutrients like phosphate or potash. While these nutrients are of great benefit to crops, repeated applications of manure can result in their building to detrimental levels. A good example is the overuse of broiler litter in the mid-South, which has put excessive phosphate in the soil and polluted surface waters. Nutrient excesses also "tie up" other minerals. Excessive phosphate interferes with plant uptake of both copper and zinc; excessive potash can restrict boron, manganese, and even magnesium.

- Continual manure use tends to acidify soil. As manure breaks down it releases various organic acids that assist in making soil minerals available—a benefit of manure that is often unrecognized. Over time, however, this process depletes the soil of calcium and causes pH levels to fall below the optimum for most crops. Manures do supply some calcium, but not enough to counterbalance the tendency toward increased acidity. Possible exceptions include caged-layer manure (when oyster-shell or similar calcium supplements are fed) and manure from dairy operations where barn lime is used.
- When fresh manure containing large amounts of nitrogen and salts is applied to a crop, it can have the same effects as excessive applications of soluble commercial fertilizers—it can burn seedling roots, reduce immunity to pests, and shorten produce shelf life. Excessive salinity is often associated with heavy applications of feedlot manure in regions where little leaching naturally occurs—as in most western states. For example, growers in southwestern states like Arizona are advised to apply gypsum and leach the soil with about 4 inches of irrigation water following incorporation of dairy or feedlot manures.

To avoid manure-induced imbalances, continually monitor soil fertility, using appropriate soil tests. Then apply lime or other supplementary fertilizers and amendments to ensure soil balance, or restrict application levels if needed. A soil audit that measures cation base saturation is strongly advised. If this service is not provided through your state's Cooperative Extension Service, use of a private lab is suggested. Understanding the soil's needs is only part of the equation. You must also know the nutrient content of the manure you're applying. Standard fertilizer values should be used only for crude approximations. The precise nutrient content of any manure is dependent not only on livestock species, but also on the ration fed, the kind of bedding used, amount of liquid added, and the kind of capture and handling system employed. Also, some traditional assumptions about manure composition may need to be updated. Because of the abundance of sulfur in rations, manure has long been recognized as a good source of sulfur. However, less sulfur is applied to crops in contemporary high-analysis fertilizers, and atmospheric deposition has been decreased by pollution controls. Sulfur deficiencies are appearing in many soils, and levels in manure may also be diminished. It is advisable to test manure as you would test the soil, in order to assess its fertilizer value.

Table 1: Approximate NPK Values of Various Animal Manures*

Animal	*% nitrogen*	*% phosphoric acid*	*% potash*
Dairy cow	0.57	0.23	0.62
Beef steer	0.73	0.48	0.55
Horse	0.70	0.25	0.77
Swine	0.49	0.34	0.47
Sheep/Goat	1.44	0.50	1.21
Rabbit	2.40	1.40	0.60
Chicken	1.00	0.80	0.39

** Adapted from: Anon. 1998. Fertilizer values of some manures. Countryside & Small Stock Journal. September-October. p. 75.*

Cooperative Extension is an excellent source of guides to manure use. These are often tailored to the region and provide useful information not mentioned in more general publications.

Weed Problems

Use of raw manures has often been associated with increased weed problems. Some manure contains weed seed, often from bedding materials like small-grain straw and old hay. High-temperature aerobic composting can greatly reduce the number

of viable weed seeds. In many cases, however, the lush growth of weeds that follows manuring does not result from weed seeds in the manure, but from the stimulating effect manure has on seeds already present in the soil (as demonstrated through studies at Auburn University using broiler litter). The flush of weeds may result from enhanced biological activity, the presence of organic acids, an excess of nitrates, or some other change in the fertility status of the soil. Depending on the weed species that emerge, the problem may be related to the sort of fertility imbalances described above. Excesses of potash and nitrogen in particular can encourage weeds. Monitor the nutrient contents of soil and manure and spread manure evenly to reduce the incidence of weed problems.

Pollution

When the nutrients in raw or composted manure are eroded or leached from farm fields or holding areas, they present a potential pollution problem, in addition to being a resource lost to the farmer. Leached into groundwater, nitrates from manure and fertilizers have been linked to a number of human health problems. Flushed into surface waters, nutrients can cause eutrophication of ponds, lakes, and streams. Excess nitrates from farms and feedlots in the Mississippi Basin are deemed the primary cause of the Gulf of Mexico Dead Zone—a hypoxic (oxygen deprived) area about the size of New Jersey that now threatens the shrimp, fishing, and recreational industries off the Louisiana and Texas coasts. The manner in which manure is collected and stored prior to field use affects the stabilization and conservation of valuable nutrients and organic matter.

Reducing manure runoff and leaching losses from fields is a matter of both volume and timing. Manure application far in excess of crop needs greatly increases the chances of nutrient loss, especially in high-rainfall areas. Manure spread on bare, frozen or erodible ground is subject to runoff, especially where heavy winter rains are common. Under some conditions, however, winter-applied manure can actually slow runoff and erosion losses from fields, likely by acting as a light organic mulch.

Sheet-composting manure (tilling it into the soil shortly after spreading) or applying it to growing cover crops are two advisable means of conserving manure nutrients. Grass cover crops, such as rye and ryegrass, are especially good as "catch crops"—cover crops grown to absorb soluble nutrients from the soil profile to prevent them from leaching. (All cover crops function as catch crops to a greater or lesser degree.) It is a sound strategy, therefore, to apply manure to growing catch crops or just prior to planting them.

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New Advances in Farm Business Management

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This article examines the management structure of farms to ascertain who controls the use of farm assets, including land and water. Management units that make decisions for farms are described, extending information about how farmers control and guide their businesses. The chapter also examines decisions of farmers from the perspective of how production, marketing, finance, and human resources are used to form farm businesses.

Characteristics of Farm Businesses' Managers

A farm's management unit consists of the individual or group responsible for decisions about how a farm will be operated. How a farm is legally organized is often viewed as being the same as its management. A proprietor makes decisions for proprietorships, partners for partnerships, and elected directors and officers for corporate farms. However, a farm's management unit may not be synonymous with its ownership. For example, land owners may or may not participate in management decisions. The Census of Agriculture reported in 1999 that 14 percent of landlords either made or shared in decisions related to selection of fertilizer and chemicals, while 13 percent helped decide cultivation practices.

Legal organization, while helpful in indicating a farm's governance structure, may not reveal who participates in farm management. Even on proprietor farms, more than one person may participate in management decisions. Of the 2.1 million U.S. farms reported by the Census of Agriculture, over 121,000 reported three or more operators. Together, farms reported 2.7 million operators. In 2003, the primary operator made crop decisions on 52 percent of farms, two operators made joint decisions on 12 percent of farms, and a third operator was involved on 1.3 percent of farms. For the remaining 33 percent of farms, crop production was likely not a part of production activities. In the last decade, involvement by persons other than the primary operator has remained an important aspect of farm management.

Operator and operator-spouse management teams controlled 59 percent of farms in 2003. When paid or informal advisors are considered, the share rises to 89 percent. These farms were, by far, the smallest in terms of acreage and value of production. Management that featured more than two people or outside hired/informal assistance operated larger businesses. Nearly a third of these farms were commercial farms, versus about 3 percent for operator-only units and 7 percent overall. Each management structure that included outside advisors represented a disproportionate share of commercial-size farms.

Operator-only management units had the highest average age, nearly 2 years older than the average for all primary operators. Primary operators in multiple-operator

management units were youngest, age 54 on average. Primary operators that used outside assistance had the largest share of college-level attainments. This group was followed by multiple-operator teams and operators in operator-only units. Farms managed by operators only or by a combination of operators and spouses were more common in the Eastern Uplands, Southern Seaboard, and Mississippi Portal. These regions have a larger share of smaller farms run by operators who work off-farm. Farms run by multiple-operator teams and that used outside assistance were more common in the Heartland, Northern Crescent, Northern Plains, Fruitful Rim, and Basin and Range. Multiple operators were more common on farms that specialized in cash grains and soybeans, high-value crops, and dairy.

Farm Business Management Entails a Host of Choices

Managers of farm businesses make choices about inputs and their use in producing crops, livestock, or other products and services. Production decisions focus on whether to produce crops, livestock, both, or nothing (for example, by placing land in conservation). Financial decisions centre on acquiring and maximizing the use of inputs. Do managers have sufficient funds to buy inputs like seed or fertilizer (short-term decisions) or invest in capital items like equipment? If not, is borrowing warranted? Marketing options range from cash markets to contracts to direct sales (farmers' markets, the Internet, wholesale/retail buyers, or livestock producers.)

Human resource issues include the amount and timing of labour needed to undertake production. In 2003, 45 percent of operators reported their primary occupation as other than farming. An even larger share worked off-farm. Thus, work arrangements vary from self-sufficiency to inclusion of household members, other operators, and a variety of custom hire, contract, and hired workers. Farmers may even work off-farm and hire someone else to do farm work.

Classifying Farm Business Systems

The result of all the choices across all these business concerns is a highly diverse farm sector. Some farms amount to a single individual supplying all labour to produce one, or maybe even no commodities, with cash sales, and without debt. Other farms produce multiple commodities, market to various outlets, use a variety of labour sources, and take on debt from multiple lenders structured for different periods of maturation. One way to overcome this complexity empirically is to devise a classification system that jointly considers management choices. To develop the farm business system classification, each of four business areas—production, finance, human resources, and marketing/contract use—was measured as a dichotomous variable. For example, farms producing 2 or fewer commodities were assigned a score of zero, while those with 3 or more commodities were given a score of 1. The same scoring convention was used for debt, hired labour, and cash sales versus production or marketing contracts. By equally weighting each of the four business activity areas, a total score ranging from 0 to 1 was calculated to reflect the overall complexity of the operation. For example, a score of 0 indicates a farm having two or fewer commodities, no debt, operator/family labour only, and cash sales.

Characteristics of Farm Business Systems

The 31 percent of farms with the least complex farm business system controlled 11

percent of acres operated and generated less than 3 percent of production value in 2003. Over 85 percent of these farms are rural residences and the rest almost entirely intermediate farms (sales below $250,000 and the operator reports farming as his or her major occupation).

Over 98 percent had sales of less than $100,000. These farms specialized in production of field crops other than cash grains or soybeans, beef cattle and general livestock.

Operator and operator-spouses managed three-fourths of the least complex farms. They had the highest average operator age and the largest share of primary operators over age 65 years (32 percent). Over 80 percent considered their primary occupation to be off-farm and almost 29 percent were retired. This helps explain the 890 hours worked onfarm by the operator, well below the all-farm average of 1,393 hours.

The most complex farms controlled 8 percent of acres and generated 18 percent of value of production in 2003. Farms in this group were mostly commercial. Over 27 percent had over $500,000 or more in sales (versus 3 percent of all farms). The most complex farms had a much larger share of management teams that included multiple persons.

These farms were more common in the Northern Crescent, Heartland, Northern Plains, and Eastern Uplands. They tend to specialize in dairy, poultry, hogs, cash grains, and soybeans. Nearly two-thirds reported hiring other individuals and three-fourths had custom hire assistance. The primary operators in these management units were younger, averaging 49 years, nearly 7 years less than the all-farm average. On average, primary operators reported working over 3,000 hours on their farms in 2003, with spouses and other operator labour adding more than 1,100 hours to the total.

Summary

Farm managers not only have to be highly skilled at the technical aspects of farm production, but they also have to handle primary and support activities for their farms that range from input procurement to technology, finance, accounting, and human resource management (Gray et al.).

Changes in crop and livestock production, including use of contract arrangements and technologically modified seed stock, mean that managers may need to interact more with both suppliers and customers. With the rising cost of inputs, particularly capital items such as machinery and equipment, managers also have to control a range of financial arrangements that transcend farm mortgages. Even land rents have become more complex, with some arrangements incorporating changes in prices and yields.

As a farm grows, expertise to handle these tasks either has to be available within the existing owner-operator-management arrangement or be acquired by adding to the management team. Survey results suggest that the size and composition of management teams align with the complexity of farm businesses. The least complex farms were most often managed by a single operator or by a combination of operator and spouse. Conversely, the most complex businesses typically involved operators, spouses, other partners, and outside advisors. Many Federal and State programs provide income and technical/other assistance to farmers, specifically a farm's decisionmaker. In today's farm sector, that person is not automatically the farm operator alone, especially on farms with the most cropland and production.

Farm Management

Farm management deals with the organisation & operation of a farm with the objective of maximizing profits from the farm business on a continuing basis. The farmer needs to adjust his farm organisation from year to year to keep abreast of changes in methods, price variability & resources available to him. Thus farm management is the science which deals with the analysis of the farming resources, alternatives, choices & opportunities within the framework of resource restrictions & social & personal constraints of farming business. This complex information is integrated and synthesized to increase profitability of the farming business, the ultimate aim being to raise the standard of living of the farming people. This does not mean that farm management deals exclusively with the maximization of income; in fact, it takes into account the goals and objectives of the individual farmer, other than income maximization. Thus this discipline deals with people or organisers and decision-makers in respect of farms and agricultural production. It is people-oriented rather than crops or livestock per se.

Farm management is a decision-making science. It helps to decide about the basic course of action of the farming business. The basic decisions of the farming business are:

(a) What to produce or what combination of different enterprises to follow?

(b) How much to produce and what is the most profitable level of production?

(c) What should be the size of an individual enterprise, which, in turn, will determine the best overall size of the farm business?

(d) What methods of production (production practices or what type of quality of inputs and their combination) should be used?

(e) What and where to market?

Management of a Farm

Farm management is different from what is commonly confused with the work of a farm manager who manages a government farm as an agronomist. His function is normally limited to supervising & handling the day-to-day routine of a farm.

It normally pertains to the existing pattern of the resource-use & crops-mix under which only the existing plan is executed, supervised & carried out. An intelligent farm manager may go a little further & look after the farm machinery to keep it going.

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SPM Level in Ambient Air of Dhanbad Area: A Case Study with Respect of Open Cast Coal Mining

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Introduction

Mining is one of the oldest industries of the world. It is as old as civilization and has always been known as a hazardous occupation. Open cast mining is one of the methods of mining, in which the rocks and alluvium, below which the ore and mineral deposit lies, are removed and dumped in the initial stage in a place which is not required in future for quarrying, residential or other purposes. The mineral exposed is completely extracted in this method of mining. The rejects are often dumped indiscriminately, and since the mineral areas are usually abandoned without any reclamation practices, the entire area becomes barren and unsightly. Also other activities of mining, which includes drilling, blasting, loading & transportation generate dust & noise pollution. The open cast mining affects the environment in many diverse ways depending on the terrain feature, type & extent of mining activities, nature of mineral etc (Srivastava, & Singh Prasad, 1990).

Experimental

Study Area

General: The Jharia coal fields are located in the Dhanbad district of Jharkhand (earlier in Bihar) state between 23^0 39′ N to 23^0 48′ N latitude and 86^0 11′ E to 86^0 27′ E longitude as shown in Map - 1. Dhanbad area includes mainly Jharia coalfield. Out of the toatal 470 sq. km. of Jharia coalfield, BCCL leasehold is spread over 280 sq. km and contains a reserve of approximately 13000 million tones of coal (Banerjee, 1992). Its leasehold covers in Raniganj Coalfield only an area of 32 sq. km. There are 29 opencast mines and 80 underground mines some of which are combined units. In 1994-95, the production of coal was 11.49 million tones from underground mines and 17.26 million tones from open cast mines. (Choudhary, et.al. 1995). The entire coalfield is elliptical or sickle shaped and is delimited by the river Damodar on the southern edge. Coal is found mainly in the Barker and the Raniganj formations and coalfields have been experiencing mining activities for about last 100 years which has resulted in severe environmental degradation in the region. Due to fires approximately 37 million tones of prime coking coal is already lost and another 48 million tones is rendered inaccessible due to flooding or sealing of underground workings (Sinha, 1986).

Study Site – OCP II

The site for the present study is taken as OCP II area in Jharia Coal Field.

Location

The Block II is about 30 kms west of Dhanbad town and is well connected by road and rail. Dumra – DB road running North-South passes through this area. The Gomoh Mohuda railway line of south Eastern Railway run parallel to the eastern boundary.

The block is located between Latitudes N 23^0 47′ 20" to 23^0 45′30" and Longitude E 86^0 10′57" to 86^0 13′ 31" in the western part of Dhanbad area (Jharia coalfields). This is bounded By Jamunia River in the west, Mohuda-Gomoh Rly line in the east, I seam in crop in the north and Dhanbad-chandrapura Rly. line in the south.

Working mine in OCP II are Nudkhurkee, Matigarha, Jamunia OCP, Block II, Benidih and Keshargata. In OCP III working mine is Kharkharee, Muraidih, Madhuband, and Phularitand.

The main drainage of the region is through Jamunia River. Some stream (called Joria Nalla in local language) is also originating from OCP II area and meeting Jamunia River. The region has a tropical monsoon type climate. The maximum temperature is usually experienced during the month of May with temperature rising up to 44^0C. Where as during winter, in December/January, temperature falls as low as 5^{0+}C to 7^0C.

Air originating from west, during winter, have very little clouds where as air flowing from east & south, in June to September, brings about 80 to 5 % annual rainfall.

Ambient Air

The air pollution in the coalfields is mostly contributed by opencast mining and transportation of coal and overburden, due to coal handling plants and coal washeries. Air pollution is also caused by coke making. Suspended particulate Matter (SPM) and respirable dust are the main pollutants in such area. During mining, most of the dust arises from drilling, blasting, excavation, crushing operations and transportation operations. Large quantities of dust become wind borne and are carried away from coal and overburden dumps. A study of the air quality in some of the coalfields of Coal India Ltd. Shows that in many of the coal fields the level of suspended particulate matter exceed the standards set by CPCB for industrial area (Sachdev, 1995).

Ambient Air Quality (AAQ) in terms of SPM, SO_2 & NO_x vicinity were studied from October 1998 to June 2000. AAQ was determined at six locations, namely AAQS – 1, AAQS – 2, AAQS – 3, AAQS – 4, AAQS – 5 and AAQS – 6 as shown below:

S.N.	*Station Code*	*Location Name*
1.	AAQS – 1	Bhimkanari
2.	AAQS – 2	Baghmara
3.	AAQS – 3	Jayramdih
4.	AAQS – 4	Near E/R & SE/R Crossing
5.	AAQS – 5	Panruabhitha
6.	AAQS – 6	Jamunia Dam Colony

The six monitoring locations as selected for the present study are described below and shown in figure – 1.

- **AAQS – 1** This location is situated in extreme north of study area. This location is known as Bhimkanari. This location is act as control station. This location is 3.0 km (approx) from main mining area (selected for study).
- **AAQS – 2** This location is also situated in north direction of study area. This area is a commercial area. This location is known as Baghmara. This location is situated in NNW to NW from Benidih Colliery & Block II OCP and NE from Nudkharki Colliery, Matigarha OCP and Jamunia OCP.
- **AAQS – 3** This location is known as Jayramdih. Situated in the north of Benidih colliery and east from Nadkharki colliery, Matigarha OCP and Jamunia OCP.
- **AAQS – 4** Location is Near E/R & SE/R Crossing (Colliery Name-Block II OCP). This location is near E/R & SE/R Crossing, which is situated in South East direction of Benidih OCP affected

by OCP II, when predominant wind direction is from W, NW and SSW.

- **AAQS – 5** This location is situated in south of Benidih colliery after Dhanbad Chandrapura railway line. This location is known as Panruabhitha. This location is affected by OCP II area when wind blowing from N, NW and NE. Madhuband Phularitand U/G Block also affects this location by S, SE and SW wind direction.
- **AAQS – 6** Jamunia Dam Colony (After Matigarha OCP) – This location is situated in west direction of OCP II area. It also affected from Damuda OCP of OCP I area and Damuda U/G block. Railway line and State high way is near by this location

Suspended Particulate Matter

The important sources of air pollutants are from Heavy Earth Moving Machinery (HEMM) movement on haul roads, drilling, blasting. The fine dust particle are dislodged by the movement of dumpers, dozers etc. During drilling and blasting SPM increases (Choudhary. et.al, 1995).

Though there is negligible air pollution (especially SPM) due to underground mining, in open cast mines, the SPM level is more in some cases. The source of emission in whole of Dhanbad area for SPM is

a) Open cast mines (haul Road, drilling & blasting etc)
b) Soft coke making
c) Hard coke making
d) Coal Handling Plant
e) Washeries
f) Domestic coal burning
g) Non-metal led colliery road.

The AAQ monitoring results are given in Tables. The summarised results are shown that the mean SPM value at all the locations was maximum during summer followed by that in winter and post monsoon season. For example a maximum value of 680 $\mu g/m^3$ at AAQS – 5 was observed in summer season while in winter season the SPM value was 483 $\mu g/m^3$. This may be due to the fact that during summer the conditions are dry and windy in the area, thereby conducive to more dust generation (Ganguly, et.al., 1998). Earlier study has conducted in same locality and the SPM level were found more than CPCB standard of 500 mg/m^3 (Bose. et.al, 1993).

Among the six locations the maximum mean value of SPM was obtained at AAQS – 5 stations followed by AAQS – 3 Station, AAQS – 2, AAQS – 4, AAQS – 6 and AAQS – 1. This may be due to fact that the AAQS – 5 location (Panruabhitha) is adjacent to Benidih OCP and AAQS – 1 is located relatively in cleaner location at Bhimkanari, where no open cast mining operation is going on. Anonymous (2000) reported that in mining area in Dhanbad percent particulate matter emission is 37% due to locking/briquetting 31% due to traffic, 9% due to coal fires, 8.0% due to Power Plant, 6.0% Mining, 4.0% by Domestic and 5.0% is Miscellaneous. Results shows high concentration is found in summer and just followed by winter and post monsoon. This tendency is also supported by the earlier study of open cast mining project (Ghosh.et.al, 1998). The suspended particulate matter (SPM) in ambient air in Jharia coalfield has been found high which is indicated by the above discussion and also supported by Choudhary. et.al, (1985).

There has been a rising trend in the levels of Pollutants in air in Jharia coalfield during the past decades. The peak value of the SPM has grown. No doubt mechanization of coal mining and total lack of any dust control are the chief causatives for this increases. A study conducted around Katras area showing an increasing trend of SPM (Mondal. et.al, 1994). A study was also conducted for another open cast coal mine and the area seems to be highly

polluted from air quality point of view. The Suspended particulate matter concentration both in mining and residential area are above from permissible limit both in summer as well as in winter season (Dhar. et.al, 1990). By this study it will also found that SPM concentration was fairly high in summer above CPCB norms. In winter season although it was fairly low in comparison to summer but it was slightly above the permissible limit. These observation have supported the present study and also indicate SPM is a constant source of air pollutant in mining area (Dhar.et.al, 1990). The summarized result of SPM, location wise for three seasons i.e. post monsoon, winter and summer season are presented in following table.

Sampling Location		*SPM*		
		Post Monsoon	*Winter*	*Summer*
Bhimkahari	Mean	389	456	500
AAQS-1	**Range**	(464 – 310)	(537 – 368)	(608 – 428)
Baghmara	Mean	499	626	659
AAQS-2	**Range**	(584 – 438)	(894 – 476)	(962 – 513)
Jayramdih	Mean	479	582	662
AAQS-3	**Range**	(584 – 389)	(737 – 467)	(867 – 527)
Near E/R &SE/R Crossing	Mean	450	586	599
AAQS-4	**Range**	(556 – 398)	(784 – 454)	(774 – 486)
Panruabhitha	Mean	483	656	680
AAQS-5	**Range**	(587 – 376)	(881 – 556)	(784 – 523)
Nadkharki	Mean	453	498	546
AAQS-6	**Range**	(569 – 386)	(632 – 389)	(667 – 409)

Value out of parenthesis indicates the mean, Value in Parenthesis indicate the range.

Conclusion

Air pollution levels of Jharia coal field are high. Land degradation has reached alarming levels due to open cast mining. 29 million tones of coal is shipped out energy year from JCF. About 60 percent of this comes from open cast mining that is cheaper and less prone to the kind of accidents that happen in underground mines. But open cast mines leave the environment in a shambles, especially as there is no effort to reclaim land.

For assessing the Ambient Air Quality in and around the OCP II mining area six monitoring station were selected. Out of six stations five stations was selected in vicinity of open cast coal mines namely AAQS-- -2 to AAQS – 6. Where as one station is AAQS – 1 was selected as control site cannot site near by mining area.

The monitoring result indicated the following:

1. Ambient air quality in open cast mining areas is mostly impacted by SPM
2. The Ambient air quality shows higher levels of SPM during summer seasons followed by that in winter and past monsoon. Possibly the dryness and windy condition during the summer and winter seasons helps more dust in the ambient air.
3. The ambient air quality regarding SO_2 and NO_x are within prescribed norms of CPCB/MoEF. But it found to go in increasing order.

High value of SPM found all most all location in summer and winter season. Open cast mining operation involving use of heavy machinery for extraction and transportation of coal and over burden cause a substantial release of air pollutants mainly SPM directly into the atmosphere. It may be due to industrial site/ traffic load/ coal combustion.

There has been a rising trend in the levels of pollutants in air in Jharia coal field. The peak values for SPM have crosses always from CPCB norms. In other area of Dhanbad SPM had no doubt very high than observed value. Mechanisations of coal mining and total lack of any dust control are the chief causatives for this increase. Other pollutants like CO and hydrocarbon have been showing an increasing trend in this area.

High rate of SPM/Dust is the most troublesome pollutant in a mining area. It is harmful to not only for men, but also for machinery, flora and fauna. Dust particles serve as foci for bacterial factors to adhere to, which in turn causes tuberculosis or other infections upon prolonged inhalation. Dust reduces visibility and participates information of winter fogs. Dust settling in rivers and ponds adds to turbidity and trace metals elements concentration (Mondal. et.al. 1992).

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Abstract

A base line data generation work was conducted at six locations in OCP II area of Dhanbad. The SPM at these sites found higher side as compared with National Ambient Air Quality. It may be due to presence of Open Cast Coal mines and other associated activity. The summarised results are shown that the mean SPM value at all the locations was maximum during summer followed by that in winter and post monsoon season. There is a need to prepare a plan for managing air pollution in whole of Dhanbad city. It can be done or achieved by implementation of best environment management system in Mining Sector and its associated activity.

Fluid Dynamics for Physicists

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In physics, fluid dynamics is a sub-discipline of fluid mechanics that deals with fluid flow—the natural science of fluids (liquids and gases) in motion. It has several subdisciplines itself, including aerodynamics (the study of air and other gases in motion) and hydrodynamics (the study of liquids in motion). Fluid dynamics has a wide range of applications, including calculating forces and moments on aircraft, determining the mass flow rate of petroleum through pipelines, predicting weather patterns, understanding nebulae in interstellar space and reportedly modelling fission weapon detonation. Some of its principles are even used in traffic engineering, where traffic is treated as a continuous fluid. Fluid dynamics offers a systematic structure that underlies these practical disciplines, that embraces empirical and semi-empirical laws derived from flow measurement and used to solve practical problems. The solution to a fluid dynamics problem typically involves calculating various properties of the fluid, such as velocity, pressure, density, and temperature, as functions of space and time. Historically, *hydrodynamics* meant something different than it does today. Before the twentieth century, hydrodynamics was synonymous with fluid dynamics. This is still reflected in names of some fluid dynamics topics, like magnetohydro dynamics and hydrodynamic stability—both also applicable in, as well as being applied to, gases.[1]

The foundational axioms of fluid dynamics are the conservation laws, specifically, conservation of mass, conservation of linear momentum (also known as Newton's Second Law of Motion), and conservation of energy (also known as First Law of Thermodynamics). These are based onclassical mechanics and are modified in quantum mechanics and general relativity. They are expressed using the Reynolds Transport Theorem. In addition to the above, fluids are assumed to obey the *continuum assumption*. Fluids are composed of molecules that collide with one another and solid objects. However, the continuum assumption considers fluids to be continuous, rather than discrete. Consequently, properties such as density, pressure, temperature, and velocity are taken to be well-defined at infinitesimally small points, and are assumed to vary continuously from one point to another. The fact that the fluid is made up of discrete molecules is ignored.

For fluids which are sufficiently dense to be a continuum, do not contain ionized species, and have velocities small in relation to the speed of light, the momentum equations for Newtonian fluids are theNavier-Stokes equations, which is a non-linear set of differential equations that describes the flow of a fluid whose stress depends linearly on velocity gradients and pressure. The unsimplified equations do not have a general closed-form solution, so they are primarily of use in Computational Fluid Dynamics. The equations can be simplified in a number of ways, all of which make them easier to solve. Some of them allow appropriate fluid dynamics problems to be solved in closed form.

In addition to the mass, momentum, and energy conservation equations, a thermodynamical equation of state giving the pressure as a function of other thermodynamic variables for the fluid is required to completely specify the problem.

An example of this would be the perfect gas equation of state:

$$p = \frac{\rho R_u T}{M}$$

where p is pressure, ρ is density, R_u is the gas constant, M is the molar mass and T is temperature.

Compressible vs Incompressible Flow

All fluids are compressible to some extent, that is changes in pressure or temperature will result in changes in density. However, in many situations the changes in pressure and temperature are sufficiently small that the changes in density are negligible. In this case the flow can be modeled as an incompressible flow. Otherwise the more general compressible flow equations must be used. Mathematically, incompressibility is expressed by saying that the density ρ of a fluid parcel does not change as it moves in the flow field, i.e.,

$$\frac{\mathrm{D}\rho}{\mathrm{D}t} = 0\,.$$

where D / Dt is the substantial derivative, which is the sum of local and convective derivatives. This additional constraint simplifies the governing equations, especially in the case when the fluid has a uniform density. For flow of gases, to determine whether to use compressible or incompressible fluid dynamics, the Mach number of the flow is to be evaluated. As a rough guide, compressible effects can be ignored at Mach numbers below approximately 0.3. For liquids, whether the incompressible assumption is valid depends on the fluid properties (specifically the critical pressure and temperature of the fluid) and the flow conditions (how close to the critical pressure the actual flow pressure becomes). Acoustic problems always require allowing compressibility, since sound waves are compression waves involving changes in pressure and density of the medium through which they propagate.

Viscous vs Inviscid Flow

Viscous problems are those in which fluid friction has significant effects on the fluid motion. The Reynolds number, which is a ratio between inertial and viscous forces, can be used to evaluate whether viscous or inviscid equations are appropriate to the problem. Stokes flow is flow at very low Reynolds numbers, $Re \ll 1$, such that inertial forces can be neglected compared to viscous forces.

On the contrary, high Reynolds numbers indicate that the inertial forces are more significant than the viscous (friction) forces. Therefore, we may assume the flow to be an inviscid flow, an approximation in which we neglect viscosity completely, compared to inertial terms.

This idea can work fairly well when the Reynolds number is high. However, certain problems such as those involving solid boundaries, may require that the viscosity be included. Viscosity often cannot be neglected near solid boundaries because the no-slip condition can generate a thin region of large strain rate (known as Boundary layer) which enhances the effect of even a small amount of viscosity, and thus generating vorticity. Therefore, to calculate net forces on bodies (such as wings) we should use viscous flow equations. As illustrated by d'Alembert's paradox, a body in an inviscid fluid will experience no drag force. The standard equations of inviscid flow are the Euler equations. Another often used model, especially in computational fluid dynamics, is to use the Euler equations away from the body and the boundary layer equations, which incorporates viscosity, in a region close to the body.

The Euler equations can be integrated along a streamline to get Bernoulli's equation. When the flow is everywhere irrotational and inviscid, Bernoulli's equation can be used throughout the flow field. Such flows are called potential flows.

Steady vs Unsteady Flow

When all the time derivatives of a flow field vanish, the flow is considered to be a steady flow. Steady-state flow refers to the condition where the fluid properties at a point in the system do not change over time. Otherwise, flow is called unsteady. Whether a particular flow is steady or unsteady, can depend on the chosen frame of reference. For instance, laminar flow over a sphere is steady in the frame of reference that is stationary with respect to the sphere. In a frame of reference that is stationary with respect to a background flow, the flow is unsteady. Turbulent flows are unsteady by definition. A turbulent flow can, however, be statistically stationary. According to Pope:[3]

The random field $U(x,t)$ is statistically stationary if all statistics are invariant under a shift in time. This roughly means that all statistical properties are constant in time. Often, the mean field is the object of interest, and this is constant too in a statistically stationary flow. Steady flows are often more tractable than otherwise similar unsteady flows. The governing equations of a steady problem have one dimension fewer (time) than the governing equations of the same problem without taking advantage of the steadiness of the flow field.

Laminar vs Turbulent Flow

Turbulence is flow characterized by recirculation, eddies, and apparent randomness. Flow in which turbulence is not exhibited is calledlaminar. It should be noted, however, that the presence of eddies or recirculation alone does not necessarily indicate turbulent flow—these phenomena may be present in laminar flow as well. Mathematically, turbulent flow is often represented via a Reynolds decomposition, in which the flow is broken down into the sum of an average component and a perturbation component. It is believed that turbulent flows can be described well through the use of the Navier–Stokes equations. Direct numerical simulation (DNS), based on the Navier–Stokes equations, makes it possible to simulate turbulent flows at moderate Reynolds numbers. Restrictions depend on the power of the computer used and the efficiency of the solution algorithm. The results of DNS have been found to agree well with experimental data for some flows.[4]

Most flows of interest have Reynolds numbers much too high for DNS to be a viable option,[5] given the state of computational power for the next few decades. Any flight vehicle large enough to carry a human (L > 3 m), moving faster than 72 km/h (20 m/s) is well beyond the limit of DNS simulation (Re = 4 million). Transport aircraft wings (such as on an Airbus A300 or Boeing 747) have Reynolds numbers of 40 million (based on the wing chord). In order to solve these real-life flow problems, turbulence models will be a necessity for the foreseeable future. Reynolds-averaged Navier–Stokes equations (RANS) combined with turbulence modeling provides a model of the effects of the turbulent flow. Such a modeling mainly provides the additional momentum transfer by the Reynolds stresses, although the turbulence also enhances the heat and mass transfer. Another promising methodology is large eddy simulation (LES), especially in the guise of detached eddy simulation (DES)—which is a combination of RANS turbulence modeling and large eddy simulation.

Newtonian vs Non-Newtonian Fluids

Sir Isaac Newton showed how stress and the rate of strain are very close to linearly related for many familiar fluids, such as water and air. These Newtonian fluids are modeled by a coefficient calledviscosity, which depends on the specific fluid. However, some of the other materials, such as emulsions and slurries and some visco-elastic materials (e.g. blood, some polymers), have more complicated *non-Newtonian* stress-strain behaviours. These materials include *sticky*

liquids such as latex, honey, and lubricants which are studied in the sub-discipline of rheology.

Subsonic vs Transonic, Supersonic and Hypersonic Flows

While many terrestrial flows (e.g. flow of water through a pipe) occur at low mach numbers, many flows of practical interest (e.g. in aerodynamics) occur at high fractions of the Mach Number M=1 or in excess of it (supersonic flows). New phenomena occur at these Mach number regimes (e.g. shock waves for supersonic flow, transonic instability in a regime of flows with M nearly equal to 1, non-equilibrium chemical behavior due to ionization in hypersonic flows) and it is necessary to treat each of these flow regimes separately.

Terminology in Incompressible Fluid Dynamics

The concepts of total pressure and dynamic pressure arise from Bernoulli's equation and are significant in the study of all fluid flows. (These two pressures are not pressures in the usual sense—they cannot be measured using an aneroid, Bourdon tube or mercury column.) To avoid potential ambiguity when referring to pressure in fluid dynamics, many authors use the term static pressure to distinguish it from total pressure and dynamic pressure. Static pressure is identical to pressure and can be identified for every point in a fluid flow field.

In *Aerodynamics*, L.J. Clancy writes[6]: *To distinguish it from the total and dynamic pressures, the actual pressure of the fluid, which is associated not with its motion but with its state, is often referred to as the static pressure, but where the term pressure alone is used it refers to this static pressure.*

A point in a fluid flow where the flow has come to rest (i.e. speed is equal to zero adjacent to some solid body immersed in the fluid flow) is of special significance. It is of such importance that it is given a special name—a stagnation point. The static pressure at the stagnation point is of special significance and is given its own name—stagnation pressure. In incompressible flows, the stagnation pressure at a stagnation point is equal to the total pressure throughout the flow field.

Terminology in Compressible Fluid Dynamics

In a compressible fluid, such as air, the temperature and density are essential when determining the state of the fluid. In addition to the concept of total pressure (also known as stagnation pressure), the concepts of total (or stagnation) temperature and total (or stagnation) density are also essential in any study of compressible fluid flows. To avoid potential ambiguity when referring to temperature and density, many authors use the terms static temperature and static density. Static temperature is identical to temperature; and static density is identical to density; and both can be identified for every point in a fluid flow field.

The temperature and density at a stagnation point are called stagnation temperature and stagnation density.

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Organometallic Chemistry of the Transition Metals: Concept and Aplications

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Abstract

Organometallic Compounds are chemical compounds which contain at least one bond between a metallic element and a carbon atom belonging to an organic molecule. Even metalloid elements such as silicon, tin, and boron are known to form organometallic compounds which are used in some industrial chemical reactions. It means Organometallic Compound is a chemical compound which contains at least one bond between a metallic element and a carbon atom belonging to an organic molecule. Metalloids such as silicon, tin, and boron are known to form organometallic compounds which are used in some industrial chemical reactions. Organometallic compounds are primarily used as homogeneous catalysts in commercial chemical reactions. They are also used as stoichiometric reagents in industrial and research-oriented chemical reactions. Organometallic compounds play an important role in organic synthesis. They supply a nucleophilic carbon atom which reacts with an electrophilic carbon to form a new carbon bond. The catalysis of reactions wherein the target molecules are polymers or pharmaceuticals can be done with the help of organometallic compounds, resulting in an increase in the rate of the reactions. Generally, the bond between the metal atom and the carbon belonging to the organic compound is covalent in nature. When metals with relatively high electropositivity (such as sodium and lithium) form these compounds, a carbanionic nature is exhibited by the carbon which is bound to the central metal atom.

Keyword- Compound, Reaction, Bond,Carbon, Chemical, Organic, Metal, Atom

Intoduction

Organometallic compound, any member of a class of substances containing at least one metal-to-carbon bond in which the carbon is part of an organic group. Organometallic compounds constitute a very large group of substances that have played a major role in the development of the science of chemistry. They are used to a large extent as catalysts (substances that increase the rate of reactions without themselves being consumed) and as intermediates in the laboratory and in industry. The class includes such compounds as ferrocene, a remarkably stable compound in which an iron atom is sandwiched between two hydrocarbon rings.

Organometallic compounds are typically discussed in terms of the metal as either main-group compounds or transition metal compounds. The main-group metals of organometallic compounds are typically considered to be those of the S-block (groups 1 and 2) and the heavier elements of the *p*-block (groups 13–15) in the periodic table of

elements. The transition metals include those elements in the *d*- and *f*-blocks (groups 3–12).

The physical and chemical properties of organometallic compounds vary greatly. Most are solids, particularly those whose hydrocarbon groups are ring-shaped or aromatic, but some are liquids and some are gases. Their heat and oxidation stability vary widely. Some are very stable, but a number of compounds of electropositive elements such as lithium, sodium, and aluminum are spontaneously flammable. Many organometallic compounds are highly toxic, especially those that are volatile.

The properties of the organometallic compounds depend in large measure on the type of carbon-metal bonds involved. Some are ordinary covalent bonds, in which pairs of electrons are shared between atoms. Others are multicentre covalent bonds, in which the bonding involves more than two atoms. A third type are ionic bonds, in which the bonding electron pair is donated by only one atom. In donor-acceptor bonds, the metal atom is connected to hydrocarbons with multiple bonds between carbon atoms.

Where metal atoms form covalent bonds with carbon atoms, the electrons are usually shared unequally. As a result, the bond is polarized—one end is more negative than the other. The extent of polarization depends on the strength with which the metal atom binds electrons. Organometallic compounds range in polar power from methylpotassium, in which the bond is almost like certain ionic bonds, to lead, which bonds with carbon with very little polarization.

Because of bond polarity, many organometallic compounds have reactivities that have made them important in chemical synthesis. The organomagnesium halides (Grignard reagents), for example, are used widely in synthetic organic chemistry, as are organolithium and organoboron compounds. Alkylaluminum compounds are also employed in organic synthesis. Used with titanium salts, they are important catalysts in the polymerization of unsaturated hydrocarbons, such as ethylene and propylene. The mechanism of action of the titanium-aluminum alkyl catalysts probably involves interaction between the titanium atoms and the double bonds of the hydrocarbons.

Organometallic compounds containing lead, tin, and mercury are all commercially significant. A large number of organotin compounds, for example, are used as pharmaceuticals, pesticides, stabilizers for polyvinyl chloride, and fire retardants. Methylmercury has caused severe pollution problems as a result of its toxicity. This fact has led to stringent controls on the discharge of mercury from chemical plants into rivers, lakes, and oceans.

Carbon monoxide reacts readily with many transition-metal atoms to form metal carbonyls, themselves a class of organometallics. One of the earliest to be discovered was tetracarbonylnickel, a volatile nickel compound that became the basis of a process for purifying nickel. Metal carbonyls are employed as catalysts in many reactions in the petrochemical industry.

Conclusion

Organometallic compounds refer to those containing at least one metal-carbon bond. They are in an interdisciplinary area between inorganic and organic chemistry. Studies of organometallic compounds have significantly advanced the understanding of chemical bonding, as these complexes show unique bonds and structures. Organometallic compounds have played a critical role in catalysis and organic synthesis, often leading

to more efficient use of reagents, higher yields of products, and less use of energy. Organometallic compounds have also been used as precursors in the preparation of nanomaterials and microelectronic materials such as thin films in integrated circuits. Species containing M-C bonds have been found in biology as well. The vitamin B_{12} coenzyme contains a Co-C bond. Synthesis of M-C containing compounds plays a central role in the field of organometallic chemistry. Both the metals and ligands are diverse. The former include those of main group, transition metals, and lanthanide and actinide elements. The latter range from CO to multidentate organic molecules/groups. Since organometallic compounds contain metals and ligands, the synthetic methods are in general grouped into two types: reactions between metal species and preformed ligands or ligand precursors; and reactions of ligands in organometallic compounds yielding new ligands. The former is used in the preparation of Grignard reagents and organolithium reagents.

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Beer–Lambert Law and Absorption of Light

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Introduction

The Beer-Lambert law (also called the Beer-Lambert-Bouguer law or simply Beer's law) is the linear relationship between absorbance and concentration of an absorber of electromagnetic radiation. The general Beer-Lambert law is usually written as:

$$A = a_\lambda \times b \times c$$

where A is the measured absorbance, a λ is a wavelength-dependent absorptivity coefficient, b is the path length, and c is the analyte concentration. When working in concentration units of molarity, the Beer-Lambert law is written as:

$$A = \varepsilon_\lambda \times b \times c$$

where λ is the wavelength-dependent molar absorptivity coefficient with units of M^{-1} cm^{-1}. The λ subscript is often dropped with the understanding that a value for is for a specific wavelength. If multiple species that absorb light at a given wavelength are present in a sample, the total absorbance at that wavelength is the sum due to all absorbers:

$$A = (\varepsilon_1 \times b \times c_1) + (\varepsilon_2 \times b \times c_2) + \ldots$$

where the subscripts refer to the molar absorptivity and concentration of the different absorbing species that are present.

Theory

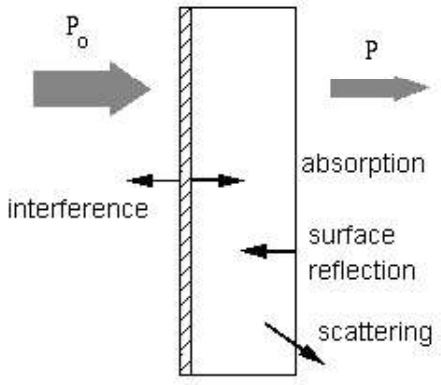
Experimental measurements are usually made in terms of transmittance (T), which is defined as:

$$T = \frac{P}{P_0}$$

where P is the power of light after it passes through the sample and P_o is the initial light power. The relation between A and T is:

$$A = -\log(T) = -\log\left(\frac{P}{P_0}\right)$$

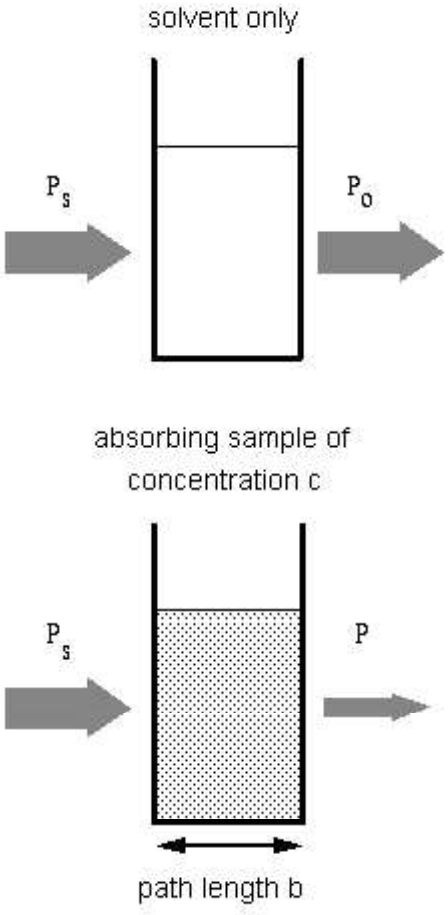
The figure shows the case of absorption of light through an optical filter and includes other processes that decreases the transmittance such as surface reflectance and scattering.



In analytical applications we often want to measure the concentration of an analyte independent of the effects of reflection, solvent absorption, or other interferences. The figure to the right shows the two transmittance measurements that are necessary to use absorption to determine the

concentration of an analyte in solution. The top diagram is for solvent only and the bottom is for an absorbing sample in the same solvent. In this example, P_s is the source light power that is incident on a sample, P is the measured light power after passing through the analyte, solvent, and sample holder, and P_o is the measured light power after passing through only the solvent and sample holder. The measured transmittance in this case is attributed to only the analyte.

Absorption of light by a sample

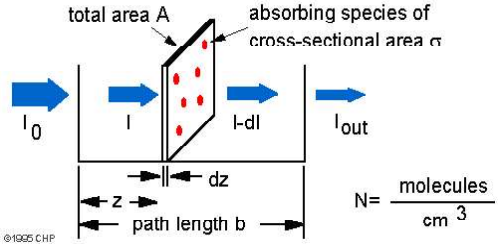


Depending on the type of instrument, the reference measurement (top diagram) might be made simultaneously with the sample measurement (bottom diagram) or a reference measurement might be saved on computer to generate the full spectrum.

Modern absorption instruments can usually display the data as either transmittance, %-transmittance, or absorbance. An unknown concentration of an analyte can be determined by measuring the amount of light that a sample absorbs and applying Beer's law. If the absorptivity coefficient is not known, the unknown concentration can be determined using a working curve of absorbance versus concentration derived from standards.

Derivation of the Beer-Lambert law

The Beer-Lambert law can be derived from an approximation for the absorption coefficient for a molecule by approximating the molecule by an opaque disk whose cross-sectional area,σ, represents the effective area seen by a photon of frequency *w*. If the frequency of the light is far from resonance, the area is approximately 0, and if *w* is close to resonance the area is a maximum. Taking an infinitesimal slab, dz, of sample:



I_o is the intensity entering the sample at z=0, I_z is the intensity entering the infinitesimal slab at z, dI is the intensity absorbed in the slab, and I is the intensity of light leaving the sample. Then, the total opaque area on the slab due to the absorbers is σ * N * A * dz. Then, the fraction of photons absorbed will be σ* N * A * dz / A so,

$$\frac{dI}{I_z} = -\sigma N\, dz$$

Integrating this equation from z = 0 to z = b gives:

$$\ln(I) - \ln(I_0) = -\sigma N b \text{ or}$$

$$-\ln\left(\frac{I}{I_0}\right) = -\sigma N b$$

Since N (molecules/cm^3) * (1 mole / 6.023x10^{23} molecules) * 1000 cm^3 / liter = c (moles/liter) and 2.303 * log(x) = ln(x), then

$$-\log\left(\frac{I}{I_0}\right) = -\sigma\left(\frac{6.023x10^{20}}{2.303}\right) c b$$

or

$$-\log\left(\frac{I}{I_0}\right) = A = \varepsilon c b$$

where $\varepsilon = \sigma^* (6.023x10^{20} / 2.303) = \sigma^* 2.61x10^{20}$

Typical cross-sections and molar absorptivities are:

	σ (cm^2)	ε (M^{-1} cm^{-1})
absorption - atoms	10^{-12}	$3x10^8$
absorption - molecules	10^{-16}	$3x10^4$
absorption - infrared	10^{-19}	3x10
Raman scattering	10^{-29}	$3x10^{-9}$

Limitations of the Beer-Lambert law

The linearity of the Beer-Lambert law is limited by chemical and instrumental factors. Causes of nonlinearity include:

- deviations in absorptivity coefficients at high concentrations (>0.01M) due to electrostatic interactions between molecules in close proximity
- scattering of light due to particulates in the sample
- fluoresecence or phosphorescence of the sample
- changes in refractive index at high analyte concentration
- shifts in chemical equilibria as a function of concentration
- non-monochromatic radiation, deviations can be minimized by using a relatively flat part of the absorption spectrum such as the maximum of an absorption band
- stray light

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Chemical Composition of Natural and Artificial Materials and Analytical Chemistry

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Analytical chemistry is the study of the chemical composition of natural and artificial materials. Unlike other major sub disciplines of chemistry such as inorganic chemistry and organic chemistry, analytical chemistry is not restricted to any particular type of chemical compound or reaction. Properties studied in analytical chemistry include geometric features such as molecular morphologies and distributions of species, as well as features such as composition and species identity. The contributions made by analytical chemists have played critical roles in the sciences ranging from the development of concepts and theories (pure science) to a variety of practical applications, such as biomedical applications, environmental monitoring, quality control of industrial manufacturing and forensic science (applied science).

Overview

Analytical chemistry is a sub discipline of chemistry that has the broad mission of understanding the chemical composition of all matter and developing the tools and experiments to make either qualitative or quantitative measurements. In a nutshell, analytical chemistry applies measurement science principles along with an understanding of chemical systems to provide useful information; and it has significant overlap with other branches of chemistry through the measurement methods that it provides. For example, the field of bioanalytical chemistry is a growing area of analytical chemistry that addresses analytical questions in biochemistry, (the chemistry of life). Experimental physical chemistry and analytical chemistry show similarity in that both have a measurement science focus. While there is occasional overlap between these two disciplines, the goal of physical chemistry experiments is to determine the dynamics of how energy affects the chemical system by making kinetic, thermodynamic, and spectroscopic measurements, while analytical chemistry sometimes uses such energy-based measurements to determine matter-related properties such as chemical identity and quantity. Analytical chemistry is also focused on improvements in experimental design and the creation of new measurement tools to provide better chemical information. Traditionally, analytical chemistry was particularly concerned with the questions of "what chemicals are present, what are their characteristics and in what quantities are they present?" These questions are often involved in questions that are more dynamic such as what chemical reaction an enzyme catalyzes or how fast it does it, or even more dynamic such as what is the transition state of the reaction. The next logical steps of understanding what it means, how it fits into a larger system, how can this result be generalized into theory, or how it can be used all result from information provided by analytical chemistry methods.

Analytical chemists work to improve the reliability of existing techniques to meet the demands for better chemical measurements which arise constantly in our society. They adapt proven methodologies to new kinds of

materials or to answer new questions about their composition. They carry out research to discover completely new principles of measurement and are at the forefront of the utilization of major discoveries such as lasers and microchip devices for practical purposes. They make important contributions to many other fields as diverse as forensic chemistry, archaeology, and space science.

Modern Analytical Chemistry

Modern analytical chemistry is dominated by instrumental analysis. Many analytical chemists focus on a single type of instrument. Academics tend to either focus on new applications and discoveries or on new methods of analysis. The discovery of a chemical present in blood that increases the risk of cancer would be a discovery that an analytical chemist might be involved in. An effort to develop a new method might involve the use of a tunable laser to increase the specificity and sensitivity of a spectrometric method. Many methods, once developed, are kept purposely static so that data can be compared over long periods of time. This is particularly true in industrial quality assurance (QA), forensic and environmental applications. Analytical chemistry plays an increasingly important role in the pharmaceutical industry where, aside from QA, it is used in discovery of new drug candidates and in clinical applications where understanding the interactions between the drug and the patient are critical.

History

Much of early chemistry (1661-~1900AD) was analytical chemistry since the questions of what elements and chemicals were present in the world around us and what are their fundamental natures is very much in the realm of analytical chemistry. There was also significant early progress in synthesis and theory which of course are not analytical chemistry. During this period significant analytical contributions to chemistry include the development of systematic elemental analysis by Justus von Liebig and systematized organic analysis based on the specific reactions of functional groups. The first instrumental analysis was flame emissive spectrometry developed by Robert Bunsen and Gustav Kirchhoff who discovered rubidium (Rb) and caesium (Cs) in 1860. Most of the major developments in analytical chemistry take place after 1900. During this period instrumental analysis becomes progressively dominant in the field. In particular many of the basic spectroscopic and spectrometric techniques were discovered in the early 20th century and refined in the late 20th century. The separation sciences follow a similar time line of development and also become increasingly transformed into high performance instruments. In the 1970s many of these techniques began to be used together to achieve a complete characterization of samples. Starting in approximately the 1970s into the present day analytical chemistry has progressively become more inclusive of biological questions (bioanalytical chemistry), whereas it had previously been largely focused on inorganic or small organic molecules. Lasers have been increasingly used in chemistry as probes and even to start and influence a wide variety of reactions. The late 20th century also saw an expansion of the application of analytical chemistry from somewhat academic chemical questions to forensic, environmental, industrial and medical questions, such as in histology.

Types

Traditionally, analytical chemistry has been split into two main types, qualitative and quantitative:

Qualitative

- Qualitative inorganic analysis seeks to establish the presence of a given element or inorganic compound in a sample.
- Qualitative organic analysis seeks to establish the presence of a given

functional group or organic compound in a sample.

Quantitative

- Quantitative analysis seeks to establish the amount of a given element or compound in a sample.

Approaches

Most modern analytical chemistry is categorized by two different approaches such as analytical targets or analytical methods. Analytical Chemistry (journal) reviews two different approaches alternatively in the issue 12 of each year.

By Analytical Targets

- Bioanalytical chemistry
- Material analysis
- Chemical analysis
- Environmental analysis
- Forensics

By Analytical Methods

- Spectroscopy
- Mass Spectrometry
- Spectrophotometry and Colorimetry
- Chromatography and Electrophoresis
- Crystallography
- Microscopy
- Electrochemistry

Traditional Analytical Techniques

Although modern analytical chemistry is dominated by sophisticated instrumentation, the roots of analytical chemistry and some of the principles used in modern instruments are from traditional techniques many of which are still used today. These techniques also tend to form the backbone of most undergraduate analytical chemistry educational labs. Examples include:

Titration

Titration involves the addition of a reactant to a solution being analyzed until some equivalence point is reached. Often the amount of material in the solution being analyzed may be determined. Most familiar to those who have taken college chemistry is the acid-base titration involving a colour changing indicator. There are many other types of titrations, for example potentiometric titrations. These titrations may use different types of indicators to reach some equivalence point.

Gravimetry

Gravimetric analysis involves determining the amount of material present by weighing the sample before and/or after some transformation. A common example used in undergraduate education is the determination of the amount of water in a hydrate by heating the sample to remove the water such that the difference in weight is due to the water lost.

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Biological Control and Holistic Plant-health Care in Agriculture

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In considering the contributions of biological pest control to a sustainable agriculture, it may be useful first to examine briefly some of the advantages and disadvantages of each of the major methods by which pests can be controlled.

The major methods of pest control can be grouped into three categories of 1) physical control, 2) chemical control, and 3) biological control. These broad categories, in turn, can be combined into integrated pest management (IPM), integrated crop and pest management (ICPM), or, as will be used in this article, holistic plant-health care or simply plant-health caret The equivalent for livestock is integrated livestock management or animal health care.

Physical control includes tillage to control weeds, open-field burning to control pests (Hardison, 1976), solar heating the soil beneath clear plastic tarp, elimination of pathogens from milk or rooting media by mild heat-treatment, the production of pathogen-free plants from tissue culture started with clean meristem or shoot tips , and the physical separation of crop from a potential pest attack by choice of planting date.

The production of pathogen-free plants from tissue culture is nonpolluting and, along with indexing of seeds, is the best or only acceptable method to eliminate some viral and bacterial pathogens so that the planting material can be certified as pathogen-free. On the other hand, tillage is energy-expensive (Phillips et al., 1980) and contributes to soil erosion; the trend in the United States is therefore toward less tillage to conserve energy, reduce soil erosion, and make U. S. agriculture more sustainable.

Open-field burning contributes to air pollution and may, over the long term, have a negative effect on the organic master content of soil; the tendency is therefore toward reduced use of burning, and legislation has been introduced in some states to regulate or even ban open-field burning. Solar-heating the soil involves the capture of incoming solar radiation beneath clear plastic sheeting placed on the soil surface. It is a safe method by which plant-parasitic nematodes, soilborne fungal pathogens, soil-inhabiting insect pests, and some weed seeds can be eliminated by heat treatment of soil in gardens, vegetable fields, and orchards , but is usually not economical except for high-value crops and in areas of abundant sunshine.

Chemical control is used in this report to mean control of pests with chemical pesticides. The problems of chemical pesticides have been reviewed amply and need not be restated here. While some pesticides must be abandoned because of their unacceptable nontarget effect, there will always be a need in agriculture for safe and selective chemicals to limit the effects of pests.

More significantly, it is becoming increasingly more difficult and expensive to find new kinds of synthetic chemical pesticides. The chemical pesticide industry has therefore been described as a "maturing industry."

Biological control is the control of one organism by another (Beirner, 1967). This control may be expressed as either a longer population of the pest (DeBach, 1964) or as a restriction or prevention of the severity or incidence of pest damage without regard to the pest population.

Biological control depends on knowledge of biological interactions at the ecosystem, organismal, cellular, and molecular levers and often is more complicated to manage compared with physical and chemical methods. Biological control is also likely to be less spectacular than most physical or chemical controls but is usually also more stable and longer lasting. In spite of biological controls having been used in agriculture for centuries, as an industry biological control is still in its infancy.

Biological control is now being considered for an increasing number of crops and managed ecosystems as the primary method of pest control. One reason for its growing popularity is its record of safety during the past 100 years considered as the era of modem biological control. No microorganism or beneficial insect deliberately introduced or manipulated for biological control purposes has, itself, become a pest so far as can be determined, and there is no evidence so far of measurable or even negligible negative effects of biocontrol agents on the environment. Another reason for considering biological control over other methods is untapped potential; biological control is underused, under exploited, underestimated and often untried and therefore unproven.

The new tools of recombinant DNA technology, mathematical modelling, and computer technology combined with a continuation of the more classical approaches such as importation and release of natural enemies and improved germplasm, breeding, and field testing should quickly move biocontrol research and technology into a new era.

Biological control describes the normal state of affairs in natural undisturbed ecosystems, where populations of organisms exist in a dynamic equilibrium and species or individuals unable to compete or to find an ecological niche are replaced by those that can. With sufficient knowledge, it becomes possible to manipulate this equilibrium so as to favour some organisms more than others. Thus be gins agriculture , silviculture , gardening, and other similar activities that favour a few desirable plant or animal species, or subsets of species (cultivars, breeds, strains), that otherwise could not succeed and might even become extinct.

This chapter is focused on biological control of pests and diseases of plants important in farmland, orchards, and other agroecosystems. Many of the examples discussed involve the control of diseases of wheat (Cook, 1986c), but the concepts presented are just as applicable to pest and disease control on other crops and in other managed ecosystems, including urban and recreational areas.

This chapter also introduces some principles of holistic plant-health care, which involves extensive use of biological control integrated with physical and chemical treatments and pest controls as appropriate

and compatible with the goals of making agriculture more sustainable.

Biological Control as a Concept

Biological control was discovered by trial and error and then practiced in agriculture long before the term itself came into use. One example is the ancient practice of not growing the same crop species in the same field more frequently than every second or third year or even longer. Such crop rotation allows time for the pest or pathogen population in soil to decrease below some economic threshold because of the predatory, competitive, and other antagonistic effects imposed by the associated microflora and fauna.

In other words, crop rotation allows time for the natural soil microbiota to sanitize the soil, especially with regard to the more specialized plant parasites and insect pests that are highly dependent on their host crop to maintain their populations.

The era of modern biological control, involving the deliberate transfer and introduction of natural enemies of insect pests, was launched 100 years ego with the highly successful introduction of the vadalia beetle from Australia to California in 1888 to control the cottony cushion scale of citrus. In 1914, the German plant pathologist C. F. von Tubuef wrote a somewhat speculative article entitled "Biologische Bekampfung von Pilzkrankheiten der Pflanzen." This is apparently the first reference in the scientific literature to the term "Biologische Bekampfung" or "biological control" (Baker, 1987). In 1916, L. O. Howard referred to control of the cottony-cushion scale insect by the vadalia beetle as a "biological method" and in 1919, H. S. Smith called it biological control.

About 80 years ago, a gene for resistance in wheat to wheat stem rust caused by Puccinia graminis f. sp. tritici was successfully transferred for the first time by crossing a rust-resistant with a rust-susceptible wheat plant (Biffen, 1906). Thus began the practice of introducing genes for resistance to pests, first by conventional methods and now expanded to include genetic engineering by use of recombinant DNA technology. Lupton (1984) gave emphasis to this approach in his presidential address to the Association of Applied Biologists in Great Britain, entitled, "Biological Control: The Plant Breeder's Objective." Moreover, the boundaries that once existed between these two approaches to biological control—transfer of whole organisms and transfer of genes—are beginning to disappear because of the tools of recombinant DNA technology. For example, a gene for production of an endotoxin by a strain of Bacillus thuringiensis, lethal to certain insect pests of crops, has now been transferred by recombinant DNA technology to tobacco and tomato and shown to function in these plants as genes for resistance to the toxin-sensitive insect pests of these plants.

It is commonly argued that biological control as a concept should exclude host plant resistance to pests and diseases achieved by introduction of genes through plant breeding (R. Baker, 1985). Such a definition puts this science into the awkward position that the use of a plant pathogen with certain genes for virulence to maintain a population of susceptible weed plants at or below some economic threshold would qualify as biological control, but the converse, the maintenance of a pathogen population at or

below some economic threshold by deployment of certain genes for resistance in the crop plants, would not qualify as biological control.

As another incongruity, the bt gene for production of the insect toxin expressed in the insect pathogen Bacillus thuringiensis would qualify as biological control but the same gene expressed in plants, as a gene for resistance to insect pests, would not qualify as an example of biological control. Such a narrow definition is artificial and scientifically indefensible. Perhaps Lupton (1984) has stated it best: "accelerating or diverting evolutionary processes in order to obtain genotypes adapted to [man's] needs are a most important example of the application of biological control to agricultural and horticultural crops."

DeBach (1964) defined biological control as "the action of parasites, predators, or pathogens in maintaining another organism's population density at a longer average than would occur in their absence." This definition covers some highly successful biological controls of insect pests with natural enemies, but it does not accommodate some other highly successful controls accepted in other disciplines as examples of biological control.

For example, citrus tristeza virus is controlled in Brazil by inoculating the citrus trees with a mild virus, which then protects the trees against the more severe strains (Costa and Muller, 1980). "Cross protection" was first shown by H. H. McKinney in 1929 to have potential for biological control of plant viruses. Plant pathologists refer to cross protection for control of plant viruses as biological control.

The many biological controls that fall outside the narrow definition have been variously labelled as "biological methods of control," "biological forms of control," and "biological pest suppression". All of these terms, like H. O. Howard's original "biological method," mean simply "biological control."

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The Tissues and Organs of the Lymphatic System

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The lymphatic system is a specialized form of connective tissue. It consists of groups of cells, tissues and organs that monitor body surfaces and internal fluid compartments and react to the presence of potentially harmful antigenic substances.

These substances include infectious micro-organisms, toxins, foreign cells and tissues, as well as normal cells that have transformed into cancer cells and are recognized as "non-self". Lymphatic tissue constitutes the second line of defence against invaders. The first line of defence is the epithelial covering of the skin, and the gastrointestinal, respiratory and urogenital tracts.

Lymphocytes are the chief cellular constituents of lymphatic tissue and are the key element in an immune response. Functionally, there are two types of lymphocytes, B lymphocytes and T lymphocytes. Both types differentiate from precursors called colony-forming units (CFUs) that originate in early fetal life in the yolk sac, liver and spleen. By late fetal life, CFUs are restricted to the bone marrow, where they continue to proliferate during postnatal life.

Differentiation of Lymphatic Tissue

Undifferentiated stem lymphocytes migrate to the primary lymphatic organs and tissues where they undergo differentiation into immunocompetent cells. This process entails the synthesis of unique internal and membrane proteins. This initial proliferation and differentiation is antigen-independent, and gives rise to populations of cells in which individual cells are genetically pre-programmed to recognize only one antigenic determinant. B and T lymphocytes undergo differentiation in different areas. T lymphocytes or T cells undergo differentiation in the thymus (hence "T"). They have a long life span and are involved in cell-mediated immunity. B lymphocytes or B cells undergo differentiation in special microenvironments in the bone marrow. Recent evidence suggests that the lymphatic tissue of the cecum, appendix and ileum is also involved. These areas of the bone marrow and gut-associated lymphatic tissue (GALT) are sometimes called the "bursa equivalent" areas, after the bursa of Fabricius, a mass of lymphoid tissue associated with the cloaca, in birds. B cells got their name because B cell differentiation was first demonstrated in the bursa of Fabricius of chicken embryos. B cells are involved in humoral immunity and the production of antibodies.

To summarize: The primary lymphatic organs are the thymus (for T cells) and bone marrow and probably specific areas of GALT, collectively called bursa equivalent, (for B cells). The primary lymphatic organs are sometimes called the central lymphatic organs.

Immunocompetent lymphocytes enter the blood and lymph systems to be transported throughout the body. Together with plasma cells, derived from B lymphocytes, and macrophages, they organize around mesenchymal reticular cells and their reticular fibres to form the secondary lymphatic organs (also called the peripheral lymphatic organs). The secondary

lymphatic organs and tissues are lymph nodules, the lymph nodes, tonsils and spleen. Immunocompetent lymphocytes also travel to the diffuse connective tissue (lamina propria) that underlies the epithelium of the digestive, respiratory and urogenital tracts.

Histology of the Lymphatic Organs and Tissues

The diffuse lymphatic tissue underlying the epithelia of various organ systems is important in monitoring against invaders. In the event that a lymphocyte reacts with an antigen, it travels to a regional lymph node and undergoes proliferation and differentiation. Its progeny then return to the lamina propria as effector B or T lymphocytes, plasma cells and memory cells. The regular presence of large numbers of plasma cells (especially in the lamina propria of the GI tract) indicates local antibody secretion.

Sometimes lymphocytes form localized concentrations that are sharply defined but not encapsulated. Such concentrations are called lymph nodules. They are common in the walls of the alimentary canal, respiratory passages and urogenital tract, as well as other parts of the body. For the most part, such nodules are disposed singly and in a random manner. However, in the alimentary canal aggregations of nodules are found in specific regions, notably the appendix and cecum and in the Peyer's patches of the ileum. A nodule consisting mainly of small lymphocytes is called a primary nodule. A primary nodule appears uniformly dense or colored. Many nodules however, are secondary nodules, containing a lighter-staining central region called the germinal centre, and an outer ring of small lymphocytes. The germinal centre develops when a lymphocyte that has recognized an antigen returns to a primary nodule and undergoes blastic transformation. It is lighter-staining due to the presence of large lymphocytes (lymphoblasts and plasmablasts). Frequently. Lymph nodes are small, encapsulated lymphatic organs located along lymphatic vessels. They are bean-shaped, with a convex and a concave surface. They range in size from 1 mm to about 2 cm along their longest dimension. They serve as filters through which lymph percolates on its way to the blood. Although they are widely distributed, they are concentrated in certain areas, such as the groin, axilla, and mesenteries.

The lymph node is covered by a capsule of dense connective tissue. Trabeculae, also made of dense CT, extend from the capsule into the substance, forming the gross framework of the node. A fine supporting meshwork of reticular fibres (made of collagen type III) is found throughout the remainder of the gland. Reticular fibres are not seen in routine preparations, but can be seen with special stains, eg. silver stains. The reticular fibres are secreted by reticular cells, which are stellate or elongate cells with an oval nucleus and a small amount of acidophilic cytoplasm. Cytoplasmic processes of reticular cells wrap around the bundles of reticular fibres, isolating them from the lymphocytic parenchyma. Although they can't be distinguished with the light microscope, two populations of reticular cells have been identified by electronmicroscopy, immunocytochemistry and autoradiography. The first population, as described above, has a structural function. The second population of reticular cells, also called dendritic cells, has functions characteristic of antigen-presenting cells or tissue macorphages. These cells are splayed along the meshwork of reticular fibres to increase the surface area for phagocytosis and other cell interactions.

Organization of Parenchyma of Lymph Node

The parenchyma of the lymph node is separated from the capsule by a sinus, the subcapsular (or marginal or cortical) sinus. The subcapsular sinus is continuous with sinuses that extend along the trabeculae, called trabecular sinuses. The parenchyma of

the lymph node is divided into a cortex and a medulla. The cortex forms the outer part of the node, except at the hilum. It consists of a dense mass of lymphatic tissue. In the outer part of the cortex, the lymphocytes are typically organized into nodules which consist mainly of B cells. The part of the cortex adjacent to the medulla is not organized into nodules. It is called the deep cortex (or juxtamedullary cortex, or paracortex). It is dependent on T cells for its development, and perinatal thymectomy results in a poorly developed paracortex. For this reason, it is also called the thymus-dependent cortex. The medulla forms the inner part of the lymph node. It consists of cords of lymphatic tissue, separated by lymphatic sinuses called medullary sinuses. The medullary sinuses are continuous with the trabecular sinuses of the cortex. They converge toward the hilum, where they drain into efferent lymphatic vessels. The medullary cords consist mostly of B lymphocytes.

Afferent lymphatic vessels penetrate the capsule at various points on its convex surface. Lymph flows into the subcapsular sinus and through the trabecular and medullary sinuses toward the efferent lymphatic vessels. Efferent lymphatic vessels leave at the hilum, a depression on the concave surface, which also serves as the entry and exit for blood vessels and nerves.

The spaces of the sinuses are crossed by a network of reticular fibres, reticular cells, and macrophages. Potential antigens, such as macromolecules, bacteria, parasites, or tumoral cells reaching the node through the afferent lymphatics are usually trapped in this network and processed by macrophages.

The sinuses have a lining of endothelium that is continuous when it is directly adjacent to the connective tissue of the capsule or trabeculae (septa), but discontinuous when it faces the lymphatic parenchyma. Lymphocytes and macrophages readily pass back and forth between the sinuses and parenchyma. A macrophage in the parenchyma may also send long cytoplasmic processes, called pseudopods, into a sinus through endothelial discontinuities to monitor the lymph percolating through.

Arteries enter at the hilum and progress toward the cortex, forming capillary beds around the cortical nodules. Postcapillary venules progress back toward the hilum, becoming larger and converging onto the vein as they do so. Postcapillary venules are lined by an unusual cuboidal or columnar epithelium. This extra-tall epithelium allows lymphocytes to pass through the vessel by diapedesis but prevents the passage of fluid. In fact, most lymphocytes enter the node through the postcapillary venules, although some enter with the lymph of the afferent lymph vessels. Antigen-transformed lymphocytes remain in the lymph node to proliferate and differentiate. T cells remain in the thymus-dependent paracortex, while B cells migrate to the nodular cortex. Most lymphocytes leave the lymph node by entering a lymphatic sinus from which they reach the efferent lymphatic vessels.

Tonsils are organs composed of aggregates of incompletely encapsulated lymphoid tissue. They are characterized by depressions of surface epithelium around which aggregations of lymph nodules are grouped. Three consular groups, the palatine tonsils, lingual tonsils, and pharyngeal tonsils, form a ring of lymphoid tissue surrounding the pharynx where the nasal and oral passages unite.

Tonsils aid in the protection of the body against invading bacteria, viruses, and foreign proteins. The antigens stimulate the production of antibodies in plasma cells derived from lymphocytes. However, epithelial erosion seems to enhance an invasion by microorganisms, and the tonsils are frequent portals of infection. Tonsils reach their maximum development in childhood, and thereafter form an incomplete ring around the pharynx. The palatine (or faucial) tonsils are paired, ovoid structures located

in the mucous membrane at the junction of the oropharynx and oral cavity (faucia). The lingual tonsils are small and fairly numerous structures located in the root of the tongue, behind the circumvallate papilla. The pharyngeal tonsil is a single tonsil located in the median posterior wall of the nasopharynx. (Extensions of the pharyngeal tonsil around the pharyngeal orifices of the eustacean tubes are sometimes considered as separate tonsils, the tubal tonsils.) Here, we will only look at the palatine tonsils.

The Palatine Tonsils

The palatine tonsils are covered on their free surface with stratified squamous epithelilum that is continuous with the lining of the mouth and pharynx. The epithelium rests on a basement membrane, under which there is a thin layer of fibrous connective tissue. In about 10 to 20 places, the epithelium covering the tonsil dips into the interior of the tonsil, forming tonsillar crypts. The crypts are lined with a continuation of the stratified squamous epithelium. The lumens of the crypts contain desquamated epithelial cells, live and dead lymphocytes, and bacteria. Lymphoid tissue surrounds the crypts as a diffuse mass in which lymph nodules are embedded. The nodules may contain germinal centres. In the deeper parts of the crypts, there is an intense infiltration of the epithelium with lymphocytes, and consequently no clear delineation between epithelium and lymphoid tissue. Adjacent to the deepest portions of the tonsil, the fibrous tissue is condensed to from a thin capsule that covers the base and sides of the tonsil. The capsule acts as a barrier against spreading tonsillar infections. Connective tissue septa extend into the interior of the tonsil and separate the various crypts, with their surrounding lymphatic tissue, from one another. Small mucous glands lie in the connective tissue beneath the tonsil and its capsule; their ducts usually open on the free surface, occasionally into the crypts. Tonsils possess no afferent lymphatic vessels. Lymphoid tissue is supplied from blood vessels coursing in the capsule and septa of the tonsils. Plexuses of lymph capillaries occur around the lymphoid tissue and drain into efferent lymphatic vessels. The spleen is the largest of the lymphoid organs. It is located in the upper left of the abdominal cavity and has a rich blood supply. While lymph nodes serve as the immunological filter of the lymph, the spleen serves as the immunological filter of the blood. It is an important defence against microorganisms that penetrate the circulation.

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Thermoluminescence Study of Calcium Fluoride

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Abstract

Natural calcium fluoride (CaF,) has been investigated for its thermoluminescence (TL) properties to evaluate its suitability for radiation dosimetry applications. Powdered CaF, samples collected from the Amba Dungar region, Chhotaudepur district, Gujarat, India, were irradiated with beta radiation from a Sr-90 source and subjected to annealing and quenching treatments at temperatures ranging from 200 to 800 °C. Thermoluminescence glow curves revealed a prominent peak at approximately 145 °C and a secondary hump near 225 °C, indicating the presence of multiple trapping centers. The maximum TL intensity was observed for samples annealed at 400 °C, which was attributed to the optimal formation and stabilization of defect-related traps, while higher annealing temperatures led to reduced TL intensity due to trap annihilation. Structural analysis using X-ray diffraction confirmed the cubic fluorite phase of CaF, with good crystallinity and thermal stability, accompanied by grain growth after annealing at high temperatures. Thermogravimetric analysis demonstrated minimal weight loss, indicating excellent thermal stability, while FT-IR and SEM studies revealed low impurity content and a uniform microstructure favorable for a reproducible TL response. The combined results suggest that natural CaF, is a thermally stable material with promising thermoluminescence characteristics for radiation dosimetry.

Keywords: *Thermoluminescence of Natural calcium fluoride (CaF,), effect of radiation on CaF_2, Thermal stability of CaF_2.*

1. Introduction

Calcium fluoride (CaF,) is a well-known inorganic compound that occurs naturally as a mineral fluorite. Natural CaF, is widely distributed in the Earth's crust and is commonly found in hydrothermal veins, sedimentary deposits and igneous rocks. Owing to its simple cubic crystal structure, high chemical stability, wide bandgap, and excellent optical transparency over a broad spectral range, calcium fluoride has attracted sustained interest in both fundamental and applied research.

The unique physical and chemical properties of CaF, make it an important material for various technological applications. It is extensively used in optical components, such as lenses, windows, and prisms, particularly in ultraviolet and infrared spectroscopy, owing to its low refractive index and minimal optical absorption. In addition, CaF, plays a significant role in metallurgy as a flux, in the nuclear industry, and as a host material for rare earth dopants in phosphors and laser materials. Its ability to accommodate defects and impurity centers further enhances its relevance for radiation detection and dosimetric studies.

Thermoluminescence (TL) is a radiation-induced phenomenon in which a material emits light upon controlled heating after exposure to ionizing radiation. This emission results from the release of trapped charge

carriers from the defect levels within the crystal lattice. The study of thermoluminescence provides valuable insights into the nature of defects, trap distributions, and recombination processes in insulating and wide bandgap materials. TL has become an important tool in material science, particularly for radiation dosimetry, geological and archaeological dating, and defect characterization.

Natural calcium fluoride exhibits promising thermoluminescent properties owing to its intrinsic defect structure and sensitivity to radiation. Investigating the thermoluminescence behavior of CaF, not only enhances the understanding of its defect dynamics but also contributes to its potential application as a reliable TL dosimeter. The present study focuses on the thermoluminescence characteristics of calcium fluoride, aiming to elucidate the trapping mechanisms and evaluate its suitability for radiation detection applications.

2. Experimental

A natural sample of calcium fluoride (CaF,) was collected from the Amba Dungar region of the Chhota Udaipur district in Gujarat, India. The collected sample was initially washed thoroughly with distilled water to remove adhered soil, impurities, and dust particles. After drying at room temperature, the sample was finely ground using an agate mortar and pestle to obtain a homogeneous powder.

Natural thermoluminescence (NTL) measurements were first recorded for the as-received sample without any artificial irradiation. Subsequently, the powdered CaF, sample was irradiated with a beta radiation dose of 25 Gy using a Sr-90 beta radiation source. To study the effect of thermal treatment on the thermoluminescence characteristics, the irradiated samples were annealed at different temperatures: 200, 400, 600, and 800 °C. The annealing process was carried out in a microcontroller-based furnace, followed by rapid quenching to room temperature.

After annealing and quenching, the samples were irradiated again with a beta dose of 25 Gy using the same Sr-90 radiation source. Thermoluminescence glow curves were recorded using a microcontroller-based Nucleonix thermoluminescence reader under controlled heating conditions.

To gain a comprehensive understanding of the thermoluminescence behavior of calcium fluoride, additional structural, morphological, and thermal characterizations were performed. Powder X-ray diffraction (XRD) patterns were recorded using a Bruker D2 Phaser diffractometer with Cu Kα radiation (λ = 1.54056 Å) to confirm the phase and crystallinity of the sample. Fourier-transform infrared (FT-IR) spectra were obtained using a Thermo Scientific Nicolet 6700 spectrometer employing the KBr pellet technique to identify functional groups and bonding characteristics.

Thermogravimetric analysis (TGA) was performed using a Mettler Toledo thermal analyzer to evaluate the thermal stability and weight loss behavior of the sample. The surface morphology was examined using scanning electron microscopy (SEM) with a Leo S-440i (EDX Model 7060). Particle size distribution analysis was performed using a Mastersizer micro-particle size analyzer.

3. Results and Discussion

Particle size analysis of the powdered natural calcium fluoride sample revealed an average particle size of approximately 55 μm, indicating a moderately fine and homogeneous powder suitable for thermoluminescence and structural investigations.

3.1 Natural and Artificial Thermoluminescence of CaF_2

Natural thermoluminescence (NTL) and artificial thermoluminescence (ATL) glow curves were recorded for all samples using a fixed sample mass of 5 mg for each sample. Figure 1 shows the TL glow curves of the as-received sample and samples annealed and quenched at 200 °C, 400 °C, 600 °C, and 800 °C, followed by beta irradiation with a dose of 25 Gy using a Sr-90 source.

The as-received natural CaF_2 sample did not exhibit any significant TL signal, indicating the absence or depletion of stably trapped charge carriers under natural conditions. However, upon beta irradiation, the sample showed a prominent TL glow peak centered at approximately 145 °C, along with a broad hump near 225 °C. These features suggest the presence of multiple trapping centers with different thermal stabilities in the CaF_2 lattice.

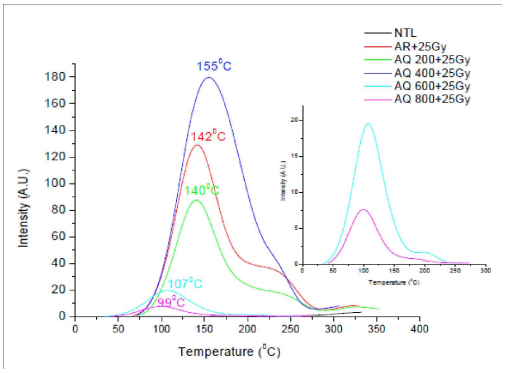

Fig. 1: NTL and ATL of calcium fluoride

Among the thermally treated samples, the highest TL intensity was observed for the sample annealed and quenched at 400 °C, followed by beta irradiation. This enhancement in the TL intensity may be attributed to the optimal creation and stabilization of defect-related trapping centers during thermal treatment at this temperature. With further increases in the annealing and quenching temperatures, a gradual decrease in the TL intensity was observed. This reduction in intensity is likely due to the annihilation or redistribution of the trapping centers at higher temperatures.

Analysis of the glow curves further indicates a shift of the main TL peak towards lower temperatures with increasing annealing temperature, suggesting a reduction in the trap depth or thermal stability of the dominant trapping centers. In contrast, the secondary hump exhibited a shift towards higher temperatures, while its intensity decreased, indicating changes in the population and activation energy of the deeper traps. These observations collectively confirm that annealing and quenching significantly influence the defect structure and thermoluminescence behavior of natural CaF_2 .

3.2 X-ray Diffraction Analysis

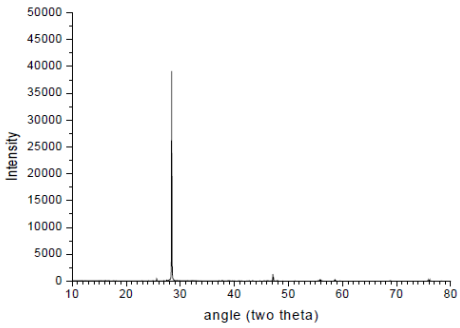

Fig.-2: X-ray diffraction pattern for as received CaF_2

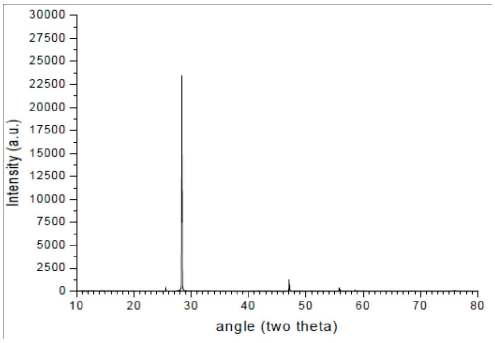

Fig.-3: x-ray diffraction pattern for the sample annealed and quenched from 800 ^{0}C

Figure 2 shows the X-ray diffraction (XRD) pattern of the as-received natural CaF_2 sample. The diffraction peaks observed at 2è values of approximately 28°, 26°, 47°, 56°, 59°, and 76° correspond well with the characteristic reflections of cubic fluorite CaF, , confirming the sample's crystalline nature. The absence of extra peaks indicates phase purity within the detection limit of the instrument.

The average crystallite size was calculated using Scherrer's equation and was found to be approximately 71.33 nm for the as-received sample. Figure 3 shows the XRD pattern of the CaF, sample that was annealed and quenched from 800 °C. No significant change in the peak positions was observed, indicating that the crystal structure remained stable even after high-temperature treatment. However, an increase in the crystallite size to approximately 85.61 nm was observed, which can be attributed to grain growth induced by thermal annealing.

3.3 Thermogravimetric Analysis

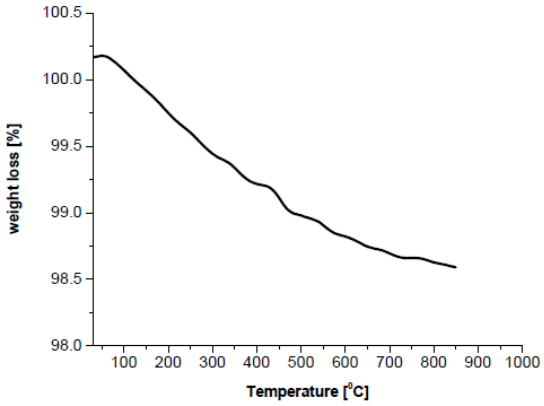

Fig.- 4: TGA curve for Natural CaF_2

Thermogravimetric analysis (TGA) of the natural CaF, sample revealed a total weight loss of approximately 1.5% up to 800 °C. This minor weight loss was attributed primarily to the removal of physically adsorbed water and moisture present in the sample. The subtle thermal event observed at approximately 400 °C may be associated with the release of more strongly bound water molecules or minor structural rearrangements within the material. Overall, the low weight loss indicates the good thermal stability of natural CaF, over the investigated temperature range.

3.4 Fourier Transform Infrared Spectroscopy

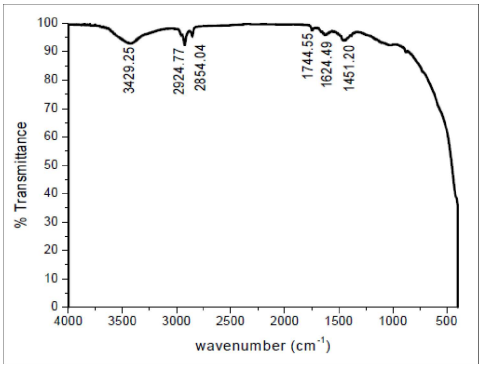

Fig.-5: FTIR absorption spectrum for as received CaF_2

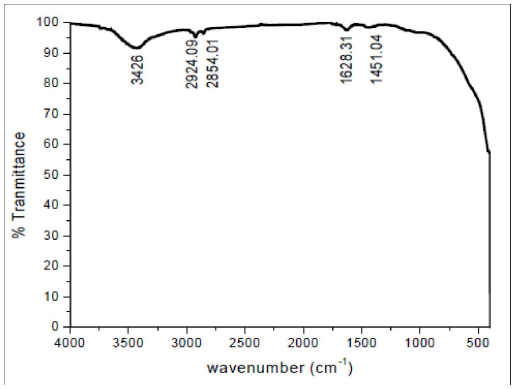

Fig.-6: FTIR absorption spectrum for sample AQ from 800^{0}C

The FT-IR spectrum of the CaF, sample exhibited weak absorption bands, indicating the minimal presence of molecular impurities. A small absorption band observed at approximately 1451 cm^{-1} is attributed to asymmetric stretching vibrations, while a broad band centered near 3429 cm^{-1}

corresponds to O–H stretching vibrations. The presence of this broad peak suggests the adsorption of water molecules on the surface of the sample, which is consistent with the observations from the TGA analysis.

3.5 Scanning Electron Microscopy

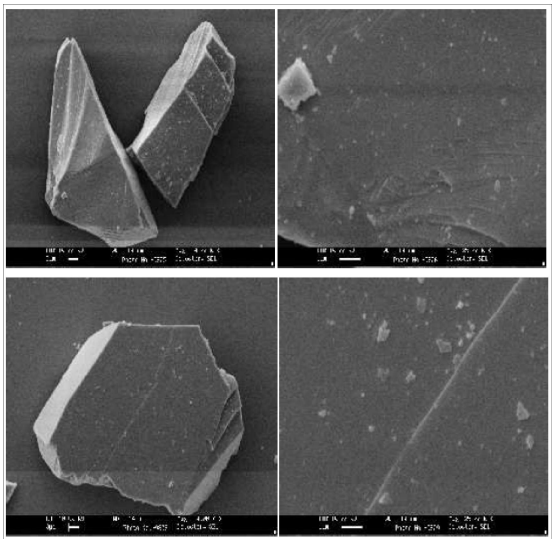

Fig.-7: SEM micrographs of natural CaF_2

SEM micrographs of the natural CaF_2 sample revealed a finely layered surface morphology with well-defined features. The observed layers appeared to be composed of nanoscale structural units, indicating a heterogeneous microstructure. The surface morphology was relatively uniform and free from large agglomerates, which is favorable for reproducible thermoluminescence measurements. The nanoscale features observed in the SEM images may play a role in defect formation and charge trapping mechanisms, contributing to the TL behavior of CaF_2 .

4. Conclusion

A thermoluminescence study of natural CaF, confirmed its sensitivity to beta radiation and its strong dependence on thermal treatment. Annealing at 400 °C optimizes defect-related trapping centers, yielding the maximum TL intensity. Structural and thermal analyses established phase purity, thermal stability, and controlled defect modification without structural degradation. These results demonstrate that natural CaF, is a stable and promising material for thermoluminescence-based radiation dosimetry applications.

5. Scope for Future Work

Future investigations should focus on the rare-earth doping of CaF_2 to enhance TL sensitivity and stability. Detailed kinetic analyses of glow peaks, dose–response studies, fading behavior, and reusability assessments would further establish its suitability for precise dosimetric and retrospective radiation measurement applications.

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