SavitribaiPhule Pune University

(Formerly University of Pune)

Three Year B.Sc. Degree Program in Zoology

(Faculty of Science & Technology)

S.Y.B.Sc. Zoology

(w.e.f. June 2020)

As per

Choice Based Credit System

Syllabusimplemented from

Academic Year 2020-2021

Preamble:

Zoology is one of the major subjects of Basic Sciences and deals with all aspects of animal biology. It includes an interesting range of highly diverse topics. A zoology student needs to gain understanding of many areas of the subject to keep pace with advancements in Life Sciences.

This under-graduate degree program has been designed by the Board of Studies in Zoology of SavitribaiPhule Pune University with a substantial component of what is needed from zoologists as a skilled career and what zoologists need to pursue for post-graduation and further academic studies. It follows the guidelines laid down by the University Grants Commission, New Delhi. This newly designed curriculum is a perfect blend of the classical aspects in Zoology and the advanced and more specialized areas.

This degree offers Discipline Specific Core Courses **[CC]** in Animal Systematics, Animal Ecology, Animal Cell biology, Applied Zoology, Pest Management, Histology, Biological Chemistry, Genetics, Developmental Biology, Parasitology, Medical & Forensic Zoology, Animal Physiology, Molecular Biology, Entomology, Techniques in Biology and Evolutionary Biology.

In addition to the Core Courses, Ability Enhancement Compulsory Courses **[AECC]** have been added in the second year i.e. Semester III and Semester IV of the undergraduate course. In the third year i.e. Semester V and Semester VI, Discipline specific Elective Courses **[DSEC]** and Skill Enhancement Courses **[SEC]** have been offered. The students, therefore, have an opportunity to take courses in Environment Awareness, Language communication: English/Marathi, Aquarium Management, Poultry Management and Environmental Impact Assessment. In Semester VI the students also have a course dedicated to Project work.

The syllabus has been framed in such a way that the student gains each year, a broader perspective of the subject as he progresses towards completion of the degree program. Field trips, Educational visits and the Project work have been included for the student to experience the applications of the theory learnt in the classroom.

After completion of the program, it is expected that students will understand and appreciate: animal diversity, few applications of Zoology, the structure, functions and life processes at cellular, tissue, organ and system level, significance of evolution, and basic concepts of human health. The students would also gain an insight into laboratory and field work through the practical course, field work and the project.

While presenting this new syllabus to the teachers and students of F. Y. B. Sc. Zoology, I am extremely happy to state that efforts have been made to seek inputs of all the stake holders to make it more relevant.

The new course that will be effective from the academic year 2019- 2020 and will follow the Choice Based Credit System in a Semester mode. It has been primed keeping in view the distinctive requirements of B. Sc. Zoology students. The contents have been drawn-up to accommodate the widening prospects of the discipline of Life Sciences. They reflect the changing prerequisites of the students. This program has been introduced with 132 credits for the subject group while 08 credits to earn from any of the 08 groups offering a range of curricular, cocuricular and extracurricular activities. This pattern has been specially aimed towards the overall development of the students'. The calculation of credits and CGPA will be as per the guidelines of the University. The B. Sc. Zoology program provides an appropriate blend of classical and applied aspects of the subject. This newly designed curriculum will allow students to acquire the skill in handling scientific instruments planning and performing in the laboratory and exercising critical judgement, independent thinking and problem solving skills.

The Syllabus has been revised with the following aims

- To foster curiosity in the students for Zoology
- To create awareness amongst students for the basic and applied areas of Zoology
- To orient students about the importance of abiotic and biotic factors of environment and their conservation.
- To provide an insight to the aspects of animal diversity.
- To inculcate good laboratory practices in students and to train them about proper • handling of lab instruments.

Course Structure:

Course Structure with Credit Distribution of the Undergraduate Science Program in Zoology

Course	Course Code and Name of the Course		Credits
F. Y. B. Sc.	**SEMESTER I**	**SEMESTER II**	
CC	ZO - 111 Animal Diversity I	ZO-121 Animal Diversity II	2 + 2
CC	ZO - 112 Animal Ecology	ZO-122 Cell Biology	2 + 2
CC	ZO - 113 Zoology Practical Paper	ZO-123 Zoology Practical Paper	1.5 +1.5
S. Y. B. Sc.	**SEMESTER III**	**SEMESTER IV**	
CC	ZO - 231 Animal Diversity III	ZO - 241 Animal Diversity IV	2 + 2
CC	ZO - 232 Applied Zoology I	ZO - 242 Applied Zoology II	2 + 2
CC	ZO - 233 Zoology Practical Paper	ZO - 243 Zoology Practical Paper	2 + 2
AECC	EVS 231- Environment Awareness	EVA 241- Environment Awareness	2 + 2
AECC	LA 231 - English/Marathi	LA 241 - English /Marathi	2 + 2
T. Y. B. Sc.	**SEMESTER V**	**SEMESTER VI**	
DSEC	ZO - 351 Pest Management	ZO - 361 Medical & Forensic Zoology	2 + 2
DSEC	ZO - 352 Histology	ZO - 362 Animal Physiology	2 + 2
DSEC	ZO - 353 Biological Chemistry	ZO - 363 Molecular Biology	2 + 2
DSEC	ZO - 354 Genetics	ZO - 364 Entomology	2 + 2
DSEC	ZO - 355 Developmental Biology	ZO - 365 Techniques in Biology	2 + 2
DSEC	ZO - 356 Parasitology	ZO - 366 Evolutionary Biology	2 + 2
DSEC	ZO- 357 Zoology Practical Paper 1	ZO - 367 Zoology Practical Paper 1	2 + 2
DSEC	ZO- 358 Zoology Practical Paper 2	ZO - 368 Zoology Practical Paper 2	2 + 2
DSEC	ZO- 359 Zoology Practical Paper 3	ZO - 369 Zoology Practical Paper 3	2 + 2
SEC	ZO - 3510 Aquarium Management	ZO- 3610 Environmental Impact Assessment	2 + 2
SEC	ZO - 3511 Poultry Management	ZO - 3611 Project	2 + 2

Detailed Syllabus of S. Y. B. Sc.

Paper	Semester III Course Code & Course	Credits	No of Hours	Marks (Internal + University)		Semester IV Course Code & Course	Credits	No of Hours	Marks (Internal + University)
I	ZO - 231 Animal Diversity III	02	30	15+ 35= 50		ZO - 241 Animal Diversity IV	02	30	15+ 35 = 50
II	ZO - 232 Applied Zoology I	02	30	15+ 35 = 50		ZO - 242 Applied Zoology II	02	30	15+ 35 = 50
III	ZO - 233 Zoology Practical Paper	02	14 Practicals	15+ 35 = 50		ZO - 243 Zoology Practical Paper	02	14 Practicals	15+ 35 = 50
AECC	EVS 231- Environment Awareness	02	30	15+ 35 = 50		EVA 241- Environment Awareness	02	30	15+ 35 = 50
AECC	LA 231- English/ Marathi	02	30	15+ 35 = 50		LA 241- English/ Marathi	02	30	15+ 35 = 50

Animal Diversity III & IV

Objectives –

1. To understand the origin and advancement of higher vertebrates (tetrapoda).
2. To understandgeneral characters of different groups of higher vertebrates.
3. To classify vertebrates and to become able to understand the possible group of vertebrates observed in nature.
4. To understand different behaviours and adaptations in higher vertebrates
5. To understand affinities among different groups of higher vertebrates.

Learning Outcomes for the course -

1. The students will be able to understand, classify and identify the diversity of higher vertebrates.
2. The students will able to understand the complexity of higher vertebrates
3. The students will be able to understand different life functions of higher vertebrates.
4. The students will be able to understand the linkage among different groups of higher vertebrates.
5. The student will become aware regarding his role and responsibility towards nature as a protector, to understand his role as a trustee and conservator of life which he has achieved by learning, observing and understanding life.

Course Title: Animal Diversity - III

Course Code: ZO – 231,

Semester - III (2 credits – 30 Hours)

No. Title & Contents **Number of Lectures**

1. Introduction to Phylum Chordata – (03)

1.1 Origin & Ancestry of Chordates.

1.2 Comparative account of fundamental characters of Chordates with Non Chordates.

1.3 Salient features of Phylum Chordata.

1.4 Classification of Phylum Chordata upto classes – Pisces, Amphibia, Reptilia, Aves, Mammalia.

2. Introduction to Group – Protochordata. (03)

2.1 Salient features of Protochordata.

2.2 Salient features of subphylumswith two example each - Names only.

Hemichordata – *Balanoglossus*and*Rhabdopleura*, Urochordata - *Herdmania*and*Salpa*, Cephalochordata –*Branchiostoma*(Amphioxus) and*Asymmetron*.

3. Introduction to subphylum – Vertebrata (02)

3.1 Salient features of Vertebrata.

3.2 Introduction and General characters of sections with two examples - Names only.

Agnatha–*Petromyzon&Myxine*&Gnathostomata–Frog&*Labeo*.

4. Introduction to Class – Pisces (04)

4.1 Salient features of Class – Pisces.

4.2 Introductaionand Salient features of sections with two examples - Names only.

Class – Chondrichthyes–*Scoliodon*and *Chimaera*&Osteichthyes – *Labeo*and*Catla*

4.3 Types of Scales in Fishes.

4.4 Types of Fins in Fishes.

5. Introduction to Class – Amphibia (03)

5.1 Salient features of Class – Amphibia.

5.2 Introduction to order – Apoda–*Ichthyophis*,Urodela–*Salamandra*(Salamander) and& Annura - *Rana*.

5.3 Parental care in Amphibia.

6. Study of *Scoliodon* (15)

Scoliodon – 6.1 - Systematic position, Geographical distribution, Habit, Habitat 01

6.2 - External characters 01

6.3 - Digestive System, Food and feeding mechanism. 02

6.4 - Respiratory System – Structure of Holobranch only. 02

6.5- External & Internal Structure of heart, Working of heart. 02

6.6 - Nervous System – Brain only. 03

6.7 - Male urinogenital system & Female reproductive System. 03

6.8- Yolk sac placenta. 01

Applied Zoology I and II

Objectives :

1. To understand the basic life cycle of the honeybees, beekeeping tools and equipments.
2. To learnfor managing beehives for honey production and pollination.
3. To understand the basic information about fishery, cultural and harvesting methods of fishes.
4. To understand fish preservation techniques.
5. To understand the biology, varieties of silkworms and the basic techniques of silk production and harvesting of cocoons.
6. To learn the different silkworm species and their host plants.
7. To study types of agricultural pests and Major insect pests of agricultural importance.
8. To study Pest control practices.

Learning Outcomes of the course:

1. The learner understands the basics about beekeeping tools, equipment, and managing beehives.
2. The learner understands the basic information about fishery, cultural and harvesting methods of fishes and fish preservation techniques.
3. The learner understands the biology, varieties of silkworms and the basic techniques of silk production.
4. The learner understands the types of agricultural pests, Major insect pests of agricultural importance and Pest control practices.

Course Title - Applied Zoology I

Course Code - ZO - 232

Semester III **2 Credits - 30 lectures**

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1) Sericulture: **16**

1.1 An introduction to Sericulture, Study of different types of silk moths, their distribution, Taxonomic position and varieties of silk produced in India : Mulberry, Tassar, Eri and Muga silk moths. 02

1.2 ExternalMorphology and life cycle of *Bombyxmori*. 02

1.3 Cultivation of mulberry :

a) Varieties for cultivation,

b) Rain fed and irrigated mulberry cultivation- Fertilizer schedule, Pruning methods and leaf yield. 02

1.4 Harvesting of mulberry : **a)** Leaf plucking, **b)** Branch cutting,

c) Whole shoot cutting. 01

1.5 Silk worm rearing :

a) Varieties for rearing,

b) Rearing house,

c) Rearing techniques,

d) Important diseases and pests. 03

1.6 Preparation of cocoons for marketing. 01

1.7 Post harvest processing of cocoons :

a) Stiffling, sorting, storage, deflossing and riddling,

b) Cocoon cooking, reeling equipment and rereeling, washing and polishing. 03

1.8 Biotechnological and biomedical applications of silk. 02

2) Agricultural Pests and their control: **14**

2.1 An introduction to Agricultural Pests, types of pests (agricultural, store grain, veterinary). 01

2.1 Major insect pests of agricultural importance (Marks of identification, life cycle, nature of damage and control measures). 06

a) Jowar stem borer,

b) Red cotton bug,

c) Brinjal fruit borer,

d) Mango stem borer,

e) Blister beetle,

f) Rice weevil,

g) Pulse beetle,

h) Tick.

2.3 Non insect pests: Rats, Crabs, Snails, and Squirrels 01

2.4 Pest control practices in brief: Cultural control, Physical control, Mechanical control, Chemical control, Biological control, Pheromonal control, Autocidal control and Concept of IPM in brief. 04

2.5 Plant protection appliances: Shoulder type Rotary duster, Knapsack sprayer, Cynogas Pump. 02

Course Title: Zoology Practical Paper

Course Code: ZO – 233

Semester - III **(2 credits – 60 Hours)**

Animal Diversity - III

1. Museum study of Group Protochordata : *Balanoglossus*, *Herdmania*, *Petromyzon*. (D)
2. Museum study of Class Pisces: Labeo, *Scoliodon*, *Hippocampus.* (D)
3. Museum study of Class Amphibia :*Salamandra*, *Rana*, *Ichthyophis*. (D)
4. Study of types of scales in fishes: Placoid scale, Cycloid scale, Ctenoid scale & Ganoid scale. (D)
5. Study of types of tail fins in fishes: Homocercal, Heterocercal &Diphycercal. (D)
6. Study of external characters & digestive system of locally available fish. (E) - Compulsory
7. Study of brain of locally available fish. (D)
8. Temporary preparation of scales & its identification from locally available fish. - (E) Compulsory
9. Compulsory field visit to study pond ecosystem with reference to Pisces and amphibians, report writing and submission. (**2 P**)

Sericulture –

1. Study of external morphology and life-cycle of *Bombyx mori.* (D)
2. Study of five equipments in Sericulture. (E) - Compulsory
3. Preparation of a map showing distribution of silk moth and rearing/ sericulture practices in India. (E)
4. Compulsory submission of Photographs/ sketches of Mulberry, Tassar, Eri and Muga silkmoths. (E)

Agricultural Pests and their control -

1. Study of following insect pests with respect to marks of identification, nature of damage, economic importance and control measures. (D)
   a) Jowar stem borer,
   b) Red cotton bug,
   c) Brinjal fruit borer,
   d) Mango stem borer.
2. Study of following pests with respect to marks of identification, nature of damage, economic importance and control measures. (D)
   a) Blister beetle,

b) Rice weevil,

c) Pulse beetle,

d) Tick.

3. Study of any two non insect pests corresponding to theory course. (D)
4. Compulsory submission of at least five Insect Pests/ Photographs/ Sketches. (E)
5. Study of pest control appliances (as per theory course). (D)
6. Compulsory field visit to Sericulture farm/ Agricultural farm, report writing and submission. **(2 P).**

Minimum 14 practicals must be conducted with at least Seven practicals from each paper.

Course Title: Animal Diversity - IV

Course Code: ZO – 241

Semester - IV (2 credits – 30 Hours)

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1. Introduction to class –Reptilia (04)

1.1 Salient features of class Reptilia with one example (name only) – *Chelone*, *Calotes*.

1.2 Venomous and Non-venomous snakes – Cobra, Russell's viper, Rat snake, Grass snake.

1.3 Snake venom, symptoms, effect and cure of snake bite, first aid treatment of snakebite.

1.4 Desert adaptations in reptiles in brief.

2. Introduction to class –Aves (05)

2.1 Salient features of class Aves with two examples (names only) – Sparrow, Parrot.

2.2 Flight adaptations in birds.

2.3 Types of Beaks and feet in birds.

2.4 Migration in birds – Altitudinal, Latitudinal.

3. Introduction to class - Mammalia. (04)

3.1 Salient features of class Mammalia with two examples (names only) – Rat, Rabbit.

3.2 Egg laying mammals.

3.3 Aquatic adaptations in mammals.

3.4 Flying adaptations in mammals.

3.5 Cursorial and fossorial adaptation in mammals

4. Study of Rat (17)

4.1 Systematic position, habit and habitat.	01
4.2 External characters.	01
4.3 Digestive system, food and feeding.	02
4.4 Respiratory system.	02
4.5 Blood vascular system – Structure of Heart.	02
4.6 Nervous system – Central Nervous system only.	03
4.7 Sense organs – Structure and functions of Eye & Ear.	03
4.8 Reproductive system.	03

Course Title - Applied Zoology II

Course Code - ZO-242

Semester IV **2 Credits- 30 lectures**

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1. Apiculture: **16**

1.1 An introduction to Apiculture, Systematic position, Study of habit, habitat and nesting behaviour of *Apisdorsata*, *Apisindica*, *Apis florae* and *Apismellifera*. 02

1.2 Life cycle, Colony organization and Division of labour. 02

1.3 Bee behaviour and communication (Round Dance and Wag-Tail Dance) . 02

1.4 Bee keeping equipments :

a) Bee box (Langstroth type),

b) Honey extractor,

c) Smoker,

d) Bee-veil,

e) Gloves,

f) Hive tool,

g) Bee Brush,

h) Queen excluder. 02

1.5 Bee keeping and seasonal management. 02

1.6 Bee products (composition and uses) :

a) Honey,

b) Wax,

c) Bee Venom,

d) Propolis,

e) Royal jelly,

f) Pollen. 02

1.7 Diseases and enemies of Bees :

a) Bee diseases - Protozoan (Nosema), Bacterial (American foul brood), Viral (Sac brood), Fungal (Chalk brood).

b) Bee pests - Wax moth (Greater and Lesser), Wax beetle.

c) Bee predators - GreenBee eater, King crow, Wasp, Lizard. 02

1.8 Bee pollination and management of bee colonies for pollination. 02

2. Fisheries : **14**

2.2 An introduction to fisheries and its types (in brief) : Freshwater fisheries, Marine fisheries, Brackish water fisheries. 02

2.3 Habit, habitat and culture methods of following freshwater forms : 03

a) Rohu (*Labeo rohita*) ,

b) Catla (*Catla catla*) ,

c) Mrigal (*Cirrhinus mrigala*).

2.3 Harvesting methods of following marine forms: 03

a) *Harpodon*,

b) Mackerel,

c) Pearl oyster.

2.4 Crafts and Gears in Indian Fishery: 02

a) Crafts – Catamaran, Machwa, Dinghi.

b) Gears – Gill net, Dol net, Rampani net, Cast net.

2.5 Fishery byproducts: 02

a) Fish meal,

b) Fish flour,

c) Fish Liver oil,

d) Fish manure,

e) Fish fin soup.

2.6Fish preservation technique: 02

a) Chilling,

b) Freezing,

c) Salting,

d) Drying,

e) Canning.

Course Title: Zoology Practical Paper

Course Code: ZO – 243

Semester - IV **(2 credits – 60 Hours)**

Animal Diversity - IV

1. Museum study of Class Reptilia: Venomous & Non-venomous snake – Two each. (D)
2. Identification of Venomous & Non-venomous snakes with the help of pictorial taxonomic keys. – (D) -Compulsory
3. Museum study of Class Aves: Crow, *Kingfisher*& Duck. (D)
4. Study of types of beaks &feets in birds – Any two each. (D)
5. Museum study of Class Mammalia: Rat, Shrew & Bat. (D)
6. Study of external characters & digestive system of Rat. (D)
7. Study of Heart of Rat. - (D) -Compulsory
8. Study of brain of Rat. (D)
9. Study of reptilian / avian diversity in and around the campus (**2 P**) - (E) -Compulsory
10. Compulsory visit to Zoo / Wildlife sanctuary / Bird sanctuary, report writing and submission. (**2 P**)

Apiculture –

1. Study of external morphology, life cycle and polymorphism in Honey Bee. (D)
2. Temporary mountingof mouth parts, legs, wings and sting apparatus of worker bee. (E)
3. Study of Bee keeping Equipment: Bee box, Honey extractor, Smoker**,** Bee-veil, queen excluder. (D)- Compulsory
4. Study of Bee products: Honey, Wax, Venom, Royal jelly, Pollen. (D)
5. Estimation of carbohydrates from Honey in different samples. (D)- Compulsory
6. Study of Bee enemies: Wax moth, Bee eater, ant. (D)

Fisheries –

1. Identification, Classification and study of habit, habitat and economic importance of **a)** Rohu (*Labeo rohita*), **b)** Catla (*Catla catla*), **c)** Mrigal (*Cirrhinus mrigala*). (D)
2. Identification, Classification and study of habit, habitat and economic importance of **a)** Prawn, **b)** Crab, **c)** Lobster, **d)** Pearl Oyster. (D)
3. Study and maintenance of Aquarium. (D) - Compulsory

4. Study of crafts: **a)** Catamaran, **b)** Machwa, **c)** Dinghi (Photographs/models/line drawings). (D)

5. Study of gears in fishing: **a)** Gill net, **b)** Dol net, **c)** Rampani net, **d)** Cast net. (Photographs/models/line drawings). (D)

7. Study of nutritional value of fish: Biochemical estimation of fish muscle proteins by using Biuret method. (E) - Compulsory

7. Compulsory study tour/field visit to Apiculture institute / Fish farm/ Aquarium. (E) **(2 P)**.

Minimun 14 practicals must be conducted with at least Seven practicals from each paper.

Recommended Reference Books

Animal Diversity – III & IV

1. Text Books of Zoology, Invertebrates Vol- II, 1992, T.J.Parker and W.A. Haswel, Edited by Marshall and Williams,CBS publications and distribution, New Delhi.
2. Integrated Principles of Zoology, Eleventh Edition, Hickman CP, Roberts LS & Larson A. International Edition ISBN 0–07–118077–X, The McGraw-Hill Companies, Inc.,
3. Modern Text Book of Zoology, Vertebrates. R. L. Kotpal, 3rd edn. Rastogi Publications, Meerut.
4. Chordate Zoology, 1982, P.S.Dhami and J.K.Dhami, R. Chand and Co., New Delhi.
5. Biology, Campbell nand Reece. 7th Edn. Pearson Education in South Asia, Delhi.
6. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
7. Pough H. Vertebrate life, VIII Edition, Pearson International.
8. Integrated Principles of Zoology, Eleventh Edition, Hickman C. P., Roberts L. S.& Larson A. International Edition ISBN 0–07–118077–X, The McGraw-Hill Companies, Inc.,
9. Arora M.P. Chordates I. Himalya Publications.
10. Organic Evolution. R.S. Lull. Light & Life Publishers.
11. Jordan E. L.&Verma P. S. 2003. Chordates Zoology. S. Chand & Company Ltd. New Delhi.
12. Biology, Campbell Nand Reece. 7th Edn. Pearson Education in South Asia, Delhi.

Applied Zoology I & II

1. Principal of Sericulture, 1994. HisaoArguo, Oxford & Co.
2. An Introduction of Sericulture, 1995. G.Ganga, J. Sulochana, Oxford & IBH Publication Co. Bambay.
3. FAQ Manual of Sericulture. Vol I - Mulberry Cultivation, Vol II - Silkworm Rearing. Central Silk Board, Bangalore.
4. Mane, P.C., Chaudhari R. D. et al. Highly sensitive label-free bio-interfacial colorimetric sensor based on silk fibroin-gold nanocomposite for facile detection of chlorpyrifos pesticide. Scientific Reports2020,10, 4198. https://doi.org/10.1038/s41598-020-61130-y
5. Entomology & Pest Management. Pedigo L. P. Prentice Hall, India 1996.
6. General & Applied Entomology, Nayar K. K. & T. N. Ananthkrishnan& B. V. Davis, Tata McGraw Hill Publication, New Delhi.
7. Insects. M. S. Mani, National Book Trust, India, 2006.
8. Insects & Mites of Crops in India. M. R. G. K. Nair – by ICAR, New Delhi.
9. The Science of Entomology. W. S. Romosor and J. G. Stoffolano, McGraw Hill Publication, 1988.

10. Agricultural Insect Pests of India and their Control, Dennis S. Hill, Cambridge University Press.
11. Applied Entomology. Vol. I & II. K. P. Srivastava. Kalyani Publication, Ludhiana, New Delhi.
12. Principles of Insect Pest Management. G. S. Dhaliwal and Ramesh Arora, Kalyani Publications, Ludhiana.
13. Pest Management and Pesticides: Indian Scenario. Editor- B. Vasantaraj David, Namrutha Publications, Madras (Chennai).
14. Concepts of Insect Control. Ghosh M. R. Wiley Eastern Ltd. New Delhi.
15. Destructive and useful Insects, their habit and Control, 1973. C.L. Metcalf and W. P. Flint, Tata McGraw Hill Publications, New Delhi.
16. A Text Book of Entomology, 1974. V. K. Mathur and K. D. Upadhayay, Goel Printing Press, Barani.
17. Imm's general Text Book of Entomology, Vol I & II, Richard and Davis Owen.
18. Biology of Insects, 1992. S. C. Saxena. Oxford and IBH Publishing Co., New Delhi, Bombay, Calcutta.
19. Bee and Bee Keeping, 1978, Roger A. Morse, Conell University Press, London.
20. The Behaviour& Social Life of Honey Bees, C. R. Ribbandas, Dover Publication inc. New York.
21. Fishes. Mary Chandy. National Book Trust India, 2005.
22. Economic Zoology, Shukla Upadhyay, Rastogi Publication, Meerut, India, 1998.
23. Fisheries Developments, K. K. Trivedi, Oxford and IBH Pub. Co.
24. Marine Fishes in India, 1990, D.V. Bal & K. Virabhdra, Tata McGraw Hill Publication.
25. Fishery Management, 1990, S. C. Agarwal, Avinash Publication House, New Delhi.

Note – Use latest editions of the books.