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**A. Module Handbook**

**MINISTRY OF HIGHER EDUCATION, SCIENCE, AND TECHNOLOGY**
**UNIVERSITY OF LAMPUNG**
**FACULTY OF TEACHER TRAINING AND EDUCATION**
Jalan Prof. Dr. Sumantri Brojonegoro No.1 Gedong Meneng - Bandar Lampung 35145
Telp./Fax: (0721) 704624 *e-mail*: fkip@unila.ac.id,
laman: http://fkip.unila.ac.id

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**Undergraduate Program of Biology Education** **MODULE HANDBOOK**

| | |
|---|---|
| Module Name | Entomology |
| Module Level, if Applicable | - |
| Code | KBO620422 |
| Sub-Heading, (*if Applicable) | - |
| Classes, (*if Applicable) | - |
| Semester | VII (Seventh Semester) |
| Module Coordinator | Dr. Dina Maulina, M.Si. |
| Lecturers | Dr. Dina Maulina, M.Si.<br>Nadya Meriza, S.Pd., M.Pd. |
| Language | Bilingual (Bahasa and English) |
| Classification With in the Curriculum | Elective – Optional Course |
| Teaching Format/Class Hours Per Week During the Semester | Contact hours: 16 weeks x 100 minutes<br>Structured learning: 16 weeks x 120 minutes<br>Independent study: 16 weeks x 100 minutes |
| Teaching Methods | Lectures (100 minutes) |
| Workfload | Contact Hours: 16 weeks x 100 minutes |
| Credit Points | 2 SKS = (1.28 * 2) = 2.56 ECTS |
| Prerequisites Courses | - |
| Course Learning Outcomes (CLOs) | Analyzing entomology as a science that studies insects comprehensively in real life in the study of the relationship between the structure and function of various insects in relation to the bioprocess and ecological status of their niece. |
| Content | 1. Scope of insects: Structure, anatomy, physiology, habitat, and general roles of insects.<br>2. Insect classification: (a) Apterygota; (b) Pterygota (Exopterygota and Endopterygota).<br>3. Apterygota: Protura.<br>4. Apterygota: Thysanura.<br>5. Apterygota: Collembola.<br>6. Pterygota (Exopterygota): Orthoptera.<br>7. Pterygota (Exopterygota): Isoptera.<br>8. Pterygota (Exopterygota): Hemiptera.<br>9. Pterygota (Exopterygota): Lepidoptera.<br>10. Pterygota (Exopterygota): Homoptera.<br>11. Pterygota (Endopterygota): Hymenoptera.<br>12. Pterygota (Endopterygota): Diptera. |

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| | 13. Pterygota (Endopterygota): Coleoptera.<br>14. Pterygota (Endopterygota): Odonata.<br>15. Roles of insects in the field of health.<br>16. Roles of insects in the field of industry.<br>17. Roles of insects in the field of agriculture.<br>18. Roles of insects in the field of forensics.<br>19. Aesthetic insects. |
| Study/Exam Achievements | 1. Mid-Semester Examination: 20<br>2. Final Examination: 20<br>3. Discussion and Presentation Activities: 20<br>4. Group Project: 20<br>5. Individual Project: 15<br>6. Attendance (minimum 80% class attendance): 5 |
| Examination Methods | Participants are evaluated based on their performance in class lectures: written test and performance practicum based project |
| Forms of Media | Virtual Class (www.v-class.unila.ac.id)<br>Powerpoint Presentation Materials<br>quizizz.com<br>Related journals |
| Literature | Primary:<br>1. Borror, D.J., C. A. Triplehorn and N. F. Johnson. 1992. *Pengenalan Serangga*, ed. 6. Terjemahan drh. Soetiyono Partosoejono MSc. Gajah Mada Univ. Press.<br>2. Borror, D.J. and R. E. White. 1987. *A. Field Guide to the Insects.* National Audubon and National Wildlife Federation USA.<br>3. Comstock, J. H. 1959. *An Introduction to Entomology, Ninth Edition.* Comstock Pub. Company, Inc. Ithaca, New York. Imms A. D. 1964. A General Textbook of Entomology. Chapman and Hall LTD. London.<br>4. Kerkut GA, Gilbert LI. 1985. *Comprehensive Insect Physiology Biochemistry and Farmacology.* Oxford. Pergamon Press.<br>5. Wigglesworth VB. 1972. *The Principle of Insect Physiology* (7th eds). Chapman and Hall.<br>6. Gullan, P. J and P. S Cranston. 2010. *The Insect.* An Outline of Entomology. Wiley-Blackwell. A John Wiley &Sons, Ltd.<br>Supporting:<br>1. Maulina, D. 2020. *Serangga dan Pengendalian Hayatinya.* Intrans Press, Indonesia.<br>2. McGavin, G. C. & Davranoglou, L.-R. 2023. *Essential Entomology* (2nd ed.). Oxford University Press.<br>3. Grimaldi, D. A. (Ed.). 2023. *The Complete Insect: Anatomy, Physiology, Evolution, and Ecology.* Princeton University Press.<br>4. Maulina, D., Amin, M., Sumitro, SB, Lestari, SR. 2019. *Serangga dan Pengendalian Hayati.* Intrans Publishing.<br>5. Maulina, D., Amin, M., Sumitro, SB, Lestari, SR. 2018. Alanine as natural biopesticide from Mirabilis jalapa and its interaction with glutamate as an inhibitor in |

insects immune system. *Journal of Biological Researches. Volume 23(2).*
6. Maulina, D., Sumitro, SB. M Amin, SR Lestari. 2018. Identification of peptides compounds from Mirabilis jalapa L.(Caryophyllales: Nyctaginaceae) potentially as a biopesticide. *Journal of Physics: Conference Series.*
7. Maulina, D., Priadi, M. A., Lengkana, D., Jalmo, T., Fauzisar, A. S., & Amin, M. 2020. Book of insects' immune system: development and implementation with pbl in increasing students' learning outcome. Biosfer: *Jurnal Pendidikan Biologi, 13(1),* 42-58. https://doi.org/10.21009/biosferjpb.v13n1.42-58
8. Maulina, D., Sumitro, S. B., Lestari, S.R., & Djoa, D. D. 2025. Spodoptera litura F. immune system against exposure to the biopesticide Mirabilis jalapa L. *AGRIVITA Journal of Agricultural Science, 47(1)*, 11-20. http://doi.org/10.17503/agrivita.v47i1.4351

**B. Course Program**

**STUDY CONTRACT**

| | |
|---|---|
| Course | Entomology |
| Course code | KBO 620422 / 2(2-0)SKS |
| Semester | VII (Seventh Semester) |
| Subject Prerequisites | |
| Level Study Program | Bachelor's Program (S1) |
| Lecturer | 1. Dr. Dina Maulina, M.Si<br>2. Nadya Meriza , S.Pd. , M.Pd. |
| Course Description | This lecture discusses the study of insects starting from anatomical structure, physiological function as well as control and their role in the ecosystem referring to the achievement of basic competencies (KD) at the secondary school level in a comprehensive manner which includes the scope of insects, insect classification, insect control, the role of insects in various fields of life (health, industry, forensics, agriculture and aesthetic insects) as well as the ecological status of insects. |
| Course Learning Outcomes (CLOs) | Analyzing entomology as a science that studies insects comprehensively in real life in the study of the relationship between the structure and function of various insects in relation to the bioprocess and ecological status of their niece. |
| Topic | 1. Scope Insects : Structure , anatomy , physiology , habitat and role insect in a way general<br>2. Classification Insects : (a) Apterygota ; (b) Pterygota (Exopterygota and Endopterygopte )<br>3. Apterygota : Prototura<br>4. Apterygota : Thusanura<br>5. Apterygota: Collembola<br>6. Pterygota (Exopterygota): Ortoptera<br>7. Pterygota (Exopterygota): Isoptera<br>8. Pterygota (Exopterygota): Hemiptera<br>9. Pterygota (Exopterygota): Lepidoptera<br>10. Pterygota (Exopterygota): Homoptera<br>11. Pterygota (Endopterygota): Heminoptera<br>12. Pterygota (Endopterygota): Diptera<br>13. Pterygota ( Endopterygota ): Cleoptera<br>14. Pterygota ( Endopterygota ): Odonata<br>15. Role insect in health<br>16. Role insect in field Industry<br>17. Role insect in field Agriculture<br>18. Role insect in field Forensics<br>**19.** Insect aesthetics |
| Lecture Strategy | Lectures are conducted with Project Based Learning, discussions, questions and answers and assignments through the Unila V-class LMS. |
| Instructional Media | Virtual Class (www.v-class.unila.ac.id)<br>Powerpoint Presentation Materials<br>quizizz.com |

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| | Related journals |
| Evaluation | Participants are evaluated based on their performance in class lectures: written test and performance practicum based project |
| Literature | Main:<br>1. Borror, D.J., C. A. Triplehorn and N. F. Johnson. 1992. *Pengenalan Serangga*, ed. 6. Terjemahan drh. Soetiyono Partosoejono MSc. Gajah Mada Univ. Press.<br>2. Borror, D.J. and R. E. White. 1987. *A. Field Guide to the Insects*. National Audubon and National Wildlife Federation USA.<br>3. Comstock, J. H. 1959. *An Introduction to Entomology, Ninth Edition.* Comstock Pub. Company, Inc. Ithaca, New York. Imms A. D. 1964. A General Textbook of Entomology. Chapman and Hall LTD. London.<br>4. Kerkut GA, Gilbert LI. 1985. *Comprehensive Insect Physiology Biochemistry and Farmacology.* Oxford. Pergamon Press.<br>5. Wigglesworth VB. 1972. *The Principle of Insect Physiology* (7th eds). Chapman and Hall.<br>6. Gullan, P. J and P. S Cranston. 2010. *The Insect.* An Outline of Entomology. Wiley-Blackwell. A John Wiley &Sons, Ltd.<br>Supporting:<br>1. Maulina, D., Sumitro, S. B., Lestari, S. R., & Djoa, D. D. (2025). Spodoptera litura F. Immune System Against Exposure to the Biopesticide Mirabilis jalapa L. *AGRIVITA Journal of Agricultural Science*, *47*(1), 11-20.<br>2. Maulina, D. 2020. *Serangga dan Pengendalian Hayatinya.* Intrans Press, Indonesia.<br>3. McGavin, G. C. & Davranoglou, L.-R. 2023. *Essential Entomology* (2nd ed.). Oxford University Press.<br>4. Grimaldi, D. A. (Ed.). 2023. *The Complete Insect: Anatomy, Physiology, Evolution, and Ecology.* Princeton University Press.<br>5. Maulina, D., Amin, M., Sumitro, SB, Lestari, SR. 2019. *Serangga dan Pengendalian Hayati.* Intrans Publishing.<br>6. Maulina, D., Amin, M., Sumitro, SB, Lestari, SR. 2018. Alanine as natural biopesticide from Mirabilis jalapa and its interaction with glutamate as an inhibitor in insects immune system. *Journal of Biological Researches. Volume 23(2).*<br>7. Maulina, D., Sumitro, SB. M Amin, SR Lestari. 2018. Identification of peptides compounds from Mirabilis jalapa L.(Caryophyllales: Nyctaginaceae) potentially as a biopesticide. *Journal of Physics: Conference Series.*<br>8. Maulina, D., Priadi, M. A., Lengkana, D., Jalmo, T., Fauzisar, A. S., & Amin, M. 2020. Book of insects' immune system: development and implementation with pbl in increasing students' learning outcome. Biosfer: *Jurnal Pendidikan Biologi,* |

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| | *13(1),* 42-58. https://doi.org/10.21009/biosferjpb.v13n1.42-58<br>1. Maulina, D., Sumitro, S. B., Lestari, S.R., & Djoa, D. D. 2025. Spodoptera litura F. immune system against exposure to the biopesticide Mirabilis jalapa L. *AGRIVITA Journal of Agricultural Science, 47(1)*, 11-20. http://doi.org/10.17503/agrivita.v47i1.4351 |
| Ethics and Rules | 1. Dress clean, neat and polite<br>2. Not allowed: wearing sandals, wearing t-shirts, long hair<br>3. Turn off *your cell phone during* offline and online lectures |

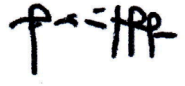
Course Coordinator (PJMK)

(Dr. Dina Maulina, M.Si )

**UNIVERSITY OF LAMPUNG**
**FACULTY OF TEACHER TRAINING AND EDUCATION**
**DEPARTMENT OF MATHEMATICS AND NATURAL SCIENCES**
**BIOLOGY EDUCATION STUDY PROGRAM**

# SEMESTER LEARNING PLAN (RPS)

| Course Name | Currency Code Studying | Weight (credits) | Semester | Date of Compilation |
|---|---|---|---|---|
| Entomology | KBO 620422 | 2 (2-0) | Odd | July 18, 202 4 |

| Authorization | Developer Coordinator Name RPS | Field Coordinator Skills (If Any) | Head of Study Program |
|---|---|---|---|
| |  Dr. Dina Maulina, M.Si<br>Nadya Meriza, S.Pd., M.Pd. |  Dr. Dina Maulina, M.Si |  Rini Rita T. Marpaung, S.Pd., M.Pd. |

**Learning Outcomes (CP)**

**CPL-PRODI (Study Program Graduate Learning Outcomes) Assigned to Courses**

**Attitude**

1. Be pious to God Almighty and be able to demonstrate a religious attitude.
2. Internalize scientific values, norms and ethics and be able to develop them through Entomology lectures
3. Collaborate and show a responsible attitude in the field of Entolomolgy studies.
4. Internalize the spirit of independence and fighting spirit and be able to develop it through Entomology lectures.

**General Skills**

1. Applying logical, critical, systematic and innovative thinking in the context of developing or implementing science and technology that pays attention to and applies humanities values that are in accordance with the field of Entomology.
2. Demonstrate independent, quality, and measurable performance through Entomology learning.

**CP Special Skills**

1. Examine the implications of the development or implementation of science and technology that pay attention to and apply humanities values in accordance with the field of Entomology based on scientific rules, procedures and ethics in order to produce solutions, ideas and designs.
2. Prepare a scientific description of the results of the Entolomolgi study in the form of an investigation report.

**CP Knowledge**

1. Mastering facts, concepts, principles, laws, theories and procedures in the field of Entomology in depth and their application.

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| | 2. Have sensitivity in finding problems regarding Entomology.<br>3. Applying logical, critical, systematic and innovative thinking in the context of solving Entomology problems.<br>4. Communicate recommendations on problem solving in the context of Entomology based on application and research. |
| | **CPMK (Course Learning Outcomes)** |
| | Analyzing entomology as a science that studies insects comprehensively in real life in the study of the relationship between the structure and function of various insects in relation to the bioprocess and ecological status of their niece. |
| **Brief Description of MK** | This lecture discusses the study of insects starting from anatomical structure, physiological function as well as control and their role in the ecosystem referring to the achievement of basic competencies (KD) at the secondary school level in a comprehensive manner which includes the scope of insects, insect classification, insect control, the role of insects in various fields of life (health, industry, forensics, agriculture and aesthetic insects) as well as the ecological status of insects. |
| **Study Materials / Learning Materials** | (1) Scope of insects: Structure, anatomy, physiology, habitat and role of insects in general<br>(2) Insect classification: (a) Apterygota; (b) Pterygota (Exopterygota and Endopterygopte)<br>(3) Apterygota: Prototura<br>(4) Apterygota: Thusanura<br>(5) Apterygota: Collembola<br>(6) Pterygota (Exopterygota): Orthoptera<br>(7) Pterygota (Exopterygota): Isoptera<br>(8) Pterygota (Exopterygota): Hemiptera<br>(9) Pterygota (Exopterygota): Lepidoptera<br>(10) Pterygota (Exopterygota): Homoptera<br>(11) Pterygota (Endopterygota): Heminoptera<br>(12) Pterygota (Endopterygota): Diptera<br>(13) Pterygota (Endopterygota): Cleoptera<br>(14) Pterygota (Endopterygota): Odonata<br>(15) The role of insects in the health sector<br>(16) The role of insects in industry<br>(17) The role of insects in agriculture<br>(18) The role of insects in the field of forensics<br>(19) Aesthetic insects |
| **Reference List** | **Main:**<br>1. Borror, D.J., C. A. Triplehorn and N. F. Johnson. 1992.Pengenalan Serangga, ed. 6. Terjemahan drh. Soetiyono Partosoejono MSc. Gajah Mada Univ. Press.<br>2. Borror, D.J. and R. E. White. 1987. A. Field Guide to the Insects. National Audubon and National Wildlife Federation USA.<br>3. Comstock, J. H. 1959. An Introduction to Entomology, Ninth Edition. Comstock Pub. Company, Inc. Ithaca, New York. Imms A. D. 1964. A General Textbook of Entomology. Chapman and Hall LTD. London.<br>4. Kerkut GA, Gilbert LI. 1985. Comprehensive Insect Physiology Biochemistry and Farmacology. Oxford. Pergamon Press.<br>5. Wigglesworth VB. 1972. The Principle of Insect Physiology (7th eds). Chapman and Hall.<br>6. Gullan, P. J and P. S Cranston. 2010. The Insect. An Outline of Entomology. Wiley-Blackwell. A John Wiley &Sons, Ltd.<br>7. Maulina, D. 2020. Insects and Their Biological Control. Intrans Press, Indonesia.<br>8. **Supporters:** 9.<br>10. McGavin, G.C. & Davranoglou, L.-R. 2023. *Essential Entomology (2nd ed.).* Oxford University Press. |

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| | 11. Grimaldi, D. A. (Ed.). 2023. *The Complete Insect: Anatomy, Physiology, Evolution, and Ecology* . Princeton University Press.<br>12. Maulina, D., Amin, M., Sumitro, SB, Lestari, SR. 2019. Insects and Biological Control. Intrans Publishing.<br>13. Maulina, D., Amin, M., Sumitro, SB, Lestari, SR. 2018. Alanine as natural biopesticide from Mirabilis jalapa and its interaction with glutamate as an inhibitor in insects immune system . Journal of BIOLOGICAL RESEARCHES. Volume 23 No.2.<br>14. Maulina, D., Sumitro, SB. M Amin, SR Lestari. 2018. Identification of peptides compounds from Mirabilis jalapa L.(Caryophyllales: Nyctaginaceae) potentially as a biopesticide. Journal of Physics: Conference Series.<br>15. Maulina, D., Priadi, M. A., Lengkana, D., Jalmo, T., Fauzisar, A. S., & Amin, M. 2020. Book of insects' immune system: development and implementation with pbl in increasing students' learning outcome. *Biosfer: Jurnal Pendidikan Biologi*, 13(1), 42-58. https://doi.org/10.21009/biosferjpb.v13n1.42-58<br>16. Maulina, D., Sumitro, SB, Lestari, SR, & Djoa, DD 2025. *Spodoptera litura F.* immune system against exposure to the biopesticide Mirabilis jalapa *L.* *AGRIVITA Journal of Agricultural Science* , 47(1), 11-20. http://doi.org/10.17503/agrivita.v47i1.4351 |
| **Lecturer Name Guardian** | 1. Dr. Dina Maulina, M.Si<br>2. Nadya Meriza, S.Pd., M.Pd. |
| **Subject prerequisites (if any)** | - |

| Week | Sub-CPMK (Planned final capability) | Study Materials (Learning Materials) | Learning Forms and Methods [Learning Media & Resources] | | Estimated Time | Student Learning Experience | Evaluation | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Criteria & Forms | Indicator | Weight (%) |
| 1 | 2 | 3 | 4 | | 5 | 6 | 7 | 8 | 9 |
| I | Describe the scope of Entomology anatomy | Study contract<br><br>Scope of Entomology | ● Lectures, Discussions<br>● Media:Video<br>● Materials: ppt | ● *e-learnin*<br>● V Class<br>● Media: Video, ppt<br>● Learning Resources: e-book | Face to Face (TM) 2 x 50' | Student presentations, class discussions and lecturer confirmation | ● Mid-term written test<br>● Structured assignment assessment | 1. Submitting the study contract<br>2. Explaining the material and scope of the lecture<br>3. Dividing the work group<br>4. Direct<br>5. V-Class Settings | **5** |
| II | Describe the scope of insects | Study of the scope of insects | ● Lectures, Discussions<br>● Media:Video<br>● Materials: ppt | ● *e-learnin*<br>● V Class<br>● Media: Video, ppt<br>● Learning Resources: e-book | Face to Face (TM) 2 x 50' | Student presentations, class discussions and lecturer confirmation | ● Mid-term written test<br>● Structured assignment assessment | 1. Describe the morphological and anatomical structure of insects. Explain the stages of spermatogenesis.<br>2. Analyzing the physiological functions of insects in relation to their habitat<br>3. Identifying the general role of insects in habitat status | **10** |
| III and IV | Describe the classification of insects | Apterygota:<br>1. Prototura<br>2. Thusanura<br>3. Collembola | ● Lectures, Discussions<br>● Media:Video<br>● Materials: ppt | ● *e-learnin*<br>● V Class<br>● Media: Video, ppt<br>● Learning Resources: e-book | Face to Face (TM) 2 x 50' | Student presentations, class discussions and lecturer confirmation | ● Mid-term written test<br>● Structured assignment assessment | 1. Analyzing the morphological and anatomical structure of apterygota<br>2. Analyze the physiological functions of apterygotes according to their classification<br>3. Explain the stages of the insect life cycle | 10 |
| V, VI and VII | Describe the classification of insects | Pterygota (Exopterygota):<br>1. Ort | 6. Lectures, Discussions<br>7. Media:Video<br>8. Materials: | ● *e-learnin*<br>● V Class<br>● Media: Video, | Face to Face (TM) | Student presentations, class discussions | ● Mid-term written test<br>● Structured assignment assessment | 1. Analyzing the morphological and anatomical structure of Pterygota<br>2. Analyze the physiological functions of pterygotes | **5** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | hoptera<br>2. Isoptera<br>3. Hemiptera<br>4. Lepidoptera<br>5. Hemoptera | ppt | ppt<br>● Learning Resources: e-book | 2 x 50' | and lecturer confirmation | | according to their classification<br>3. Explain the stages of the insect life cycle | |
| **VIII** | | | | | | | | | |
| IX and X | Describe the classification of insects | Pterygota (Endopterygota):<br>1. Hymenopter<br>2. Diptera<br>3. Cleoptera<br>4. Odonata | 9. Lectures, Discussions<br>10. Media: Video<br>11. Materials: ppt | ● *e-learnin*<br>● V Class<br>● Media: Video, ppt<br>● Learning Resources: e-book | Face to Face (TM) 2 x 50' | Student presentations, class discussions and lecturer confirmation | ● Final Exam Written Test<br>● Structured assignment assessment | 1. Analyzing the morphological and anatomical structure of Pterygota<br>2. Analyze the physiological functions of pterygotes according to their classification<br>3. Explain the stages of the insect life cycle | 5 |
| XI to XV | Examining the role of insects in various areas of life | 1. Health Sector<br>2. Industrial Sector<br>3. Agriculture<br>4. Forensic Field<br>5. Aesthetic insects | 12. Lectures, Discussions<br>13. Media: Video<br>14. Materials: ppt | ● *e-learnin*<br>● V Class<br>● Media: Video, ppt<br>● Learning Resources: e-book | Face to Face (TM) 2 x 50' | Student presentations, class discussions and lecturer confirmation | ● Final Exam Written Test<br>● Structured assignment assessment | 1. Discovering the role of insects in various areas of life<br>2. Compare the role of insects in life | 10 |
| **XVI** | **Final exams** | | | | | | | | **20** |

**Notes** :

1. Study Program Graduate Learning Outcomes (CPL-PRODI) are the abilities possessed by each PRODI graduate which are the internalization of attitudes, mastery of knowledge and skills according to the study program level obtained through the learning process.
2. The CPL charged to a course is a number of learning outcomes of study program graduates (CPL-PRODI) which are used to form/develop a course consisting of aspects of attitude, general skills, special skills and knowledge.
3. Course CP (CPMK) is a capability that is specifically described from the CPL that is assigned to the course, and is specific to the study material or learning material of the course.
4. Sub-CP Course (Sub-CPMK) is a capability that is specifically described from CPMK that can be measured or observed and is the final capability planned at each learning stage, and is specific to the learning material of the course.
5. Assessment Criteria are benchmarks used as a measure or yardstick for learning achievement in assessment based on established indicators. Assessment criteria are guidelines for assessors to ensure consistent and unbiased assessment. Criteria can be quantitative or qualitative
6. The assessment indicators for the ability in the process and results of student learning are specific and measurable statements that identify the ability or

performance of student learning results accompanied by evidence .

**Assessment Rubric**

In determining the final value, the weighting percentage is based on the following:

| Assessment Components | Percentage Value (%) |
|---|---|
| 1. Mid-term exam<br>2. Final Exam<br>3. Discussion and presentation activities<br>4. Group Project<br>5. Independent Project<br>6. Attendance (minimum 80% attendance at lectures) | 20<br>20<br>20<br>20<br>15<br>5 |
| Amount | 100 |

Independent Assignment:
file:///C:/Users/Rizky/Downloads/Kelompok%204_Ordo%20Isoptera%20dan%20Hemiptera.pdf

Project format: file:///C:/Users/Rizky/Downloads/Kel%205%20MBKM_Entomologi.pdf

**Student participatory assessment**

| No | Assessment aspects | Participatory weight |
|---|---|---|
| 1 | Participation in discussions, | 25 |
| 2 | Ability to ask and answer questions | 25 |
| 3 | Cooperation in groups | 25 |
| 4 | Responsible for the task | 25 |

**Presentation Assessment**

| No | Assessment aspects | Participatory weight |
|---|---|---|
| 1 | Mastery of the material | 25 |
| 2 | Communication skills | 25 |
| 3 | Presentation product | 25 |
| 4 | Presentation attitude | 25 |

**Question Sheet for Mid Term Course Examination**

### Midterm Exam for Entomology Course

### Odd Semester 2023/2024 Tuesday, September 12, 2023

# Student Midterm Project

**Make the working group into 8 groups,**

1. Each group makes a paper on the topic of the lecture on the scope of insects.
2. Each group creates a project assignment in the form of a flipbook learning media collection of insects for each insect order according to the division in the list below (divided into different orders for each group)
3. All Class Assignments are combined into one Flipbook (Example: https://heyzine.com/flip-book/e4fd5d5f91.html)
4. Deadline for collection is September 30, 2023

| Meeting | Discussion Topics | Lecture Activities |
|---|---|---|
| I | Describe the scope of entomology learning | College contract<br>Insight into the material and scope of the lecture. Dividing the work groups.<br>Direct<br>V-Class Settings |
| II | Scope of insects | Structure, anatomy, physiological, habitat and role of insects in general Habitat Status |
| III | Insect Classification | Apterygota;<br>Pterygota (Exopterygota)<br>Pterygota (Endopterygota) |
| IV | Apterygota; | Prototura Thusanura |
| V | Apterygota;<br>Pterygota (Exopterygota) | Collembola Orthoptera |
| VI | Pterygota (Exopterygota) | Isoptera Hemiptera |
| VII | Pterygota (Exopterygota) | Lepidoptera Hemoptera |
| **VIII** | **Midterm Exam (Project)** | |
| IX | Pterygota (Endopterygota) | Hymenoptera<br>Diptera |
| X | Pterygota (Endopterygota) | Celeopteara Odonata |

**Question sheet for Final Course Examination**

**Entomology Course Final Exam**

**Odd Semester 2023/2024; November 30, 2023**

# Student Final Exam Project

1. Divide the class into 5 groups
2. Make a paper according to the theme below
3. Deadline for submission is 30 October 2023

| | | |
|---|---|---|
| IX | Pterygota (Endopterygota) | Hymenoptera<br>Diptera |
| X | Pterygota (Endopterygota) | Celeopteara Odonata |
| XI | The role of insects in the health sector | • Types of Insects<br>• Benefit<br>• Applications in society that are already in use<br>• Looking for 3 articles related to the role of insects in each aspect |
| XII | The role of insects in industry | |
| XIII | The role of insects in agriculture | |
| XIV | The role of insects in the field of forensics | |
| XV | Aesthetic insects | |
| Final exams | | |

**Assessment Rubric of Final Examination**

| No. | Answer Key | Scoring Rubric |
|---|---|---|
| 1 | Group project on Pterygota (Endopterygota) - Hymenoptera:<br>- Classification and morphological characteristics of Hymenoptera.<br>- Life cycle and metamorphosis type.<br>- Ecological role and economic importance.<br>- Examples of species and their relevance. | Score 0–20:<br>0–4: Provides incomplete classification or morphology.<br>5–8: Provides basic classification and morphology.<br>9–12: Includes life cycle but lacks detail on roles and examples.<br>13–16: Detailed explanation with examples but missing some relevance.<br>17–20: Complete, accurate, and relevant classification, morphology, life cycle, roles, and examples. |
| 2 | Group project on Pterygota (Endopterygota) - Diptera:<br>- Classification and morphological characteristics of Diptera.<br>- Life cycle and metamorphosis type.<br>- Ecological role and medical/veterinary importance.<br>- Examples of species and their impact. | Score 0–20:<br>0–4: Provides incomplete classification or morphology.<br>5–8: Provides basic classification and morphology.<br>9–12: Includes life cycle but lacks detail on roles and examples.<br>13–16: Detailed explanation with examples but missing some relevance.<br>17–20: Complete, accurate, and relevant classification, morphology, life cycle, roles, and examples. |
| 3 | Group project on Pterygota (Endopterygota) - Coleoptera & Odonata:<br>- Classification and morphological characteristics of both orders.<br>- Life cycles and types of metamorphosis.<br>- Ecological roles and economic/health relevance.<br>- Examples of species for each order. | Score 0–20:<br>0–4: Provides incomplete classification or morphology.<br>5–8: Provides basic classification and morphology.<br>9–12: Includes life cycles but lacks detail on roles and examples.<br>13–16: Detailed explanation with examples but missing some relevance.<br>17–20: Complete, accurate, and relevant classification, morphology, life cycles, roles, and examples. |
| 4 | The role of insects in the health sector:<br>- Types of insects relevant to health (vectors, beneficial insects).<br>- Benefits and applications in public health.<br>- Examples of disease transmission or medical uses.<br>- Summary from 3 scientific articles. | Score 0–20:<br>0–4: Mentions insect types without details.<br>5–8: Mentions benefits or applications briefly.<br>9–12: Explains insect types and roles but lacks literature support.<br>13–16: Explains insect types, benefits, and applications with some references.<br>17–20: Complete, accurate, and well-referenced explanation including examples and applications. |
| 5 | The role of insects in industry, agriculture, forensics, and aesthetics:<br>- Industrial uses (silk production, pollination services, biomaterials).<br>- Agricultural roles (pollination, pest control, pest damage).<br>- Forensic applications (estimating post-mortem interval).<br>- Aesthetic uses (ornamental, educational, cultural). | Score 0–20:<br>0–4: Mentions only one role without details.<br>5–8: Mentions some roles but incomplete.<br>9–12: Explains multiple roles but lacks examples.<br>13–16: Explains roles with examples but lacks comprehensive coverage.<br>17–20: Complete, accurate explanation with examples for all roles and applications. |

4. Sample Answer of Final Examination

**PAPER**

# THE ROLE OF INSECTS IN AGRICULTURE

Course:

Entomology

Lecturer:

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**2023**

# CHAPTER I INTRODUCTION

## 1.1. Background of the Problem

Agriculture is one of the key aspects in efforts to meet human food needs. In the world of agriculture, the role of insects, such as dragonflies, grasshoppers, and bees, is very important. These insects are not only natural elements of the agricultural ecosystem, but also have a significant impact on crop productivity and health.

One example of the very positive role of insects in agriculture is the dragonfly. Dragonflies are primitive insects that prey on plant pests such as caterpillars, aphids, and other small insects that can damage agricultural crops. In other words, dragonflies are predators that consume other organisms, especially insect pests. Their role is very important because dragonflies help control plant pest populations within acceptable limits. This helps plants grow healthier and produce more productively. Without dragonflies, agriculture would be more vulnerable to pest attacks that could result in reduced yields.

In addition, another insect that plays an important role in agriculture is the grasshopper. Grasshoppers are natural predators of insect pests such as locusts and caterpillars. By helping to control pest populations, they reduce dependence on chemical pesticides that can potentially damage the environment and human health. Furthermore, grasshoppers also play a role in stimulating plant growth, participating in the nutrient cycle, and playing an important role in the food chain. In fact, some species of grasshoppers are considered ecological indicators that describe the quality of related ecosystems in ecological networks.

Bees, on the other hand, have a unique role in the pollination process of plants. Bees are the primary pollinators for many flowering plants, including vegetables and fruits. They help transfer pollen from one flower to another, enabling the formation of fruits and seeds. Without the help of bees, agricultural production would be hampered, resulting in reduced yields and plant quality.

From an agricultural perspective, insects are irreplaceable allies, playing an important role in maintaining the sustainability of our agricultural ecosystems. Unfortunately, however, the existence of these insects is currently threatened by various factors such as excessive pesticide use, climate change, and the loss of their natural habitats. A decline in insect populations can disrupt the balance of agricultural ecosystems, reduce crop yields, and even potentially threaten food security. Therefore, it is important to understand the important role of insects in agriculture and the protection efforts needed to ensure sustainable agriculture.

## 1.2. Problem Statement

### 1.2.1. What are the types of insects in agriculture?

1.2.2. What are the benefits of insects in agriculture?

1.2.3. How are insects applied in society that are already used in agriculture?

## 1.3. Objectives

1.3.1. To learn about the types of insects in agriculture

1.3.2. To learn about the benefits of insects in agriculture

1.3.3. To identify insect applications in communities that are already used in agriculture

# CHAPTER II DISCUSSION

## **2.1.** Types of Insects

### 2.1.1. Bees

Kingdom : Animalia

Phylum : Arthropoda

Class : Insecta

Subclass : Pterygota

Order :

Hymenoptera

Bees are a large group of insects known for living in colonies, although not all bees are social. There are approximately 20,000 species of bees in the world and they can be found on every continent except Antarctica. As insects, they have two pairs of legs and two pairs of wings. Bees build their nests on hills, in trees, and on the roofs of houses. Their nests are built from propolis (a glue made from tree sap) and wax produced by the glands of young female bees. Bees feed on flower nectar and pollen.

Female insects play an important role in this insect group. Bee behaviour is largely determined by the behaviour of female bees. Some female bees of certain species live alone (solitary) and others are known to have social behaviour. Solitary bees build their own nests and forage for their offspring without the help of other bees and usually die or leave the nest before their offspring become adult bees. Sometimes, some solitary bee species feed and care for their young without providing food reserves for them; this type of relationship is known as subsosial. At a higher level, bees live in groups and share tasks according to their physical characteristics.

- Types of Bees

a) *Apis dorsata*

Source: Riau Ecosystem Restoration, 2020.

*b) Apis mellifera*

Source: CABI Digital Library, 2022.

*c) Apis carnea*

Source: Charles Lam via Flickr, CC-BY-SA-2.0.

2.1.2. Locust

Kingdom : Animalia Phylum :

Arthropoda Class : Insecta

rder

Grasshoppers are herbivorous insects belonging to the order Orthoptera, with approximately 20,000 species (Borror, 2005). According to Rowell (1987), grasshoppers can be found in almost all terrestrial ecosystems. Most grasshopper species are found in forest ecosystems (Rowell, 1987). They feed on almost all wild and cultivated plants (Probe and Scalpel, 1980). Several studies by Baldi and Kisbenedek (1997) show that grasshopper diversity is more stable in undisturbed ecosystems ( ). Saha et al. (2011) add that the diversity and abundance of species (Acrididae: Order Orthoptera) ( ) in undisturbed ecosystems is higher than in disturbed ecosystems. According to Bhargava (1996), grasshopper diversity is influenced by ecological factors including rainfall patterns, atmospheric temperature, relative humidity, soil type,

protection from external enemies, and vegetation structure. Fielding and Bruseven (1995) state that vegetation greatly influences the composition and presence of grasshopper species in an ecosystem. The higher the diversity of vegetation in a habitat, the higher the food source for grasshoppers in that habitat, resulting in their abundance. Morris (2000) states that vegetation structure is an important parameter for determining grasshopper diversity in a habitat on a large scale. Guo (2006) adds that changes in the diversity of vegetation communities can cause variations in the specific patterns of locust biodiversity because, according to Sanger (1977) and Ingrisch (1980), locusts usually have a specific dependence on vegetation and microclimate.

- Types of grasshoppers

There are various types of locusts that we need to know about. Here are some types of locusts:

a) Migratory locust (*Locusta migratoria*),

Source: Ministry of Home Affairs Research and Development, 2019

b) Leaf Grasshopper (*Phyllium fulchrifolium*),

Source: Flickr, 2009

c) Wood grasshopper (*Valanga nigricornis*),

Source: Media Banten, 2021

### 2.1.3. Dragonfly

Kingdom : Animalia Phylum : Arthropoda Class : Insecta

Subclass : Pterygota Order : Odonata

One order of insects that has quite high diversity and also plays a beneficial role in the environment is dragonflies (Odonata). Dragonflies are one of the primitive insect groups (Ruslan, 2020). The order Odonata is divided into two suborders, namely Anisoptera (dragonflies) and Zygoptera (damselflies). These two suborders can be distinguished by their body shape, with Anisoptera having a larger body than Zygoptera. The eyes of Anisoptera are fused, while those of Zygoptera are separate. Anisoptera have a wider flight range than Zygoptera (Rahadi 2013). Adult dragonflies are often found flying around water bodies such as rivers, reservoirs, ponds and lakes. Some dragonfly species can fly far from water bodies, such as Gynacantha sp, Potamarcha congener and several species of the Libellulidae family (Theischinger & Hawking 2006 in Laily, Rifqiyati, & Kurniawan, 2018).

Dragonflies are known as predators that play an important role in controlling the population of other insects, and they are often considered a symbol of beauty and good luck. Dragonflies (Odonata) are said to be predatory insects because during their lifetime they eat smaller insects, and even their own kind can be prey. Their presence in nature acts as a predator that balances the population of other insects. This type of insect also has benefits for the ecosystem. One indicator of good environmental and ecosystem conditions is the presence of dragonflies (Odonata) in an area (Muktitama, Hari, & Yulianti, 2018). The following is a classification of dragonflies.

- Types of dragonflies

The types of dragonflies are as follows:

a) *Diplacodes trivialis.*

Source: https://jv.wikipedia.org/wiki/Diplacodes_trivialis

b) *Pantala hymenaea*

Source: https://commons.wikimedia.org/wiki/Category:Pantala_hymenaea

c) *Pseudagrion microcephalum*

Source. Muktitama, Hari, & Yulianti, 2018.

## **2.2.** Benefits of insects

### 2.2.1. Benefits of Bees

Honeybees are a group of insects that act as pollinators for flowering plants, thereby increasing the production of these plants. Honeybees honeybees and flowering plants have a relationship that is mutually beneficial relationship, where plants provide bees with nectar and pollen as food, while honeybees pollinate the plants. Honeybees obtain nectar and pollen from plant flowers, which are continuously collected by worker bees. Nectar is a sweet liquid secreted by the nectaries of plants that can develop on flowers, leaves and stems. The nectar and pollen collected by bees are sources of carbohydrates, proteins, fats, vitamins and minerals that are essential for growth, development, tissue repair and stimulation of the hypopharyngeal glands. Pollen is a product produced by the male reproductive organs of plants in the form of powder and is the raw material for the production of bee pollen by worker bees. Pollen contains proteins, vitamins, and minerals needed by honey bees to build healthy colonies (Yuni et al., 2018).

Honey bees have many benefits, such as direct products in the form of honey, pollen, royal jelly, propolis adhesive and bee stings. Indirect benefits of honey bee farming include improving community nutrition, creating jobs and assisting in the pollination of forest and agricultural crops, thereby preserving Indonesia's forests and increasing agricultural production. Honeybees are a group of insects that act as pollinators for flowering plants, thereby increasing the production of these plants (Yuni et al., 2018).

### 2.2.2. Benefits of Grasshoppers

Grasshoppers (*Caelifera*) are one of the animals that are easily found around us. According to *National Geographic*, there are more than 2,500 species of grasshoppers in the world. They live side by side with humans. Grasshoppers are a type of insect that can reproduce rapidly in nature. A distinctive feature of grasshoppers is their ability to jump with strong legs while producing sounds from the friction of their body parts. Grasshoppers are herbivorous animals that consume all types of plants available in their surroundings. They thrive in warm seasons and are generally intolerant of cold weather. Some grasshoppers can disrupt agriculture, but grasshoppers also can provide benefits that do not suspect. After eating plants,

herbivorous animals will excrete food waste through faeces. Faeces or animal waste contains several chemical elements that are needed by the soil, and it contains so much fibre that it can help fertilise the soil. Therefore, grasshoppers and other herbivorous animals indirectly provide nutrients for the soil.

### 2.2.3. Benefits of Dragonflies

Dragonflies are natural predators that eat many insect pests that are harmful to plants, such as aphids, caterpillars, flies, and moths. By reducing the population of these pests, dragonflies help maintain the balance of the agricultural ecosystem and reduce dependence on chemical pesticides. In the ecosystems they inhabit, dragonflies and damselflies play a role in maintaining the balance of the food chain, where damselflies act as predatory insects that are natural enemies that can reduce the population of crop pests, thereby suppressing the population dynamics of insects that have the potential to become agricultural pests (Rizal & Hadi, 2014). Dragonflies are natural predators that feed on various insect pests, including aphids, caterpillars, flies, moths, and other small insects that can damage agricultural crops. By eating these pests, dragonflies help control pest populations and reduce damage to crops. Dragonflies play an important role in rice field ecosystems as they are predatory insects, both in their nymph and adult forms. They prey on various insect species and other organisms, including rice plant pests. The presence of dragonflies around farms can be an indicator of environmental quality. Dragonflies are organisms that are sensitive to water and environmental pollution. Their presence indicates that the agricultural environment is quite healthy (Sarah, 2021).

## **2.3.** Applications in Society that have been used

### 2.3.1. Applications of Bees in Society that have been used

Research conducted by Udayani et al., 2020, states that bees play an important role in the pollination of purple eggplants carried out by local farmers in Bali. The research was conducted in the form of a split-plot design (RPT) in a randomised block design. There were three groups, namely plot A (natural or open pollination), plot B (pollination assisted by bees), and Plot C (100% self-pollination), each containing 36 plants for a total of 108 purple eggplants. The presence of honeybees in treatment group B showed an increase in production quality, particularly in fruit weight and number of fruits produced. At the same time, fruit ripening and fruit weight were of better quality compared to fruit produced from self-pollination. The presence of honey bees in plantations is one of the agrotechnical factors needed to increase land productivity.

The number of fruits in plot B treatment group increased due to successful fruit formation, better known as fertilisation. The interaction between pollination time and pollen age. Pollen viability determines the ability of pollen to deliver the generative nucleus to the ovule to enable double fertilisation, while pistil receptivity determines the availability and readiness of the ovule for fertilisation.

### 2.3.2. Applications of Grasshoppers in Society that have been used

Locusts are also beneficial to humans as a food commodity rich in protein and fat. Insects contain essential amino acids that are good for the body (*Osimani* et al., 2016). According to *the Entomological Society of America*, compared to cattle, chickens, or pigs, locusts are animals with a high protein content. They have a very low percentage of cholesterol and body fat. Grasshoppers contain good nutrients, namely 62.20 g/100g protein, 15.80 g/100g carbohydrates, 10.40 g/100g fat, 30.48 mg/100 g vitamin E, 61.98 mg/100 g copper, 0.71 mg/100 g zinc, 217.72 mg/100g sodium, 169.65 mg/100g potassium, 1841 mg/100g calcium, 21.56 mg/100g manganese and 154.430 mg/100g iron, 719.940 mg/100g magnesium (*Blasquez* et al., 2012). Many Africans believe that locusts are an important source of protein (*Van Huis and Oonincx,* 2017). Locusts can have several applications for society, particularly in the context of sustainability, food and human welfare. Some of these applications include:

- Food and Nutritional Source

  Some communities around the world consume grasshoppers as a source of protein and nutrition. Grasshoppers are a relatively low-cost source of animal protein

  and have a lower carbon footprint compared to other animal protein sources. This could be a sustainable food alternative.

- Natural Pest Control

  Some types of grasshoppers are natural predators of plant pests, such as aphids, caterpillars, and other insects. Utilising such grasshoppers can reduce dependence on chemical pesticides in agriculture, which can reduce the risk of pesticide residues in agricultural products and a healthier environment.

- Industry Development

  In some countries, the locust farming industry has developed as a commercial enterprise. These locust farms can create jobs and new business opportunities in the community.

- Research and Education

  Grasshoppers can also be used in scientific research and education. They are often used in animal behaviour, biology, and ecology research. Education about grasshoppers can also increase awareness of ecology and the environment among the public.

- Ecotourism

  Some places in the world attract tourists by offering experiences to observe locusts in their natural habitat. This can be an additional source of income for local communities and support environmental conservation.

- Traditional Medicine

Some communities use grasshoppers in traditional medicine. Although these medicinal claims may not always be supported by scientific evidence, grasshoppers still hold cultural value in the use of traditional medicines.

It is important to note that the use of grasshoppers in society must be done with consideration for the sustainability of grasshopper populations and ecosystem balance. Utilising grasshoppers in various ways can provide benefits, but it must also be regulated so as not to excessively damage grasshopper populations or disrupt local ecosystems.

### 2.3.3. Applications of Grasshoppers in Society that have been used

Dragonflies are natural predators that can help control agricultural pests. Here are some applications of dragonflies as predators in an agricultural context:

- Insect Pest Control

Dragonflies feed on various types of insect pests, including aphids, caterpillars, flies, and moths. They can be used to reduce the populations of these pests in agricultural fields.

- Specific Pest Attacks

Humans can select specific dragonfly species that are more specific in eating certain pests. For example, Coccinellidae dragonflies (ladybirds) are effective in controlling aphids.

One pest that dragonflies can control is the rice stem borer, known as sundep or beluk. Naturally, dragonflies are natural predators of sundep pests in their imago (adult) phase. One sundep can produce 50-300 eggs. If, for example, one dragonfly can prey on one sundep in one day, then if there are 100 dragonflies, they can thwart a potential attack of 5,000-30,000 sundep larvae. To keep dragonflies present in the rice fields, stakes are installed. These dragonfly perches help dragonflies land and monitor their prey. They can be tree branches with several twigs, placed around or in the middle of the rice field. Use fairly large branches so that birds do not land on them (Benih Pertiwi, 2017).

## **2.4.** The Role of Insects

### 2.4.1. The Role of Bees

Agriculture and bees have a very close relationship. As pollinators, the pollination carried out by bees provides various benefits for humans. Bees contribute to food processing, raw materials, medicines, fibres, socio-cultural values, and the maintenance of biodiversity and environmental protection. In flowering plants, the pollination process is an important part of their life cycle. This is not only important for the preservation of plant species, but also, in practical terms, for the productivity of cultivated food crops and other commodities. Insects are known to be effective pollinators, as demonstrated in several previous studies, enabling pollination to occur more effectively and efficiently (Udayani et al., 2020).

### 2.4.2. The Role of Grasshoppers

- Praying mantis (*Mantis religiosa*)

Source: Istock, 2019

The presence of locusts determines the quality of agricultural land. Locusts play a role as herbivores, predators, decomposers, and pests, so they have the potential to be used as indicators of agricultural land quality. Grasshoppers are often considered pests, even though they play a vital role in the ecosystem. Not all types of grasshoppers play an important role in agriculture. The role of grasshoppers in agriculture can vary depending on the species and ecological conditions. Some species of grasshoppers can play a positive role, such as pest control. Meanwhile, others have no significant impact or may even become pests in some situations. Here are some examples of the role of grasshoppers in agriculture. Praying mantis (*Mantis religiosa*): As explained earlier, praying mantises are insect predators and can help control pest populations in agriculture. Not all grasshoppers are beneficial to agriculture; most grasshoppers are known as pests in the agricultural world, so it is important to identify the species of grasshoppers present in the agricultural environment and understand their ecological role in order to take appropriate action if necessary to maintain ecosystem balance and control potential pests.

Praying mantises (*Mantis religiosa*) are insects that play an ecological role in agricultural ecosystems. Although often considered pests because of their habit of eating other insects, praying mantises can also provide benefits to agriculture. Here are some of the roles of praying mantises in the context of agriculture:

a) Pest Control: Praying mantises are predators of insects, including insects that are often considered plant pests. They eat aphids, caterpillars, grasshoppers, and other insects that can damage agricultural crops. By eating these pests, praying mantises can help control pest populations and reduce damage to crops.
b) Reducing Pesticide Use: The presence of praying mantises in agroecosystems can reduce the need for chemical pesticides. Thus, more sustainable and environmentally friendly agriculture can be implemented, reducing the negative impact of pesticides on the environment and human health.
c) Facilitating the Nutrient Cycle: Praying mantis droppings can be used as natural fertiliser rich in nutrients. When they eat insects and small plants, they convert organic matter into droppings

that contain nitrogen and other nutrients. This can increase soil fertility and support better plant growth.

d) Ecosystem Indicator: The presence of praying mantises in agriculture can also be an indicator of ecosystem health. If the praying mantis population declines dramatically, this could indicate problems in the ecosystem, such as excessive pesticide use or environmental damage.

Although praying mantises have many benefits for agriculture, it is important to remember that they can also become pests in some situations. When praying mantis populations exceed a certain threshold, they can eat agricultural crops, especially young plants. Therefore, it is important to create the right ecological balance in agroecosystems and consider ways to utilise their positive role while controlling populations when necessary.

### 2.4.3. The Role of Dragonflies

Dragonflies (Odonata) are predatory insects, as they feed on smaller insects throughout their lives, even preying on their own kind. Their presence in nature acts as a predator that balances the populations of other insects. This type of insect also benefits the ecosystem. One indicator of a good environmental and ecosystem condition is the presence of dragonflies (Odonata) in an area (Muktitama, Hari, & Yulianti, 2018). In addition to being predators, dragonflies can also be used as bioindicators in an aquatic environment. Dragonfly nymphs are highly sensitive to changes in water quality (water chemistry). Nymphs that are highly sensitive to water quality will die, and their existence in nature will be threatened with extinction (Kalkman 2008 in Laily, Rifqiyati, & Kurniawan, 2018).

# CHAPTER III CONCLUSION

## **3.1.** Conclusion

The conclusion from the above discussion is as follows:

1. Grasshoppers are herbivorous insects belonging to the order Orthoptera, with many species spread across various ecosystems, especially forests.
2. Grasshopper diversity is more stable in undisturbed ecosystems, and vegetation has a significant impact on the presence of grasshoppers in a habitat.
3. Grasshoppers can be used as a high-protein and nutritious food source for humans and represent a sustainable food alternative.
4. In agriculture, grasshoppers play a role as natural predators that help control populations of insect pests that damage crops. However, they need to be managed carefully so as not to excessively destroy grasshopper populations or disrupt local ecosystems.
5. Bees are important pollinators in agriculture, helping to pollinate flowering plants, increasing productivity, and providing benefits through honey, bee pollen, royal jelly, propolis, and bee stings.
6. Dragonflies are natural predators that feed on insect pests in agriculture, reducing reliance on chemical pesticides, and can be used as bioindicators of aquatic environmental quality.

Therefore, all these insects play a vital role in ecosystems and food production, and their application in agriculture can help enhance productivity and sustainability.

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