

## **Entomology**

**Course title: Entomology**

**Full Marks: 80**

**Course No. Zoo. 621**

**Pass Marks: 32**

**Nature of the course: Theory**

**Year: II**

**Course description: Systematic entomology, Anatomy and Physiology, Embryology and Endocrinology**

### **Course objectives**

- to make students able to know insect diversity, classification, evolutionary relationships of insect orders
- to develop insect identification skills to students,
- to make the students able to name different insect organs, physiology and endocrinology.

### **INTRODUCTION TO ENTOMOLOGY**

**10hrs**

- Why to study insects?
- Habits and evolution of the hexapod classes
- Origin and relationship among the orders of insects
- Insect diversity and classification of Hexapoda

### **SYSTEMATIC ENTOMOLOGY**

**50hrs**

Insect orders of Ametabolous, Hemimetabolous and Holometabolous should focus on, i) general morphology, particularly key taxonomic characters; ii) diversity and distributions; iii) habitat, habits and life histories; iv) economic importance vi) phylogenetic relationships and classification of family groups.

#### **Ametabolous insects**

Collembola\*, Thysanura\*, Archeognatha

#### **Hemimetabolous insects**

Ephemeroptera\*, Odonata\*, Blattodea, Mantodea, Isoptera, Dermaptera, Plecoptera\*, Orthoptera,\* Phasmatodea, Psocoptera, Hemiptera\*, Thysanoptera

#### **Holometabolous insects**

Megaloptera, Neuroptera, Siphonaptera, Coleoptera\*, Diptera\*, Lepidoptera\*, Trichoptera\*, Hymenoptera\*

*Emphasis should be given to the orders marked as (\*), families found in Oriental region and which are ecological and economically important.*

## **INSECT ANATOMY AND PHYSIOLOGY**

**20 hrs**

### **External anatomy:**

Insect body plan: Head, Thorax and Abdomen

Integument: forms and functions

Head: head, neck, and antennae and mouthparts

Thorax: Segmentation and its appendages (basic structures of legs and wings and their modifications)

Abdomen: Segmentation, Abdominal appendages and genitalia

### **Internal anatomy:**

**25hrs**

Respiration- integument, gills, trachea and gas exchange

Digestive system: alimentary canal, nutritional requirements and digestion and absorption

Excretory system

Circulation and thermoregulation

Reproductive system : Anatomy of reproductive organs (male and female)

Sound and light producing organs

## **INSECT EMBRYOLOGY AND ENDOCRINOLOGY**

**20 hrs**

Insect eggs, embryonic development, viviparity, polyembryony, parthenogenesis, pedogenesis and metamorphosis, types of larvae and pupae, Molting and Diapause physiology. Types of hormones in insects, structure and functions.

## ENTOMOLOGY

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**Course No. Zoo. 624**

**Pass Marks: 32**

**Nature of the course: Practical**

**Year: II**

**Course description: Systematic entomology, Anatomy and Physiology, Embryology and Endocrinology**

### **Course objectives**

- to make students able to know insect diversity, classification, evolutionary relationships of insect orders
- to develop insect identification skills to students by studying detail morphology and anatomy of different insects and

### **Course contents**

Collection: Students must have field trips to collect insects from diverse habitat types: forest, agriculture, grassland, lakes, pond, river and streams. Students are encouraged to use standard methods of scientific collections.

### **Study of Insect Morphology**

Typical insect morphology of different orders: segmentation and structure of head, thorax and abdomen.

Students need to draw the studied insect by using camera lucida and need to compare the part with other order.

### **Internal anatomy**

Study of different systems- Alimentary canal, nervous system, reproductive organs, tracheal system by dissecting commonly available insects, primarily pest species.

### **Taxonomy**

Identification of insects: Students must identify at least 20 species from their own collection upto species level. Wherever needed students must supply their identification proofs by setting camera lucida drawings, photographs, and slides of appropriate organs (antenna, wings, legs, genitalia etc.) or whole mount. The numbers and insect groups are given as follows;

Ametabolous - 4

Hemimetabolous - 6

Holometabolous - 10

**Collection and identification of aquatic insects**

Identify nymph, larvae and adults of aquatic insects at least upto genus level.

**Proper deposition of identified species and their arrangement:** Students must register their identification and indicate ID number in their practical class record. This ID number remain as permanent deposition of the animal and entomologists and researchers have access to these specimens.

**Presentation of the identification report:** Students must present their identification and must write a scientific paper in publishable format.

## **Recommended Text Books**

- Chapman, R.F. 1998. The insects structure and function 4<sup>th</sup> edition. Cambridge University Press.
- Comstock, J.H. 1984. An introduction to Entomology. 9<sup>th</sup> edition revised. Satish Book Enterprise Bookseller and publishers, Agra.
- Fox, R.M. and Fox, J.W. Introduction to comparative entomology. Reinhold Publishing Corporation, New York.
- Gillott, C. 1995. Entomology . 2<sup>nd</sup> Edition. Plenum Press, New York.
- Kapoor, V.C. Origin and evolution of insects. Kalyani Publishers, New Delhi.
- Klowden.M.J.2007. Physiological systems in insects: Academic Press, 2E edition. 688 pages.
- Richards, O.W. and Davies, R.G. 1977. Imm's general textbook of entomology. 10<sup>th</sup> edition vol. I Structure, physiology and Development, Chapman and Hall., London.
- Richards, O.W. and Davies, R.G. 1977. Imm's general textbook of entomology. 10<sup>th</sup> edition vol. II Classification and Biology. Chapman and Hall., London.
- Steinmann, H. and Zombori, L. 1981. An atlas of insect morphology. Akademiai Kiade.

## ENTOMOLOGY

**Course title: Entomology**

**Full Marks: 80**

**Course No. Zoo. 622**

**Pass Marks: 32**

**Nature of the course: Theory**

**Year: II**

**Course description: Research methodology, Insect ecology and behaviour, medical and veterinary entomology, industrial entomology, forensic entomology**

### **Course objectives**

- to make students able to tell about insect ecology and behaviour, medical and veterinary entomology, industrial entomology, forensic entomology and research methodology
- to develop practical knowledge to study species level information about medical and veterinary importance insects,
- to make the students able to carry out standard scientific studies.

### **RESEARCH METHODOLOGY**

**30 hrs**

Introduction to research methodology, tools and techniques of insect collection, preservation and maintenance, identifying, describing and naming species, insect population estimation techniques, scientific proposal writing, defining a research question, research objectives, research planning and rationale, literature review-Science libraries, literatures and softwares, experimental design, data collection, management and analysis, Use of statistical tools in data analysis, discussion, conclusion, abstract, recommendation on the basis of research finding, citation of literatures, scientific paper writing and publication.

### **INSECT ECOLOGY AND BEHAVIOR**

**40 Hrs**

#### **Introduction:**

An overview of insect ecology, insects and climate, Global climate change and synergistic impacts, Insects as regulator of ecosystems, ecology of urban insect pests, economic and

ecological decision making, conventions and social issues in insect diversity, biodiversity assessment methods and need for insect conservation, insect as food.

**Insect populations and communities:** Spatial structure and dynamics of insect populations, Life tables, The regulation of populations by density-dependent and density independent processes; predator prey systems, evolution of insect feeding modes, insect relationships (competition, parasitism, parasitoids, predation, mutualism), soil fauna as bioindicator, aquatic fauna and river health assessment, high altitude insects, ecological role of insect outbreak, insect monitoring and forecasting, pollination ecology-Pollination biology, coevolution and mutual benefit to plants and pollinators, factors affecting pollination.

**Insect behaviour:** Introduction, basic responses and patterns of behaviour, behavioural periodicity and clocks, oriental navigation and homing, feeding behaviour, defence behaviour, foraging behaviour, resting behaviour, visual communication, chemical communication, epigamic behaviour, oviposition behaviour, parental care, presocial behaviour, eusocial behaviour, leadership behaviour.

## **MEDICAL AND VETERINARY ENTOMOLOGY**

**30 hrs**

Introduction to medical and veterinary entomology, Overview of vector borne diseases in Nepal, Climate change and vector distribution

Classification, Morphology, life history, pathology and importance of : mosquitoes, sandflies, houseflies, fleas, eye gants, cockroaches, black flies, horse flies, ticks and mites, bed bugs and sucking lice.

Vector pathogen interaction; Insecticide resistance in vector; Vector sampling, management and control; Other human health problems due to arthropods: Phobias, Psychoses, Annoyance, Allergies, Toxins, Venoms and Myiasis.

## **INDUSTRIAL ENTOMOLOGY**

**25hrs**

**Apiculture:** Prospects in Nepal, honeybee species, factors influencing bee keeping in Nepal, different types of bee hives and significance, apiary management, seasonal management of

bee colony, bee forages and crop pollination, diseases of honey bees, enemies of honey bee, bee keeping plan- extension and marketing.

**Sericulture:** Prospects in Nepal, factors influencing sericulture in Nepal, mulberry propagation and nursery establishment, field cultivation of mulberry, intercultural practices, mulberry pests and their management, disinfection of rearing environment, silkworm egg procurement and incubation, cocoon production, care and storage, pests of silkworms and their management, non-mulberry silkworms, silk production and marketing.

**Lac culture:** Lac insects and their culture: prospects and possibilities in Nepal

## **FORENSIC ENTOMOLOGY**

**5hrs**

An introduction to forensic entomology, general terms & background history of forensic entomology, insects associated with forensic cases.



## References

- Atkins, M. D. 1980. Introduction to Insect Behaviour. Macmillan Publishing Co. Inc. New York.
- Chandler, A.C. and Read, C.P. 1961. Introduction to Parasitology with special reference to the parasites of man. John Wiley & Sons Inc. New York. 821 pp.
- Cheng, T.C. 1986. General Parasitology Second edition. Academic Press. 827 pp.
- Dempster, J.P. and McLean, I.F.G. (Eds) 1999. Insect Populations: In Theory and in Practice. Springer.
- Eldridge, B.F. and Edman, J.D. 2003. Medical Entomology: A Textbook on Public Health and Veterinary Problems Caused by Arthropods. Springer; 2nd revised ed.
- Faust, E.C., Russel, P.F. and Jung, R.C. 1970. Craig and Faust's Clinical Parasitology. EA & Febiger, Philadelphia.
- Neupane, F.P. (ed.) 2003. Integrated pest management in Nepal: Proceedings of a National Seminar, Kathmandu, Nepal, 25-26 September 2002. Himalayan Resources Institute, New Baneswor, Kathmandu, Nepal. xvi+349pp.
- New T. 1988. Associations between insects and plants. NSW University Press.
- Patton, W.S. and Evans, A.M. 1929. General Textbook of Entomology Vol.I. Akashdeep Publishing House, New Delhi.
- Patton, W.S. and Evans, A.M. 1929. General Textbook of Entomology Vol.II. Akashdeep Publishing House, New Delhi.
- Price, P.W. 1975. Insect ecology. John Wiley and Sons, New York.
- Samways, M.J. 2005. Insect Diversity Conservation. Cambridge University Press.
- Schmidt, G.D. 1989. Essentials of Parasitology. Fourth Edition. Universal Books Stall, New Delhi.
- Schowalter, T.D. 2006. Insect Ecology: An Ecosystem Approach. Academic Press; 2 edition.
- Speight, M.R., Hunter, M. D. and Watt, A.D. 2008 Ecology of Insects: Concepts and Applications. WileyBlackwell; II Edition.
- Southwood, T.R.E. and Henderson, P.A. 2000. Ecological Methods. III Edition. Blackwell Science.
- Verma, L.R. (ed.) 1992. Honeybees in mountain agriculture. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Verma, L.R. 1990. Beekeeping in integrated mountain development. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Wall, R. and Shearer, 2001. *Veterinary Ectoparasites: Biology, Pathology and Control* 2nd Edition. WileyBlackwell.

Youdeowei, A. and Service, M.W. 1983. *Pest and vector management in tropics with particular reference to Insects, Ticks, Mites and Snails*. Longman, London.

## ENTOMOLOGY

**Course title: Entomology**

**Full Marks: 80**

**Course No. Zoo. 623**

**Pass Marks: 32**

**Nature of the course: Theory**

**Year: II**

**Course description: Insect pest management, and quarantine entomology**

### **Course objectives**

- to make students able to tell about insect pests and their management
- to develop practical knowledge about, pests, vectors, pathogens, pesticide regulations etc.
- to make the students able to carry out standard scientific studies.

### **INTRODUCTION TO ACAROLOGY**

**5hrs**

Introduction and biology of mites associated with crop plants and stored products, management of mites in field and storage.

### **INSECT PEST MANAGEMENT**

**20hrs**

Concept of insect pests and their management, Integrated pest management: concept and techniques of IPM (cultural, physical, chemical, mechanical, biological and legislative approaches); host plant resistance, botanical pest management.

### **TOXICOLOGY**

**20hrs**

History of insecticide use and development, classification of pesticides (based on mode of entry, based on mode of action, based on toxicity, and based on chemical nature); Formulation of insecticides, Toxicity of insecticides (acute and chronic), Synergism of insecticides, Bioassay techniques, mode of action and metabolism of pesticides, Insect resistance to insecticides, Semiochemicals (naturally secreted- pheromones, alleochemicals, allomones, kairomones; Synthetic- attractants, repellents, anti-feedants, juvenile hormones, chemo-sterilents, brain hormones, chitin synthesis inhibitors, molting hormones);

insecticides calculation, Pesticide application equipments; Safe use of insecticide- insecticide poisoning and treatment, hazards to man, animal and ecosystem.

### **INSECT PATHOLOGY**

**10hrs**

History, definition and some terms used in microbial control, group of pathogens and their biology (bacteria, protozoa, nematodes, fungi, viruses, rickettsiae), uses of pathogens in pest control, mass rearing and testing of insect pathogens, advantages and disadvantages of microbial agents.

### **STORAGE ENTOMOLOGY**

**5hrs**

Post-harvest crop losses and loss assessment studies in stored grains, grain storage structures, major insects and mite pests of stored grains and their management, vertebrate pests of stored grains and their managements ( rodents).

### **FIELD CROP ENTOMOLOGY**

**10hrs**

Major insect pests of field crops (rice, maize, wheat, pulses, oil seed crops and cash crops) including biology, damage and management.

### **HORTICULTURAL ENTOMOLOGY**

**15hrs**

Major insect pests of horticultural crops; biology, damage, and management of vegetables (cruciferous, potato) and fruits ( mango, litchi, guava, citrus, peach, pear, banana and apples). Important pests of ornamental plants (aphids, thrips, whitefly, scale insect, leaf minor and leaf eating caterpillars and borers).

### **FOREST ENTOMOLOGY**

**15hrs**

Overview of the forest management system in Nepal; Rules and regulations; Diversity and abundance of insects in forests; Insects and forest ecosystems; Insect pests in natural and planted forests; canopy insects, defoliating Lepidoptera, saw flies, beetles, flies; Sap suckers- scale insects, aphids and bugs; galls and gall insects; insect pests of stored timber

**INSECT VECTORS OF PLANT DISEASES****10hrs**

Insect vectors and their importance in disease transmission, relationships between host plant, insect vectors and disease development, methods of disease transmission and development in plants, management of plant disease through vector management.

**INSECT RESISTANCE IN CROP PLANTS****5hrs**

Historical development, host plant resistance, mechanism of resistance, insect pest management through resistance of plants, vertical resistance and horizontal resistance.

**PESTICIDE REGULATIONS AND ENVIRONMENTAL POLLUTION****5hrs**

Acts and regulation of pesticides, fate of pesticides in environmental pollution and their ecological consequences, safe use of pesticides or safety measures of pesticides use, pesticide poisoning and their treatment.

**QUARANTINE ENTOMOLOGY****5hrs**

Current status of quarantine entomology in Nepal, development and application of quarantine treatments and other mitigation approaches, research and regulatory issues in quarantine approach- WTO and Pest Risk Assessment (PRA).

**BIOTECHNOLOGY (ADVANCES IN ENTOMOLOGY)****5hrs**

Concepts of new approaches in insect pest management, development of transgenic plants for pest resistance, The Bt gene transfer, Bacterial pesticides, viral pesticides, protozoans, nematodes, fungus.

## References

- Beeson, C.F.C. 1941. Forest insects.
- Hill, D.S. 1993. Agricultural insect pests of the tropics and their control. Second edition. Special edition for sale in South Asia only. Cambridge University Press, Cambridge.
- Insects and Forests: The Role and Diversity of Insects in the Forest Environment. Roger Dajoz, G.M.De Rougement. Intercept Ltd . 2000
- Invasive Forest Insects, Introduced Forest Trees, and Altered Ecosystems: Ecological Pest Management in Global Forests of a Changing World by Timothy D. Paine, Springer 2006. Insect Pests in Tropical Forestry by M.R. Speight and F.R.Wylie. CABI Publishing, 2000.
- Matthews, G. 1995. Pesticide Application Methods. Wiley Blackwell; 2nd Revised edition, 405 pages.
- Mengech, A.N., Saxena, K.N. and Gopalan, H.N.B.1995. Integrated pest management in the tropics: Current status and future prospects. UNEP, John Wiley and Sons. Chichester, New York.
- Metcalf, R. L. and Luckmann, W.H.(eds.) 1975. Introduction to Insect Pest Management. John Wiley & Sons, New York.
- Neupane, F.P. 2002. Integrated Management of Vegetable Insects. Jagadamba Press, Lalitpur.
- Neupane. F.P. 2058 BS. Balibiruwaka shatru ra tinko roktham. Shaja Prakashan. (in Nepali).
- Walter, G.H. 2008. Insect Pest Management and Ecological Research. Cambridge University. Press.400 pages

## ENTOMOLOGY

**Course title: Entomology**

**Full Marks: 80**

**Course No. Zoo. 623**

**Pass Marks: 32**

**Nature of the course: Practical**

**Year: II**

**Course description: Research Methodology, Ecology, Medical and Veterinary Entomology, Industrial Entomology, Insect pest management, and quarantine entomology**

1. Review of literature in the given topics by teacher and preparation of review article in publishable format.
2. Measurement of biodiversity indices of insects– (a) population, (b) density and relative density, (c) frequency and relative frequency, (f) abundance and distribution, (g) Shannon- Wiener index.
3. Extraction of soil fauna by using Burlese funnel and comparison with soil properties (moisture, pH, NPK).
4. Collection of aquatic fauna from different freshwater habitats (river, streams, lake, pond, paddy fields) and scoring the water quality.
5. Analysis of water quality (DO, CO, temperature, BOD, turbidity etc.).
6. Life cycle study of store grain pests- illustration of different stages and preparation of life table on the basis of experimentation.
7. Plantation of mulberry plants and rearing of silkworm in lab.
8. Management of bee hives in the department.
9. Collection, preservation, labeling, identification and storage of pest species (students supposed to visit concern organizations such as NHM, NARC).
10. Temporary and permanent mounting of pest species
11. Mass rearing of insects (parasites, predators, host insects, pathogens) in laboratory
12. Handling and calibration of sprayers and dilution of insecticides.
13. Safety measures and handling of equipments.
14. Pesticide residues extraction procedures (extraction, purification and concentration procedures).
15. Yield loss assessment and assessment of crop damage level.
16. Study of insect damage patterns of different plant species (defoliator, leaf minor, borers, gall insects etc).

17. Study of the traditional pest control techniques in rural areas of Nepal.
18. IPM project area visit and report preparation.

### **Seminar Presentation**

1. At least two power point presentation in one academic year.
2. In addition to major presentations mentioned above, there will be many other presentations on the basis of course taught and completed practical courses.