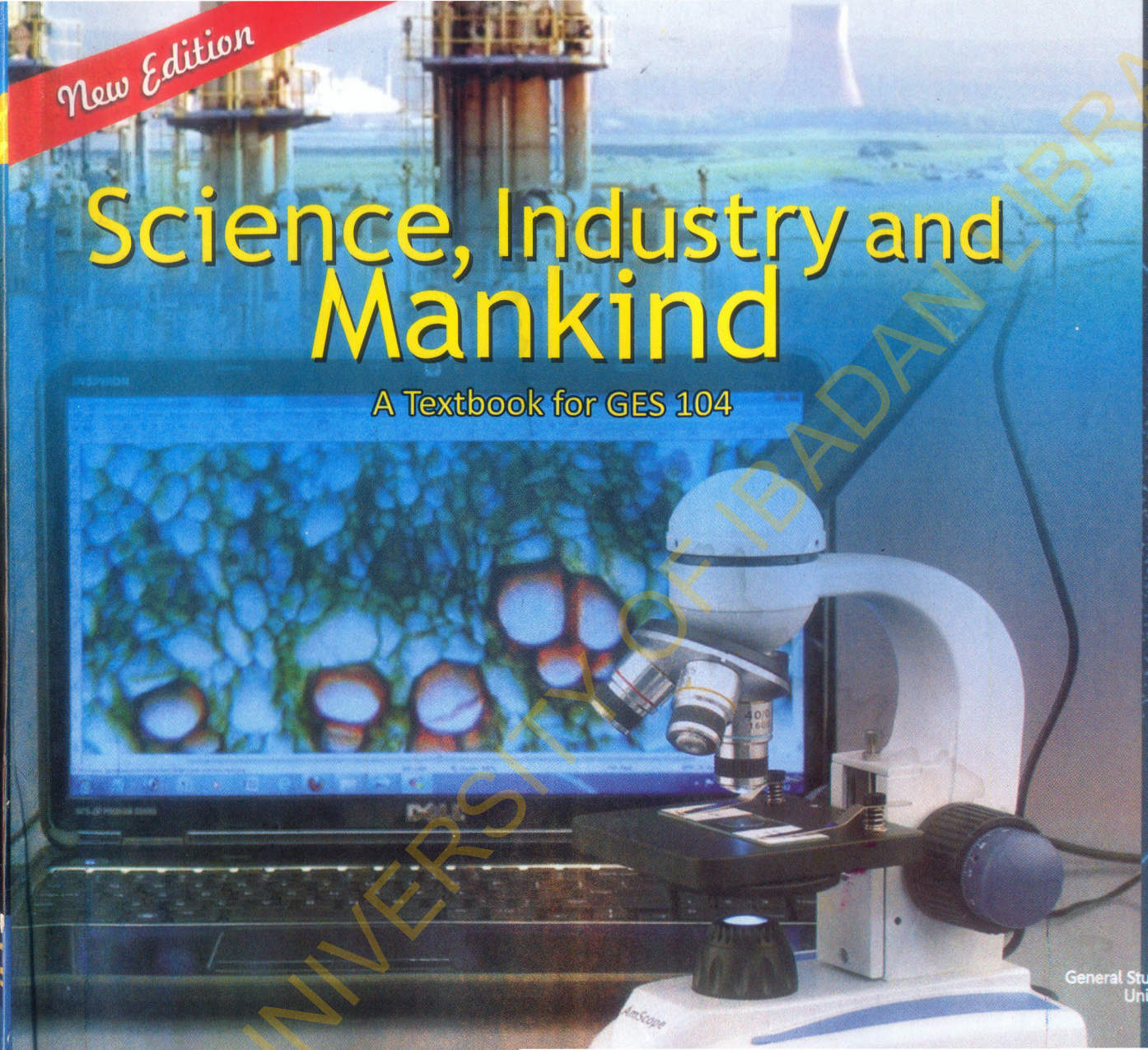
New Edition

Science, Industry and Mankind

A Textbook for GES 104



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Preface

This book, *Science, Industry and Mankind*, is a revised version of *Science and mankind* published in 1995. The original idea was embraced and motivated by the Faculty of Science, University of Ibadan, in a bid to aid the teaching of General Studies courses in Nigerian Universities and in other tertiary institutions. The book is intended to serve as a guide to the rudiments and principles of basic scientific techniques and applications for students from non-science based faculties.

The Faculty recognizes the need for excellence in teaching and research in science and so welcomes this new edition. The purpose of this book is to acquaint non-science students with fundamental and essential scientific principles, including the appropriate familiarization with science, to enable them to perform brilliantly in a dynamic world. Since science has become so closely intertwined with society's needs, a formal introductory course like this will be auspicious for everyone that is not in a science based discipline.

With the above goal in mind, this book becomes a pedagogical experiment to present the materials in a coherent and attractive form suitable for students having their first exposure to science courses at the tertiary level. This material has been class-tested, as a one semester course, on fresh undergraduates at the University, meeting three days a week for fifteen weeks. Upon completion of the course, the students are able to appreciate science as a tool to industrial growth and human welfare.

To understand industry and mankind, a familiarity with certain principles of science is essential. The need to present these principles at an introductory level and the challenge of doing so has prompted the preparation of this book by distinguished scientists in the Faculty. The book covers important topics like the history of science, the process of acquiring organized scientific data, science in various industries, energy utilization, industrial hazards and pollution, the ecosystem, problems of infectious diseases, the environment and mineral resources. These concepts and principles integrate smoothly into the broader goal of teaching science as a developmental tool to improve the quality of life. Each of the sections is accompanied with review questions on the subject matter. References are also included for extensive study.

It is with pleasure that I recommend this book to non-science students who are offering the General Studies course in tertiary institutions.

Prof. A. B. Odaibo

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Zoology Practices in Food Production, Sericulture and Pest Control

K.O.K.Popoola

Introduction

The study of nature generally referred to as Natural History or Biology has contributed immensely to the development and management of human population. This in turn has brought about sporadic increase in human population with challenges in acquisition of knowledge, job creation, food production, shelter and some other needs of life. Science, if well applied, is for human development and survival. Science provides a lot of facilities for the survival of man in terms of certain essential needs for transportation, energy and food production, medicine, communication, etc. This aspect of General Studies Programme aims at providing some practices in Applied Zoology for non-science based students of the University to stimulate their interest in the field of science for possible self employment, economic empowerment and ultimately life sustenance after their studies in the University. Consequently, practices in apiculture, sericulture, aquaculture, snail farming and pest control and slides preparation will be the focus of this section. The importance of these areas in self employment cannot be overemphasized, considering their relevance to our daily life. Apart form the materials produced; they also generate income, so they are good sources of job creation.

Practices in Apiculture

The management of bees in hive is known as bee-keeping. However, bee-keeping can be loosely used to involve all techniques involving bees and the subsequent harvesting and processing of bees products.

The benefits of Honeybees

- Bee products, i.e. honey, beewax, pollen, propolis, royal jelly, bee venom, bee bread, apilarnil and apilanilprop.
- Pollinating activities which are of great value to food production.
- Bee-keeping does not require huge investment since hive and other equipment can be made from local materials.
- Keeping bees allows for time flexibility since it does not require daily attention. It can be done on a part-time or full-time basis.

- Bee farming provides people in developing countries with sources of income, nutrition and also a source of foreign exchange earnings.

Bee-keeping Equipment

(i) **Bee hives**

A bee hive is any container provided by the bee-keeper for honeybees to nest in, so that they can be easily managed and exploited. Types of hive include Kenya top-bar hive, Tanzania transitional hive, Langstroth hive and traditional hives

(ii) **Smoker**

When bee colonies is being manipulated and a gentle puff of smoke at the entrance is introduced, guard bees release alarm pheromones but the smoke's odour masks the alarm pheromone, thus the bees fail to respond to the message "attack the intruder"

(iii) **Hive Tool**

A hive tool is a strong spring steel material about 25cm long, used for scraping propolis or wax off a wooden surface.

(iv) **Protective equipment**

Protective clothing, Bee veil, Gloves and Boots are wears that are used in covering workers on farm. Every beekeeper must possess adequate protective bee dress. It makes workers to be comfortable when at work. Minimally the face should be covered it is optional to cover the hand and arms based on the beekeepers skill at keeping the bee under control.

(v) **Comb foundation**

It is the base of the bee hive inserted in the frame by the farmer. It is made up of pure wax and is hexagonal in shape. It permits for easy and rapid manipulation of the colonies.

(vi) **Feeders**

Substances (sugar) used to lure bees in the hive for the establishment of a new hive.

Feeders are mostly used when there is scarcity or dearth season and when a swarm is newly caught.

(vii) **Bee brush**

This is made out of camel-hair brush or quill feathers or a handful of grass or leaves. It is used to brush off the combs during inspection and harvesting periods.

(viii) **Uncapping Knife/Fork**

Mature honey hive is sealed or capped with wax layer to prevent it from dripping.

During harvest, the cap is removed with kitchen knife or fork .The knife will be dipped into hot water, and wipe off the water on the knife before use.

(ix) **Pollen trap**

This is used for the collection of pollen from the hive. It is a device kept at the entrance of a bee hive.

(x) **Honey extractor**

This is a device that spins the combs so rapidly in order to remove honey through centrifugal force. There are different types of extractor. These include manually

operated or tangential extractor and motorised multi-frame honey extractor.

(xi) **Honey Refractometer**

This instrument is used for the measurement of the sugar and moisture contents of honey. It is operated by adding a few drops of honey into the prism and the hinged window closed down on them. This allows for the spread of the honey. The thinness of the spread honey is looked at through the eyepiece and the calibrated scale is used to read the honey qualities.

Factors to be considered in selecting apiary site

The following factors should be considered when selecting an apiary site:

- Access Road: An apiary must be easily accessible to both human and vehicular traffics in all weathers.
- Topography: A level surface must be chosen.
- Availability of food resources: An apiary should be sited very close to the source of nectar and pollen, the main food resources for honeybees.
- Water: Bees use water to cool the colony and feed the brood nest, there should be a source of water nearby.
- Wind: An apiary should be shielded from wind so as not to reduce foraging efficiency.
- Open space: Colonies should be sheltered to avoid exposure to direct weather.
- Predators/Pest: Check for bee enemies before siting your apiary.
- Stocking: Avoid over-stocking of an apiary as it may bring about infection problem.
- Environmental Pollution: An apiary should be protected against air, water and agro-chemical pollution.
- Vegetation: An apiary should be sited away from thick or dense vegetation that may cause damp and chilly environment.
- Safety from Vandals and Theft: An apiary should be sited not too far away from the bee keepers for regular inspection against theft, vandalism and pest attack.
- Bush Fires: Prepare adequately to prevent bush fire from spreading to your apiary by good apiary sanitation and fire tracing.

Harvest period

This occurs after the end of the honey flow usually towards mid-February through April. There is little pollen and nectar available and bees are busy ripening nectar into honey. At this period brood rearing decreases.

Apiary Management:

Other management technique such as bees handling, time floral calendar, and seasonal changes are to be considered for good honey yield.

Uses of Honey

Honey is useful at home, for food and pharmaceutical industrial uses, and for apiterapeutic application.

Honey and its products are very lucrative and with very large markets both international and local.

Practices in Sericulture

Sericulture is an act of producing raw silk from the larva of the moth, *Bombyx mori*. This insect is the only living species in its family, Bombycidae. Silk production from *Bombyx mori* was discovered as far back as 2,700 B.C according to the Chinese records. When the great prince, Hoang-Ti directed his wife, Si-ling-chi to examine the silkworm and also test the practicability of using the thread. Thereafter, Si-ling-chi discovered not only the means of raising silkworms but also the manner of reeling the silk, and of employing it to make garments. Based on this discovery she was honoured as 'The Goddess of Silk worms'.

Afterwards, the techniques of sericulture spread across other countries from China to Rome, Japan, Korea, India, England, United States, and African countries with various advancements geared towards the production of raw silk. However, the production of silk nowadays is a blend of both ancient techniques and modern innovations. Hatching of silkworm eggs previously examined and shown to be free from disease is the first stage of silk production. The larvae are then fed with cut-up mulberry leaves and after the fourth month, a twig is placed near them followed by spinning of their silken cocoons.

The silk is a continuous-filament fibre consisting of: (a) fibroin protein secreted from two salivary glands in the head of each larvae and (b) sericin, a gum which cements the two filaments together. Pupae within cocoons are often killed by steaming or fumigation to prevent adult emergence. Cocoons are later freed by softening the binding sericin and then locating the filament end and unwinding or reeling the filaments from several cocoons at the same time, sometimes with a slight twist, forming a single strand. Several silk strands that are too thin are usually twisted together to make thicker, stronger yarn in a process called **THROWING**, producing various yarns differing according to the amount and direction of the twist imparted.

Silk containing sericin is called raw silk. The gumming substance is usually retained until the yarn or fabric stage is removed by boiling the silk in soap and water, leaving it soft and lustrous with its weight reduced by as much as thirty percent (30%). Spun silk is made from short length obtained from damaged cocoons broken off during processing, twisted to make yarn. Silk is sometimes treated with a finishing substance such as metallic salt in order to increase its weight, add density, and improve draping quality in a process called weighting.

The degumming process leaves the silk lustrous and semi-transparent with a smooth surface that does not readily retain soil. Silk has good strength, resisting breakage when subjected to a weight of about 4g per denier while wetting reduces its strength by about 15-25% percent. A silk filament can be stretched about 20% beyond its original length before breaking, but does not

immediately resume its original length when stretched beyond 2%. The yarn is further dried, packed according to quality and now available in form of raw silk ready for marketing.

In spite of several man-made fibres replacing silk, world silk production has doubled during the last thirty years, leaving China as the world's main producer of silk today.

Practices in Aquaculture

Aquaculture is the rearing of water bodies organisms under controlled or semi-controlled conditions. The term 'aquatic' refers to a variety of water environments, including freshwater, brackish water and marine. 'Aquatic organisms' that are of interest with regard to human food production include a wide variety of plants, invertebrates and vertebrates. Mariculture is a term reserved for the culture of organisms in saltwater (from brackish to full strength seawater).

Role of Aquaculture

(1) Increasing food production, especially of animal proteins,
(2) Producing food near consuming centres, thus contributing to improvement in human nutrition,
(3) Supplementing or replacing capture fishery protection of over-exploited fish and shellfish stocks,
(4) Generating new sources of employment,
(5) Earning foreign exchange through export or saving foreign exchange through import substitution, and
(6) Creating and maintaining leisure-time activities, including sport fishing and home and public aquaria.

Factors to be considered in aquaculture farm establishment

- Selection of suitable Sites with adequate water supply,
- Selection of Species for Culture,
- Design and Construction of Aquafarm,
- Nutrition and Feeds,
- Reproduction and Genetic Selection,
- Health and Diseases management,
- Control of Weeds, Pests and Predators,
- Harvesting and Post-Harvest Technology,
- Marketing of Aquaculture Products,
- Economics and Financing of Aquaculture, and
- Farm Management.

The African catfish

Clarias lazera (= *gariepinus*), known as the African catfish, was later added to aquaculture in Africa, which has been largely dominated by tilapia for long. *Clarias lazera* can best be described as an omnivore, often feeding on vegetable matter, aquatic invertebrates, small fish, detritus, etc. The fish have been observed to reach over 130 cm in length and 12.8 kg in weight. A high degree of hardiness, the ability to feed on a variety of

feedstuffs, and good growth and survival in poorly oxygenated waters has made it an attractive fish for aquaculture.

The most common system of culture for this catfish is in pond farms, either in monoculture or in combination with tilapia, which has been shown to be a compatible species under pond conditions.

Spawning and fry production

Clarias lazera are reported to become mature under natural conditions at the size of about 32 cm (two or three years old) and spawn in the flooded rivers. Under pond conditions, they mature in about seven months, when they have attained a weight of 200–300 g. The spawning season varies between regions, in West Africa which is between April and May. They seem to spawn only once with the onset of the rainy season, under natural conditions, but can be bred throughout the year in captivity. Observations confirm that spawning is stimulated by floods or increased levels of water in ponds due to rain or exchange with fresh water, as in the case of *C. batrachus*. Eggs are ejected in several batches (15–50 batches) during the extended mating and spawning, at temperatures above 17°C. The eggs adhere to sedges and grass. While it is fairly easy to spawn mature fish in ponds by simulating changes in water levels, as it happens during floods in nature (by draining the ponds partly and filling them suddenly with fresh water), the survival of offspring is generally very poor. Unlike some of the other catfish, *C. lazera* does not seem to show any parental care, and under pond conditions the larvae and fry seem to become cannibalistic. In addition, there is a fair amount of predation by frogs and other aquatic animals in ponds. Because of these limitations, methods of induced spawning are adopted for the production of fry.

For **induced spawning**, brood stock from natural habitats or culture ponds can be used. Ripe females in captivity range in size from 28–65cm, weighing 175–1600g. Females can be identified by the rounded vent with a longitudinal cleft, and the males by the elongated urogenital papilla. From experimental studies it is concluded that the best means of stimulating ovulation in females is by injection of the hormone product desoxycorticosterone (DOCA). The suggested dose is a single intraperitoneal injection of 5mg DOCA per 100g weight of fish. Injected females and mature males (which may not require any injection) are kept in separate tanks for about 10 hours, after which they are placed together in a tank or cement cistern, usually in the evening.

Spawning occurs during the night, about 10–16 hours after injection of the female. The eggs can easily be collected in the morning and hatched in separate containers. The main problem with this method is that the couples often inflict fatal injuries on each other. To avoid this, the injected females can be stripped and the eggs fertilized artificially. First the females are injected with the above dose of DOCA, usually in the morning and the males in the evening. The female is stripped about 10 hours after the injection. Males cannot be hand

stripped because of the structural peculiarities of the seminal vesicle. If pressure is exerted on the abdomen, the milt will pass to the dorso-lateral lobes of the vesicle and not to the genital opening. So the males have to be killed and the sperm collected directly from the vesicles. Injection helps to increase the yield of milt three to five times. Embryonic development is completed in about 24 hours after fertilization at temperatures around 26°C. The yolk sac is absorbed in six days and the larvae start feeding when about three days old.

Clarias lazera can be spawned by hypophysation as well, like many other species. Acetone-dried carp pituitary at a dose of 4 mg per kg body weight is adequate to ripen females. As mentioned earlier, injection of males does not seem to help in stripping them, and they have to be sacrificed to obtain milt. The females can be stripped 11–16 hours after injection. At 20°C, hatching of fertilized eggs occurs in about 48 hours, when the hatchlings can be transferred from incubators to a trough for rearing.

The stocking rate of fry is generally 10,000 – 20,000 per ha. Fed on natural food, they reach a weight of around 10 g in about three weeks. Thereafter, the fry start feeding on larvae of aquatic insects. Artificial feeds can be given to the fry at this stage. Though amphibians, aquatic insects and occasionally wild fish prey on the fry, the main reason for low survival in ponds appears to be the lack of appropriate feed.

Snail Farming.

This is rearing of snails for protein supplement and for the generation of income by people. There are different species of snails being reared, these include the *Achatina* and *Limicolaria*.The species of *Archachatina* and *Achatina* are usually favoured and they grow to reasonable sizes. They belong to the Phylum Mollusca; about 100,000 species have been described making them to be the second largest in the Animal Kingdom.

Factors to be considered in snail establishment

Snail farming can be carried out in densely forested areas, with regular rainfall seasons. The site must be sheltered location with less wind and strong light intensity. Moisture and decaying vegetable matter in a rain forest offer ideal condition for the snail.

Temperature and humidity are two important climatic factors that influence the distribution of snails, because snail's physiology and metabolic activities requires water for effective activities.

Breeding Management in Snail farming

Sail farming is a fast growing practice to supplement protein production. Earlier farmers were not mainly snail farmers but take up snail farming as part of their produce. Currently, many farmers are now culturing snail as a major produce in their farm.

Breeding involves the basic techniques of farming such as:

i. Eggs collection and hatching / growing of juvenile snails.
ii. Utilization of the best areas for growth and reproduction;
iii. Pest and diseases control

Snail handling is a function of the snail species and the purpose of rearing. The handling procedure adopted may influence snail output, economic returns and inputs as well as health status. Snails can either be reared in cages or paddocks/pens. (Odaibo, 1997)

Rearing snails in cage

Wood, bricks, stones, bamboo and other suitable materials can be used to construct snail cage. The size of the cage is not fixed, however it is a function of one's needs, but surface area should be larger than the depth of the cage. Objects such as stones, nonresinous tree bark, etc can be added to increase the surface area and to provide place of refuge. In addition to moisture snails also need peat moss, leaf litter, soil and gravel. (Cooper and Knowler, 1991)

Achatinidae may need cage that is about 10cm to permit them to burrow and facilitate egg laying. The cage must be well ventilated. The vent (either by whole or wire mesh) must not be too open, to prevent reduction in humidity, an optimum temperature of 20-25 °C is required. The setting of the cages in snail rearing depends on the specific purpose of the cage.

Breeders cage:

This cage is set up for egg production from healthy snails. The soil here should be very soft to allow for eggs recovery. Also the cage should supplied with organic materials. Flat containers should be used to provide water in all the cages .

Nursery cage:

This is a cage where eggs are hatched. The soil should have stones and lots of decaying plants materials. The substrate must be kept damp but not wet. The hole for ventilation must be very small to prevent escape of hatchlings. Adequate food must be supplied . Young snail prefers succulent leaves to fruits.

Fattening cage:

After six to eight months young snails are transferred to fattening cage, which may be indoor or outdoor. The cage surface should be larger than the depth, with adequate damp substrate. Aestivation should be prevented so as to achieve the purpose of the set up.

Paddock/Pens Farming:

This involves the use of a fenced-in area. The area in use must be sheltered from prevailing winds and shaded to provide protection from intense sunlight. A pen can be as large as several square meters in size. The fence materials should be up to 60cm deep to prevent attack of reared snail by burrowing animals. Employed fencing materials could be corrugated sheet metal, plastic sheet,

woven plant materials, chicken wire or wire netting and planks. Measures should be put in place to prevent escape of snail by bending fence inwards. Useful plants that serve as food can be grown in the pen for food provision.

Stocking Density

A pen of 5m by 5m ($25m^2$) can be stocked with (FAO1986):

- 150 juvenile snails (6 per square meter)
- 25 adult snails (1 per square meter)

High mortality rates, stunting, shell rasping and cannibalism are indication of overcrowding.

Sanitation and Hygiene:

Cages should be cleaned at least weekly. Decaying food materials should be removed promptly. Also soil should be replenished especially where high density rates are used. Cage sides should be wiped off of slime and faeces. Optimum condition can be provided by using three layered substrate as recommended by Cooper and Knowler, (1991).

Little earthworm can be introduced for aeration. Ensure you have gloves on when working with the cages.

Most importantly all dead snails and uneaten food should be removed immediately. This will prevent pests and parasites from overtaking the farm.

Pest control: Insect control in homes

Controlling pest in and around the home seems to be a never ending problem. Insects invade homes, contaminate stored food products, carry certain organisms that cause serious human and animal diseases, infest pet and threaten fruiting trees, ornamental plants and vegetables.

To help home owner to control pests in and around home, a wide array of pesticides has been developed. Insecticide is a chemical used in reduction of insects' population. Pesticides are substances or mixture of substances used for destroying, preventing, repelling or mitigating pests. Insecticides are commonly used in and around homes because most home-owners consider insects and insect relatives (e.g. mites, spiders, centipedes and millipedes) as pests or as a nuisance, especially when they occur in homes.

Pest around homes

Insects and insects relatives frequently encountered outdoor are ants, mosquitoes, spiders, bees, and flies while some of these pest like cockroach etc., become a nuisance when found indoors.

In addition, some invertebrate pests like fleas, sawtoothed grain beetle, and red flour weevil, and vertebrates such as rodents, bats and birds also become pests when they seek refuge indoors.

Some invertebrates are brought indoors on infested food materials, and if the environmental and nutritional requirements are not met they will perish, and others

may thrive due to favourable environmental factors, such as availability of food, and absence of natural enemies.

Reasons for pest control

Home owners apply control measures against outdoor and indoor pests because they dislike the presence of pests, prefer to maintain a pest-free property and want to eliminate pests that transmit disease, e.g. cockroach, tick, flies, etc.

Keys to successful pest control

The following are some of the notable keys to successful pest control:

1. Correct identification of the pest: This will assist in getting the information on the pest biology, ecology and behaviour.
2. Early detection of pest's population: Most pest controls work well at low density population.
3. Control measure must be timed to target the most vulnerable stage of pests.
4. Pesticides should be used only as a last resort, i.e. it should complement non-chemicals or biorational methods.

Integrated Pests Management (IPM)

The application of more than one control method or the combination of both chemical and other control methods is called integrated pests management. Integrated Pest Management (IPM) is a holistic approach to pest management that uses a full range of pest control methods in a safe, cost-efficient, and environmentally sound manner. This includes physical, biological, mechanical, chemical, management, among others. The goal of an IPM strategy is to prevent pests from reaching economic threshold levels. All these methods should be harmonised in a way to grant highest priority to the protection of the human health as well as the environment. This control method is cheap, not toxic; it requires less technical know-how and environmentally friendly.

Integrated Pest Management application depends on the pest species, intensity or severity. The underlisted practices can be combined with different control measurers for proper IPM:

Exclusion: This is the prevention of organisms from entering indoors through openings in the building structure, doors, and windows and on infested food materials.

Sanitation: To maintain clean surroundings both outdoor and indoor, remove potential areas where pests can feed, breed and hide.

Habitat Modification: This includes any method used to eliminate or disrupt areas where pests reside, e.g. removing weeds, keeping well mowed lawn and removing debris.

Temperature Control: This is artificially manipulating the temperature of substrates infested by pest or areas where pests reside, e.g. an infested beans at home can be kept in a refrigerator below 30°C.

Mechanical Control: This comprises killing, hand picking and trapping of pests; storing of cereal product in tight containers, dry cleaning cloth may eliminate clothes moth infestation, etc.

Biological Control: parasitic and predatory insects, mites and nematodes are commercially used to control pests. Parasitic and predatory insects should be used only where pesticides are discontinued or were not previously used because they are highly susceptible to pesticide, e.g. lacewig larvae and ladybird beetle larvae and adult are predators of aphids.

Bio rational Pesticides

For some pests, non-chemical techniques are ineffective. Therefore, bio rational products, which offer better control efficiency and reduce hazard to human, pets, wildlife and the environment, become handy.

Insecticidal Soaps: Soap solution has insecticidal value because when applied to soft bodied insect, they penetrate through the waxy outer protective layer (cuticle) and dissolve cell membranes. As a result, the cells collapse and leak, leading to dehydration and death. Any household soap or laundry detergent can be used at a rate of ½ cup per gallon of H_2O on soft bodied insect. Kerosene can also be used to kill insects at home.

Horticultural Oils: are highly returned petroleum based oils and kill insect by asphyxiation (by clogging spiracles or exterior openings along side of the insect body that facilitates breathing).

Botanicals: They are essential plants derived chemicals, e.g. neem, the component in neem that is most active against insect is azadirachtin which is an effective feeding or ovipositor deterrent and also disrupt the normal development of insect.

Baits: it consists of food materials combined with a selective pesticide to kill pests, e.g. for pantry pest, use of wheat germ plus mineral oil bait is effective in drawing insects out of their hiding places into the bait. The bait must be in a small shallow cup. The oil kills trapped insects by suffocation (by clogging spiracles). Therefore, controlling pest in and around the home is a never ending problem and a wide array of pesticides has been developed. For the home owner who chooses to use them, it is a personal decision. Integrated Pest Management method should be used in controlling pests.

Slide preparation

A slide is a small thin rectangular glass about 1x3 inches. The glass is used to mount specimens so that they can be handled and seen under a microscope. Slide can be prepared in two ways namely: permanent and temporary slide preparations.

Permanent slide preparation

A permanent slide is a slide that can be fixed and locked into place. A permanent slide has the tissues or specimen

chemically preserved. Permanent slides have a top and a bottom that are glued or otherwise sealed together.
Procedures for permanent preparation: The process described here must be followed step-by-step in order to obtain satisfactory results. There is no short cut to good slides. The following procedure should be adopted.

Maceration
For preparation of sclerotized (hard) parts of insects, boil in 5% or 10% sodium hydroxide or potassium hydroxide solution. Add a few pins to the liquid so that the boiling caustic soda or potash does not splash. Use a low flame. For delicate specimens, such as silver fish or mosquitoes, soak them in cold or warm caustic soda or potash solution for about 20 minutes instead of boiling specimens. The duration of boiling or soaking will depend upon how delicate the material is. As the material remains in the caustic soda or potash, it gradually becomes brownish, and sometimes distended. Keep an eye on the process. When sufficiently softened, remove and wash the material in plenty of water. Remove the digested internal tissues of the specimen by carefully applying repeated pressure with a blunt seeker. Then transfer the specimen to water containing a little glacial acetic acid.

Dehydration
This is done by transferring the specimen from acid water into each of the following solution in turns. This is done to remove water from the specimens. The times given should be varied according to the type of specimen being treated. Delicate specimens, such as aphids, need shorter times.
(a) Put in 30% alcohol for 5-10 minutes
(b) Put in 50% alcohol for 8-10 minutes
(c) Put in 70% alcohol for 10-15 minutes
(d) Put in 90% alcohol for 15-20 minutes
(e) Put in 98% alcohol for 20-30 minutes (or absolute alcohol)
During each transfer, the specimen must be pressed with the seeker to ensure that the alcohol penetrates into all the parts.

Clearing
The specimen is now transferred to xylene, where it should be left for about 15 to 20 minutes, after which time it will be somewhat transparent. Before the specimen is put into xylene, blot up all the absolute alcohol with tissue paper. This is done by placing the specimen briefly on tissue paper or filter paper immediately after removing it from the absolute alcohol. The specimen must not remain too long in xylene before it is mounted, otherwise it becomes brittle.

Mounting
The most common mounting reagent is Canada balsam; euparal or 'depex' are also sometimes used. Do not use a thin, diluted balsam, particularly in the case of thick specimens. Circular cover slips are the easiest to use,

although square and oblong ones are needed for large materials such as insect wings.

To mount the specimen, clean the slide thoroughly with absolute alcohol and spread a small quantity of Canada balsam on the middle of it with a seeker. The area covered should be less than the width of the cover slip to be used. Then put the specimen on this balsam. Arrange it on the slide, and allow to dry for about 10 minutes. Drying can be speeded up by holding the slide near the bulb of a microscope lamp or a table lamp.

Then squeeze a drop of Canada balsam on to the material, keeping the slide flat on the table. Gently place the cover slip on this drop of Canada balsam, so that the centre of the cover slip first touches the surface of the drop of Canada balsam.

The Canada balsam will then spread out on all sides towards the edges of the cover slip, thus eliminating air bubbles.

An alternative method of mounting is as follows: after sticking the specimen to the slide, allow it to dry as described earlier. Then put the cover slip flat on filter paper on the table and put a drop of Canada balsam in the middle of it. Then turn slide upside down and gently lower it so that the insect material touches the Canada balsam on the cover slip. As soon as contact is made, press down the slide gently and quickly reverse it. This method may be found difficult at first but with some practice it will be found to produce more satisfactory results than the first method.

When making thick preparations, put pins, with the heads cut off, or chips of glass, parallel to the sides of the glass. Stick the pins or glass chips down to the sides of the glass. Stick the pins or glass chips down to the slide with Canada balsam before mounting the specimen. Special mounting rings can also be used, but it should be remembered that the ring and the cover slip used must be of the same size.

Finishing In order to make slides more permanent, they should be' ringed' with a suitable vanish after drying. It is easier to ring slides with circular cover slips than those with square or oblong ones. As soon as a preparation is completed it should be labeled fully. Labeled specimens should be stored away in slide boxes, which should be kept in an air-conditioned room.

Temporary preparation

Temporary slides usually have a top and a bottom with the object secured-in between. It is temporary because it will quickly dry out.

Sometimes it is only necessary to make a temporary mount of an insect part on a slide for immediate study. In this case, mount the fresh material in glycerine on a slide and examine it under the microscope. Such temporary preparations do not keep more than two days and it does not require the use of Canada balsam when mounting.

Market for prepared slide

Slides prepared are needed by every primary and secondary school. Also, tertiary institutions are not left

out. Large markets are available for the products.This is a very lucrative work which do not require too much of technical know-how.

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