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P1

Preliminary result of a taxonomic study on Cryptochetidae (Diptera: Ephydroidea), a newly recognized family to Korean insect fauna

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Cryptochetidae is a small family with 34 known species worldwide. The family currently includes three genera, namely *Cryptochetum*, *Librella* and *Phanerochaetum*. *Cryptochetum* comprises 32 species, whereas *Librella* and *Phanerochaetum* are monotypic genera. In East Asia 20 species are known from China and Japan up to date, without any record from Korea. As a result of our taxonomic study of the South Korean Cryptochetidae, we have recognized a total of three species in *Cryptochetum* using morphological and molecular data: *Cryptochetum* sp. 1 near *glochidiatusum*, *C*. sp. 2 near *zalatilabium* and *C*. sp. 3. In the present study, we provide comparative diagnoses of those species along with images.

Key words: Diptera, Ephydroidea, Cryptochetidae, *Cryptochetum*, South Korea

P2

Preliminary result of a taxonomic study on South Korean lachryphagous Steganinae: focused on *Amiota* and *Phortica* (Diptera: Drosophilidae: Steganinae)

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Drosophilidae is a considerably diverse group among dipteran families, of which the members have extremely various ecological traits. The family currently includes two subfamilies (Drosophilinae and Steganinae), comprising about 4,000 species in over 60 genera worldwide. Among them, some species in only three genera, *Amiota*, *Apsiphortica* and *Phortica,* have been recognized as lachryphagous. In South Korea seven species in *Amiota* and two species in *Phortica* have been recorded up to date. As a result of our taxonomic study of the South Korean lachryphagous Steganinae, we have recognized a total of six species, including possible new species in *Phortica*, using morphological and molecular data: *Amiota* sp. 1 near *albilabris*, *A*. sp. 2 near *dispina*, *A*. sp. 3, *Phortica* sp. 1 near *okadai*, *P*. sp. 2 near *variegata* and *P*. sp. 3. In the present study, we provide comparative diagnoses of those species along with images and a molecular phylogenetic tree.

Key words: Diptera, Drosophilidae, Steganinae, *Amiota*, *Phortica*, South Korea, DNA barcoding

P3

Identification of five genera belong to Apioninae (Coleoptera: Brentidae) based on COI gene sequences

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The weevil family Brentidae (Coleoptera: Curculionoidea) is presently subdivided into six subfamilies (Eurhynchinae, Microcerinae, Ithycerinae, Brentinae, Nanophyinae and Apioninae). The subfamily Apioninae is reported 16 species, 13 genera, 7 Tribe in Korea. However, it is almost impossible to rapidly identify non-adult stages based on external morphological characteristics. Molecular techniques for the identification of Apioninae species are required, we establish the phylogentic tree of five genera based on the mitochondrial DNA cytochrome oxidase subunit I (COI) gene sequences. It is expected that this tree can be applied to identify species belong to the subfamily Apioninae.

Key words: Apioninae, phylogenetic tree, COI, Brentidae

P4

Keys to parasitic wasps of the spotted wing drosophila (*Drosophila suzukii*) in South Korea

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Eight parasitoids of the spotted wing drosophila (SWD, *Drosophila suzukii*) have hitherto been recorded in South Korea. They are larval and pupal parasitic wasp belonging to Braconidae (3 species), Figitidae (3 species), Diapriidae (1 species), Pteromalidae (1 species). For rapid identification of the species, this study provides information regarding their taxonomy, diagnosis, and distribution. Keys to families and species are also provided.

Key words: *Asobara, Leptopilina, Ganaspis, Trichopria, Pachycrepoideus,* SWD

P5

First record of Adelognathinae, Brachycyrtinae and Stilbopinae (Hymenoptera, Ichneumonidae) from South Korea

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Three subfamilies, Adelognathinae, Brachycyrtinae and Stilbopinae, are small groups of the family Ichneumonidae. Subfamily Adelognathinae consists of the single genus *Adelognathus*, with 48 described species occurring in the world. The genus *Adelognathus* is a Holarctic genus but most of the species are from Palaearctic region (43 species). Subfamily Brachycyrtinae is a small group of Ichneumonidae with a single genus, *Brachycyrtus*, with 22 described species occurring in the world. The genus *Brachycyrtus* is a Holarctic genus but most of the species are Neotropical region (12 species), only 2 species from Eastern Palaearctic region. Subfamily Stilbopinae is one of the small subfamilies of Ichneumonidae, comprising four genera (*Notostilbops*, *Panteles*, *Rovenosa* (fossil) and *Stilbops*). Among them, the largest group, genus *Stilbops*, consist of 27 cosmopolitan species. These groups are recognized for the first time with four newly recorded species (*Adelognathus nigriceps, A. pallipes p., Brachycyrtus nawaii* and *Stilbops cavigena* from South Korea. Diagnoses of four unrecorded species, illustrations of diagnostic characters are provided.

Key words: new record, taxonomy, parasitoid wasp, Eastern Palearctic region

P6

A new record of the genus *Latuspina* Monzen, 1954 (Hymenoptera: Cynipidae: Cynipini) from South Korea

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The genus Latuspina Monzen, 1954 belongs to the tribe Cynipini in the family Cynipidae. Until now, two species of the genus Latuspina have been recorded from South Korea. We herein describe and illustrate a newly recorded species and its galls from South Korea.

Key words: Hymenoptera, Cynipidae, Cynipini, *Latuspina*, South Korea

P7

The first record of *Periphyllus acerihabitans* Zhang, 1982 (Hemiptera: Aphididae: Chaitophorinae) from South Korea

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The genus *Periphyllus* is consists of 47 monoecious and holocyclic species. It is associated with *Acer buergerianum*. These species have been recorded in Japan, China, and Korea. In this study, *Periphyllus acerihabitans* Zhang, 1982 is recognized for the first time in South Korea, of which specimens were firstly collected in Jinju. We described morphological features of apterae viviparous and alate viviparous females, respectively.

Key words: *Acer burgerianum*, *Periphyllus*, Korea

P8

A preliminary checklist of the genus *Eupithecia* (Lepidoptera: Geometridae: Larentiinae) in Korea

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The genus *Eupithecia* Curtis is one of the most species-rich genus among the family Geometridae, Lepidoptera, comprising more than 1,400 species worldwide (Scoble, 1999; B.TÓTH, 2018; Mironov & Galsworthy, 2014). The adults of *Eupithecia* are relatively small in sized moth among the allied genera, which have cryptically colored grayish and brownish forewing with regularly fasciated and a definite discal spot and the more weak fascia in hindwing (Holloway, 1997; Mironov, 2003). They have been known as a difficult group to distinguish due to these external characteristics, and requiring dissection of the genitalia and the DNA barcode for exact identification.

Up to the present, a total of 55 species of the genus have been known from Korea. A taxonomic study on this group has been poorly conducted in Korea due to similar external appearance. The aim of this study was to enumerate the known species for future study on taxonomic and phylogy of this group. A checklist of the genus *Eupithecia* from Korea is provided with available information.

Key words: Geometridae, Larentiinae, Eupithecia, Taxonomy, Checklist, Korea

P9

First record of the family Diptilomiopidae (Acari: Eriophyoidea) from Korea

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The superfamily Eriophyoidea is presently divided into three families (Phytoptidae, Eriophyidae and Diptilomiopidae), but a family Eriophyidae only reported in Korea. We collected a Diptilomiopidae species on leaves with rust symptom of *Quercus acuta* Thunb. in Wando island of Jeonnam Province and *Ternstroemia gymnanthera* (Wight & Arn.) Bedd. (Teaceae) in Jeju island. It is identified as *Diptilomiopus gilibertiae* Kadono, 1984 that is the first species belongs to the family Diptilomiopidae in Korea. This family differs from family Eriophyidae as the large ganathosoma in comparison to body; and from family Phytoptidae as the prodorsal shield without anterior setae. We provide photographs of morphological characters in this study.

Key words: Diptilomiopidae, *Diptitomiopus gilibertiae*, first record, Korea

P10

First report of *Aceria diospyri* Keifer (Acari: Eriophyidae) on the fruits of sweet persimmon in Korea

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Sunchon National University

At late June 2021, a species of bud mite in the genus *Aceria* (Eriophyidae, Eriophyinae) was found on the fruits of sweet persimmon (*Diospyros kaki* Thunb.) in the Suncheon city of Jeonnam Province, Korea. The bud mite was subsequently identified as persimmon bud mite, *Aceria diospyri* Keifer, 1944. This is the first reported in Korea, and also occurs in U.S.A., Australia, New Zealand and Japan. It seems likely it will be found wherever persimmons are grown. The mites live under the fruit buttons and in the buds. Their activity causes browning under the buttons and perhaps fruit drop.

Key words: Persimmon bud mite, *Aceria diospyri,* Eriophyidae, *Diospyros kaki*, Korea

P11

Application and comparison of Artificial Intelligence (AI) approach for classification of cicada exuvium

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'선퇴(매미 탈피각)'는 다양한 약효와 기전이 입증되고 있으나, 종의 정확한 분류학적 위치를 확인하기에 어려움이 있다. 이에 정확한 종 동정을 위해 선퇴의 다각도 이미지 및 형태학적 계측 형질을 이용하여 다양한 인공지능 기법을 적용하고 성능을 검증하였다. 2021년 5월부터 8월까지 확보된 한국산 매미 6종에 대하여 딥러닝 이미지 분석을 위한 고해상도 선퇴 이미지 데이터를 축적하였고, 기계학습을 이용한 형태학적 분류를 위해 종별 계측 형질을 조사하였다. 정밀한 결과값을 위해서 필요시 Digimizer 프로그램을 활용하였다. 그 결과 말매미, 참매미, 유지매미, 소요산매미, 털매미, 애매미에 대하여 AI 분석이 가능한 수준의 선퇴 이미지 16,276장을 구축하였으며, 미동정 종 및 중국산 선퇴 이미지 38,589장을 확보하여 추가 분석을 진행중이다. 본 연구에서는 선퇴 이미지 분석을 위해 인공지능 심층 학습기술(딥러닝)을 적용하여 자동 종 분류 프로그램을 개발하였으며, tensorflow 기반 InceptionResNetV2 모델을 이용하였다. 특히 fine Tuning(파인튜닝)을 통해 결과의 정확도를 개선시켰으며 그 결과 분류학적 실체가 확인된 6종에 대해 98.6%의 정확도를 확인하였다.

검색어: 선퇴, 매미, 분류, 인공지능, 기계학습, 심층학습

P12

A new *Monoctonus* (Hymenoptera: Braconidae: Aphidiinae) species from South Korea

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The genus *Monoctonus* is a small group of 25 species worldwide, which has not been studied thoroughly less than other groups such as *Aphidius* due to its low economic importance. It has been recorded only one species in South Korea. In this study, a new species of genus *Monoctonus* is confirmed to be new to science from South Korea. Descriptions and illustrations of the new species are provided, also with their mitochondrial *cytochrome c oxidase subunit I* (*COI*) data.

Key words: DNA barcoding, parasitoid wasps, systematics, taxonomy

P13

Taxonomic review of the genus *Cosmopterix* (Lepidoptera: Cosmopterigidae) in Korea

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The genus *Cosmopterix* under the family Cosmopterigidae, which includes 135 genera of 1,792 species worldwide (Sinev 2002). In Korea, the Cosmopterigidae have been listed with a totally of 31 species of 11 genera under 4 subfamilies have been listed up to present(Yoon and Byun 2017; Sohn and Park 2018; Kim et al 2020; Sohn and Sinev 2021). The members of the genus are small sized moths(forewing length 2.9-6.9mm), with the characteristic wing shape, narrowing toward the apex. Main characters of the genus is are fancy, colorfuland shiny wings generally (Koster 2015).

This study was conducted to review the genus *Cosmopterix* in Korea with taxonomic arrangement. In this study, totally 22 species of the genus were recognized from Korea. Among them, one species, *Cosmopterix* sp. nov. is described as new to science. Also, 8 species, *Cosmopterix dulcivora*, *C. flavidella*, *C. laetificoides*, *C. microstegiella*, *C. oplismeniella*, *C. phyladelphella*, *C. scribaiella japonica* and *C. tateshinensis* are reported for the first time from Korea.

Key words: Cosmopterigidae, *cosmopterix*, new record, taxonomy, korea

P14

Characterization of *Metarhizium anisopliae* isolated from stick insect, *Ramulus irregulariterdentatus* (Phasmidae)

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Stick insects are recently considered as important forest insect pests especially broadleaf trees. In the past two years, sporadic insect pest have caused damage in various areas, especially in Gyeonggi-do and Seoul city. Currently, insect pesticide spraying is mainly used to control stick insects, and this causes damage not only to target insect pests unfortunately also to other organisms, so other alternatives are needed. In this study, entomopathogenic fungus was isolated from the cadaver of an adult *Ramulus irregulariterdentatus* supporting fungal conidiation. This fungus identified as *Metarhizium anisopilae* by microscopic examination, genetic sequencing of the ITS and EF1-α regions. This is the first characterization of *M. anisopilae* from *R. irregulariterdentatus*. We provide photo of fungal spores and colonization also genetic sequences.

Key words: stick insect, *Ramulus irregulariterdentatus,* entomopathogenic fungus, *Metarhizium anisopilae*

P15

A new species of Korean *Ectinohoplia* (Coleoptera: Scarabaeidae: Hopliini) in Jeju Island

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The genus *Ectinohoplia* Redtenbacher, 1868 was described based on *Ectinohoplia sulphuriventris*. This genus includes 46 species distributed in Palearctic region (Smetana, 2006; Prokofiev, 2015). Only one species, *E. rufipes* is known from Korean peninsula. The diagnostic characters of this genus compare to the genus *Hoplia* were not clear (Prokofiev, 2015), however they have been classically divided as following two characters; setae at inner apical angle of elytra and propygidium which is not covered by elytra. During a revisionary taxonomic study of the Korean Hopliini species. We recognized one new species, *E. jejuensis* sp. nov., in Jeju island. Descriptions, a key, illustrations of habitus and aedeagus are provided.

Key words: new species, *Ectinohoplia*, Hopliini, Scarabaeidae

P16

Morphological determination of sex in pupae of an endangered species, *Argynnis nerippe* (Lepidoptera:Nymphalidae) in Korea

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An endangered species, *Argynnis nerippe*(Lepidoptera:Nymphalidae), is distributed in some areas such as mid-northern region and western islands in Korea. Recently, the number of populations has decreased rapidly because of habitat deterioration. During the artificial rearing for the conservation of *A. nerippe,* some larvae showed significantly different developmental periods. So the mismatches of those in adult periods hamper proper mating. In order to control the mating period, it is necessary to deterimine the sex of pupa and adjust the development speed at pupal stage. Adults of this species can be identified by wing pattern, external genitalia. The gender morphological difference between male and female pupa have been not reported. Therefore, this study investigated the male and female discrimination method on pupal stage. Larvae were reared in the laboratory to collect pupae. *Viola papilionacea* leaves were provided for food. Pupae were investigated under a microscope. *Argynnis nerippe* pupae were grouped into two according to the external appearance. The feature of female pupa was in the shape of '+'. This vertical suture in the center of segment crossed the eighth abdominal segment to nineth abdominal segment. The feature of male pupa was that has small suture on segment 9 and no vertical suture on segment 8. After adult emergence, the gender were 100% consistent. The discrimination of male and female in the pupal stage can be used for research on the restoration of endangered insects with a small population. This work was supported by a grant from the Rural Development Administration(RDA, PJ015738) of the Republic of Korea.

Key words: endangered species, *Argynnis*, Lepidoptera

P17

A new record of the genus *Scaphoideus* Uhler (Hemiptera: Auchenorrhyncha: Cicadellidae: Deltocephalinae) from Korea

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The leafhopper genus *Scaphoideus* Uhler belonging to the tribe Scaphoideini (Hemiptera: Auchenorrhyncha: Cicadellidae: Deltocephalinae). The genus consists of about 190 species in the world. In this study, we report a new record of *Scaphoideus* from Korea. Redescription, photographs of the species and a key to the Korean *Scaphoideus* species are provided.

Key words: Hemiptera, Cicadellidae, *Scaphoideus*, new record, Korea

P18

The first record of two strepsipteran parasites on *Vespa velutina nigrithorax* (Hymenoptera: Vespidae), an invasive vespine species in South Korea

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Vespa velutina nigrithorax, as known as the Asian hornet, is a notorious invasive species inflicting economic damage on beekeeping industry in South Korea since its invasion in 2003. During a research on Korean Vespidae, some strepsipteran individuals were found to parasitize inside the abdomen of Asian hornet workers, which were collected from Andong city, South Korea. Using their DNA barcodes, two strepsipteran species in Xenidae were identified as *Xenos moutoni* du Buysson, 1903 and *X. oxyodontes* Nakase and Kato, 2013. This finding is the very first record of strepsipteran species on the Asian hornet outside the native range of the hornet.

Key words: Sterpsitera, Xenidae, *Xenos*, parasite, *Vespa velutina nigrithorax*

P19

Frist report of the female *Olethreutes komaii* from in Korea (Lepidoptera: Tortricidae: Olethreutinae)

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The genus *Olethreutes* is belonging to the subfamily Olethreutinae (Lepidoptera, Tortricidae). Moths of the *Olethreutes* are mostly medium--sized, approximately 232 species have been described worldwide, mostly distributed in Nearctic Regions (Gilligan *et al*., 2018), at the time of this writing 21 species of Korea have been reported.

Olethreutes komaii (Bae, 2005) was first reported by Bae (2005) from Japan. In Korea Sohn (2020) *O. komaii* (Bae) was first reported but his paper reported only male. In this study, we provide illustartion of male, female adult and genitalia of *O. komaii* (Bae) frist Korea.

Key words: Korea, Olethreutinae, *Olethreutes*

P20

A new species of the genus *Brodskyella* Horák (Coleoptera: Mordellidae: Mordellinae: Stenaliini) from Cambodia

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The genus *Brodskyella* was established by Horák (1989) and is characterized by the serration of the antenna starting with antennomere 6, the glabrous eyes, and the filiform tarsi. Hitherto only 4 species have been described in this genus and the distribution is restricted in the Oriental region (Vietnam, Nepal, India).

In this study, we report the genus, *Brodskyella* from Cambodia for the first time, and provide the description of a new species and a key to the species of this genus together with photographs of adult specimens and genitalia.

Key words: *Brodskyella*, new species, Cambodia

P21

Taxonomic notes on the Galleriinae (Lepidoptera: Pyralidae) from Korea

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The subfamily Galleriinae was established by Zeller, 1848, with type genus *Galleria* Fabricius, 1798. Galleriinae is belonging to the family Pyralidae, in the superfamily Pyraloidea. Moths of galleriine are 258 species in worldwide, including Australian and Palearctic Regions (Nuss *et al.*, 2021). In this study, illustrations of adults and genitalias are presented.

Key words: Pyraloidea, Pyralidae, Galleriinae, Korea, Taxonomy

P22

Four newly recorded species of Eucharitidae (Hymenoptera: Chalcidoidea) from Korea

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The family Eucharitidae is comparatively small group in Chalcidoidea, with approximately 500 species worldwide.. They consist of four subfamilies (Akapalinae, Eucharitinae, Gollumiellinae, Oraseminae) and are known for parasitoids of ants. In East Asia, nine species and eight species are recorded from China and Japan respectively, however only two species are known from Korea: *Eucharis esakii* Ishii, 1938 and *Silbula cyniformis* (Rossi, 1792) (Noyes, 2020). Here, we report four species from Korea for the first time. Key to Korean species of the family Eucharitidae, diagnoses and photographs of the characteristics are provided.

Key words: Ant, Parasitoids, Taxonomy

P23

A new insect pest of the web-spinning sawfly *Cephalcia lariciphila japonica* (Hymenoptera: Pamphiliidae) from South Korea

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The genus *Cephalcia* Panzer, a member of the subfamily Cephalciinae, currently includes 43 described world species. The general morphology of *Cephalcia* adults is very similar to that of *Acantholyda* Costa, but it can be easily distinguished by having only apical spur on fore tibia. The larvae feed on needles of coniferous trees like *Picea*, *Abies*, or *Larix* and live by forming webs.

Although this genus is widely distributed in the Holarctic, very little is known about the South Korean species. Here, we newly find the subspecies of *Cephalcia lariciphila japonica* Shinohara in South Korea. Their larvae attack the leaves of *Abies holophylla* that caused serious damage in the forest in Hwacheon-gun, Gangwon Province in 2020-2021. They are newly recognized as an important forest insect pest. We provide a key, diagnosis, photographs of the diagnostic characters, distribution and host plants.

Key words: Cephalciinae, conifer, needle fir, new pest, Symphyta

P24

A Preliminary Checklist of the Thyatirinae (Lepidoptera: Drepanidae) In Korea

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The subfamily Thyatirinae is a medium-sized moths with wingspan of 29-40mm belonging to the family Drepanidae (Werny, 1966; Zhao, 2004). More than, 300 species of the subfamily Thyatirinae have been described to date worldwide (Nam *et al.*, 2015). Most of them are mainly distributed in Eurasia, especially in the East Asian and Himalayan region so far as we know(Laszlo *et al.*, 2007).

In Korea, a total of 29 species of 17 genera under 3 tribes have been known from Korea to date. The aim of this study is to summarize all information and available material on this family in the Korea. The preliminary checklist of the known species is provided with all available information including the distributional ranges, bionomics, and so forth.

Key words: Drepanidae, Thyatirinae, taxonomy, checklist, Korea

P25

First record of the genus *Dentatissus* Chen, Zhang & Chang (Hemiptera: Auchenorrhyncha: Issidae) from the Korean Peninsula

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The planthopper genus *Dentatissus* (Hemiptera: Issidae) is recorded from the Korean Peninsula for the first time. Diagnosis and redescription of the newly record species of the genus are presented with photographs of its habitus and genitalia. Additionary, female genitalia and new hosts are provided for the first time.

Key words: Auchenorhyncha, *Dentatissus*, Issidae, new record, the Korean Peninsula

P26

A new species of the genus *Aprostocetus* Westwood (Hymenoptera: Chalcidoidea: Eulophidae) from Korea

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The genus *Aprostocetus* Westwood is the most diverse genus of the family Eulophidae, however only one species of the genus has been reported so far from Korea. In this presentation, we report a new species of *Aprostocetus* from Korea with its figures and description.

Key words: taxonomy, parasitoid, Tetrastichinae, the Korean Peninsula

P27

First record of *Cochylimorpha alticolana* (Lepidoptera: Tortricidae: Tortricinae) from Korea

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The family Tortricidae is a large group of 10,350 described species in the world. Among them, the genus *Cochylimorpha* Razowski contains 89 species worldwide and five species are recorded in Korea. In this study, *Cochylimorpha alticolana* Razowski (Tortricidae: Tortricinae: Cochylini) is reported for the first time from Korea. Distributions, redescription and illustrations of the specimens including the wing pattern, genitalic structures of male are provided.

Key words: Leaf roller moth, Cochylini

P28

A new species of the genus *Hylcalosia* Fischer (Hymenoptera: Braconidae: Alysiinae) from South Korea, with a key to the Korean species

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The species of the genus *Hylcalosia* Fischer, 1967 (Braconidae: Alysiinae) from South Korea are revised. One species, *Hylcalosia bicolor* sp. nov., is described as new to science. They are described and illustrated herein. An identification key to the Korean species is provided. In addition, mitochondrial *cytochrome c oxidase subunit I* (*COI*) has been sequenced of new species and *H. sutchanica*.

Key words: *COI* barcode, natural enemy, koinobiont, systematics, taxonomy

P29

A newly recorded species of *Stigmella betulicola* (Lepidoptera, Nepticulidae), leaf-miner of *Betula chinensis* (Betulaceae), from Korea

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In this study, *Stigmella betulicola* (Stainton, 1856) (Lepidoptera, Nepticulidae) was recognized for the first time from Korea. The larvae made mines on *Betula chinensis* Maxim (Betulaceae), and they were reared under the laboratory condition. Previously, *S. betulicola* has been recorded from in Japan, China, Russia, Europe, which known that the host plant *Betula platyphylla* var. *japonica*, *B. humilis*, *B. nana*, *B. pendula*, *B. pubescens*. We provide the diagnostic character, photographs of the adults, genitalia, and leaf mines of species with some biological data including new host-plant and distribution.

Key words: Nepticulidae, *Stigmella*, *Stigmella betulicola*, leaf miner

P30

The first discovery of the termite family Kalotermitidae (Blattodea: Termitoidae) in Korea

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Department of Agricultural Biology, National Institute of Agricultural Sciences

The drywood termite Kalotermitidae Froggatt, represented by *Glyptotermes nakajimai* Morimoto, is identified for the first time in Korea. They were collected in Yeoseo-do Island, the southern part of the Korean peninsula. A key to the termite species in Korea, Habitus photographs of all castes, ecological information and illustrations of diagnostic characters are provided.

Key words: Kalotermitidae, *Glyptotermes*, Termite, Korea, new record

P31

Two new and one newly recorded species of the genus *Edwardsiana* Zachvatkin (Hemiptera: Auchenorrhyncha: Cicadellidae: Typhlocybinae) from Korea

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The genus *Edwardsiana* Zachvatikin, 1929 (Hemiptera: Auchenorrhyncha: Cicadellidae: Typhlocybinae) belongs to the tribe Typhlocybini. A total of 80 species are reported in the Holarctic and Palearctic region. Most members are monophagous or narrowly oligophagous. Some species of the genus are known the important pest of crops. In Korea, four species are known to date; *E. bilirata, E. corylicola, E. indefinita*, *E. rosae*. In this study, we provide two new species and one newly recorded species of the genus *Edwardsiana* from Korea with a key to Korean species.

Key words: leafhopper, taxonomy, key, pest

P32

Producing images for developing diagnosis system about insect pests damaging fruit trees based on Artificial Intelligence (AI) technology

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농작물 해충 피해를 최소화하기 위해선 신속하고 정확한 해충 종 진단이 필요하다. 하지만, 일반 농가에서 정확한 해충 동정 및 피해증상을 바탕으로 한 해충 진단은 쉽지 않다. 현장에서도 사용할 수 있는 진단시스템의 구축의 필요성이 꾸준히 요구되고 있다. 최근 인공지능(AI) 기술이 다양한 진단분야에 활용되고 있다. 이에, 해충의 외부형태, 피해증상 등의 이미지 정보를 활용한 해충 종 진단시스템을 구축하고자, 주요 과수류 포도, 자두, 감, 사과, 배, 귤, 복숭아 7개 작물에 대해 발생하는 16종의 해충에 대하여, 알, 유충/약충, 번데기, 성충 등 다양한 태별, 정상기주, 피해기주 등에 대한 영상자료 14,000매를 생성하였다. 이들 자료는 AI 기반 해충 종 진단 시스템에 활용될 것이다.

검색어: 해충, 인공지능, 진단시스템, 과수류

P33

Producing images for developing diagnosis system about insect pests damaging vegetable crops based on artificial intelligence (AI) technology

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농작물 해충 피해를 최소화하기 위해선 신속하고 정확한 해충 종 진단이 필요하다. 하지만, 일반 농가에서 정확한 해충 동정 및 피해증상을 바탕으로 한 해충 진단은 쉽지 않다. 현장에서도 사용할 수 있는 진단시스템의 구축의 필요성이 꾸준히 요구되고 있다. 최근 인공지능(AI) 기술이 다양한 진단분야에 활용되고 있어 해충의 외부형태, 피해증상 등의 이미지 정보를 활용한 해충 종 진단시스템을 구축하고 자, 주요 채소류인 배추, 무, 오이, 토마토, 호박, 딸기, 생강, 파 8개 작물에 대해 발생하는 18종의 해충에 대하여, 알, 유충/약충, 번데기, 성충 등 다양한 태별, 정상기주, 피해기주 등에 대한 영상정보 데이터 셋 18,000매를 생성하였다. 이들 영상정보 데이터 셋은 AI 기반 해충 종 진단 시스템에 활용될 것이다.

검색어: 채소류, 해충, 인공지능, 진단시스템

P34

New species of the genus *Stratiolaelaps* Berlese, 1916 (Acari: Laelapidae) with a key to the unregistered species in Korea

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Genus *Stratiolaelaps* is one of the most frequently tested biocontrol agents in horticulture environments and also can get this mite through pest control companies. In Korea, none of the *Stratiolaelaps* species are recorded naturally, while we can access easily to them. Herein we provide descriptions of a newly discovered mite *Stratiolaelaps* sp. nov. and short explanations about other species of mites that can be observed in Korea.

Key words: New record, Laelapidae, *Stratiolaelaps* sp. nov., Biocontrol agents, Acari, Taxonomy

P35

Analysis of thrips occurrence patterns and dominant species in horticultural crops in Gangwon province

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총채벌레는 토마토, 파프리카, 고추 등 주요 원예작물에 토마토반점위조바이러스(*Tomato Spotted Wilt Virus*) 감염이나, 과실기형을 유발하는 대표적인 바이러스 매개충이다. 이러한 총채벌레를 방제하기 위해서는 트랩 예찰을 통해 초기 발생 시 살충제를 살포하는 것이 가장 효과적인 방법이다. 하지만 총채벌레 종류에 따라서 처리하는 살충제 성분에 대한 약제 저항성이 각각 다르게 나타나기 때문에 재배작물에 발생하는 총채벌레 종이 무엇인지 파악하는 것이 매우 중요하다. 따라서 지역별 총채벌레 발생양상과 우점종 동정을 통한 효과적인 방제전략을 수립하기 위해 본 연구를 수행하였다. 발생양상을 분석하기 위해 도내 토마토, 파프리카 주요 재배지역인 춘천, 횡성 등 4시군 26지점을 선정하여 트랩예찰을 통한 발생밀도를 분석하였다. 지역별로는 평창에서 7월에 가장 많은 밀도를 보였는데 조사지점으로 선정한 일부 농가가 고령으로 인해 하우스 측장 방축망 및 이병주 제거가 제대로 이루어지지 않은 상태에서 기온이 올라가 총채벌레 발생이 증가하여 다른 지역에 비해 평균 발생 밀도가 높아진 것으로 판단된다. 지역별 우점종 분석으로는 춘천 토마토, 평창 파프리카 하우스에 발생한 총채벌레를 채집하여 종별 특이 프라이머를 활용한 PCR분석 결과 춘천은 대만총채벌레, 평창은 꽃노랑총채벌레가 우점종인 것으로 분석되었다.

검색어: 총채벌레, 토마토반점위조바이러스, 약제 저항성, 우점종, 대만총채벌레, 꽃노랑총채벌레

P36

A preliminary study of *COI* DNA barcoding of cyclostome braconids (Hymenoptera: Ichneumonoidea: Braconidae): part II

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The braconids consist of the second largest family in the order Hymenoptera, members of Braconidae are seperated two group based on mouth part morphology: cyclostome group characterized by mouth part concave clypeus while non-cyclostome group by mouth part clypeus convex. Some braconid species of the cyclostome group are commercially used for biological control because they parasitize various insect pests such as flies and aphids. Nevertheless, cyclostome group has been not thoroughly explored because of indentification difficulties and low taxonomic sampling.

In this study, phylogenetic relationships were analyzed through *cyctochrome oxidase c subunit I* (*COI*) DNA barcodes of opiinae, alysiinae, aphidinae and other subfamilies that were mainly studied in the laboratory among the cyclostome groups.

Key words: cyclostome complex, Bootstrap analysis, alysioid subcomplex, paraphyletic

P37

Genetic composition of the fall armyworm, *Spodoptera frugiperda* (Smith), in South Korea

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The fall armyworm, *Spodoptera frugiperda* (Smith), originated from tropical or subtropical America is one of sporadic agricultural pests worldwide. In South Korea, the moth were first found, damaging corn leaves at Jeju Island, in early June 2019. In 2021, the moth was first found by pheromone traps at corn fields of Jeju in late April, and subsequently found in mainland of South Korea. The migratory populations of *S. frugiperda* in Korea were genetically confirmed using mtDNA cytochrome oxidase subunit I (*COI*) and triosephosphate isomerase (*Tpi*) genes. The *COI* gene analysis for larval or adult samples collected nationwide shows that *COI* clades in South Korea composes of two groups, COI-A in major and COI-B in minor. The proportion of COI-B in 2021 has increased from about 5% to above 20% compared to that in 2020. *Tpi* gene analysis shows that all samples belong to subpopulation of “corn strain” as in 2020.

Key words: *Spodoptera frugiperda*, genetic composition, migration, Korea

P38

COI-haplotype composition of the oriental fruit fly, *Bactrocera dorsalis* (Diptera: Tephritidae), in Taiwan

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오리엔탈과실파리(*Bactrocera dorsalis*)는 동남아시아 원산의 과실파리과 해충으로서 최근 세계적인 확산과 과수류에 대한 심각한 피해로 인해 농작물의 가장 중요한 해충의 하나이다. 또한 매우 넓은 기주범위와 높은 생식력 및 이동능력으로 인해 각국에서 중요한 검역해충으로 다루어지고 있다. 본 연구에서는 대만에서 오리엔탈과실파리의 미토콘드리아 COI 유전자의 haplotype 다양성을 분석하였다. 2018년 8월부터 9월까지 대만의 15개 지점(서부 10, 동부 5)에서 메틸유제놀 유인제를 이용한 유인트랩으로 채집한 총 403개체로부터 미토콘드리아 COI 유전자의 부분 염기서열(561bp)을 확보하고 GenBank와 BOLD에 등록된 염기서열과 비교하였다. 대만에서 확인된 COI-haplotype은 총 201개였으며, 서부지역에서 가장 많은 haplotype이 확인되었다(60.2%). 서부와 동부에 공통적으로 발견되는 haplotype은 23개(12.4%)로 매우 적어서 동부와 서부의 지역간 차이가 뚜렷하였다.

검색어: 오리엔탈과실파리, 유전적 구성, COI-haplotype, 대만

P39

Review of Subamily Amphicrossinae Kirejtshuk, 1986 (Coleoptera: Cucujoidea) in Korea with descriptions of immature stage

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The subfamily Amphicrossinae Kirejtshuk, 1986 is reviewed as 3 species in 1 genus from Korea. One species (*Amphicrossus hisamatsui* Jelinek, 1993) is recorded for the first time in Korea. A key to species is provided, with the description of adults and larval stage of genus *Amphicrossus*. Biological information, and illustrations of Korean Amphicrossinae are also provided.

Key words: Cucujoidea, Nitidulidae, Amphicrossinae, *Amphicrossus*, new record

P40

A new species of *Stomaphis* (Hemiptera: Aphididae) from Korea

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A new aphid species of the genus *Stomaphis* Walker, 1870 (Hemiptera: Aphididae: Lachninae) is described with the illustrations of the apterous and alate viviparous female. The brief biology in the host plant and the key to species of *Stomaphis* in Korea also provided.

Key words: Aphids, *Castanea*, new taxa, Korean Peninsula

P41

Distribution of *Anopheles* mosquitoes near the Demilitarized Zone in Korea, 2020

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한국에서는 매년 300건이 넘는 말라리아 환자가 보고되고 있고, 이 중 60% 이상은 비무장지대(DMZ) 인근의 강원도와 경기도에서 발생하였다. 말라리아는 *Anopheles*(얼룩날개모기) 속 암컷 모기가 흡혈하는 과정에서 인간에게 전파되는데, 한국에는 총 8종의 *Anopheles* 속 모기가 보고되어있다. 본 연구는 DMZ 인근의 6곳에서 Mosquito Magnets® 및 New Jersy light trap을 이용하여 2020년 5월에서 11월까지 채집한 *Anopheles* 속 모기를 분자적 방법을 통해 동정하여 종 다양성을 비교하였다. 조사 결과 총 1,901마리의 *Anopheles* 모기가 채집되었으며, *An. pullus*(32.2%), *An. kleini*(27.0%), *An. sineroides*(20.5%), *An. sinensis*(12.6%), 기타(7.7%) 순으로 채집되었다. 5월부터 채집량이 점차 증가하여 6월에 가장 많은 개체가 채집되었으며 이후 감소하다가, 9월에 다시 증가하고 급격히 감소하는 양상을 보였다. 월별 종 분포를 비교해보았을 때, 5월에는 *An. pullus*와 *An. sineroides*가 전체의 81.5%를 차지하며 가장 많았지만, 이후 점차 감소하였다. 6월부터는 *An. kleini*의 비율이 증가하였으며 7월에 가장 많이 채집되었고, 이후 급격히 감소하는 양상을 보였다. *An. sinensis*는 8월에 전체의 41.2%로 가장 많았으며, 이내 감소하였다. *An. lindesayi*와 *An. lesteri*는 전체적인 채집량은 다른 종에 비해 적었지만, 각각 10월, 11월에 전체의 32.9%, 45%를 차지하며 가장 많이 채집되었다. 본 연구 결과 각 종의 발생시기가 다양하게 나타났고, 매개모기의 종에 따라 말라리아 매개 능력 또한 다르다고 알려진 만큼, 이들에 대한 지속적인 감시 및 분포 양상에 대한 모니터링이 요구된다. 더 나아가 말라리아 병원체 조사도 함께 수행해나가는 것이 필요해 보인다.

검색어: 말라리아, *Anopheles* mosquitoes, DMZ, Mosquito Magnets®, New Jersy light trap, multiplex PCR

P42

Animal fauna of Island and Coastal areas in Korean peninsula

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섬과 연안은 생태계가 잘 보존되어 있고, 보전 가치가 높은 생물자원이 풍부하며 희귀생물 및 신종·미기록 생물자원이 지속적으로 보고되고 있다. 그러나 섬과 연안 동물상 조사의 경우, 일부 지역 소수 분류군만이 수행되어 종합적인 동물상 조사 및 표본정보가 부족한 실정이다. 본 연구는 동물자원 대상 분류군별(곤충 · 척추동물 · 무척추동물) 섬 동물자원에 특화된 중점 조사와 신종 · 미기록종 발굴, 확증표본 확보, 분류정보 파악 등 생물다양성 연구 기반자료 구축을 목적으로 수행되었다. 본 연구 결과는 국가 생물주권 강화와 생물다양성 인식 재고 및 생물다양성의 주류화에 기여 할 수 있을 것으로 판단된다.

검색어: 동물자원조사, 동물표본, 분류 연구, 섬과 연안, 자생생물

P43

A platform service for Science Museum Exhibition (SMEP)

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본 연구를 통해 SMEP(Science Museum Exhibition Platform)을 구축하여 국내 과학관의 전시 콘텐츠 관리 및 정보 공유 서비스를 제공기반을 마련하였다. 본 플랫폼은 과학관 실무자 및 일반인용 2가지 버전으로 구축되었으며 관리자용 페이지에서는 국내 과학관의 전시물을 등록하고 기관별로 전시물을 공유와 대여 및 분양기능이 가능하도록 하였다. 더불어, 국민들에게 전시물의 사진, 정보 및 유튜브 사이언스플랫폼 서비스를 제공함으로써 비대면 관람도 가능하기 때문에 대국민 서비스로도 연결이 가능하다. 금번 연구에서는 통계 기능을 추가하여 전시콘텐츠별 조회 수, 방문자 수 등 서비스 되고 있는 메뉴 중 가장 많이 활용되고 있는 기능을 구현하였다. 따라서 SMEP 서비스 페이지는 실무자가 전시물을 통일된 분류체계에 맞추어 전시 콘텐츠를 분류하고 정보를 등록하여 관리가 가능하기 때문에 소규모로 운영되고 있는 과학관 및 박물관 또는 통일된 관리 체계가 필요한 실무자에게 용이할 것으로 기대된다. 또한, COVID-19로 인해 대면관람이 어려워지고 있는 상황에서 비대면으로 관람할 수 있는 온라인 과학관으로의 가능성도 갖추고 있어 앞으로의 활용도가 높아질 것으로 사료된다.

검색어: SMEP, 전시 콘텐츠, 과학관, 박물관, 분양, 대여, 공유, 플랫폼, 방구석과학관

P44

Preliminary reports of DNA extration method and COI sequences for Chigger mite

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털진드기(chigger mite)는 급성 열성 질환인 쯔쯔가무시증(Tsutsugamushi)의 매개체로 국내에서 매년 4,000명 이상의 환자를 감염시킨다. 이러한 숙주, 병원체, 매개체 간의 상호작용을 고찰하기 위해선 세 가지의 유전체 정보가 모두 필요하지만, 털진드기의 경우 병원체 유무에만 집중되고 있을 뿐만 아니라 크기가 상당히 작고 현재까지 알려진 종 동정 방법인 외형 동정 이후에는 DNA 추출이 어려운 관계로 인해 유전체 정보는 알려진 종 수에 비해 현저히 적다. 이에 분자데이터 확보를 위한 DNA 추출 이후 외형 동정이 가능할 수 있는 방법 적용과 더불어 털진드기의 분자적 종 동정을 위해 본 연구를 실시하였다. 이를 통해서 GenBank에 등록되지 않은 털진드기 3종(*Leptotrombidium orientale, Neotrombicula gardellai, Eushoengastia koreaensis*)의 부분적 COI(cytochrome c oxidase subunit I) 서열을 획득하였다. 따라서 본 연구를 토대로 털진드기 DNA 추출 및 한국의 털진드기 종별 COI 정보를 활용하여 분자적 종 동정도 동시에 가능할 수 있을 것으로 생각된다.

검색어: Chigger mite, Tsutsugamushi, DNA extration, COI

P45

Taxonomic review of the genus *Pemphigus* Harting, 1839 (Hemiptera: Aphididnae: Eriosomatinae) in Korea Peninsula

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The genus *Pemphigus* Harting, 1839 is belonging to the subfamily Eriosomatinae (Hemiptera: Aphididae) including 72 species in the world. The genus is widely distributed in the Holarctic region. Most of the species in this genus form variously shaped galls on the primary host of *Populus* species. Until now, there are few studies about the genus on the morphological taxonomy in Korea. Up to date, three species of the genus have been recorded from Korea. In this study, a total of four species of the genus is revised. Among them, one species *Pemphigus populitransversus* Riley, 1879 was recognized for the first time in Korea. We provide a key to the Korean species and redesctiptions in detail.

Key words: Eriosomatinae, gall-forming aphid, *Pemphigus*, Korea

P46

A new species of genus *Nomada* Scopoli, 1770 (Hymenoptera, Apidae) from Korea

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The genus *Nomada* belong to the tribe Nomadini of Subfamily Nomadinae (Hymenoptera: Apidae), the only genus in the tribe. The species group revision of this genus was conducted by Alexander (1994), who divided the genus into 16 species group. So far, 39 species which belong to the 8 species group have been recorded in Korea. Here we present one new species, belonging to the *superba* species group with the description and illustrations.

Key words: Hymenoptera, Apidae, *Nomada*, new species, taxonomy

P47

Phylogenetic study of the family Tomoceridae (Collembola) in Korea Based on *COI* gene

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A phylogenetic analysis of Tomoceridae was performed based on morphological and molecular characters in order to classify them into lower taxonomic categories and to establish a robust generic concept. Total 42 sequences of the partial *COI* gene from 16 species of Tomoceridae species were used in this study. We confirmed that the genus *Plutomurus* Yosii were only weakly supported as a monophyletic group; three species, *P. jangamensis* Chang & Park, *P. gul* Yosii, and *Plutomurus* sp., were superficially similar and not able to be distinguished by external morphological characters, but they were separated by molecular characters (*COI*). All three species were each strongly supported as a single lineage using *COI* on both neighbor-joining and maximum-likelihood trees. Interspecific genetic divergence of *COI* using uncorrected *p*-distance ranged from 9.9% to 27.3%, while intraspecific divergence ranged from 0.0% to 7.2% among Tomoceridae species. Among them, the intraspecific genetic divegence of *Aphaenomurus* sp. (16.8%) was relatively higher than others.

Key words: Tomoceridae, *Plutomurus*, monophyletic group, genetic divergence

P48

Skin beetles (Coleoptera: Dermestidae) investigated on the egg masses of Asian gypsy moth, *Lymantria dispar* in Korea

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Sunchon National University

The Asian gypsy moth (AGM), *Lymantria dispar asiatica* Vnukovskij is a serious quarantine pest which is not present in North America. Since 1992, the North American Plant Protection Organization (NAPPO) has established regulatory inspection and certification requirements for vessels that have visited ports where the AGM is present in the Russian Federation, Japan, South Korea and China. The skin beetles are parasitic on the egg masses of asian gypsy moth. Asian gypsy moth egg masses were collected on the branches, bark cracks of pine trees and exterior walls of buildings from Gyeonggi-do, Gangwon-do, and Gyeongsangbuk-do in 2021. As a result, the genera associated with the asian gypsy moth were identified as *Anthrenus*, *Dermestes*, *Megatoma*, and *Trogoderma*. Photographs of habitus and larvae, and diagnosis are provided in this study.

Key words: Dermestidae, *Lymantria dispar*, egg mass, predator, Korea

P49

Pictorial key to genus *Tribolium* (Coleoptera: Tenebrionidae) with larval characters

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The members of the genus *Tribolium* Macleay (Coleoptera: Tenebrionidae) are important as the stored product insect pests worldwide. They are usually founded in rice processing complex (RPC), grain storages and imported grains. The morphological characteristics of adult are good used for their identification, but those of larva are less known. We are provided a pictorial key for more accurate identification with specific-level using the larval characters for five species of *Tribolium* which are four Korean species and a plant quarantine pest.

Key words: *Tribolium*, Tenebrionidae, larval character, pictorial key

P50

Population genetic divergence and relationships of *Lymantria dispar* (Lepidoptera: Erebidae) in South Korea using mitochondrial DNA sequences

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In 2020, the gypsy moth, *Lymantria dispar* Linnaeus (Lepidoptera: Erebidae) outbreaks occurred in South Korea, inducing severe damage to Gangwon-do (1,638ha) and Gyeonggi-do (1,134ha). In this study, we investigated the genetic diversity and their relationships of *L. dispar* 10 populations in South Korea using COI sequences. The 10 populations as a result of analyzing the COI sequencers for 230 individuals, a total of 32 haplotypes were identified. The genetic divergence between haplotypes ranged from 0.065% to 0.458%. In the F_{ST} results between populations to compare genetic isolation, it was confirmed that there was a genetic exchange in Gunpo and Danyang and all other groups derived positive values to confirm that they were genetically isolated. In addition, AMOVA analysis, diversity, structural analysis, and PCoA analysis were performed to confirm the relationships between the gypsy moth populations.

Key words: *Lymantria dispar*, Population genetic analysis, Mitochondrial DNA, COI

P51

Taxonomy, diversity, biogeography and host plant patterns of jumping plant-lice (Hemiptera: Psylloidea) of Korean Peninsula

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A particular problem of East Asian psyllid taxonomy is that the faunas of China, Japan, Korea and Russia have been studied independently from each other with insufficient reference to other faunas. Another problem is the inadequacy of some species descriptions often based on insufficient material and without host data. An updated taxonomy of jumping plant-lice from the Korean Peninsula is provided with information on distribution within the Peninsula and host plants based on published records and our own extensive field surveys. Diversity, biogeography and host plant patterns of Korean psyllids are analysed and provided within a Far Eastern context.

Key words: Psylloidea, jumping plant-lice, Korea, taxonomy, host plant, biogeography

P52

Rapid classification of three species of *Solenopsis; S.invicta*, *S.geminata* and *S.japonica* by CAPS marker based on a single nucleotide polymorphism(SNP)

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The red imported fire ant, *Solenopsis invicta*, is one of the worst invasive alien species in the world. The agricultural impacts of the Red Imported Fire Ant, *Solenopsis* invicta Buren 1972, have been well studied in North America, and has been documented in Korea where the specis was first detected in the 2017. Early detection is an important strategy to prevent *S.invicta* expansion. However non-experts cannot easily identify *S.invicta*, *S.germinata* and *S.japonica* because of similar morphological characteristics. We developed CAPS markers designed using the key sites in ND4 gene. We analyzed the SNP sites and found a suitable restriction endonuclease, Psil-v2, to be suitable for the development of the CAPS marker. Among the three species of *Solenopsis*(*S.invicta, S.geminata and S.japonica*), Only the amplicon from the *S.invicta* produced 310bp upon digestion with Psil-v2. The target sequence pattern of *S.japonica* has different from *S.invicta* and *S.geminata*. Developed Cleaved Amplified Polymorphic Sequences (CAPS) marker confirmed genotype of *Solenopsis* genus(*S.invicta*, *S.germinata* and *S.japonica*) successfully in a few hours. The method using developed CAPS marker is simple, quick, and reliable for idnentifying the best species for efficient three species of *Solenopsis*.

Key words: red imported fire ant, *Solenopsis*, CAPS marker, single nucleotide polymorphism

P53

Two new species and a new record of the genus *Meganola* Dyar, 1898 (Lepidoptera, Nolidae, Nolinae) from Laos

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This research contains the description of two new *Meganola* Dyar, 1898 species (*M. canaliculata* Cha & Bae sp. n. and *M. phuana* Cha & Bae sp. n.) and a new record of *M. tetrodon* (de Joannis, 1928) from Laos. Colour figures of adults and genitalia of the examined species are provided.

Key words: Noctuoidea, *strigivena* species-group, *flexuosa* species-group, taxonomy, Oriental Region

P54

Development of markers using microsatellite loci of *Paederus fuscipes* Curtis and *Aleochara* (*Aleochara*) *curtula* Goeze (Coleoptera: Staphylinidae), with analyses of genetic diversity and population structure

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The family Staphylinidae is a speciose beetle group in the world. Outbreaks of two staphylinid species, *Paederus fuscipes* and *Aleochara* (*Aleochara*) *curtula*, have been recently reported in South Korea. These two species are important predators or parasitoids for controlling agricultural/hygienic pests. With increases of their abundancesr, some cases of human damage have been reported. Despite their ecological importance and recent issues, genetic differences among populations of these two species are poorly known. Microsatellite loci are tandemly repeated sequences scattered in the genome. Because of their length polymorphisms, they can used as markers for monitoring genetic variations in a population. In this study, we developed microsatellite markers based on genome sequences obtained by Next-Generation sequencing. Genetic diversity and population structure were evaluated using polymorphisms of developed markers. Our results can be used to quickly monitor species with drastically increased abundance.

Key words: *Aleochara* (*Aleochara*) *curtula*, microsatellite, Next-Generation sequencing, *Paederus fuscipes*, SSR

P55

A new record of *Areotetes* van Achterberg & Li (Hymenoptera: Braconidae: Opiinae) from South Korea

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The small genus *Areotetes* van Achterberg & Li, 2013 (Hymenoptera: Braconidae: Opiinae) has been reported for the first time in China, of which members are koinobiont endoparasitoids of leaf-mining and fruit-infesting dipteran larvae (Yu et al., 2016). There are four species of this genus in Hunan, Fujian, China. The genus *Areotetes* is recognized for the first time from South Korea by reporting *Areotetes carinuliferus* Li et al., 2013. In this study, diagnosis, description, distribution and diagnostic illustration are provided.

Key words: Ichneumonoidea, identification, natural enemy, parasitoid wasp, taxonomy

P56

Screening of entomopathogenic fungi infected with mycoviruses

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Mycoviruses are a special group of viruses that infect filamentous fungi. Most mycoviruses cause crytic infections or hypovirulence, but some can confer hypervirulence which is characterized by conidiation and growth. Studies on mycoviruses that can cause hypervirulence of entomopathogenic fungus *Beauveia bassiana* have been reported abroad, however in our knowledge, there is no study in Korea. In this study, a mycovirus isolation method was established to find virus-infected fungal isolates and significant infection patterns were confirmed in several fungal isolates using this method.

Key words: mycoviruses, dsRNA, cellulos, *Beauveria bassiana*

P57

Two new species of the genus *Longileptoneta* & *Falcileptoneta* (Araneae: Leptonetidae) from Korea

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Leptonetidae Simon, 1890 are tiny (1-3mm) spiders that live in moist habitats such as caves, rotted logs, and leaf litters. Especially, the genus *Longileptoneta* was firstly described by Seo (2015) from Korea and so far, 14 species are recorded in Korea and eastern part of China. The species of *Falcileptoneta* were firstly described by Seo (2015), that were translated from several *Leptoneta* species with many new additional species. In this study, each one new species of the genus *Longileptoneta* Seo, 2015 and *Falcileptoneta* Komatsu, 1970 are described from Korea. The new species were collected from Mt. Amisan (Dangjin-si) and Namsan park (Goseong-gun), respectively. Description of two new species are provided with diagnoses and microscopic photographs.

Key words: Leptonetidae, *Longileptoneta, Falcileptoneta*, new species, morphology, taxonomy

P58

A new record of the genus *Cerapteroceroides* (Hymenoptera: Chalcidoidea: Encyrtidae) from Korea

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The genus *Cerapteroceroides* contains 12 valid species in the world. Its members are known as hyperparasitoids of Diaspididae and Pseudococcidae via other encyrtids or aphelinids. They are distributed in the Palaearctic and Oriental region. In the eastern Asia, there are six species in China, three species in Japan and two species in Russia, but no species has been reported from Korea yet. In this work, the genus *Cerapteroceroides* is reported from Korea with one new record. The diagnosis, photographs of the species are presented.

Key words: Calcidoidea, *Cerapteroceroides*, Encyrtidae, Encyrtinae, Hyperparasitoids

P59

Effect of *Bursaphelenchus mucronatus* on pathogenicity of *Bursaphelenchus xylophilus*

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지난 2017년 연구에서 *Bursaphelenchus xylophilus*(Bx)와 *Bursaphelenchus mucronatus*(Bm) 2종을 소나무에 접종할 경우 Bx 단독 접종 보다 두 선충(Bm+Bx)을 섞어서 접종할 때 병원성이 늦게 발현되는 특이점이 발견되었다. 2019년 7월에 5년생 곰솔(*Pinus thunbergii*)과 잣나무(*Pinus koraiensis*)에 Bm을 선 접종하고, 2주 뒤 Bx를 후 접종처리(Bm+Bx) 하였다. 9주 동안 매주 증상을 관찰한 결과. 'Bm+2주 뒤 Bx접종', 'Bm+Bx 동시접종' 처리구 모두 병 진행 속도가 곰솔이 잣나무보다 빠르게 나타났고, 소나무재선충병 감수성이 높은 곰솔에서 병의 지연 효과가 매우 뚜렷하게 나타났다. 선충의 밀도는 Bx와 Bm 두 종 모두 약 3:1 비율로 Bx가 우세하였으나, 갓 죽은 기주에서는 Bx가 절대적으로 우세하게 나타났다. 또한, 고사 된 시간이 길어질수록 Bx의 밀도는 낮아지고 상대적으로 Bm의 밀도가 높아지는 경향을 보였다.

검색어: *Bursaphelnchus xylophilus, Bursaphelenchus mucronatus,* Pathogenecity

P60

A low-temperature condition affects emamectin benzoate resistance-associated traits in *Frankliniella occidentalis*

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Western flower thrips, *Frankliniella occidentalis*, is a major agricultural pest damaging various crops and has developed high levels of resistance to almost all groups of insecticides including emamectin benzoate (EB). In this study, EB-resistant *F. occidentalis* population (EBR) was maintained under normal (28°C, EBRH) or gradually lowering temperature (28°C to 15°C, EBRL) without EB selection pressure. For 5 generations, the resistance allele frequencies and expression levels of the genes possibly involved in EB resistance were traced. The frequencies of V211E and A241T resistance mutation on glutamate-gated chloride channel (*glucl*) estimated by quantitative sequencing were reduced only in EBRL to 95% and 91%, respectively. In addition, the transcription levels of *cyp4c1* and *cyp6a14* were significantly lower in EBRL population. These results suggest that the EB resistance is likely to carry fitness costs, which negatively affects the maintenance of the resistance-associated traits in low-temperature condition.

Key words: western flower thrips, insecticide resistance, emamectin benzoate, GluCl

P61

Expression of the *pyrokinin* and *capa* genes and immunocytochemistry in the western flower thrips, *Franklinella occidentalis*

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In this study, using reverse transcriptase (RT)-PCR and qPCR, we determined the expressions of *pk* and *capa* genes at the developmental stages, adults, and the adult tissues (head, thorax, abdomen) in the western flower thrips, *Frankliniella occidentalis*. PRXamide-like immunoreactivity recognizes both pk- and capa-derived peptides, is localized to cells in the central nervous system (CNS) of the adult. During the developmental stages, the *pk* and *capa* genes were more expressed in males than females, and the *capa* gene was not expressed in eggs. In the tissues, the *pk* gene was expressed in the head, not in the abdomen. On the other hand, the *capa* gene was expressed in all the tissues, more in the head and less in the abdomen. In immunocytochemistry, CAPA peptide was shown in all the tissues. Immunoreactivities with PRXamide were observed with at least four neurosecretory cells in the brain, and a pair of immunoreactive neurons in the pro-, meso- and meta- thorax, respectively. Surprisingly, seven pairs of the immunoreactive neurons were recognized in the abdominal ganglia, which is the first report in insects.

Key words: western flower thrips, *Frankliniella occidentalis*, PK, CAPA, gene expression, immunocytochemistry

P62

Head capsule width, body weight and length measurement for instar determination in *Osmia cornifrons* larva

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We collected and carried out to examine potential correlations of instar and larval stage of *Osmia spp* larvae. The head width of larval instar from the 1st to the 5th instar was ranged from 0.4 ± 0.1 mm to 1.3 ± 0.3 mm, and growth rate of each instar was significantly high between the 1st and the 2nd instar. The fitness regression model for the head capsule width was analyzed. The head capsule width plotted against the number of instars, the calculated regression line was $y=0.146x+0.551$, $R^2=0.838$. The body weight of larvae increased with larval developmental stages, and the coefficient of variation of larval weight was apparently high. However, the calculated regression line was $y=5.122x^2-12.154x+11.444$, $R^2=0.900$. The growth ratio of the larval length was clearly high between the 3rd and 4th instars, and that of larvae from the 5th instar was decreased. The calculated regression line is $y=2.595x+0.472$, $R^2=0.920$. Its result is suggested that measurement of head capsule width, weight and length may be useful as a method of determining larval instar.

Key words: Mason bee, *O. cornifrons*, larval development, head width, weight, length, instar

P63

Burkholderia gut symbiont regulates *Kr-h1* and *BR-C* expression in the bean bug, *Riptortus pedestris*

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Recent studies in the *Riptortus-Burkholderia* symbiosis model have shown that gut symbionts regulate the development, fitness and reproduction of host insect by stimulating hemolymph proteins through the juvenile hormone signal pathway. However, since the nucleotide sequences of the JH- transcriptional factors, *Kr-h1* and *BR-C* genes, are unknown, in this study, we characterized molecular and biological function of *Kr-h1* and *BR-C* genes and investigated gene expression patterns under a symbiotic relationship. The *Kr-h1* gene showed a high expression level in female adult insects with symbiotic bacteria, and the *hexamerin* genes, downstream molecule, also showed the same expression pattern. As a result, it was found that the production of *Riptortus* hexamerin-α and vitellogenin proteins in the hemolymph increased and affected the reproduction of female host.

Key words: symbiosis, *Kr-h1*, *BR-C*, *Riptortus pedestris, Burkholderia insecticola*

P64

Study on optimal temperature conditions for indoor honeybee pesticide toxicity evaluation

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The most basic method for assessing acute pesticide toxicity to honeybees is the indoor bioassay. Most bioassays involving worker bees gather newly emerged adults from the colony and keep them in incubators for conditioning before use, but isolating individual bees from a colony produces significant stress in social honeybees, which likely affects toxic reaction. However, no defined condition for reducing incubation stress is currently available. The purpose of this study was to establish the ideal incubation temperature for toxicity evaluation by evaluating incubation settings that were most similar to the natural environment inside the hive. After dividing newly emerged nurses into four groups, one group was kept inside the hive, while the other three were incubated at different temperatures (25°C, 30°C, and 35°C) for a week. The toxicity of three insecticides (coumaphos, fluvalinate, and imidacloprid) was determined and compared among groups, as well as the average body weight and gene expression patterns involved in key stress and detoxification physiologies. All characteristics studied, including the toxicity of test pesticides, were altered by different incubation conditions. The incubation temperature of 30°C was most similar to the natural hive state, implying that 30°C is the best incubation temperature to preserve normal honeybee physiology and ensure intrinsic toxic reaction.

Key words: honey bee, temperature, toxicology, pesticide, indoor bioassay, toxicity evaluation

P65

Molecular characterization of two 5-hydroxytryptamine receptors, 5-HT7A & 5-HT7B, in the Asian tiger mosquito, *Aedes albopictus*

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In mosquitoes, serotonergic axons innervated the proximal region of lateral lobe of salivary glands. Depletion of serotonin inhibited salivary secretion and blood feeding of Aedes mosquitoes. However, no studies have been examined the physiological mechanism of 5-hydroxytryptamine (5-HT, serotonin) receptor in mosquito salivary glands. In this study, two 5-HT receptors were characterized by identifying gene structure and profiling temporal expression. The full length of 5-HT7A and 5-HT7B was 1395bp and 1431bp, which encode 465 and 477 amino acid residues, respectively. The identity of nucleotide and amino acid sequence between 5-HT7A and 5-HT7B was 65.8% and 60.8%, respectively. Phylogenetic analysis revealed that 5-HT7A and 5-HT7B of *Aedes albopictus* were grouped with 5-HT7Rs of other insects. Both serotonin receptors were differently expressed depending on the developmental stages and sexes. The understanding of physiological mechanism of 5-HT7A and 5-HT7B in mosquito salivary secretion might provide an insight for the development of novel method controlling mosquito-borne disease and mosquito population.

Key words: *Aedes albopictus*, salivation, 5-hydroxytryptamine receptor

P66

Effect of temperature on developmental period of the small brown plant hopper, *Laodelphax striatellus*

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Over the last 40 years, the average temperature and precipitation have increased by about 1.4℃ and 17%, respectively. Such climate changes accelerated migration of the small brown grasshopper (SBPH, *Laodelphax striatellus*) from China and increased the rate of rice plants infected by rice stripe virus (RSV) in the west coast of Korea including Seocheon, Buan, Jindo, and Haenam. In this study, developmental period of time was examined to access the effect of temperature on the life cycle of *L. striatellus*. SBPH were reared at three difference temperatures: 24, 27 and 30℃. At 30℃, *L. striatellus* finished their development in 18 days, which was 3 days shorter than those reared at 24 or 27℃. In addition, SBPH were monthly collected from the west coast of Korea to estimate the time and region of migration. Population genetics study using molecular marker (mtCOI) identified the genetic variation between populations. Taken together, SBPH spent less time to finish their development as the temperature increases and the time and region of migration of *L. striatellus* were estimated by monthly monitoring and population genetic studies.

Key words: *Laodelphax striatellus*, climate change, life cycle, population genetics

P67

Validation of quantitative real-time PCR reference genes for gene expression study in different development stages of honeybee, *Apis mellifera*

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The Western honeybee, *Apis mellifera*, is one of the most important model organisms for understanding insect sociality. Quantification of gene expression is essential to identify genes putatively involved in physiological changes depending on the developmental stages of honeybee. In order to normalize the expression level of gene of interest, appropriate reference genes stably transcribed in different developmental stages must be selected. In this study, the amplification efficiencies of five candidate reference genes (*RPS5*, *RPS18*, *GAPDH*, *ARF1*, and *RAD1a*) were measured, and their expression stabilities in developmental stages (egg, instar^{1st}, instar^{3rd}, instar^{5th}, pupa, nurse, and forager) were evaluated with three programs (geNorm, NormFinder, and BestKeeper). Although three programs showed slightly different results, *ARF1* and *RAD1a* were generally proposed to be the most stable reference genes for gene expression study in different developmental stages in honeybee.

Acknowledgement: This study was supported by research fund (PJ015778) from Rural Development Administration.

Key words: Honeybee, development stage, qRT-PCR, reference gene

P68

Epidemiological investigation for the differentialis grasshopper, *Melanoplus differentialis*, via population genetic analysis using DNA barcode

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The differentialis grasshopper, *Melanoplus differentialis,* is one of major devastating insect pests damaging most crops including corn and wheat throughout the United States. They feed on not only various crops of farmland but urban landscape plants. Animal and Plant Quarantine Agency (APQA) in Korea had firstly identified *M. differentialis* from a ship at Onsan port in Ulsan in 2018. The spread of *M. differentialis* in Korea might lead significant damages in economy and ecology of agricultural areas and request a lot of effort for control. In this study, we analyzed the sequences of DNA barcode, mitochondrial cytochrome oxidase subunit 1 (mtCO1), between *M. differentialis* collected from Ulsan in Korea and five locations in the Southern U.S. The genetic variation of each individual was analyzed to identify the origin of *M. differentialis* population collected in Ulsan, which formed a clade with populations of Texas and Louisiana but not with Mississippi. Mississippi population formed a distinct clade, which might be generated by the geographical separation of the Mississippi River between Louisiana and Mississippi. Taken together, we suggest that Ulsan population of *M. differentialis* was likely invaded from the Southern U.S. including Texas or Louisiana via international trade. In addition, population genetic studies using DNA marker might help us to identify the origin of *M. differentialis* if they spread to other parts of Korea.

Key words: DNA barcode, population genetics, the differentialis grasshopper, invasive insects

P69

A model for spring emergence prediction of the plum sawfly *Monocellicampa pruni* (Hymenoptera: Tenthredinidae)

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Influence of temperature on the development of the post-diapause of the plum sawfly *Monocellicampa pruni* Wei, 1998 were investigated through field observations and laboratory experiments. The growth rate of the post-diapause period of *M. pruni* is strongly correlated to tested temperatures of 8.1, 12.8, 18.0, 20.9, and 24.5 °C, and can be described by a linear regression model. The lower temperature threshold of 4.96 °C and the total effective degree day of 120.5 were estimated for the post-diapause period of *M. pruni.* Cumulative emergence data of an adult was well-explained by a two-parameter Weibull function with a shape and scale of 8.05 and 1.03, respectively. The results support for the use of temperature model for predicting emergence of the insect pest in spring.

Key words: lower threshold, degree day, post diapause, Weibull model

P70

Habitat status and paddy field management model for spillage prevention of Golden Apple Snail (*Pomacea canaliculata*) in the paddy field

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왕우렁이(*Pomacea canaliculata*)는 남미 원산의 열대성 동물이지만 우리나라에 도입된지 30여년이 지나면서 내한성 발달로 월동이 가능해졌다. 친환경 벼 재배에서 제초제를 대체할 수 있는 가장 효과적인 대안으로 왕우렁이를 활용하고 있다. 반면 환경부에서는 생태계 교란을 이유로 논 투입 왕우렁이가 생태계에 유출되지 않게 관리하도록 하고 있다. 우리나라 남부지역에서 잡초제거를 위하여 6월 상순 논에 투입한 치패는 7월 상순에 성체가 되어 산란하고 10여일 후 부화하여 생장한다. 이 시기부터는 월동세대와 새롭게 형성된 세대가 중첩되어 존재한다. 논 투입 왕우렁이 수거에 가장 효과적인 방법은 중간물떼기시 논둑을 타고 물길을 조성하여 물을 천천히 빠지게 하면 물을 타고 대부분의 왕우렁이는 가장자리로 유인되었다. 생태계에 유출된 왕우렁이 난괴의 부화억제효과가 우수한 유기농업자재는 빙초산으로 10배액 처리시 모두 부화하지 못했다.

검색어: 왕우렁이, 친환경, 서식실태, 논 관리모형

P71

The effects of constant temperatures on the fecundity of *Spodoptera frugiperda* and the development of oviposition model

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열대거세미나방(fall armyworm, *Spodoptera frugiperda* Smith)은 전 세계적으로 농작물에 심각한 피해를 입히는 해충으로 국내에도 비래하여 피해를 주고 있다. 이들 유충은 경제적으로 중요한 벼, 사탕수수, 수수, 비트, 토마토, 감자, 면화, 목초 등 다양한 작물을 가해한다. 열대거세미나방의 비래 후의 개체군 변동을 추정하기 위해서는 온도실험에 기반한 여러 가지 기초 모형이 필요하다. 본 연구에서는 옥수수를 섭식한 열대거세미나방을 이용하여 온도(16, 20, 28, 32℃)별 산란실험을 진행하였다. 각 항온 조건에서 암컷 성충의 산란전기간과 총산란수, 수명을 확인하고, 산란모형과 관련된 매개변수를 제시하였다.

검색어: 비래해충, 식량작물, 개체군모형, 항온실험, 열대성해충

P72

Survey of species diversity of ground insect using pitfall-trap in Jeju Gotjawal Provincial Park

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본 연구는 2021년 4월부터 9월까지 함정트랩을 이용하여 제주곶자왈도립공원에 분포하는 육상곤충의 다양성을 조사하기 위하여 실시되었다. 100m 간격으로 10개소를 선정하여 매달 식물성과 동물성의 트랩 2개씩을 설치하였고, 설치 7일 후에 회수하는 방법으로 채집을 실시하였다. 본 조사기간 동안 채집 확인된 곤충류는 6목 21과 171개체이며, 4월에 0개체로 가장 적은 개체가, 5월이 62개체로 가장 많은 개체가 조사되었다. 조사지점별로는 S6지점에서 다양성이 가장 높게 나타났으며, S8지점은 다른 조사지점과 다르게 종다양성이 현저하게 떨어지는 것으로 나타났다. 이는 S6지점이 통행로가 좁아지고, 고도가 높아지는 지역으로 다양한 곤충류들이 서식하고 있기 때문인 것으로 보이며, S8지점은 나무 뿌리 안에 트랩을 설치하였기 때문에 식생의 영향을 받은 것으로 보인다. 이러한 연구결과를 통하여 학술적 가치가 높은 곶자왈의 곤충 종다양성에 대한 기초자료를 확보하여, 추후 조사지역 및 채집법 등을 변경하여 추가적인 조사를 통해 제주곶자왈도립공원 곤충 다양성 연구의 생태자료를 확보하고자 한다.

검색어: 제주곶자왈도립공원, 종다양성, 육상곤충

P73

Damage symptoms of *Scirtothrips dorsalis* (Thysanoptera: Thripidae) at different growth stages of Satsuma Mandarin

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감귤원에서 발생하는 주요 총채벌레류로 볼록총채벌레, 꽃노랑총채벌레, 오이총채벌레, 파총채벌레, 하와이 총채벌레가 보고되었다. 이 중 현재 감귤원에서 경제적으로 가장 문제가 되고 있는 해충은 볼록총채벌레이며 감귤 생육 및 과실 상품성을 크게 저하시켜 감귤 안정생산에 큰 위협이 되고 있는 해충이다. 감귤원 내 볼록총채벌래 피해진단을 위한 기초자료를 구축하기 위하여 감귤생육기에 따라 볼록총채벌레를 접종 후 새순과 과실에서 발생하는 피해증상을 확인하였다. 감귤 착과기에 볼록총채벌레 피해 발생 시 조기낙과와 과실 꼭지부 원형 코르크증상이 주로 발생하였고, 비대기 피해증상으로 중하단부 과피를 주로 가해하여 회백색코르크증상이 발생하였다. 착색기 이후 피해증상으로 과피가 검붉은색으로 변색되는 증상이 나타났다. 새순에서 피해가 발생할 경우 새순 발생 초기에는 신초 기형 및 위조 증상으로 나타났고 중기 이후에는 회백색으로 변색되거나 위축 증상이 나타났다. 본 연구에서는 감귤의 생육시기별 볼록총채벌레 피해증상을 세분화하여 정리하였다.

검색어: 볼록총채벌레, 피해증상, 착과기, 비대기, 착색기

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Multiplex PCR for simultaneous detection of four major thrips found in Jeju island

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총채벌레는 외국으로부터 유입된 침입해충으로 채소류는 물론 과수, 화훼 등에 피해를 주고 있으며 주변 잡초에도 발생해 기주 범위가 대단히 광범위한 것으로 알려져 있다. 특히 감귤 과원에서는 감귤잎뿐 아니라 과실에 흡즙흔을 남겨 상품성을 떨어뜨린다. 하지만 총채벌레는 발육기간이 짧고 증식력이 뛰어나 효과적인 방제를 위한 예찰이 중요하나 크기가 1mm 내외로 작아 피해가 나타나기 전까지는 육안조사로 발생여부를 확인하기 어렵다

본 연구에서는 생물 종 분류에 주로 사용되는 Cytochrome c oxidase I (COI)와 ITS2 영역을 주형으로 하는 primer 를 제작하여 제주도 감귤 과원에서 주로 발견되는 4개의 총채벌레 (대만총채, 꽃노랑총채, 볼록총채, 파총채)를 동시에 검정할 수 있는 multiplex PCR을 개발하였다. 또한 미지의 총채벌레 범용 primer를 포함시켜 DNA sequencing를 통해 4종 이외의 총채벌레를 검정가능하게 하였다.

검색어: 볼록총채벌레, 대만총채벌레, 꽃노랑총채벌레, 파총채벌레

P75

Role of insect garden for conservation of insect diversity: Case study in Sangju

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Insect garden was designed and constructed to support native insects attraction into the artificially and intentionally modified landscapes of wild flower patches, grasslands and wetland in ap. 3ha in Silkworm and Insect Management Center in Sangju, Gyeongbuk from 2013. The garden could function not only as tourist attraction to plants with diverse insects providing the healing environment but also as conservation site of insect diversity. A study was conducted to investigate insect fauna in the insect garden during 2021. Total 1,979 individuals were recorded with Arachinida and Coleoptera were dominant followed by Orthoptera and Diptera. Total 68 species 38 families and 8 Order of insects were recorded from study sites. Dominant species were *Silpha perforata* and *Teleogryllus emma*. Lepidoptera insects were investigated followed by *Artogenia rapae*, *Papilio machaon*, *Atrophaneura alcinous* and *Polygonia c-aureum* by visual investigation. Compared with the data from 2012 when the insect garden was not constructed, compositional difference were significant, especially in Lepidoptera of which most visitors are particularly interested in. The faunal information will provide background for insect ecological healing programs and conservation as well. In the near future, we will use natural resource-industries such as insect ecological garden for care and social service.

Key words: Insect fauna, care-farming, social service

P76

Thermal effects on hatchability and development of overwintered eggs of gypsy moth, *Lymantria dispar* in Korea

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매미나방은 일반적으로 활엽수에 식엽 피해를 일으키는 해충으로서, 최근 2년 동안 중부 지방(서울: 1,200ha, 경기: 1,480ha)을 중심으로 전국적으로 대발생하여 산림에 큰 피해를 입혔다. 지속적으로 매미나방 유충에 대한 화학적 방제와 난괴 제거를 통한 물리적 방제를 하고 있으나, 효과적인 방제 및 발생 예측을 위해 매미나방의 생태 연구가 필요하다. 본 연구에서는 5개 지역(군포, 단양, 석모도, 영양, 원주)에서 채집한 매미나방 난괴의 온도 발육 실험을 6개의 온도(8, 13, 18, 23, 28, 33℃)에서 진행하였고, 난괴의 지역별 부화율, 발육률과 산란수를 확인하였다. 또한, 지역별 난 기생봉의 기생률 차이를 확인하였다.

검색어: 매미나방, 난괴, 온도 발육, 부화율, 기생, 월동

P77

Seasonal population change of *Haplotropis brunneriana* Saussure (Orthoptera: Pamphagidae) in Korea

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The flightless grasshopper *Haplotropis brunneriana* Saussure was a common species, widely distributed in Korea by the 1980s. However, recently *H. brunneriana* has been identified only in some habitats such as Yeongwol, Gangwon-do, because of habitat destruction and fragmentation. This study was performed to investigate the seasonal population change of *H. brunneriana* at two study regions as a basic research for restoration. The field survey was conducted once a month from March to June in 2021 at Yeongwol-gun and Jecheon-si, respectively. A total of 25 individuals were identified (18 and 7 individuals per 60㎡ in Yeongwol-gun and Jecheon-si, respectively). We also collected a pair of *H. brunneriana* for rearing in laboratory.

Key words: Endangered species, Population density, Grasshopper

P78

Preliminary results on the developmental and ovipositional characteristics of a braconid parasitoid on the two *Monochamus* vectors of the Pine wilt disease

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A breeding experiment of a braconid parasitoid, namely *Cyanopterus flavator* (Fabricius, 1793), was conducted prior to development of a biological control method for two *Monochamus* vectors of the Pine wilt disease (PWD). The project is still ongoing, and we, hereby, report preliminary results on developmental and ovipositional characteristics of the parasitoid. A pair of male and female *C. flavator* were placed in plastic cages (20°C, 25°C and 30°C; 70%RH; 16:8 LD) and exposed to one sentinel log of *M. alternatus* and *M. saltuarius* for 24 hours. After 24 hour exposure, new sentinel logs were replaced and put into the incubators until females are dead. A female required an average pre-ovipositon period before starting ovipositon, which was 14.2±9.7d, 6.4±2.9d, and 4.6±1.8 at 20°C, 25°C and 30°C, respectively. The average fecundity on *M. alternatus* was 16.7±9, 19.7±12.8 and 21.3±9.3 and on *M. saltuarius* 9±3.3, 15.7±6.9, and 24.7±9 at 20°C, 25°C and 30°C, respectively. Total developmental period from egg to adult emergence required 19d, 16.6±1.5d and 13.7±1.4d on *M. alternatus* and 23d, 18d and 12.9±1.7d on *M. saltuarius* at 20°C, 25°C and 30°C, respectively. A male lived for an average 53.3±14.4d, 43.8±13.1d and 48.5±10.5d and a female for 46.8±4.5d, 38.2±13.1d and 33.5±6.4d at 20°C, 25°C and 30°C, respectively, when 10% diluted honey water was provided.

Key words: biological control, *Cyanopterus flavator*, *Monochamus,* pine wilt disease, indoor mass breeding

P79

Occurrence of Fall Armyworm, *Spodoptera frugiperda* in Gyeongbuk province and method of monitoring

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The fall armyworm, *Spodoptera frugiperda* occurring in the Gyeongbuk province were first detected in Goryeong in July 2019, and have continued to occur in Goryeong, Gyeongsan in 2019, Gyeongsan in 2020, Gyeongju, Yeongdeok, Cheongsong, Gyeongsan, Gyeongju, Pohang, and Yeongcheon in 2021. In the Gyeongju region, it is occurring every year in Naenam-myeon, Cheonbuk-myeon, and Oedong-eup in 2020 and 2021, and it is gradually expanding. In addition, in Yongseong-myeon, Gyeongsan, it occurred in the same area of corn cultivation in 2020 and 2021. In order to quickly observe *Spodoptera frugiperda* that occurred in Gyeongju, it was found that it was possible to efficiently investigate when inspecting at a height of 5 m above the ground using an unmanned aerial vehicle and an RGB camera mounted on an unmanned aerial vehicle.

Key words: *Spodoptera frugiperda*, occurrence, monitoring, aerial vehicle

P80

Handling efficiency of *Apis mellifera* on the flowers of *Robinia pseudoacacia* and *Tilia amurensis*

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아까시나무와 피나무는 개화기에 꿀벌의 방화 활동이 활발한 중요한 밀원자원이다. 본 연구에서는 꽃의 형태가 각각 나비형과 개방형으로 상이한 두 수종에서 꿀벌의 화밀 채취 활동을 관찰하였다. 두 수종의 꽃봉우리에 차단망을 설치한 후 개화한 꽃의 화밀양, 꿀벌이 꽃에 방문하여 머무른 시간, 방문한 꽃에 남아 있는 화밀의 양을 측정하였다. 개화가 완료된 아까시나무와 피나무에서는 개화 첫날 각각 2.2 ± 2.09 μl와 6.4 ± 3.64 μl의 화밀이 분비되었다. 꽃에 꿀벌이 머문 시간은 각각 18.1 ± 9.12초와 23.0 ± 14.86초였고, 방화 후에 0.9 ± 0.59 μl, 0.2 ± 0.51 μl가 남아있었다. 피나무꽃에 꿀벌이 머문 시간이 더 길었지만, 시간당 더 많은 양의 화밀을 수집하는 것으로 조사되었다. 이 결과는 꽃의 구조에 따른 밀선 접근 효율과 화밀이 분비되는 밀선의 분포에 따른 것으로 추정된다.

검색어: 아까시나무, 피나무, 화밀, 방화

P81

Predicting current and future potential distribution of *Melanoplus differentialis*

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Melanoplus differentialis is a pest that can cause widespread agricultural damage in a short time due to their ability to spread rapidly by flight. Unfortunately, it was reported that this pest was accidentally introduced to South Korea, Port of Onsan. Therefore, in this study, we developed a MaxEnt model and used it for spatially evaluating the worldwide and domestic occurrence possibility of the pest in South Korea. The current, 2050 future scenario meteorological data coded as bioclimatic variables were obtained from world climate database. The occurrence records in native area were spatially filtered to confirm the final georeferenced points. As a result, relatively low occurrence possibility was projected throughout the country, but coastal areas in Gyeonggi-do and Gyeongsangbuk-do showed relatively high likelihood of *M. differentialis*.

Key words: differential grasshopper, Maxent, occurrence possibility, presence-only model

P82

Analysis of the genetic structure of a new invasion Red imported fire ant population in Gwangyang Port, Korea and trace the origin, using 66 microsatellite markers

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붉은불개미, *Solenopsis invicta*는 중앙아메리카 열대기후지역이 원산지이다. 그러나 세계적인 무역과 관광객의 이동 증가로 인하여 본래 서식지를 이탈하여 세계 각국으로 침입하고 있다. 이들은 토착 생태계에 매우 공격적으로 침투하여 보건, 농축산 분야에 심각한 피해를 입히고 있다. 국내에서는 2017년 부산항 터미널에서 붉은불개미가 처음 발견된 이래로 새로운 집단이 수입 화물 및 항만 부두에서 발견되고 있다. 올해 광양항에서 새로운 2개 집단이 발견되었으며, *Gp-9* 유전자 및 DNA 바코드(*COI*) 분석 결과 단일여왕군체(Monogyne)의 두 개 haplotype (H22, H5)으로 분석되어 두 집단이 유입된 것으로 추정된다. 또한, 66개의 초위성체 마커를 이용한 집단 분석 결과 과거 국내에서 발견된 붉은불개미 집단(중국 하이난 및 광저우)과는 다른 새로운 집단으로 분석되었다. 현재까지 확보된 해외 표본 가운데 광양항에서 발견된 집단과 유사한 유전자형은 없어, 향후 정확한 원산지 분석을 위해서는 지속적인 해외 표본 확보가 필요하다.

검색어: *Solenopsis*, red imported, population, genetics, microsatellite, structure, tracing origin

P83

Occurrence of *Scotinophara lurida* (Hemiptera: Pentatomidae) in Gyeonggi Province

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Due to the climate change Black Rice Bug(BRB) *Scotinophara lurida* became able to overwinter and the damage is occurring Gyeonggi Province. The BRB is the pest to suck and inflict the rice stems, especially in the eco-friendly cultivation rice. The eco-friendly rice cultivation area in Gyeonggi Province is 5,437ha(2019), and the damage area is expected to spread out, consequently we investigated the area where it occurred with regional temperature.

Visual investigation was conducted three times in total during March, June and July for 17 major regions of Gyeonggi Province. BRB were not found in northern area of Gyeonggi province. In contrast, almost southern area found BRB such as Yangpyeong, which has the largest eco-friendly rice cultivation area, showed the average density as 0.45 per head and the damage was very severe. Since we are concerned that BRB outbreaks will spread in the future, we think that continuous and precise monitoring is necessary in Gyeonggi province.

Key words: Black rice bug, *Scotinophara lurida,* rice, occurrence

P84

A temporal and spatial simulation using CLIMEX model to evaluate the effects of western flower thrips, *Frankliniella occidentalis* in Korea

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꽃노랑총채벌레는 국내 각종 작물, 화훼류를 광범위하게 가해하는 해충이며 토마토반점위조바이러스의 주요 매개충이기도 하다. 국내에서 재배중인 작물들에서 이 해충의 영향력을 평가하기 위하여 우리나라 기후에 대한 적합성을 공간적, 시간적으로 표출할 필요가 있다. 꽃노랑총채벌레에 관하여 기존에 기존에 발표된 CLIMEX 종 매개변수가 존재하나 그 결과는 실제 분포와 맞지 않는 점이 있다. 이에 미국 대륙과 아시아, 아프리카 등 각지의 발생 정보를 근거로 하여 새로운 CLIMEX 종 매개변수를 작성하였고 국내 1km 해상도에 해당하는 근년도 및 미래기후 데이터를 적용한 모의 결과를 시각적으로 도출하였다.

검색어: 기후적합성, 기후변화, 작물해충, 생물기후지수, GIS

P85

A parasitized ratio of *Mythimna separata* (Lepidoptera: Noctuidae) larvae collected at a maize field, and their developmental and cannibalistic traits in indoor rearing

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6월 중순 수원 옥수수 포장에서 5-6 엽기였던 옥수수 말린 잎 중심부에서 새 잎을 가해하는 나비목 유충들을 채집하였다. 피해주율은 약 4.7%였다. 채집된 유충들을 실내에서 사육하여 약 31%가 2~3종의 기생벌에 의해 기생된 것이 확인되었다. 우화한 성충들은 외부형태와 시토크롬 옥시다제 1 유전자 비교로 멸강나방으로 동정되었다. 다음 세대 유충을 25℃와 15:9 h (명:암) 광조건에서 인공사료로 개체별로 사육하였을 때, 모든 개체가 6령기를 경과하면서, 18.8일을 지나 용화하였고, 용화율은 100%였다. 용 기간은 10.7일로 90%가 우화하였다. 그런데, 유충을 10마리씩 집단으로 사육하였을 때는 용화율이 20%로 개체사육 때보다 낮았고, 약 300마리를 한 통에서 사육하였을 때는 용화율이 1%로 더 낮았다. 이 결과는 멸강나방 유충의 동족포식 특성이 매우 강한 것을 나타냈다. 동족포식행동은 4령기부터 뚜렷하게 관찰되었다.

검색어: 멸강나방, 옥수수, 유충기생율, 발육특성, 동족포식

P86

Enhanced detoxification of honey bees in honey bees exposed to organophosphate and diamide insecticides by rosmarinic acid and G-3

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Understanding of the detoxification mechanism in honey bees is essential as honey bees are continuously exposed to pesticides. Pesticides are classified to different groups based on their mode of action. In this study, we selected two insecticides of organophosphate and diamide. We investigated the effect of rosmarinic acid (RA) and G-3 on enhancing the detoxification mechanism in honeybees after oral and contact exposure to imicyafos and cyantraniliprole. In response to detoxification testing, RA and G-3 were found to be effective in reducing honey bee mortality. Our results indicated that both detoxification chemicals reduced honey bee mortality, for instance by 10-20 even in the highest concentrations treatments of both pesticides; imicyafos, 75 ppm and cyantraniliprole, 50ppm, 48 hr post exposure. RA treatment was better than G-3 treatment which is the commercial products. Therefore, rosmarinic acid would have potential for further testing and development as pesticide detoxifing agent.

Key words: poisoning, *Apis mellifera*, imicyafos, cyantraniliprole, oral, contact expose

P87

Development of a new trap using multi narrow tubes to guide ants

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2017년 9월 부산 감만부두에서 국내 최초로 붉은불개미(*Solenopsis invicta*)가 검출된 이후, 수입컨테이너 적치장 조사와 수입화물 검역에서 주기적으로 붉은불개미가 검출되고 있다. 농림축산검역본부에서는 외래개미류의 유입가능성이 높은 공항만구역 및 내륙컨테이너 기지 등 광활한 장소를 주기적으로 예찰하기 위해 주로 함정 트랩을 이용하고 있다. 그러나 현재 사용중인 함정트랩은 개미가 들어갔다가 다시 쉽게 빠져나올 수 있으며, 무엇보다도 토양이 없는 단단한 바닥환경에서는 설치하기가 곤란하다는 단점이 있다. 이러한 단점들을 해결하기 위해 개미류가 빠져나오기 어려운 다단협관을 이용함과 아울러, 콘크리트 바닥에 설치가 용이한 트랩을 개발하였다. 개발된 트랩의 성능시험을 위해 트랩내 포살제별, 유인먹이별 포집 개미수의 차이를 확인하였다. 포살제 시험에서는 기존에 주로 사용되는 ethylene glycol과 에탄올 혼압액에 비해 끈끈액에서 10배 이상의 개미 유인효과를 보이는 것으로 확인하였다. 유인먹이별 시험에서는 햄이 육포, 봉밀, 감자칩에 비해 다소 높은 유인효과를 보였다. 개미가 트랩에 들어왔다가 탈출이 가능하지를 48시간 동안 관찰한 결과, 트랩내 포충물질을 넣지 않을 경우에는 2.4%, 포충물질로 끈끈액을 처리했을 경우 0%의 탈출률을 확인하였다. 연구진은 개미류의 트랩내 유인율을 높이고, 탈출률을 낮추며, 무엇보다도 기존 트랩의 설치가 어려운 지역에도 손쉽게 설치가 가능한 트랩을 개발하였다. 향후, 본 트랩이 국경지역에서 외래개미류의 국내 침입을 효과적으로 차단하는데 기여하기를 기대한다.

검색어: 개미, 예찰, 트랩

P88

Monitoring reports on Lepidopteran pests occurring in wild vegetables in Gangwon Province

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2016~2021년, 강원도 평창군 산채연구소와 태백시 고원시험장의 시험 포장 등에서 고려엉겅퀴, 곰취, 어수리, 참취에 발생하여 잎, 줄기, 꽃대, 뿌리를 가해하여 피해를 주는 나비목 해충류를 조사하였다. 고려엉겅퀴에는 큰금무늬밤나방이 4~5월에 발생하여 잎을 가해하였고, 곰취에는 자두갈색잎말이나방이 5~6월에 잎을 가해하였으며, 8월부터 다음해 4월까지 큰섬들명나방이 잎과 꽃대뿐만 아니라 뿌리를 가해하였다. 어수리에는 어수리애기잎말이나방, 줄고운가지나방, 매미나방, 도둑나방이 6~11월에 잎과 줄기를 가해하였고, 이 중, 어수리애기잎말이나방과 도둑나방이 우점 해충으로 확인되었다. 참취에는 긴금무늬밤나방이 8~9월에 발생하여 잎을 심하게 가해하여 피해를 주었다. 모두 개별 사육을 통해 성충 발생을 확인 후, 종 동정하였고, 산채류에 피해를 주는 발생시기와 가해부위 그리고 피해정도 등을 조사하여 관련 정보를 확보하였다.

검색어: 곰취, 어수리, 참취, 큰섬들명나방, 어수리애기잎말이나방, 긴금무늬밤나방

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Effects of temperature on reproduction of *Spodoptera frugiperda* (Smith) (Lepidoptera: Noctuidae)

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국내에 2019년에 비래가 처음 확인되었고, 2021년에도 비래하여 옥수수 등에 주로 피해를 주고 있는 열대거세미나방의 산란에 미치는 온도의 영향을 15, 18, 21, 24, 27, 30℃, 광주기 14L:10D에서 조사하였다. 암컷 수명은 21℃에서 27일로 가장 길었으며 30℃에서 13.9일로 가장 짧았다. 산란기간은5.7~11.2일이었으며 산란 전 기간은 3.5~5.2일, 산란 후 기간은 3.5~10.5일이었다. 평균 산란수는 24℃에서 1,348.9개로 가장 많았으나 개체별 편차가 큰 경향이었다. 그러나 온도별 일일평균산란수는 18℃에서 90.5개, 30℃에서 189.2개로 온도가 높아질수록 많아졌다. 15℃에서는 산란이 확인되지 않아 추가적인 조사가 필요할 것으로 판단되었다. 또한 5월 중순에 옥수수 포장에 성충 방사 후 산란된 난괴의 평균 알수는 96.7개, 발육 후 우화한 성충의 난괴당 평균알수는 235.1개이었다.

검색어: 열대거세미나방, 옥수수, 온도, 산란수

P90

Occurrence of *Spodoptera frugiperda* (Smith)(Lepidoptera: Noctuidae) in Jeonbuk province

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열대거세미나방은 아메리카가 원산지인 열대.아열대성 해충으로 최근 아프리카, 동남아, 중국, 일본 등으로 확산되고 있으며, 국내에도 2019년 처음으로 비래가 확인된 이후 해마다 비래하여 옥수수 등에 피해를 주고 있어 방제관리를 위하여 전북지역 발생상황과 성충 방사시기에 따른 충태별 변화 양상을 조사하였다. 2021년 전북지역에서는 고창에서 비래성충이 5월 14일, 유충은 5월 하순에 발생이 처음 확인되었고 정읍, 김제 등 8개 시군의 옥수수 포장에서 발생하였다. 비래성충에 의한 옥수수 피해주율은 1% 이하로 적었으나 2세대 유충에 의한 피해주율은 최고 40% 정도까지 발생하여 피해를 주었다. 5월 12일부터 약 1주 간격으로 방사한 결과 1령 유충은 방사 후 6~8일째부터 발생하였으며 다음 세대 성충 우화까지는 38~41일정도 소요되었다.

검색어: 열대거세미나방, 옥수수, 피해주율, 발육

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Comparative incidence of plant-parasitic nematodes at peanut and ginger in Jeollabuk-do and Gyeongsangbuk-do provinces

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전라북도와 경상북도의 땅콩과 생강 포장에서 발생하는 식물기생성선충 종류를 조사하기 위해 21년 6월 9일부터 9월 15일까지 정읍, 김제 등 전북 6개 지역 땅콩 58포장, 생강 37포장과 21년 9월 9~10일에 경북 안동시와 예천군의 땅콩 22포장, 생강 13포장에서 채취하여 분리하였다. 전북지역 땅콩재배 포장에서 식물기생성선충이 발생한 포장비율은 31.0% 이었으며 뿌리혹선충류, 씨스트선충류, 나선선충류, 참선충류가 분리되었으며 이중 나선선충이 밀도가 가장 높았으며 뿌리혹선충, 씨스트선충, 참선충 순이었다. 생강 포장에서의 발생비율은 21.6% 이었으나 발생밀도는 낮았다. 경북지역 땅콩재배 포장에서 식물기생성선충이 발생한 포장비율은 50.0% 이었고 전북 지역과 달리 뿌리혹선충과 씨스트선충의 밀도가 높은 경향이었다. 반면 경북 생강 포장에서는 식물기생성선충의 발생이 확인되지 않았다.

검색어: 식물기생성 선충, 땅콩, 생강, 뿌리혹선충

P92

Comparison of attraction to LED wavelengths between two strains of *Orius laevigatus* (Fieber) (Hemiptera: Anthocoridae)

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Inter-strain variation in attraction to specific LED wavelengths has been reported on *Nesidiocoris tenuis* previously. Here, we report differences in attraction of two commercialized strains (Biobest and Koppert) of *Orius laevigatus* to 10 or 11 different LED wavelengths. For the Biobest strain, attraction was the highest in 365 and 385 nm wavelengths, while for the Koppert strain, it was the highest in 365, 385, 395, and 405 nm wavelength. In pooled data of both strains, the 385 nm wavelength also showed the highest attraction rate among the wavelengths tested. Thus, the wavelength of 385 nm would be applied to enhance the establishment of *O. laevigatus* in field pest management strategies.

Key words: establishment, natural enemy, minute pirate bug, optical manipulation, ultraviolet, Y-tube

P93

Population of chigger mites, the vector of tsutsugamushi disease, in Yeongdeok, 2019-2020

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We monitored population of chigger mites once a week in Yeongdeok, from September to December (37-week to 50-week), 2019 - 2020, in four environments: rice paddy, upland field, waterway, and grassland. In 2019, 4 species belonging to 2 genera were identified, and *Leptotrombidium palpale* (65.5%) was a dominant species, followed by the *Neotrombicula tamiyoi* (13.8%), *N. gardella* (10.3%), and *L. pallidum* (10.3%). Among 5 species in 3 genera collected in 2020, *L. palpale* (94.3%) was a dominant species, followed by the *N. kwangeun* (3.2%), *L. pallidum* (1.3%), *N. japonica* (0.6%), and *Euschoengastia koreansis* (0.6%). The first mites appeared at 45-week and 42-week in 2019 and 2020, respectively. Among four environments, mites were most dominantly collected in the rice paddy.

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Key words: Chigger mite, Tsutsugamushi disease, Yeongdeok, vector

P94

Composition and abundance of wood-boring beetles inhabited in pine trees

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Plants are consumed by a myriad of organisms that compete for resources. Direct interactions among multiple plant-feeding organisms in a single host can range for each species from positive to negative. Biotic factors, including arthropod pests and diseases, and abiotic factors, such as drought and water-logging, are the major constraints affecting host trees. The present study aimed to provide basic data for analyzing forest health in regards to identification of wood-boring beetles in the central part of Korea. Our second goal was to analyze the species composition and diversity of regional beetle communities. A total of 10,461 individual wood-boring beetles, comprising 50 speciesin 8 families, attracted to trap trees in pine forests were recorded during the study period in study sites. The results of the analysis of collected species showed that the community structure in all study sites was similar. Seasonal occurrences of dominant wood-boring beetles (5 species) from each site showed the highest number of all species, except for *Siphalinus gigas* in May, followed by a gradual decline, and the largest number of *S. gigas* appeared in June. The similarity index of species composition was relatively high, ranging from 0.75 to 0.90 for each study site.

Key words: wood-boring beetle, community structure, species richness

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Developmental characteristics of *Cryptolaemus montrouzieri* on artificial diets

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깍지무당벌레는 상업적으로 생산 판매되고 있는 천적곤충으로 가루깍지벌레류의 생물적 방제에 가장 일반적으로 사용되는 포식성 천적이다. 이러한 깍지무당벌레의 생산은 기주식물로 사육한 먹이곤충에 의존하고 있어 공급가격이 높은 천적이다. 본 연구에서는 깍지무당벌레의 생산단가 절감과 보조먹이로의 이용 가능성을 검토하기 위해 귀뚜라미 동결건조 분말 등을 이용한 인공사료를 사용해 발육시험을 수행하였다. 항온조건(24±1℃, RH 60±10%)에서 귤애가루깍지벌레를 먹이로 했을 때 깍지무당벌레의 약충기간은 22.4일, 번데기 기간은 13.6일로 성충까지 총 35.9일이 걸렸다. 인공사료를 이용 했을때는 약충기간 35.1일, 번데기 기간 10.4일로 성충까지 총 45.8일이 걸렸다. 성충까지의 생존율은 먹이해충 93.3%, 인공사료 85.7%로 나타났으며 성충의 무게는 먹이해충 수컷 0.012g, 암컷 0.013g, 인공사료 수컷 0.009g, 암컷 0.010g으로 나타났다. 본 연구 결과 인공사료를 이용한 깍지무당벌레의 완전한 사육은 어려웠지만 보조먹이로서 사용될 수 있음을 확인할 수 있었다.

검색어: 깍지무당벌레, 인공사료, 사육, 발육

P96

Monthly occurrence of wood-boring beetles in *Pinus densiflora* and *Larix kaempferi* stands in Korea

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천공성 딱정벌레류는 최근 기후변화 및 신규 외래종의 침입으로 대발생의 위험이 커지고 있으며 외국에서 활발히 연구되고 있으나 국내에서는 연구가 미흡한 실정이다. 본 연구는 국내에 소니무 임분과 일본잎갈나무 임분에 서식하는 천공성 딱정벌레류인 나무좀, 바구미, 하늘소류의 종을 확인하고 각 종의 발생시기를 파악하였다. 2019년 3월부터 9월, 2020년 3월부터 9월까지 강원도 춘천 지역에서 조사를 진행하였고, 멀티펀넬 트랩과 ethanol, (-)-α-pinene, (-)-β-pinene, β-caryophyllene, (±)-limonene, β-myrcene 그리고 3-carene을 다양하게 조합한 루어를 사용하였다. 조사 결과 소나무 임분에서 나무좀 40종, 바구미 33종, 하늘소 31종이, 일본잎갈나무 임분에서 나무좀 45종, 바구미 51종, 하늘소 34종이 발견되었다. 소나무 임분에서는 3월과 4월에 소나무좀이 우점하였고, 5월부터 9월까지 솔흰점박이바구미와 흰점박이바구미가 우점하였다. 일본잎갈나무 임분에서는 3월과 4월에는 소나무줄나무좀, 5월에는 팥배나무좀, 6월에는 왕녹나무좀, 7월에는 오리나무좀과 닮은오리나무좀, 8월에는 참목도리바구미 그리고 9월에는 솔검정혹바구미가 우점하였다.

검색어: 소나무, 일본잎갈나무, 천공성 딱정벌레, 모니터링, 월별 발생시기

P97

A Occurrence of *Spodoptera frugiperda* on maize crops in Gangwon province

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열대거세미나방은 편서풍을 타고 비래하는 해충으로 2019년 국내 최초 유입된 것으로 확인되고, 2019년 6월 제주에서 처음 발견된 이후 2021년은 4월 말에 발견되었다. 이는 겨울철 기온 상승으로 비래시기가 점점 빨라지고 있다고 생각된다. 2019년부터 2021년 동안 강원도내 비래한 열대거세미나방을 육안조사와 트랩조사를 병행하여 조사한 결과 강원도는 7월 초·중순 정선군 임계면과 낙천리 일대에서 처음 발견되어 7월 하순에서 8월 초순에는 영월·동해 8월 중순에서 9월까지 원주·홍천·횡성에서 발견되고 있다. 현재까지 조사기간내에 강원도내 열대거세미나방늬 첫 발견은 지점과 시기가 비슷하고, 이 후 발견되는 지점과 시기도 모두 비슷한 양상을 보였다. 이는 지형과 기온, 기주작물인 옥수수의 재배시기와 밀접한 연관이 있다고 생각된다. 강원도내에서는 7월과 8월사이에 2기작으로 옥수수를 많이 재배하는데, 이 기간내 10엽기 이하의 어린 옥수수에서 주로 피해가 발생됨을 확인 할 수 있었다.

검색어: 열대거세미나방, 강원도, 분포, 비래해충, 옥수수 해충, 발생현황

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Within-tree distribution of *Ricania shantungensis* (Hemiptera: Ricaniidae) eggs on persimmons

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감에서 갈색날개매미충의 심각한 경제적 피해가 예상되고 있지만 표본단위는 아직 개발되어 있지 않다. 따라서, 이번 연구에서는 감에서 갈색날개매미충의 주내분포에 근거하여 표본단위를 설정하기 위해 수행되었다. 실험은 사천시에 위치한 상업적 과수원과 폐농에서 각 과수원당 30그루씩 60그루의 감나무를 임의로 선택하여 수행하였다. 각 나무는 수평적으로 4개의 방향(동, 서, 남, 북)에서 수직적으로 3개의 기준(상, 중, 하)으로 12개의 가지를 임으로 잘라서 잘려진 나무의 가지끝에서 10cm 간격으로 존재하는 갈색날개매미충의 알덩어리 숫자를 조사하여 기록하였다. 표본단위는 변동계수와 상관계수를 이용하여 선정되었다. 감에서 갈색날개매미충 알은 수평적으로 발생량에 통계적($P < 0.05$)으로 차이가 없었으나 수직적으로는 차이가 있었다. 감에서 갈색날개매미충의 최적표본단위는 변동계수와 상관계수에 의해 30cm 가지끝이 선정되었다. 이 작은 표본단위를 사용함으로써 갈색날개매미충의 표본조사는 경제적이고 효율적으로 수행될 수 있을 것으로 생각된다.

검색어: 갈색날개매미충, 표본단위, 주내분포, 감

P99

Assessment of domestic potential risk of *Procambarus clarkii* establishment by using MaxEnt model

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Procambarus clarkii is an ecosystem-disrupting species, causing damage to agricultural land and disturbance to aquatic ecosystems in South Korea. For this reason, it is necessary to predict the occurrence potential of *P. clarkii* to provide data applicable for monitoring and managing the species. In this study, MaxEnt model was used to evaluate the domestic occurrence possibility of *P. clarkii* based on global occurrence records. The model showed reliable model performance with 0.873 of AUC and 0.71 of TSS. Among the selected variables, minimum temperature in the coldest month and altitude showed the highest contribution to model prediction. The result showed that the probability of *P. clarkii* was found to be low in South Korea. We expected that an improved model can be built with field survey data collected in Korea.

Key words: MaxEnt, model performance, occurrence possibility, *Procambarus clarkii*

P100

Spatial and temporal dispersion of Aphid-Parasitoid under different micro-climates in Paprika greenhouse

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The initial outbreak of aphids in Paprika greenhouse has partially occurred since mid-March after planting in late February. The outbreak began in the center of about 660㎡ greenhouse. As a result of analyzing the environmental conditions through the HOBO data logger installed each point within greenhouse, the maximum temperature at the initial point was 39.9℃ which was more than 4.2℃ higher than the average maximum temperature at other points, 35.7℃. The average relative humidity was also 43.3%, more than 2% higher than other points. There was no significant difference in average temperature each point.

At the beginning of the occurrence, dispersion pattern of parasitoids showed the aphid density dependent response. However, changes of the aphid density by dispersion parttern of parasitoids were showed after the initial decrease of aphid population by parasitoids. Therefore, we need further works on dispersion patterns of *A. colemani* mummies and adults under different microclimate within Paprika greenhouse as well.

Key words: Aphid-parasitoid dispersion, *Aphidius colemani*, Micro-climate

P101

A tenebrionid beetle, *Platydema takeii* Nakane (Coleoptera: Tenebrionidae) attacking cultivated wood ear (*Auricularia auricula-judae*) in Jeju

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As a result of an investigation on severe destruction of the wood ear (*Auricularia auricula-judae*) cultivated in a plastic house in Jeju city from April to August 2021, a tenebrionid beetle has been found. The insect pest was subsequently identified as *Platydema takeii* Nakane, 1956 (Coleoptera: Tenebrionidae: Diaperinae). This is the first report of a tenebrionid species infesting commercially cultivated mushroom. Its damage symptoms and diagnosable characters for the adult and larva are provided in this study.

Key words: *Platyderma*, Tenebrionidae, wood ear, mushroom

P102

Morphological identification of Antennal Sensilla of Western conifer seed bug, *Leptoglossus occidentalis* (Heteroptera: Coreidae)

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소나무허리노린재(*Leptoglossus occidentalis*)는 소나무 및 잣나무 등을 비롯한 다양한 침엽수를 기주로 하며, 최근 경기도 가평지역의 잣 생산에 큰 피해를 주고 있는 해충이다. 본 연구에서는 주사전자현미경(scanning electron microscope) 관찰을 통해 소나무허리노린재 암, 수컷의 촉각(antenna)에 있는 냄새감각기(olfactory sensilla)의 종류와 분포를 파악하였다. 관찰된 감각기들은 형태에 따라 basiconic sensilla, trichoid sensilla, coeloconic sensilla 및 chaetic sensilla로 분류하였고, 감각기의 폭과 소켓의 유무 및 표면 구조의 차이를 기준으로 몇 가지 하위그룹으로 분류한 결과, basiconic sensilla는 3가지, trichoid sensilla는 2가지, coeloconic sensilla는 2가지, 그리고 chaetic sensilla는 2가지의 하위그룹으로 나눌 수 있었다. 소나무허리노린재의 촉각에 존재하는 basiconic sensilla와 trichoid sensilla의 표면에서 다수의 미세공이 관찰되었고, coeloconic sensilla에서는 길이방향의 홈이 있는 것을 확인하였다. 이들의 표면 구조에 따라, 주 감각기능은 냄새감각기능일 것으로 판단된다.

본 연구 결과는 소나무허리노린재의 냄새통신을 이해하고, 이들의 유인제 개발에 유용한 정보를 제공할 것으로 기대된다.

검색어: 소나무허리노린재, 촉각, 냄새감각기, 주사전자현미경

P103

Biodiversity of overwintering arthropods in paddy field ecosystem in Chungnam

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Paddy fields are important areas for producing rice and it has the characteristics of a semi-natural wetland ecosystem that temporarily holds water during rice cultivation. For this reason, many terrestrial organisms, including various aquatic organisms, live in paddy fields. So, this study intends to provide information on biodiversity through an investigation on the occurrence of arthropods in rice paddies and ridge between paddies during the winter season. Insects were collected by inhaling a 5 certain area(50cm×50cm) through a aspirator once a month. As a result of investigating biodiversity in rice fields, The total number of collected individuals is 41,197. Most were collected in the order of Collembola, Hemiptera, Diptera. The occurrence patterns of arthropods in organic fields and conventional fields were almost similar. But, the number of collected individuals was higher in organic fields than conventional fields. And, the species diversity index, the species abundance index, and the species evenness index were all larger in the paddy fields than in the ridge between paddies, and there was a large difference by time period.

Key words: paddy, ridge between paddies, arthropods, biodiversity

P104

Prediction of activity period of *Scotinophara lurida* (Burmeister) (Hemiptera: Pentatomidae) in overwintering site

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The Rice black bug, *Scotinophara lurida* is one of the economical pest in rice cultivation. To reduce damage to rice fields, overwintered *S. lurida* were studied at the rice paddy field in Chungnam area, from 2020 to 2021. Five potted rice were placed in the nearby hills around the rice fields, and the number of attracting *S. lurida* to rice was investigated periodically. The first time *S. lurida* were attracted to potted rice was may 19th. There is a difference of about two weeks from when the rice was transplanted. As a result of analyzing the activity model of *S. lurida* based on the data surveyed over two years, Statistically, the accuracy was 92.5%.

Key words: rice black bug, overwintering, prediction, rice

P105

Trend on imported cut flowers and intercepted pests from 1996 to 2020

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The plant quarantine aims to reduce the economic impact of alien pests brought from other nations on the agricultural and forestry industries. In this study, we focused on insects detected in imported cut flowers over the last 25 years (1996-2020). Total 163,213 cut flowers (215 items) were imported from 78 countries to Korea. During this period, 562 species of insect pests, acari and mollusks with a total number of detections of 16,720 were detected in all imported cut flowers. They were classified as quarantine managed pests in 85 species, provisional regulated pests in 330 species, and non-quarantine pests in 130 species. Of the 16,722 records of alien insects, Thysanoptera and Homoptera had the highest number of detections (more than 70% of the alien insects) among the nine orders. These findings have confirmed the necessity for continued inspection activities on imported cut flowers aimed at preventing the entrance or incursion of quarantine pests into Korea.

Key words: plant quarantine, cut flower, quarantine inspection, insect pest, quarantine managed pest

P106

Evaluation of insect pollinator dependence of flowering plants

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Most angiosperm plants depend on diverse insects for pollination for reproduction. However the degree of the dependency differ by plants. In this study, we evaluated the dependency of insect pollinator on some woody plants in Korea. The study was conducted during flowering and fruit period of each plant from 2019 to 2021. In order to evaluate the fruit rate of each plant, a pollinator blocking net (blocking treat) was installed on the flower buds just before flowering. The number of buds in the control and the treatment groups was counted, and the experiments were repeated three times. After flowering periods, the blocking net was removed and compared fruit rates between control and treatment of each plant species. Bases on this comparison, we calculated pollination dependency by insect of plant species. A total of 40 species of plants were investigated, and information was listed up. *Cornus officinalis* representative the highest dependence on pollinator, followed by *Pseudocydonia sinensis*, *Ligustrum obtusifolium*, *Hydrangea macrophylla*, and *Syringa villosa* subsp. *wolfii*. *Quercus acutissima* representative the lowest dependence on pollinator, followed by *Buxus sinica* var. *koreana*.

Key words: pollinator, ecological service, plant-insect interaction, fruit yield

P107

The Occurrence and proper control of Mites in Shine musket vineyards in ChungCheongbuk-do

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2021년에 충북 샤인머스켓 포도원에서 발생하는 응애류의 발생생태를 조사해 효율적인 방제체계를 구축하기 위해 본 실험을 수행하였다. 시설하우스와 간이비가림 시설에서 주로 점박이응애(*Tetranychus urticae*), 차먼지응애(*Polyphagotarsonemus latus)*가 관찰되었다. 포도나무 생육 전에 줄기 껍질을 벗겨 조사한 결과 5.6~8.4마리/ 나무가 관찰되었다. 포도나무에 싹이 트고 개화기 무렵까지 피해가 관찰되지 않았고, 개화 20일 경과 후에 1마리/잎가 관찰되기 시작하여 개화 40일후부터 밀도가 높아져 포도잎 끝에 거미줄이 관찰되고, 엽색이 노란색을 띄는 피해가 관찰되었다. 개화 직후 살비제를 2회 살포하고, 개화 50일 후 10일 간격 3회 살포한 경우 응애 밀도가 증가하지 않아 수확기에 피해허용밀도 이하로 피해가 관찰되지 않았다. 수확 후 밀도 증가하였다가 감소하는 것이 관찰되었다.

검색어: 포도, 응애, 샤인머스켓, 발생, 방제

P108

Spatial evaluation of domestic *Lymantria dispar* (Lepidoptera: Erebidae: Lymantriinae) distribution by using MaxEnt

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Recent outbreak of gypsy moth, *Lymantria dispar*, caused aesthetic discomfort along with damage to host plants in South Korea. For this reason, to prevent further spread, prediction of the likelihood of occurrence due to climate change was requested in advance. In this study, domestic occurrence possibility of gypsy moth was evaluated by using MaxEnt. Occurrence records were obtained through multiple sources and spatial filtering was peformed to confirm the final georeferenced occurrence points. Bioclimatic variables were biologically driven at first; then, highly correlated variables were removed to prevent multicollinearity. The final model was operated with optimal conditions determined by using ENMeval with application of climate change scenario (SSP585). The developed MaxEnt model showed reliable model performance test with TSS (>0.8), and suggested that gypsy moth could occur nationwide. However, the occurrence possibility of gypsy moth would significantly reduce according to climate change.

Key words: gypsy moth, climate change, MaxEnt, occurrence possibility

P109

Effect of temperature on development and reprodcution of *Myzus persicae* (Hemiptera: Aphididae)

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The green peach aphid, *Myzus persicae*, is one of the significant aphid pests of several crops, damaging various tissues, and acting as a vector for the transport of plant viruses. We investigated the effect of temperature on development and reproduction of *Myzus persicae* at 10, 25, 30, and 32.5℃, respectively. *M. persicae* developed successfully to adult stage except 32.5℃. Life table parameters and population growth of *M. persicae* analyzed using age-stage two-sex life table analysis method. The intrinsic rate and finite rate of increase were highest at 25℃ (0.27 and 1.32). The intrinsic rate and finite rate of increase at 30℃ was –0.01 and 0.99. Mean generation time was shortest at 30℃ (9.35days)

Key words: *Myzus persicae*, Life table analysis, Temperature

P110

Population parameters and growth of *Myzus persicae* nymphs (Hemiptera: Aphididae) under different CO_2 concentrations

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We evaluated the direct effect of three different CO_2 concentrations (400, 600 and 1000ppm) on the life table parameters and population growth of green peach aphid, *Myzus persicae*, while being fed on cabbage. The raw life table data from *M. persicae* was analyzed using an age-stage, two-sex life table to take the viable development rate among individuals into account. Based on the age-stage, two-sex life table analysis, the population projection of *M. persicae* provide the stage structure and variability of the population growth under different CO_2 treatments. Our results showed significantly longer oviposition periods and higher fecundity under elevated CO_2 (600 and 1000ppm) than those under ambient CO_2 (400ppm).

Key words: *Myzus persicae*, Carbon dioxide, Life table analysis, Population projection

P111

Occurrence and damage of the crambid moth *Syllepte pallidinotalis* on 'Campbell Early' grapes in Korea

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우리나라에서 재배되고 있는 주요 포도 품종 중 하나인 '캠벨얼리'에서 잎의 가장자리를 말고 그 속에서 갉아 먹는 들명나방류 유충에 의한 피해가 흔하게 관찰된다. 과거 관련 문헌에는 이 해충이 포도들명나방(*Herpetogramma luctuosalis* Guenee)으로 기록되어 있으나, 가해 유충을 실험실에서 사육하여 얻은 성충은 포도들명나방과는 형태적 차이가 뚜렷하였다. 이에, 충북 영동과 전북 김제의 '캠벨얼리' 포도에서 채집한 들명나방류 유충의 COI 유전자와 수컷 성충의 생식기를 조사한 결과, 이 해충이 연무늬들명나방(*Syllepte pallidinotalis* Hampson)임을 확인하였다. 연무늬들명나방 유충이 주로 가해하는 시기는 7~9월이며 노숙유충으로 월동하는 것으로 추정된다. 비록 이 해충이 포도 잎만 부분적으로 가해하기 때문에 경제적 중요성이 그리 크지 않을 것으로 보이지만, 국내 포도원에서 매우 흔하게 발견되고 있으므로 연무늬들명나방의 생활사와 경제적 피해 해석에 대한 연구가 필요할 것으로 판단된다. 아울러 포도들명나방의 발생 여부와 연무늬들명나방의 분포에 대한 좀 더 집중적인 조사가 필요하다.

검색어: 포도, 캠벨얼리, 연무늬들명나방, 피해

P112

Distribution and phenology of the spotted-wing drosophila, *Drosophila suzukii*, in Korean cherry orchards

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벗초파리(*Drosophila suzukii* Matsumura)는 아시아 원산으로 지금은 북미와 유럽에 침입하여 핵과류와 베리류에 큰 피해를 주는 해충이다. 과거 우리나라에서는 이 해충의 경제적 중요성이 미미하였으나, 최근 체리와 블루베리 재배가 확산되면서 일부 지역에서 피해가 발생하고 있다. 우리는 2020년부터 국내 체리 과수원을 대상으로 벗초파리 피해실태를 조사하는 한편, 전북 완주의 체리 과수원에서 유인제(acetic acid, ethanol, acetoin, ethionol의 혼합물)를 이용하여 성충의 발생소장을 조사하였다. 체리를 가해하는 초파리류를 채집하여 유전자 검정으로 동정한 결과, 이천, 예산, 완주, 곡성, 순천, 김천, 창녕, 하동에서 벗초파리의 발생을 확인하였다. 한편, 벗초파리 성충은 6월 상순부터 7월 상순까지 유인제 트랩에 유살되었으며, 성충의 시기별 발생은 품종에 따라 큰 차이가 있어 과실이 늦게 성숙하는 품종에서 급증하는 특성을 보였다.

검색어: 벗초파리, 체리, 유인제, 발생소장

P113

Monitoring of the ground-beetle (Coleoptera: Carabidae) in Chupungryeong Eco corridor

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백두대간 생태축에서 추풍령 구간의 생태통로 완공에 따라 지표성 딱정벌레의 생태통로 이용현황을 알아보기 위하여 생태통로 완공 전 경부선, 경부고속도로, 4번 국도에 의해 단절되어있던 4곳의 산림구역을 A, B, C, D지점으로 선정하고 생태통로1, 2, 3과 함께 지표성 딱정벌레류 분포 및 출현을 Pitfall trap을 이용하여 조사해 비교하였다. 2016, 17년 산림구역 조사에서는 총 21종 1,456개체가 조사되었으며 우점종으로는 윤납작먼지벌레(471개체), 아우점종으로는 쌍무늬먼지벌레(451개체)가 조사되었다. 2019, 20년 생태통로 상부 조사에서 총 27종 186개체가 조사되었으며 우점종으로는 가는청동머리먼지벌레(65개체), 아우점종으로는 *Amara* sp.(23개체)가 조사되었다. 생태통로 건설 절 A, B, C, D지점과 건설 후 1, 2, 3통로의 조사결과에서 공통종 출현은 9종 77개체 이며 유사도는 0.367로 나타났다. 아직까지 생태통로를 이용한 딱정벌레의 단절된 서식처가 완전히 복구되었다고 보기는 어렵지만 꾸준한 모니터링이 필요할 것으로 생각된다.

검색어: 추풍령생태통로, 생태통로, 함정트랩, 딱정벌레

P114

Dispersal ability of *Leptoglossus occidentalis* (Heteroptera: Coreidae) in nature

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소나무의 구과를 가해하는 외래해충인 소나무허리노린재(*Leptoglossus occidentalis* Heidemann, 1910)의 확산 능력을 확인하기 위하여, 인천시 연수구에 위치한 인천대학교 부지 내 소나무 군락 및 야외 운동장에서 소나무허리노린재의 이동성 및 비행 능력을 실험하였다. 소나무허리노린재의 이동성은 무선인식태그(RFID)를 사용한 표식-방사-재포획(MRR)방법을 이용하여, 단위 시간당 이동 거리를 측정하여 추산하였고, 비행 능력은 야외 운동장에서 개체별 비행거리를 측정하여 확인하였다. 이동성 실험 결과, RFID를 부착한 96마리 소나무허리노린재 중 5마리만이 재포획되었고(재포획률 5.2%), 평균적으로 2.6일간 4.0 m를 이동하였다. 일별 평균 이동거리는 3.1 m/day이며, 최대 7.4 m/day 까지도 이동하였다. 총 23마리를 이용한 비행 실험에서, 모든 실험 개체는 1회 비행만으로 평균 39.3 m를 비행하였고, 최대 64 m 까지도 비행한 개체가 나타났다.

검색어: 외래해충, 소나무허리노린재, 확산, 이동 능력, 비행 능력

P115

Investigation of the time of occurrence of aphids, trips, and whitflies in medicinal crops such as *Schizonepeta tenuifolia* using yellow sticky trap

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형개, 둥글레 등 약용작물에 피해를 주는 진딧물, 총채벌레, 가루이의 발생 시기와 밀도를 음성과 평창에서 끈끈이 트랩을 이용하여 조사하였다. 형개에서 진딧물은 음성과 평창 포장에서 6월 하순, 총채벌레는 음성에서는 7월 초순, 평창에서는 7월 하순, 가루이는 음성에서 7월 초순에 발생 밀도가 가장 높았으며 그후 감소하였다. 둥글레에서 진딧물은 음성에서 6월 하순, 평창에서 8월 중순, 총채벌레는 음성에서 7월 중순, 평창에서 7월 하순, 가루이는 음성에서 7월 초순에 발생 밀도가 가장 높았으며 그후 감소하였다. 어성초에서 진딧물은 음성에서 6월 하순, 평창에서는 6월 중순, 총채벌레는 음성에서는 7월 중순, 평창에서는 7월 하순, 가루이는 음성에서 7월 초순에 발생 밀도가 가장 높았다.

검색어: 형개, 둥글레, 어성초, 진딧물, 총채벌레, 가루이

P116

Occurrences of insect pests in *Rubus crataegifolius* in Gyeongnam Province

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Rubus crataegifolius is a shrub species and is primarily distributed throughout Asia and Europe. Cultivation area for *Rubus crataegifolius* are steadily increasing. However, despite the damage to the production of *Rubus crataegifolius* due to pests, development of pest control technologies is insufficient.

This study was conducted to investigate the occurrence and damage of insect pests in *Rubus crataegifolius* in Gyeongnam province and utilize it as basic data for development of major pest control technology. As a result, 11 species of insect pests were investicated. In particular, eriophyid mite occurred throughout the growing season. Damaged leaves are reduced in growth and the amount of photosynthesis is greatly reduced. *Frankliniella occidentalis* mainly live in flowers during the flowering period, and even the harvest, giving consumers a sense of disgust. *Drosophila suzukii* occur in late harvested fields, and larvae emerge from the harvest, giving consumers a sense of disgust.

Key words: *Rubus crataegifolius,* eriophyid mite, *Frankliniella occidentalis, Drosophila suzukii*

P117

Surveilance of sporadic and subtropical insect pests in Gyeongnam province

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기후변화와 세계시장 개방에 따른 외래 및 돌발해충의 종류는 다양해지고 밀도는 지속적으로 증가하고 있지만 발생 실태에 관한 자료는 미흡하다. 본 연구는 경남지역 돌발 및 남방계 해충의 발생과 피해조사를 위해 먹노린재, 톱다리개미허리노랜재 2종을 경남 18시·군에서 조사하였다. 먹노린재는 유입기(6월), 발생최성기(7월) 조사를 진행하였고, 지점당 20주에 대한 마리수를 육안조사하였다. 톱다리개미허리노린재는 콩 생육 초기, 중기, 후기 조사를 진행하였고 지점당 페로몬트랩 1개를 설치하고 1주 후 채집된 마리 수를 조사하였다. 먹노린재는 친환경 벼 재배 논에서 주로 발생하였고, 남해, 밀양, 창녕, 의령 등에서 가장 밀도가 높게 조사되었다. 톱다리개미허리노린재는 전시군에서 발생이 확인되었으며, 특히 밀양 하동 등에서 밀도가 가장 높았다.

검색어: 경남지역, 돌발해충, 남방계해충, 발생조사

P118

Seasonal occurrence of two-spotted spider mites, *Tetranychus urticae* (Acari: Tetranychidae) on chrysanthemums greenhouse in Chungnam province

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시설에서 절화국화 재배시 문제가 되는 점박이응애를 태안, 당진, 예산 지역별로 조사한 결과, 농가별로 약제살포 주기나 농약종류에 따라 발생되는 응애밀도는 농가별로 차이를 보였으며, 태안지역이 발생밀도가 높았다. 시기별로 점박이응애 밀도를 조사 한 결과, 6월 상순부터 8월 상순까지 태안에서는 엽당 마리수가 0.8～1.6, 당진은 0.2～0.6, 예산은 0.1～0.3 마리 발생하였다. 농약 직접살포 경우 92.9%, 살포간격은 4～7일 간격이 50% 차지하였고, 점박이응애 방제로 아바멕틴유제 사용농가는 조사농가 모두 사용하였고, 클로르페나피르수화제, 에톡사졸액상수화제, 스피로메시펜 액상수화제, 비페나제이트 액상수화제 순으로 사용하였다.

검색어: 점박이응애, 국화

P119

Seasonal occurrences and halo spot symptom of Thrips on Shine Muscat Grapes(*Vitis vinifera* L.)

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A total of 12 shine muscat orchards were investigated in Gyeongbuk province of Gyeongsan, Yeongcheon, Gimcheon, and Sangju for three years from 2018 to 2020. The type and density of occurrence was investigated using yellow adhesive traps (15×25 cm, greenagrotec, Gyeongsan), and early March to late October at intervals of 10 days. The dominant species in Shine Muscat Grape Orchard were *Frankliniella occidentalis* and *Frankliniella intonsa, Frankliniella intonsa* and *Scirotothrips dorsalis* occurred from early March to October, and *Frankliniella occidentalis* occurred from mid-April to October. Amorphous white stains and brown spots were found on the surface of the fruit from the early stage of the Shine Muscat Grape. As a result of investigation, a wound with a small hole made when thrips were oviposition remained in the center. As a result of genetic analysis by removing the pericarp tissue including the eggshell, it was found that the halo spot damaged was caused by the *Frankliniella occidentalis*.

Key words: Grape, Shine Muscat, Thrips, Oviposition

P120

Individual-based model applied to *Leptoglossus occidentalis* for simulating population dispersal according to passive movement

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Leptoglossus occidentalis is a forest pest expanding widely in the southern Peninsula of Korea since 2010s. An individual based model (IBM) was developed to emphasize the passive moment of the insect individuals due to traffic effect. Life events of metamorphosis, reproduction and active/passive movements were included in the model. Given heterogenous environmental conditions including forest, residence and traffic load, the passive movements were simulated in two stages: probability of reaching the nearest road followed by movement within the road network. The results were compared with advancement patterns according to previous data. Relations between population dispersal and transport due to traffic effects were disclosed through simulation. Effectivity of IBM with an emphasis on passive movements of insects was further discussed regarding monitoring and management of forest insect pests.

Key words: forest insect pest, dispersal, passive movement, monitoring, pest management

P121

Comparison of arthropod community between eco-friendly and conventional culture rice paddies in Gyeongbuk region

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본 연구는 경북지역 관행 및 친환경 논 재배지의 주요 해충발생과 절지동물의 다양성을 비교하였다. 조사지는 쌀 주산지인 의성과 군위로 지역별 관행 및 친환경 논을 각각 3지점으로 하였으며, 2020년 2월부터 2021년 9월까지 각 지점의 논과 논두렁에서 절지동물을 조사하였다. 2~3월의 절지동물 총 개체수는 친환경 재배지보다 관행 재배지에서 논과 논두렁 모두 높게 나왔으며, 익충류의 절지동물 중 거미류와 톡토기류는 관행 재배지, 벌목류(개미)는 친환경 재배지에서 각각 높게 나타났다. 2~3월 절지동물 종 풍부도는 관행 논보다 친환경 논에서 약간 높거나 비슷한 결과를 보였으며, 4월의 경우 종다양도와 종풍부도 등 대부분의 지수가 비슷한 양상을 보였다. 이앙 후 생육기(6월~9월) 주요 해충 발생의 경우, 멸구류는 친환경 재배지보다 관행 재배지에서 발생밀도가 다소 높았으며, 벼물바구미는 친환경 및 관행에 상관없이 산간지방에서 높은 비율로 관찰되었다. 흑명나방의 발생은 관행과 친환경간 차이가 없었으며, 먹노린재, 흰등멸구, 이화명나방의 발생은 모든 재배지에서 매우 낮거나 관찰되지 않았다.

검색어: 월동, 절지동물, 병해충, 친환경, 벼논

P122

Application of deep feed forward model to predict of pine wilt disease

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Pine wilt disease (PWD), as a notorious *pinus* disease caused by *Bursaphelenchus xylophilus*, was first recorded in 1988 in South Korea. Currently, PWD has occurred in millions of pine trees, and the infestation has still expanded by vectors of *Monochamus alternatus* and *Monochamus saltuarius*. Accordingly, this study tried to predict the potential distribution of PWD as a useful data for risk management by using the deep feed forward (DFF) model. The DFF model showed an accuracy of approximately 80%, but it was difficult to classify areas of absence. Nevertheless, the current DFF model performed better than other species distribution models, suggesting this model could be an option to investigate an indicator for the risk of PWD. In the future, we will test new methods to improve the model performance with improving architecture because the DFF model which is the most basic model in artificial neural network.

Key words: aritifical neural network, deep feed forward, pine wilt disease, species distribution modeling

P123

Seasonal occurrence patterns of *Cephalcia lariciphila japonica* (Hymenoptera: Pamphiliidae) in *Abies holophylla* plantation

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In August 2020, 10-year-old *Abies holophylla* plantations, located in Hwacheon-gun, Gangwon-do, were severely defoliated by an outbreak insect pest species, *Cephalcia lariciphila japonica*. We investigated density of overwintering larvae in November, 2020. From April to July, 2021, we monitored seasonal changes in adult's emergence and larval occurrences. We also measured the rate of defoliation of *A. holophylla* caused by larvae of *C. l. japonica* in accordance with larval density. Average (± s.e.) density of overwintering larvae and newly emerged adults were 19.5 (± 1.00) per 0.04㎡ and 270.2 (± 42.09) per 0.36㎡, respectively. Male adults were emerged eariler than females and they showed peaks in early May, 2021. Sex ratio (female:male) was 1:3.26. The rate of defoliation was high in June compared to May and July, 2021.

Key words: larch web-spinning sawfly, phenology, forest insect pest, outbreak

P124

Effects of temperatures on development and reproduction of *Matsumuraeses falcana* (Lepidoptera: Tortricidae)

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콩과 작물 해충인 어리팥나방(나비목: 잎말이나방과)을 10~31℃ 사이의 3℃ 간격 항온조건에서 인공사료로 사육하면서 온도가 발육과 생식에 미치는 영향을 조사하였다. 유충은 10℃에서, 번데기는 10, 13, 31℃에서 발육하지 못했고, 성충은 10과 31℃에서 자손을 생성하지 못했다. 온도가 증가하면서 발육기간이 짧아졌는데, 31℃에서 알과 유충 기간이, 28℃에서 성충의 산란전 기간이 바로 아래 온도보다 길어졌다. 생식 성공률은 25℃에서 가장 컸다. 암컷 한 마리는 일생동안 19~25℃에서 평균 약 140마리와 최대 약 270마리의 자손을 생성하였다. 알과 유충, 번데기, 산란전 기간에 대한 최저발육온도와 발육완성온일도(DD, 괄호 안)는 순서대로 10.0°C(63.1DD)과 11.6°C(209.6DD), 12.1°C(133.6DD), 11.1°C(56.2DD)이었다. 관찰된 값들을 이용하여 어리팥나방의 온도의존적 발육과 생식 특성을 대표하는 비선형 모형들이 작성되었다.

검색어: 어리팥나방, 발육, 생식, 온도 영향

P125

An issue on emergence seasons of *Chilo suppressalis* (Lepidoptera: Crambidae) observed through analyses of outdoor rearing and sex pheromone trapping data

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이화명나방의 갓부화 유충을 야외에서 시기별로 사육하면서 우화하는 시기를 조사하였다. 5월 중하순에 발육을 시작한 유충들은 그 해 7월 초에 우화 피크를 보였다. 6월 하순~ 7월 하순에 발육을 시작했을 때는 한 집단 안에서 그 해와 이듬해 우화하는 개체들이 같이 발생하였다. 7월 말과 8월 초부터 9월 중순 사이에 발육을 시작하는 유충들은 모두 월동하였다. 한편, 충남과 경기도에서 성페로몬트랩으로 성충의 연중 발생 시기를 조사했을 때, 4~5월과 7월, 8-9월의 3회 발생이 의심되는 지역들이 있었다. 7월에 포획된 성충들은 5월 중하순부터 유충들이 발육할 때 포획될 수 있는 집단으로 추정되었다. 이 결과는 이 곤충이 연중 2회 성충이 발생하는 시기에 대한 기존의 생태 정보와 달라, 향후 먹이식물의 분포와 성페로몬 트랩에 포획되는 종의 정밀 분석을 통해 이화명나방의 발생 시기를 재검토할 필요성이 제시되었다.

검색어: 이화명나방, 휴면 유기 시기, 연중 세대수, 재검토

P126

Survey on the occurrence of sporadic and subtropical insect pests in jeollanamdo province

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최근 기후변화로 인해 유입된 남방계해충과 시기 및 장소의 제한 없이 발생하는 돌발해충은 농작물에 그을음병 등 심각한 피해를 주고 있다. 이에 따라 전남지역에서 발생하는 돌발해충 3종(미국선녀벌레, 갈색날개매미충, 먹노린재)과 남방계해충 3종(썩덩나무노린재, 볼록총채벌레, 톱다리개미허리노린재)에 대한 발생실태를 2020~2021년 조사하였다. 미국선녀벌레는 조사 기주인 감나무에 발생하지 않았으나 주변 야산의 환삼덩굴 등 다른 기주식물에는 발생했으며, 성충은 유아등 불빛에 잘 유인되는 것을 확인하였고, 친환경 방제제로 마늘추출물 등 7종이 85.3% 이상 방제 효과를 보였다. 갈색날개매미충의 월동 난괴는 0.6개/가지, 약충은 0.6마리/가지, 성충은 0.2마리/가지, 썩덩나무노린재의 성충은 유입기 22.6마리/트랩, 약성충기 16.4마리/트랩 발생하였고, 먹노린재의 약성충수는 본답유입기에 0.09마리/60주, 발생최성기에 0.17마리/60주, 톱다리개미허리노린재의 약성충수는 139마리/트랩, 등숙기 243마리/트랩, 생육후기 87마리/트랩 발생하였다.

검색어: 전남지역, 돌발해충, 남방계해충, 발생실태

P127

Interactive effects of temperatures and plant hosts on the development of *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae)

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The beet armyworm, *Spodoptera exigua* is one of the most serious pests in field crops, vegetables and ornamentals. Temperatures (15, 20, 25, 27, 30, 35, and 40 °C) and host plants [(soybean and maize), and Artificial diet as a control] dependent developmental parameters and survival of *S. exigua* were studied in this study. Stage-specific parameters such as lower developmental threshold and thermal constants were determined by linear and non-linear models (SSI). The total developmental time (egg - adult) decreased with increasing temperature from 15 – 35 °C on both plant hosts, and artificial diet. The traditional linear model estimated the lower temperature thresholds (T_{min}) and the thermal constants (K) for each life stage. Temperature and plant hosts also influenced the adults longevity. Findings of this study can be employed in predicting number of generations, occurrence, and population dynamics of *S. exigua*.

Key words: Beet armyworm, thermal models, development, thermal constants, forecasting

P128

Species composition, abundance, and seasonal dynamics of perilla seed bugs (Heteroptera: Lygaeidae) in weeds and perilla fields in Korea

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The perilla seed bugs (PSB) are emerging pests of several field crops in Korea. A survey of PSB on weeds and perilla was conducted over 2 years in Miryang, to determine species composition, abundance, and seasonal dynamics of PSB. Three species, *Nysius plebeius*, *Nysius hidakai*, and *Nysius inconspicuus*, and several parasitoids were collected during monitoring. *N. hidakai* had the greatest abundance throughout the sampling seasons. In 2019 and 2020, adult PSB and parasitoids were more abundant in weed than perilla. Four and 2 peaks with higher number of *N. hidakai* was found in weeds in 2019 and 2020, respectively. However, identical peak was found in perilla crops in both years. Six parasitoid families (Eulophidae, Braconidae, Figitidae, Aphidiidae, Pteromilidae, and Ichneumonidae) were dominant. Continuous monitoring of PSB in alternative weed hosts are needed in order to protect the perilla crops against PSB.

Key words: Sampling, seasonal peak, parasitoids, alternative hosts, management

P129

Comparison of biodiversity and community structure on different farming methods in Jeju Island

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농업생태계는 최근 중요한 생태계로 인정받고 있다. 특히 관행농은 경작지에서 수확률을 높이기 위해 여러 약품, 물질을 인위적으로 첨가하는 농법으로 친환경 경작지의 환경과 많은 차이를 나타내게 된다. 본 연구는 유기농지와 관행농지의 환경을 평가하기 위한 연구의 한 부분으로서 제주도에서 대표적인 6가지 작물에 대한 친환경 농지, 관행 농지 밭을 1개씩, 총 12개의 밭을 선정하여 생물상을 조사했다. 더불어 각각의 밭의 내, 외부를 구분하여 조사를 수행하여 밭에서 가장자리 효과가 나타나는지에 대한 평가가 진행됐다. 이를 통해 농법에 따라 경작지 생태계의 생물상이 어떻게 변하는지 확인하고 발생 해충 및 잡초의 정보를 기록하여 기초데이터를 제공할 수 있다. 추후 물리, 화학적 연구와의 통합비교분석을 통해 관행농지와 유기농지에 대한 종합적인 환경평가가 진행될 예정이다.

검색어: 농업생태계, 생물 다양성, 군집분석, 가장자리 효과

P130

Tracking experiment to confirm the flight and dispersion ability of the *Callipogon relictus* Semenov using radio telemetry

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천연기념물 제218호인 장수하늘소는 지금까지 정확한 생태가 알려지지 않아 복원 및 보전에 어려움이 많은 곤충이다. 국립수목원에서는 광릉숲에 서식하는 장수하늘소의 비행 및 분산 능력 등 생태적인 특성을 파악하기 위하여 비행 실험 및 위치 추적 실험을 수행하였다. 실험은 장수하늘소의 성충이 발생하는 시기인 6월 말부터 8월까지 진행하였으며, 라디오 태그를 부착한 성충 10개체를 방사하여 위치 추적을 통한 이동 경로 및 광릉숲 내에서의 이동 능력을 알아보고자 하였다. 추적실험 결과 위치 추적 실험을 통해 GPS 좌표 및 고도, 이동 여부, 육안 관찰 여부 등을 기록하였으며, 이를 토대로 이동 거리 및 패턴을 확인하였다. 또한 기주식물로 알려진 참나무, 서어나무가 아닌 칠엽수에서 수액을 섭취하는 것이 추가적으로 확인되었다.

검색어: 장수하늘소, 생태 조사, 위치 추적, 분산 능력

P131

Comparison of the thrips species on red pepper grown in open fields and in greenhouses

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고추에 발생하는 총채벌레는 직접적 가해뿐만 아니라 토마토반점위조바이러스(TSWV)를 매개하여 그 피해가 크다. 총채벌레의 발생 조사를 위해 2021년 5월부터 9월까지 전북 고창의 노지와 시설 고추의 꽃에서 채집한 총채벌레를 현미경 하에서 유전자 분석으로 동정하였다. 노지 고추에서는 꽃노랑총채벌레, 대만총채벌레, 파총채벌레의 3종이 발생하였고 특히, 대만총채벌레는 모든 시기에 높은 발생을 보였다. 파총채벌레는 6월에 일부 발생하였다가 이후 발생하지 않았다. 시설 고추에서는 꽃노랑총채벌레와 대만총채벌레가 발생하였고 꽃노랑총채벌레가 모든 시기에서 높은 발생 밀도를 보였다. 이와 같이 고추 재배 방식에 따라 총채벌레 발생 종과 우점도가 다르므로 차별화된 방제 전략을 수립해야 할 것이다.

검색어: 노지, 시설, 고추, 꽃노랑총채벌레, 대만총채벌레, 발생

P132

Response of *Frankliniella occidentalis* to different colors in pepper greenhouses

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총채벌레는 우리나라에 90여 종이 알려져 있으며 다양한 시설작물에서 직접적인 섭식 피해 이외에 토마토반점위조바이러스(TSWV)를 매개하는 간접적인 피해도 유발한다. 그동안 총채벌레 방제는 살충제에 의존해 왔는데, 이는 농업환경에 많은 부작용을 유발하고 해충에 저항성을 유발시켜 더욱 방제를 어렵게 하고 있다. 이러한 문제를 해결할 수 있는 새로운 대안으로 색상 트랩을 활용하고자 2021년 5월부터 10월까지 고창과 합천의 고추 하우스에서 12가지 색상 트랩을 설치하여 포획량을 비교하였다. 그 결과, 파란색, 노란색, 주황색의 포획량이 상대적으로 높았던 것으로 조사 되었다. 반면, 검은색, 분홍색, 빨간색 트랩에서는 거의 포획되지 않아 상대적으로 기피 효과가 높은 것으로 조사되었다. 이런 결과는 기피 색상을 시설 하우스 외부에 설치하여 본 해충의 내부로의 유입을 차단하고, 시설 내부에서 발생하거나 유입된 총채벌레는 유인색 트랩으로 포획한다면 효과적으로 방제할 수 있을 것으로 보인다.

검색어: 고추, 꽃노랑총채벌레, 색상, 유인, 기피

P133

Larvicidal activity of methyl benzoate, a volatile organic compound, against the mosquitoes *Aedes albopictus* (Skuse) and *Culex pipiens* (L.)

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Methyl benzoate (MBe) is a volatile organic molecule with floral characteristics used as a food flavoring component. MBe has an insecticidal effect against a variety of agricultural and urban arthropod pests. For the first time, the current study examined the mosquito larvicidal potential of MBe against fourth-instar larvae of *Aedes albopictus* (Skuse) and *Culex pipiens* (L.) (Diptera: Culicidae). A positive association was observed between MBe concentrations and larval mortality in both species. The highest mortality recorded was 100% for *A. albopictus* and 56% for *C. pipiens* at 200 ppm MBe after 24 h of exposure. LC_{50} values of MBe against fourth-instar larvae of *A. albopictus* and *C. pipiens* were 60 ppm and 184 ppm, respectively. These results suggest MBe has great potential as an environmentally friendly larvicidal agent in mosquito control.

Key words: insecticide, larvicidal activity, methyl benzoate, mosquito control

P134

Identifying food additives toxic to Fall armyworm and Fall webworm

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We conducted on the development of control techniques against two invading pests, Fall armyworm (FAW) and Fall webworm (FWW), using food additives known to be non-toxic to humans and livestock. While culturing FAW and FWW larvae with feed containing various kinds of food additives, we investigated the induction of developmental abnormalities and insecticidal effects of food additives on two insects. We are currently underway to identify food additives that have a synergistic effect on the insecticidal effect when mixed with approved crop protection agents. This work was supported by a grant from RDA (No. PJ0148452021).

Key words: fall armyworm, fall webworm, food additives, crop protection agents

P135

Sublethal Effects of Plant Extracts on *Riptortus pedestris* (Hemiptera: Alydidae)

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Riptortus pedestris (F.) is one of the major fruit pests that causes economic damage by piercing and sucking fruits. Although growers often use synthetic pesticides to manage this pest, there is a growing demand for environment-friendly insecticides. The effects of *Nicotiana tabacum* L. and *Allium sativum* L. on the fecundity of female *R. pedestris* were studied in this experiment. We also evaluated them for repellent activity against different life stages (< 24 h) of *R. pedestris*. In results, the lifetime fecundity of non-mated females was lower (48.4) in *N. tabacum. N. tabacum* also had a higher repellency on only second instar nymphs (56.4%) and adults (26.0%), after 48 h of exposure, compared to *A. sativum* and a mixture of *N. tabacum* and *A. sativum*. These results suggest that *N. tabacum* can be a potential botanical insecticide against *R. pedestris*.

Key words: repellent, fecundity, *Nicotiana tabacum*, *Allium sativum*

P136

Acaricidal activity of *Trachyspermum ammi* L. oil and its major components to Varroa destructor and selectivity to honey bee (*Apis mellifera*) adult and larvae

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The parasitic mite Varroa destructor is one of a major threat and responsible for substantial decline in honeybee colonies worldwide. The aim of this study was to investigate acaricidal activity of *T. ammi* oil and its major components against *V. destructor*, honeybees by complete exposure method. Honeybee larvae was initially exposed to contaminated food. The mortality of *V. destructor* and workers was recorded 4-h post exposure to estimate the lethal concentration (LC_{50}). Additionally, the repellency, and sub-lethal effect of against foragers' were measured. *T. ammi* and thymol showed high toxicity against mites (LC_{50} = 97.50μg/ml and LC_{50}= 70.7 μg/ml and moderately toxic against worker (LC_{50}=7962 μg/ml, LC_{50} = 483 μg/ml) respectively. γ-terpinene, was low toxic to both mites with LC_{50}=1338.8 μg/ml and worker LC_{50}= 39,995 μg/ml. The relative selectivity ratios calculated for *T. ammi*, thymol and γ-terpinene were 82, 7, and 30 respectively in case of adult bees. The toxicity and relative selectivity of larvae, repellency and interaction of major components of essential oil will be discussed.

Key words: *Trachyspermum ammi*, Lethal concentration, Fumigation test, Selectivity ratio, Repellency, Sub-lethal concentration

P137

Analysis feeding behavior of *Sogatella furcifera* (Hemiptera: Delphacidae) by sublethal concentration of imidacloprid and sulfoxaflor

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흰등멸구(*Sogatella furcifera*)는 벼멸구(*Nilaparvata lugens*)와 같이 우리나라에서 월동하지 못하고 매년 중국 남부로부터 비래한다. 비래하여 건너온 흰등멸구는 분산 발생하여 피해가 크지는 않지만, 벼의 초기 생육부진 및 출수 지연 등의 피해를 야기한다. 본 연구에서는 흰등멸구를 실내 사육하여 imidacloprid와 sulfoxaflor에 대해 생물검정을 실시하였고 Electrical Penetration Graph (EPG)를 이용하여 아치사농도에 대한 섭식양상을 파악하였다. 총 흡즙시간은 약제처리 한 그룹이 무처리 그룹 보다 짧았으며 특히 체관 흡즙 시간이 큰 폭으로 감소하였다.

검색어: 흰등멸구, EPG, 아치사농도, 섭식양상

P138

Hitchhiking report on the differential grasshopper, *Melanoplus differentialis* (Thomas, 1865) (Acrididae, Orthoptera)

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선박에서 검출된 편승자 해충의 국내 발생 모니터링을 항만 지역을 중심으로 실시하던 중 울산 온산항에서 빗살무늬미주메뚜기(*Melanoplus differentialis*)가 발견되어 보고한다. 본 연구에서는 위 침입종의 발생 양상 모니터링을 선조사 방법으로 실시하였으며, 검출 침입종의 동정은 DNA바코드 분석 후 형태적 재검도를 실시하였다. 빗살무늬미주메뚜기는 온산항을 중심으로 좁은 녹지에 대량 발생하는 것을 확인할 수 있었다. DNA 바코드를 이용한 동정에서는 종내 서열 차이가 3.9%까지 상당히 높게 나타나 동정이 어려웠으나, 형태적으로는 명확하게 단일종으로 동정되었다. 또한, DNA바코드를 이용한 유전자형 분석에서는 46개 염기좌위에서 다변형을 나타내면서 45개 유전자형으로 구분되었는데, 이를 통해 본 메뚜기는 다중 편승 침입한 것으로 판단할 수 있었다. 결과적으로 우리는 본 연구를 통해 본 메뚜기에 대한 위험성 평가를 위한 생물학적 특성 분석을 실시하고자 하였으며, 최종적으로는 본 메뚜기의 확산을 차단하기 위한 모니터링 및 조기 방제의 필요성을 제안하고자 한다.

검색어: 빗살무늬미주메뚜기, 편승자 해충, 침입종, 예찰, 한국

P139

Evaluation of ethyl formate on invasive insect pests using surrogate for eradication purpose in vinyl house

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Invasive insect pests were increasing due to increased international exchange and climate change in Korea. A vinyl house was likely to be overwintering habitats for invasive insect pests such as whiteflies, aphids, thrips and mites. The emerging invasive insect pests were difficult to control in vinyl house due to conventional insecticide resistance to and its limited use related environmental and residual concern. Herein, ethyl formate (EF), which have been using fumigant as replacement of methyl bromide in quarantine purpose and firstly attempted to use on vinyl house in cucumber and yellow melon cultivation, was evaluated efficay on surrogate insect pest. When EF exposured for 24-h to *B. tabaci*, *M. persicae*, *F. occidentalis* and *T. urticae*, LCt_{99} value of EF were 13.2, 44.7, 12.6 and 98.2 g h/m^3 respectively.

Key words: Ethyl formate, invasive insect pests, surrogate, vinyl house

P140

Evaluation of the efficacy and phytotoxicity of ethyl formate fumigation to control quarantine insect pests using surrogate, *Panonychus ulmi*, on post-harvest mangoes

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The production area of subtropical apple mangoes (*Mangifera indica*) is increasing due to climate changes and development of crop cultivation technology in green house. Increasing possibility of invasive pests in subtropical fruit cultivation and post-harvest in trade, it will be necessarily prepared the disinfestation method in case of emerging them. we evaluated the efficacy of EF fumigation against *Panonychus ulmi* as surrogate pest and phytotoxic effect to mangoes at 5°C for 4 hours. As a result, the LCt_{99} value of EF on *P. ulmi* was 29.4 g h/m^3 and then treated mangoes fruits was no phytotoxicity found in terms of sugar content, colority and hardness.

Key words: Ethyl formate, *Panonychus ulmi*, mango fruit, surrogate quarantine insect

P141

Evaluation of environmental friendly agricultural materials against stick bug, *Ramulus mikado* (Phasmatodea, Phasmatidae)

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대벌레는 2020년부터 서울특별시 은평구의 산림 지역에서 대발생하여 경기도 의왕시(2ha)와 군포(0.2ha) 등 점차 발생 범위가 국소적으로 넓어지고 있고, 활엽수에 대한 식엽 피해가 심각해 방제가 시급히 요구되고 있다. 이러한 피해를 막기 위해 살충제를 이용한 화학적 방제법을 사용하고 있지만, 생태계 안전성, 잔류성 문제 등이 발생할 수 있으며, 효율적인 화학적 방제 연구가 적은 상황이다. 이에 따라 시중에서 구할 수 있는 6종의 유기농업자재를 이용하여 대벌레에 대한 살충효과를 검정하였다. 그 결과, 대벌레 종령 유충과 성충에 대하여 유기농업자재 A (주성분: azadirachtin)은 약제 처리 3일 차에 85%의 살충효과를 보였으며, 7일 차에는 100%의 살충력을 나타내었다. 유기농업자재 B (주성분: eugenol)와 C (주성분: geraniol, rotenone)는 약제 처리 3일이 경과한 후에 각각 33.3%, 48.1%이 살충률을 보였으나, 7일 차에 88.9%, 85.2%의 높은 치사율을 보였다. 나머지 약제는 살충력이 미미하거나 낮았다.

검색어: 대벌레, 화학적 방제, 유기농업자재, 살충 효과

P142

Evaluation of ethyl formate reactivity on major electronic components in agricultural machinery and automobiles

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As increasing the international trade of agricultural and non-agricultural products, the possibility of introducing invasive insect pests is also increasing. Potential invasive pest such as fire ants and stink bugs have been detected in containers carrying machineries and automobiles. To eradicate invasive pests, methyl bromide (MB) has been provisionally used. However, MB is restricted chemical due to its ozone depletion properties, issues related human health under inappropriate ventilation and consumer safety. Here, we report the reactivity of ethyl formate (EF) on main electronic components (generators, ignition coils) to replace MB use. After fumigation with 35 and 70 g/m^3 EF for 4h at 15℃ on generators, ignition coils *etc*, various types of operation tests were conducted by time intervals. As a result, EF treated generators and ignition coils operated normally.

Key words: Methyl bromide alternative, generators, ignition coils, invasive pest

P143

Evaluation of shelf life of yellow melon after ethyl formate fumigation in modified atmosphere packaging

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Modified atmosphere packaging (MAP), lowering O_2 concentration and increasing CO_2 concentration, can extend the shelf life of fruits and vegetables. Use of MAP in yellow melons exported to East Asias countries can control respiration of fruits and extend its shelf life. In this study, ethyl formate (EF) was fumigated to the yellow melons to disinfest quarantine insect pests such as tobacco whitefly (*B. tabaci*). We evaluated phytotoxic damages on and maintaining freshness of the fruits by four parameters (color change, weight loss, sugar content, deterioration rate) after fumigation (15 and 30 g/m^3 EF, 4-h, 5°C) under two storage conditions, MAP and normal atmospheres packaging. There was no phytotoxic damages on the fruits due to EF fumigation. When stored for 14 d at 5°C in MAP, freshness of the yellow melon fruits was better than those in normal atmosphere in terms of colors, weight loss and overall index.

Key words: Packaging materials, tobacco whitefly, pest control

P144

Seasonal occurrence of *Ricania sublimata* and insecticidal activity on Omiza(*Schisandra chinensis*) orchard in Gyeongbuk province

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Recently, the occurrence of *R. sublimata* in Gyeongbuk province is spreading to various regions, and rapidly increasing. Occurrence is severe in the Gunwi and Mungyeong region on Omiza(*S. chinensis*) orchard. Therefore, in this study, the occurrence characteristics of the *R. sublimata* and the insecticidal activity against 15 pesticides. Mungyeong area have been increasing every year since the first occurrence of *R. sublimata* was confirmed in mid-August 2017. Hatching is early May and showed about 50% hatching in early June, and the final hatching rate in early July was 75%. Adults appear in early July and peaked in mid-August. For nymphs and adults of *R. sublimata* nymph, fenitrothion, phenthoate, chlorpyrifos from organophosphates, etofenprox from synthetic pyrethroids, acetamiprid, thiamethoxam, and dinotefuran from neonicotinoids showed high insecticidal activity of more than 90.0% at 72 hours after treatment. However, the insecticeds of spinosyns, avermectins, pyrrole and diamide were low effect at 50-60% control.

Key words: *Ricania sublimata*, occurrence, monitoring, insecticide

P145

Report on the hitchhiker insect pests detected from the foreign vessels entering into Korea in 2021

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2021년도 상반기 우리나라에 입항한 선박을 대상으로 편승자 해충에 대한 예찰을 실시하였다. 그 결과, 124개체의 편승자 해충을 확보하였으며, 이 중 108개체는 통합분류학적 종동정 방법을 통해 8목 38과 74종으로 동정되었으나 16개체는 과 수준까지만 동정되었다. 종 수준까지 동정된 108개체 중 14개체는 한국미분포종(not-distributed species in Korea)으로 노린재목 1종, 딱정벌레목 1종, 벌목 2종, 파리목 1종, 나비목 4종으로 분류되었으며, 이 중 나비목의 *Odontopera aurata*는 2019년 조사에서도 발견된 종으로 금년도에도 6개체가 다중 검출되어 지속적인 예찰이 필요할 것으로 사료되었다. 이에 따라, 본 연구에서는 한국미분포 편승자 해충에 대한 보고와 함께 예찰 방안 마련 및 위험성 평가를 위한 data sheet를 제공하고자 한다.

검색어: 편승자 해충, 미분포종, 외래선박, 모니터링, 검역검사

P146

Mortality of six pesticides against quarantine pest differential grasshopper, *Melanolus differentialis* Thomas (Orthoptera: Acrididea)

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검역해충 빗살무늬미주메뚜기가 2020년 7월 울산광역시 울주군 소재 온산항과 온산국가산업단지 일원에서 첫 발견된 이후 금년 7월부터 2km 인근의 농경지에서도 일부 개체가 발견되고 있다. 본 메뚜기의 기주는 농작물, 국화과 잡초 등 미주지역에서 200여종이 보고되었고, 국내 발견지에서는 칡, 개나리, 사철나무, 실내 사육에서 벼, 땅콩, 들깨, 고구마 등도 가해하였다. 본 연구는 빗살무늬미주메뚜기가 농경지로 대량 확산되어 농작물에 피해를 줄 경우를 대비하여 효과적인 방제약제를 선발하기 위하여 수행하였다. 국내에서 풀무치, 메뚜기 등에 등록된 약제 6종을 이용하여 실내 생물검정을 수행한 결과, 약충과 성충에 살충력이 80% 이상인 에토펜프록스 유제 등 3종을 선발하였다. 살충율은 성충보다 약충의 령기가 낮을수록 더 높았고, 먹이에 약제를 살포하는 기주 분무처리보다 메뚜기에 직접 약제를 살포하는 충체 분무처리에서 더 높았다.

검색어: 검역해충, 빗살무늬미주메뚜기, 약제, 살충력

P147

Occurrence and damage of moth pests in fodder and commercial edible corn

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여수, 괴산 등 주요 옥수수 재배지에서 7월~8월에 시판중인 옥수수와 서천지역 사료용옥수수 재배지에서 수확한 옥수수를 대상으로 나방류 해충의 발생과 피해를 조사하였다. 사료용옥수수 4품종의 피해율은 30~56%였고, 다청옥에서 피해율과 유충수가 각각 56%, 8마리로 가장 높았으나 열대거세미나방은 발견되지 않았다. 여수 등 7지역의 시판 옥수수에 대한 피해율은 3.1~94.0%였고, 여수 94%, 해남 38%, 고성 31% 순이었고 태안이 3.1%로 가장 낮았다. 여수, 해남, 고성에서는 열대거세미나방이 각각 65, 31, 30마리 발견되었고, 조명나방, 담배나방도 일부 발견되었다. 발견된 열대거세미나방은 2령부터 종령까지 다양하였고 여수에서는 번데기도 1개체 발견되었다. 그러므로 식용옥수수 재배 시 나방 유충 때문에 소비자들이 항의하는 사례가 발생되지 않도록 세심한 방제노력이 필요하다.

검색어: 옥수수, 나방, 해충, 발생, 피해

P148

Evaluation of biological activity of entomopathogenic fungi against agricultural antibiotics

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Antibiotics are used in various fields and applied to control insect pests and plant diseases in agriculture. Antibiotics used in agriculture mainly include streptomycin, chloramphenicol, kasugamycin, spinosad and spinetoram. Among them, streptomycin, oxytetracycin, oxolinic acid, kasugamycin, polyoxin, validamycin, spinosad, and spinetoram are registered in Korea. Agricultural antibiotics are used in various crops, including facilities crops such as peppers and cucumbers. Recently, entomopathogenic fungi are widely applied to control insect pests in facility crops. Herein the biological activity of fungi against agricultural antibiotics was evaluated.

Key words: agricultural antibiotics, biological activity, entomopathogenic fungi, spinetoram, spinosad

P149

Distribution and abundance of stored product insects in Korean wheat general storage facility

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최근 2025년 까지 자급률 5%를 달성하기 위한 밀산업 육성법이 시행되어 생산, 유통, 가공, 소비 단계에서 다각적인 연구가 진행되고 있으며 본 연구는 우리밀 비축 시 저장해충 피해를 최소화하기 위한 방법을 도출하기 위해 진행되었다. 연구의 1단계로 현재 대부분 농가나 다수의 소규모 유통 주체가 평창고에서 톤백 형태로 건조, 보관하는 조건에서 저장해충 발생 양상을 조사하기 위해 부여의 영농조합 시설과 수확, 건조 후 톤백 보관 중인 우리 밀의 발생 해충 양상과 온습도를 모니터링 하였다. 페로몬 트랩과 probe 트랩을 활용 해충발생 양상을 모니터링한 결과 톤백 내부에서는 머리대장류, 곡식쑤시기, 어리쌀바구미 순으로 시설 내 돔 트랩에서는 어리쌀바구미, 곡식쑤시기, 머리대장류, 외미거저리 순으로, 윙 트랩에서는 화랑곡나방, 보리나방, 밀가루줄명나방 순으로 모니터링 되었다.

검색어: 우리밀, 저장해충, 모니터링, 페로몬 트랩, Probe 트랩

P150

Construction of entomopathogenic fungal library for pest management

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In recent years, the problem of pest has emerged due to climate change and the expansion of agriculture. Entomopathogenic fungi has got interested as biological pesticides instead of chemical pesticides which cause serious environmental issues. We constructed an entomopathogenic fungal library and investigated the virulence of fungi against pests such as melon thrips, *Thrips palmi* and cotton aphids, *Aphis gossypii*. We isolated 64 isolates from soil, and performed virulence tests against melon thrips which damage plants by feeding activities. As a result, six isolates showed high virulence against melon thrips were selected. Next virulence tests were performed against cotton aphids which transmit various types of plant viruses. One isolate showed the highest virulence against cotton aphids, and this results suggest that our fungal library provide new isolates of fungal pesticide for various pest management.

Key words: entomopathogenic fungi, fungal library, melon thrips, cotton aphid, pest management

P151

Comparative efficacy of ethyl formate to the citrus mealybug, *Planococcus citri*, by different temperature conditions

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Since methyl bromide (MB) has been designated as ozone depleting substance, its usage is prohibited by Montreal protocol except quarantine and preshipment purpose. Ethyl formate (EF), one of the most effective MB alternative fumigants for plant quarantine, is naturally originated material, so it is safer than other fumigants and it can easily volatilize in the air. However, EF can cause phytotoxicity on some fresh commodities and it is more expensive than MB, so establishing a proper fumigation schedule is essential to reduce phytotoxicity and treatment cost. In this study, in order to reduce such phytotoxicity and cost problems, EF was treated on the citrus mealybug, *Planococcus citri*, at various temperatures of 5, 10, 13, and 20℃ to confirm the combined effect of fumigant and temperature treatment.

Key words: Ethyl formate, methyl bromide, *Planococcus citri*, Orange

P152

Establishment of the effective indoor augmentative rearing of *Exorista japonica* (Diptera: Tachinidae)

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For establishing the effective indoor mass rearing of *E. japonica* known as a parasitoid against lepidopterous larvae, biological characterstics related with an oviposition strategy and fecundity of the tachinid females were investigated.

From 2nd day of emergence, *E. japonica* females started laying macrotype eggs on the host larvae cuticle and its average fecundity was about 260 eggs per female for entire life. However, the average daily fecundity was less than 10 eggs after 14 days of emergence so that over 14 day old females seemed to be inappropriate to be used as individuals for indoor mass rearing.

E. japonica could lay over 30 eggs per host larva. However, the number of pupae produced in a host was limited despite the increase of the number of eggs per host. It was able to obtain 2.78 pupae per host on average. When 120 *Spodoptera litura* 4th larvae as hosts for *E. japonica* oviposition were supplied on daily and once every other day for 2 weeks, the average number of pupae produced in a cage were 52.5 and 72.3, respectively. But there was no statistically significant difference.

Key words: Indoor mass rearing, *Spodoptera litura*, Fecundity

P153

Control efficacy of 6 plant oil on thirps

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Thrips are economically important pests that cause problems for a variety of crops, both in greenhouse and in the field. Thrips are very difficult to control because they have the ecological characteristics of laying eggs in plants and pupating in the soil. In order to control these thrips in an eco-friendly environmentally way, the control effect of 6 plant oils was investigated on *Frankliniella occidentalis* and *Frankliniella intonsa*, which occur mainly on crops. The plant oils used in the experiment were peppermint oil, marjoram oil, eucalyptus oil, lavender oil, rosemary oil, and tea tree oil. Among them, when tea tree oil and peppermint oil were diluted 100 times, it showed more than 90% higher on *F. occidentalis* and *F. intonsa*. As a result of investigating the control effect by dilution factor, the control effect was more than 60% when diluted 100 and 200 times, but the control effect was decrease under 60% when diluted over 300 times.

Key words: thrips, plant oil, control

P154

Correlation between 6 acaricides and target site resistance point mutations of two-spotted spider mite, *Tetranychus urticae* (Acari: Tetranychidae)

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국내 7개 지역(경주, 성주, 옥천, 칠곡, 평택_1, 평택_2, 홍성)에서 채집된 점박이응애 집단과 실내 사육 중인 감수성, 그리고 etoxazole과 pyridaben 저항성 계통 점박이응애를 대상으로 생물검정 및 저항성 점 돌연변이의 발생을 확인하였다. 6개 살비제(abamectin, bifenazate, etoxazole, fenpropathrin, pyridaben, pyflubumide)에 대한 살비율 및 살란율을 감수성과 비교한 결과, 야외채집 집단은 여러 살비제에 대한 복합 저항성을 나타냈다. 각 살비제에 보고된 점 돌연변이 발생 유무와 그 빈도를 확인한 결과, 감수성 평가 수준과 점 돌연변이와의 상관관계는 bifenazate, etoxazole, pyridaben의 점 돌연변이에서만 확인할 수 있었다. 이외의 약제 abamectin 점 돌연변이와 fenpropathrin의 점 돌연변이 A1215D는 몇몇 집단에서 발생하였으나 상관관계를 찾기 어려웠고, pyflubumide의 점 돌연변이와 fenpropathrin의 점 돌연변이 L1024V는 모든 집단에서 확인되지 않았다.

검색어: 점박이응애, 살비제, 저항성, 점 돌연변이

P155

Control of *Eurytoma maslovskii* in Korean apricot orchards using the mating disruption technique

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복숭아씨살이좀벌(*Eurytoma maslovskii* Nikolskaya)은 매실과 살구 등 핵과류의 종자를 가해하여 과실의 상품가치를 떨어뜨리고 줄기를 마르게 하여 큰 경제적 손실을 유발하는 해충이다. 우리는 건강식품으로 인식되어 있는 매실에 대한 살충제 살포를 줄이기 위하여 복숭아씨살이좀벌의 성페로몬인 2,10-dimethyldodecyl propionate와 2,8-dimethyldecyl propionate를 이용한 교미교란 방제의 가능성을 조사하였다. 2020년에 두 성분이 1:1 비율로 처리된 폴리에틸렌 파우치를 친환경 매실 과수원에 ha 당 1,000개를 설치한 결과, 피해과율은 36~78% 범위에 이르러 경제적으로 수용할 만한 수준이 아니었다. 2021년에는 주성분인 2,10-dimethyldodecyl propionate의 방출률을 높이고자 탈지면에 처리하고 부성분인 2,8-dimethyldecyl propionate를 폴리에틸렌 파우치에 처리하였으나, 주성분의 유효기간이 짧아 피해과율이 40~61%로 여전히 높았다. 이러한 결과는 성충 발생 기간인 2개월 동안 주성분을 지속적으로 충분히 방출할 수 있도록 폴리에틸렌 파우치를 대체할 새로운 소재가 필요함을 보여준다.

검색어: 복숭아씨살이좀벌, 성페로몬, 교미교란, 매실, 방출 소재

P156

Efficacy and phytotoxicity evaluation of fumigants to *Planococcus citri* on 4 imported seedlings

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Methyl bromide (MB) was used for quarantine fumigation of seedlings, but the use of MB was limited as it was known to deplete the ozone layer and affect on worker safety. Phosphine (PH_3) and ethyl formate (EF), which are less toxic to environment, have been developed as MB alternative fumigants. In this study, phytotoxicity of MB, EF and PH_3 on 4 imported seedlings and efficacy on *Planococcus citri* were evaluated. As a result, green fern, Keumjeonsu and Polysias showed the most damage in EF, followed by MB and PH_3. For cactus, no phytotoxic symptom was observed on all treatments. *P. citri* showed 100% egg mortality at PH_3 0.102 g/m^3, MB 40 g/m^3, and EF 30 g/m^3, respectively. In conclusion, PH_3 showed less phytotoxicity on seedlings at 100% mortality concentration of *P. citri*, but MB and EF showed phytotoxic symptoms on 3 seedlings.

Key words: *Planococcus citri*, Phospine, Ethyl formate, Methyl bromide, Phytotoxicity, Efficacy

P157

Spatial projection of pine wilt disease with different modeling resolution

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Pine wilt disease (PWD) has caused severe economic and ecological losses in South Korea, suggesting timely control to prevent rapid spread is important. In this study, hence, we attempted to spatially analyze the possibility of PWD occurrence in South Korea. The main idea of this study was to develop and compare two MaxEnt models with different resolutions; model targeted the whole country and provinces. Both models were developed based on actual records of PWD surveyed from 2016 to 2020 and climatic variables. As a result, it was possible to obtain information on subdivided potential occurrence areas within administrative districts with the regional-scale model, while only administrative district-level results could be presented with the national-scale model. This might be due to high spatial density of occurrence records in a specific region (Gyeongsang-do, Gyeonggi-do, and Jeju-do in this study). In conclusion, when detailed projection is necessary in a small area in species distribution modeling, it may be appropriate to develop a regional-scale model.

Key words: MaxEnt, model scale, occurrence possibility, Pine wilt disease, spatial resolution

P158

Susceptibility of chemical insecticides to Wsetern flower thrips (*Frankliniella occidentalis*)

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꽃노랑총채벌레는 고추, 토마토, 참외, 상추 등의 채소뿐만 아니라 화훼, 과수, 약용작물 등 거의 모든 작물을 가해하고 토마토반점위조바이러스(TSWV), 국화줄기괴저바이러스(CSNV), 봉선화괴저반점바이러스(INSV)를 매개하여 작물 생육, 상품성 저하, 수확량 감소를 초래하고 그 피해가 확산되고 있다. 총채벌레 방제를 위한 장기간 무분별한 화학 약제 사용이 약제 저항성 발현 개체 출현과 다른 약제에 대한 교차저항성 유발로 점차 사용할 수 있는 살충제 종류가 감소하여 농가 현장에서는 이로 인한 약제 효력 저하에 대한 의구심 증대와 함께 해충 방제의 어려움을 호소하고 있다. 유기합성 살충제 10종에 대한 꽃노랑총채벌레 약제 감수성을 실내 검정한 결과 benfuracarb, chlorfenapyr를 함유한 살충제가 살포 1일 후 95% 이상의 살충력을 보여 benfuracarb, chlorfenapyr 성분이 함유된 살충제의 교호 살포가 꽃노랑총채벌레 방제에 효율적이라 판단된다.

검색어: Wsetern flower thrips, Insecticide, benfuracarb, chlorfenapyr

P159

Insecticidal activity of plant essential oils and their proposed synergistic mechanism against Common Housefly, *Musca domestica* (Diptera: Muscidae)

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Although conventional interventions achieved great success on pest management, concerns on insecticide resistance and non-target toxicity led to claims for developing alternatives. Therefore, plant essential oils are recently gaining attention as biorational control agents. Owing to their nature as a mixture, the interactions among the constituents often account for the insecticidal activity of plant essential oils. However, there is no general understanding of synergistic mechanisms. In the present study, the insecticidal properties of 23 plant essential oils were screened against adult *M. domestica* via topical application method under laboratory condition. Furthermore, to investigate potential synergistic combinations, a fixed-dose factorial design under the Bliss independence model was employed to examine a binary mixture of selected essential oils. Interestingly, fennel sweet oil and lemongrass oil, which mainly consisted of *trans*-anethole and citral, respectively, showed synergism to the majority of other oils. Compound elimination assays indicated that *trans*-anethole in fennel sweet oil and citral in lemongrass oil were the major synergistic constituent. Enhancement of cuticular penetration and inhibition of detoxification enzymes were tested as the general synergistic mechanisms. The former was tested *via* injection assays. The identified synergists maintained their interactions, indicating cuticular penetration was not responsible for synergism. Furthermore, we investigated their effect on esterases and glutathione-S-transferases detoxification systems but neither fully explained the observed synergism. These findings suggest the involvement of a novel synergistic mechanism of *trans*-anethole and citral which was previously undiscovered.

Key words: housefly, essential oil, synergy, trans-anethole, citral

P160

Identification of sex pheromone biosynthesis-related genes in *Bemisia tabaci* via transcriptome analysis

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Bemisia tabaci is an important agricultural pest that causes secondary damage by mediating viruses while sucking host plants. Although various studies have been performed on *B. tabaci* so far, studies on sex pheromone are still insufficient. Therefore, in this study, sex pheromone biosynthesis-related genes were identified by transcriptome analysis from *B. tabaci* (Q-type). To identify the sex pheromone biosynthesis-related genes from *B. tabaci*, total RNA was extracted from the whole body of adults and sequenced by NovaSeq 6000 RNASeq analysis. The RNASeq data was assembled using Trinity program and annotated by Blast analysis. Approximately, 10.6Gb was obtained, and 274,242 contigs were annotated. Thirteen percent of contigs were homologous to reported genes by GO analysis. Finally, sex pheromone biosynthesis-related genes were identified such as fatty acid synthase, desaturase, fatty acyl reductase, and alcohol dehydrogenase, etc. These genes are likely to be involved in the sex pheromone biosynthesis of *B. tabaci*.

Key words: *Bemisia tabaci*, sex pheromone, transcriptome

P161

Response to LED light source of major pests of cucumber (1)

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LED 광원에 대한 오이의 생육 및 주요 해충들의 행동반응을 조사하였다. 담배가루이는 520nm 파장에서 번식률이 가장 높았으며, 450nm 파장에서 번식률은 억제되었다. 목화진딧물은 660nm 파장에서 번식률이 가장 높았으며, 그 외 파장대(520, 450, 520+450+660nm) 간에는 큰 차이를 보이지 않았다. 꽃노랑총채벌레는 520nm 파장에서 번식률이 가장 높았으며, 450nm 파장에 노출될 경우 번식률이 가장 억제되었다. 점박이응애는 520+450+660nm 파장에서 번식률이 가장 높았으며, 520, 450nm 파장에서는 번식률이 억제되는 경향을 보였다. 오이 유묘는 520nm 파장에 장기 노출될 경우 근장, 생체중, SPAD가 감소하는 등 생육이 억제되었다. 담배가루이는 385, 405nm의 단파장 LED 광원(UV)에 유인되는 특성이 뚜렷하였다. LED 광도는 광원으로부터 40cm 멀어질 경우 1/3로 크게 감소하여, 해충 포획용으로 활용시 작물 내부에 설치되어야 할 것으로 생각된다.

검색어: LED, 오이, 담배가루이, 목화진딧물, 꽃노랑총채벌레

P162

Development of cellulose nanocrystal-stabilized Pickering emulsions of massoia and nutmeg essential oils for the control of *Aedes albopictus*

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The larvicidal potential of 10 plant essential oils (EOs) against the Asian tiger mosquito, *Aedes albopictus* was investigated. Among the EOs, massoia (*Massoia aromatica*) and nutmeg (*Myristica fragrans*) EOs showed the strongest larvicidal activities against *Ae. albopuctus,* presenting 95.0% and 85.0% mortality at 50 μg/mL, respectively. A total of 4 and 14 compounds were identified from massoia and nutmeg EOs, respectively, and two massoia lactones, C10 and C12, were isolated from massoia EO. Among the identified components, benzyl salicylate, terpinolene, C12 massoia lactone, sabinene, benzyl benzoate, methyl eugenol, and C10 massoia lactone exhibited strong larvicidal activities. Cellulose nanocrystal (CNC)-stabilized Pickering emulsions of massoia and nutmeg EOs were developed to overcome hydrophobicity of the EOs. CNC/massoia and CNC/nutmeg emulsions were stable for at least 10 days, and larvicidal activities of CNC/massoia and CNC/nutmeg emulsions were higher than those of crude massoia and nutmeg EOs. This study suggests CNC-stabilized Pickering emulsion of massoia and nutmeg EOs as a potential larvicide against *Ae. albopictus.*

Key words: Cellulose nanocrystal-stabilized Pickering emulsion, *Massoia aromatica*, *Myristica fraagrans*, *Aedes albopictus*, Larvicidal activity

P163

Establishment of indoor rearing condition for *Binodoxys communis*

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본 연구에서는 목화진딧물 및 콩진딧물에 대한 기생성 천적인 쌍꼬리진디벌의 적정 사육 조건을 탐색하고자 하였다. 쌍꼬리진디벌 사육 시, 물을 제공하였을 경우 3일 후의 쌍꼬리진디벌 생존률은 2.5%였으나 꿀물을 제공할 경우 생존률이 30%로 유의하게 증가하였고, 이에 따라 최종적으로 생산되는 머미의 수도 유의하게 증가하였다. 오이에 목화진딧물 성충을 20마리 접종하고 진딧물 접종 2일, 3일, 4일 후에 쌍꼬리진디벌 2쌍을 도입하였을 경우, 진디벌 도입 후 15일까지 사육 케이지 당 쌍꼬리진디벌 머미 생산 수는 각각 평균 115개, 90개, 131개였지만 도입 시기별로 유의한 차이는 없었다. 그러나 진딧물 접종 1일 후에 진디벌을 도입하였을 경우는 케이지 당 평균 12개의 머미만이 생산되어 다른 시기에 비해 유의하게 적었다. 4일 후 도입의 경우 과도한 진딧물의 증식으로 인해 기주인 오이의 관리가 어려우므로 진딧물 접종 후 2일 또는 3일 후에 진디벌을 도입하는 것이 가장 효과적일 것으로 생각된다. 쌍꼬리진디벌과 목화진딧물의 상대밀도가 1:15나 1:20의 경우, 기주인 오이가 건강하게 유지되면 1:10에 비해 많은 수의 머미가 생산되었지만 오이가 시들어 머미 생산이 저해되는 경우가 많았다. 1:5의 경우는 진디벌에 비해 진딧물이 부족하여 매우 적은 수의 머미만이 생산되었으며 우화율도 65%로 90% 이상을 보인 다른 처리에 비해 낮았다.

검색어: 쌍꼬리진디벌, 목화진딧물, 적정 사육 조건

P164

Comparative efficacy of single and combined treatment of fumigants and low temperature to the two-spotted spidermite, *Tetranychus urticae*

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Animal and Plant Quarantine Agency

Two-spotted spidermite, *Tetranychus urticae*, is one of the most important agricultural pests in the world. *T. urticae* can be a problem when exporting Korean agricultural product to other countries, so developing the proper fumigation method is important. In this study, we assessed the efficacy of single and combined treatment of quarantine fumigants, methyl bromide and ethyl formate, mixed with cold treatment to control *T. urticae*. Methyl bromide was treated for 2h and ethyl formate was treated for 4h at 20°C, followed by 3 days cold (1°C) treatment. Combined treatment of fumigants and cold treatment showed less efficacy on *T. urticae* than single treatment at low dosage, but efficacy was increased at higher dosage. The synergistic effect of combined treatment of chemical and physical treatment can be differed by pest species and treatment conditions.

Key words: *Tetranychus urticae*, methyl bromide, ethyl formate, cold treatment

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Biological control of *Spodoptera frugiperda* using entomopathogenic fungi

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Spodoptera frugiperda is an invasive polyphagous pest derived from America. It has annually invaded to Korea at summer season since it was firstly reported in 2019. To minimize the damages by *S. frugiperda*, appropriate control methods should be studied and developed. This study is aimed to assess the potential ability of entomopathogenic fungi as biological control agents against *S. frugiperda*. Ninety-three isolates of entomopathogenic fungi were selected to screen insecticidal activity against 2nd instar larvae of *S. frugiperda*. Among them, thirty-four isolates showed 100% mortality at 8 days after fungal treatments in laboratory condition. Conidial productivity and thermotolerance of conidia cultured on 1/4 SDA were evaluated to characterize the possibility for field application. Based on the characterization, about ten isolates were selected to determine the high virulence against *S. frugiperda.*

Key words: Biological control, entomopathogenic fungi, *Spodoptera frugiperda*, conidial productivity, thermotoelrance

P166

Edible substances that interfere with the binding of juvenile hormone receptors

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Methoprene-tolerant (Met), a known juvenile hormone receptor, binds to Steroid receptor co-activator (SRC), another type of receptor protein, in the presence of the juvenile hormone. In this case, it is known that the conjugate formed by this binding directly regulates the activity of the juvenile hormone. In this study, using a screening system for analysis of the species-specific juvenile hormone disruptor of *Spodoptera litura*, also known to be an invasive pest, we selected substances that interfere the binding of the juvenile hormone receptor. When the food of *S. litura* larvae was mixed and treated with the selected substances, we observed that the larvae developed into deformed pupae and did not develop normally. Based on these results, the selected substances show potential as eco-friendly agents for use in the future.

Key words: Juvenile hormone, Methoprene-tolerant, Steroid receptor co-activator, *Spodopter litura,* Screening

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Production of *Beauveria bassiana* JEF-350 blastospores with high thermotolerance

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Compared to fungal solid culture, liquid culture could be more advantageous, such as production time & cost and risk management in contamination. However, fungal blastospores from the liquid culture are frequently susceptible to high temperature stress. We tried to investigate culture media if they could increase the viability of *Beauveria bassiana* JEF-350 blastospores under high temperature. After liquid cultures of JEF-350 at SDB, SSYP and YPG media for seven days, the productivity and thermotolerance of JEF-350 blastospores were investigated. Solid cultures at the same agar media served as controls. A relatively large amount of JEF-350 blastospores was produced in YPG and SSYP liquid media, and interestingly SSYP liquid medium produced the highest thermotolerant blastospores, which was comparable to conidia from SSYP-agar. From a virulence test against *Thrips palmi* in laboratory conditions, blastospores showed similar virulence to the conidia in each medium treatment. In this study, SSYP liquid media was most suitable for production for heat-resistant JEF-350 blastospores.

Key words: *Beauveria bassiana*, liquid media, solid media, thermotolrance, productivity, virulence

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Use of entomopathogenic fungi to control asian tiger mosquito, *Aedes albopicturs*

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Asian tiger mosquito, *Aedes albopictus*, is the most important serious vectors of human diseases like malaria and is responsible for the transmission such as dengue fever and yellow fever in the world. Recently, entomopathogenic fungi have been used as an important control agent to control mosquitoes. Entomopathogenic fungi, which are environmentally friendly insect pest control agents and are used to control various pests. Herein, we assayed 10 entomopathogenic fungi against mosquito larvae and selected the fungal strains with high pathogenicity. Based on these results, it suggests that entomopathogenic fungi can be control the mosquito larvae as an effective biopesticide.

Key words: asian tiger mosquito, *Aedes albopictus,* biological control, entomopathogenic fungi, fungal insecticide

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Possibility of biological control of Fig Weevil, *Aclees taiwanensis* using entomopathogenic fungi

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Fig weevil, *Aclees taiwanensis*, is one of the pests that causes serious damage on fig trees. The damage of weevil was first reported in Jeonnam, Korea in 2020. The fig trees cultivated under Environment-friendly agricultural practices need to develop biological control agents to control fig weevil. Entomopathogenic fungi have been known as one of the important biological insecticide that can control weevils. To control fig weevil, the entomopathogenic fungi were treated for screening. The conidial suspensions of 10 fungal strains were adjusted to 1×10^7 conidia/ml and sprayed on fig weevil. These result suggest that fungal insecticide can be control the fig weevil as an biological control agents.

Key words: *Aclees taiwanensis,* biological control, fig tree, fig weevil, fungal insecticide

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Development of RNAi method for screening candidate genes to control *Varroa destructor*

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The ectoparasitic mite *Varroa destructor* is one of the most destructive pests of the honey bee (*Apis mellifera*), leading to the collapse honey bee colony in many regions of the world. In order to minimize acaricide exposure to honey bee, RNA interference (RNAi)-based method has recently been suggested as an alternative control measure of *V. destructor*. To develop the potential of RNAi approaches in the *V. destructor*, we searched candidate genes for RNAi through the finding orthologs of genes using *V. destructor* genome database. Additionally, we compared three methods for the delivery of double-stranded RNA (dsRNA) to determine efficient method for dsRNA delivery. We identified 30 genes putatively involved in important biological functions from the *V. destructor* genome. These candidate genes are largely divided into 8 groups such as ribosomal protein, formation of transport vesicles (coatomer protein), proton potential regulation (v-type ATPase), osmoregulation (aquaporin), chitin synthesis (chitin synthase). To evaluate the efficiency of dsRNA delivery, three delivery methods (direct injection, immersion with 0.9% NaCl and 0.2% triton X-100) were compared for 12h following treatment with green fluorescent protein (GFP)-dsRNA. Direct injection, immersion with 0.9% NaCl, and immersion with 0.2% triton X-100 showed mite survival rates of 53%, 75%, and 15%, respectively. In summary, the searching for orthologous genes using genome database is the efficient strategy to analyze candidate genes in the RNAi pathway. Furthermore, dsRNA delivery via direct injection and immersion with 0.9% NaCl is an effective system to establish an RNAi-based control system against *V. destructor*.

Key words: *Varroa destructor*, *Apis mellifera*, RNAi, Green fluorescent protein

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2021 occurrence status of *Spodoptera frugiperda* in corn fields in Chungcheong province

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열대거세미나방은 아메리카 대륙의 열대 및 아열대 지역이 원산지인 해충으로서 2019년 제주에서 국내 발생이 첫 보고된 이후 매년 비래하여 피해를 주고 있다. 열대거세미나방은 광식성 해충으로서 벼과 식물을 주로 가해하며, 국내에서는 특히 옥수수에서 그 피해가 크게 발생을 하고 있다. 충북 청주, 보은, 괴산, 충남 태안, 당진, 홍성 지역을 대상으로 충청지역의 열대거세미나방 발생을 조사한 결과, 대부분의 열대거세미나방의 성충은 8월부터 발생이 시작되었으나, 충남 태안지역은 이보다 빠른 5월 3주, 6월 2주에 각 1개체가 페로몬 트랩에 유인되었다. 유충의 피해량 조사의 경우 지역별로 20~30 필지를 임의로 조사한 결과 8월 4일 기준 발생 필지율 및 평균 피해율은 청주 25.0/6.8, 보은 20.0/2.1, 괴산 20.0/2.6, 홍성 35.0/11.4, 태안 57.1/9.6, 당진 66.7/6.0%로 조사되었다. 충북지역 보다 충남지역의 피해율이 높은 것으로 조사되었다. 그 이유는 편서풍을 타고 남중국(대만)으로부터 유입되는 열대거세미나방의 성충이 지역 위치 특성상 충남에서 먼저 피해가 시작되었기 때문으로 판단된다.

검색어: 열대거세미나방, 옥수수, 발생현황

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Occurrence status of sporadic and subtropical insect pests in Chungbuk province

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최근 기후변화로 인해 해충의 발생 패턴이 점점 변화하고 있다. 기존에 보고되지 않던 해충이 발생을 하는가 하면, 적은 밀도로 발생하던 해충이 다발생 하는 등 기후변화가 농업 생태계에 다양한 영향을 끼치고 있다. 충북지역 11개 시군을 대상으로 돌발 해충 4종(미국선녀벌레, 꽃매미, 갈색날개매미충, 먹노린재), 남방계 해충 2종(톱다리개미허리노린재, 썩덩나무노린재)의 발생 현황을 조사한 결과, 돌발 해충인 갈색날개매미충 난괴와 약충의 발생가지율은 각각 84.0, 22.7%로 청주지역의 발생이 가장 많았으며, 미국선녀벌레의 약충은 청주가 19.0%로 가장 높은 발생율을 보였다. 먹노린재의 경우 벼 피해주율이 가장 높은 지역은 6월 옥천 2%, 7월 옥천 11%, 8월 음성 19%, 9월 진천 38%로 조사되었다. 남방계 해충인 볼록총채벌레의 발생 밀도는 개화기인 6월 영동 2.1개체, 과실비대기인 8월 영동 2.9개체, 썩덩나무노린재는 유입기인 6월 영동 22.2개체, 약·성충기 7월 충주 58.5마리, 먹노린재는 6월 단양 72개체, 7월 괴산 15개체, 8월 옥천 197개체로 충북 11개 시군은 가장 많은 발생이 조사되었다.

검색어: 돌발 해충, 남방계 해충, 기후변화, 발생 현황

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Efficacy and phytotoxicity of combined treatment of ethyl formate and cold treatment to the citrus mealybug, *Planococcus citri*, on pineapple

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Single application of fumigant is widely used to control quarantine pests, but recent researches indicate that concurrent treatment of chemical and physical treatment can enhance efficacy and decrease phytotoxicity. In our previous research, methyl bromide (MB) mixed with cold treatment showed improved efficacy on the citrus mealybug, *Planococcus citri*, with less damage on imported pineapples. In this study, we assessed the efficacy and phytotoxicity of single and combined treatment of ethyl formate, a promise MB alternative fumigant, and cold treatment to control *P. citri* on imported pineapple. Combined treatment of ethyl formate (EF) and cold treatment showed increased efficacy on *P. citri* than single treatment, and there was no damage on pineapple. Combined treatment of EF and cold treatment can be a good MB alternative fumigation method for environment.

Key words: *Planococcus citri*, methyl bromide, cold treatment, pineapple

P174

Evaluating the biological characteristics of newly established transgenic cell line Sf9-QE

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Baculovirus 발현계를 이용하여 외래 유용단백질을 생산하기 위해서는 바이러스의 정량(titration)과정들이 반드시 필요하지만, 그를 위해서는 긴 시간과 높은 숙련도가 요구되는 문제점이 있다. 이러한 문제점을 개선하기 위해 손쉬운 정량과 빠른 정량이 가능한 새로운 형질전환 곤충 세포주인 Sf9-QE 세포주가 최근 구축되었으나 그 생물적 특성에 대한 평가는 이루어지지 못하고 있다. 따라서 본 연구에서는 Sf9-QE 세포주의 세포증식 및 바이러스 감수성 등의 기본적인 특성 구명과 함께 바이러스 정량의 속도 및 편이성에 대한 추가적인 평가를 실시하였다. 본 연구 결과를 통해 Sf9-QE 세포주는 바이러스의 정량 뿐 만 아니라 바이러스 증식에도 유용하게 이용될 수 있음을 확인하였다.

검색어: Baculovirus 발현계, 형질전환 세포주, 바이러스 정량, Sf9-QE

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Enhancement of various forms of memories by HongJam in Mild cognitive impairment animal models

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Mild cognitive impairment (MCI) is a disease that is considered an intermediate stage between normal aging and dementia caused by severe memory loss. Since dementia is known to progress from MCI, it is predicted that the prevalence of dementia patients can be significantly reduced by preventing or delaying the progression from MCI to dementia. In this study, we conducted on how HongJam affects various types of memory. The results of this study show that HongJam is effective in improving various forms of memories, so it will be possible to use HongJam in the future research on the development of health functional food or food for special medical purpose. This work was supported by a grant from Foundation of Agri. Tech. Commercialization & Transfer (No. SA00016446).

Key words: HongJam, Memory, Mild cognitive impairment, Dementia

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Effects of P10 protein fusion expression to improve recombinant protein productivity of baculovirus expression system

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In order to increase the industrial usefulness of baculovirus, it is necessary to further maximize the productivity of an insect virus expression system that maintains high activity based on eukaryotes. The purpose of this study was to determine whether P10 fusion expression, which forms a large matrix in virus-infected cells, could increase the production of the target recombinant protein. As a result, it was confirmed that the P10 fusion expression could increase the production of recombinant protein, and it was also confirmed that the effect was different depending on the P10 fusion region. These results suggest that the P10 protein is suitable as a fusion partner for increasing the production of the target protein in BES.

Key words: Baculovirus expression system, P10, fusion expression

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Evaluation of contact and oral toxicity of tomato registered insecticides to the Bumblebee (*Bombus terrestris*)

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토마토 수정을 위해서는 토마토톤 처리 아니면 화분매개곤충인 서양뒤영벌을 주로 활용 하는데, 토마토톤 처리는 식물생장조절제로 점차 감소 되는 추세이다. 시설재배 토마토에 활용되는 작물보호제가 화분매개를 위해 투입된 뒤영벌에 미치는 영향을 조사하기 위해 서양뒤영벌에 노출될 가능성이 있는 34종의 작물보호제를 선정하여 서양뒤영벌 섭식독성시험과 접촉독성시험을 실시하였다. 그 결과 13종이 1일차에 100% 사충율을 보여 시판용 작물보호제 독성에 따라 서양뒤영벌 활동에 영향을 미치기 때문에 농가에서 해충 방제를 위한 살충제와 서양뒤영벌 혼용 사용 시 적합한 안전방사 기준의 기초자료를 제시하였다.

검색어: 서양뒤영벌, 토마토, 접촉독성, 섭식독성, 안전방사

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Development of mass production of black soldier fly (*Hermetia illucens* (L.)) using automatic larvae breeding system

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아메리카동애등에 대량사육시스템은 최근 다양하게 연구되어지고 있으나 현장 검증이 부족한 실정이다. 본 유충자동화 사육장치는 현장에서 수년간 시행착오를 거친 완성도가 높은 시스템으로서 일평균 3톤, 월평균 100톤의 동애등에 건조사료를 생산할 수 있는 자동화 대량사육 시스템이다. 유충 자동화 사육장치는 다단식 유충대차 이송장치(10단), 유충 사육트레이(1 × 3 m), 먹이 공급 장치(180 kg/트레이) 그리고 종령유충 자동 선별장치(3단 바이브레이터)로 구성되어있다. 이러한 시스템을 활용하면 하루 처리할 수 있는 남은음식물사료(습식 및 건조사료)가 평균 60톤이며 생산된 유충은 10톤, 분변은 20톤이다. 유충사육트레이에 먹이와 부화유충을 1회 공급하여 최종수확까지는 10일이 소요되었다. 이러한 유충사육트레이를 이용한 동애등에 대량사육시스템을 통해 사료곤충의 가격경쟁력을 확보하고 대량생산의 가능성을 높일 수 있음을 확인하였다.

검색어: 아메리카동애등에, 대량생산, 유충 이송장치, 자동사육시스템

P179

Hydrolysis of feed insect using microorganisms and investigation of efficacy of their products

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사료곤충인 아메리카 동애등에 유충 탈지 분말을 유용미생물로 가수분해하여 발효 사료첨가제를 제작하였다. 곤충키틴분해는 집파리 번데기 탈피각을 액상발효방법으로 제한 배지에서 키틴분해 미생물(*Bacillus sp.*)을 배양하였고 이렇게 생산된 배양액을 활용하여 동애등에 탈지 분말을 2차 고상발효시스템에서 발효시켰다. 발효 후 사료첨가제의 조단백질은 45.61%, 조지방은 9.73%로서 발효 전 조단백질 44.89%, 조지방 11.50%와 유사하였다. 아미노산 함량은 대조구와 비교하여 발효구에서 2-Aminiethanol은 9.1mg에서 23.8mg과 42.8mg으로 크게 증가하였으며 L-Arginine은 179.9mg에서 4.4mg과 2.1mg으로 감소하였다. 발효 후 새롭게 검출된 아미노산성분은 β-Alanine과 L-Anserine 이었다. 이렇게 생산된 발효사료첨가제를 2, 4% 급여한 육계에서 비특이적 면역력 증강 효과와 항병력 향상을 확인하였다.

검색어: 아메리카동애등에, 키틴분해미생물, 발효 사료첨가제, 면역

P180

Development of phorid fly(*Phoridae* spp.) control methods in mass breeding room of black soldier fly for feed

Young Kyu Park[1], Young Cheol Yang[1], Ki Seok Oh[1], Sang Hyun Lee[1], Eun Hee Lee[1], Baek Ryang Choi[1], Seung Ho Kang[2] and Gwang Soo Lee[2]
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벼룩파리는 초파리와 혼동하기 쉬운 해충으로 유기물을 먹이로 이용하는 사료 곤충사육시설에서 발생하여 큰 피해를 주고 있다. 사료용 아메리카 동애등에 대량사육시설의 부화유도용 사육상자에 발생하는 벼룩파리는 1월부터 12월까지 7.0±4.8, 16.3±8.2, 32.6±16.4, 57.3±14.5, 133.0±49.5, 555.0±190.7, 860.0±334.0, 795.0±320.1, 507.0±194.5, 201.0±70.0, 42.0±29.8, 9.1±6.0개체로 조사되었다. 동애등에 사육상자에 벼룩파리가 발생하면 화학적 방제를 할 수 없어 물리적 방제에 따른 노동력이 증가하여 생산성을 감소시킨다. 벼룩파리를 방제하기 위하여 LED 등(VIOLED CUN66A1F 365nm))과 살충제를 포함한 유인 함정트랩을 1개월 이용하여 방제한 결과 대조구의 10.4 ± 5.6 개체에서 방제 후 0.8 ± 0.8 개체로 감소하였다. 이러한 유인 포집트랩은 동애등에 대량사육시설에서 벼룩파리 밀도를 감소시킬 수 있음을 확인하였다.

검색어: 아메리카동애등에, 벼룩파리, 유인트랩, 방제

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Identification of peptides with biological activities in some dipteran larval species

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Removal of infected wounds by maggots has been known for centuries, and early researches have shown that larval exosecretion, whole body, and fecal waste products of Calliphoridae and Sarcophagidae species contain a variety of alkaline peptides, which inhibit bacterial growth. Since the wide application of antibiotics such as penicillin as a medicine, hugh ratio of bacterial infections have been insensitive to antibiotic treatment and the larval therapy has been successfully applied for treatment of chronic wounds. To identify and compare expression patterns of peptides with antimicrobial activities, in particular, in some dipteran larval species, transcriptome analyses were conducted for five Calliphoridae and Sarcophagidae larval species. Orthologous bio-active peptides across the Calliphoridae and Sarcophagidae species were identified and their relative abundance was determined by comparing normalized transcripts per kilobase million (TPM) values. This comparative transcriptome study may provide new insights into bio-active compositions in some dipteran species.

Key words: bio-active peptide, calliphoridae, sarcophagidae, larvae, transcriptome analysis, orthologous analysis

P182

Survey of insect pollinators use for horticultural crops in Korea, 2010

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We have surveyed the current status of insect pollinators use for horticultural crops in 2020. The use rate and farm number of insect pollinators for 27 horticultural crops were 28.0% and 64,049, respectively. The colony number of insect pollinators used in this survey was 615,609, which include 413,359 for honeybees, 181,141 for bumblebees, 16 for mason bees, 545 for flies, and 20,548 for the combination of bumblebees, honeybees, and mason bees. The use rate of insect pollinators was 67.2% for 12 vegetable crops and the colony number of insect pollinators used for 12 vegetable crops was 581,635, which include honeybees (70.0%), bumblebees (28.8%), flies (0.1%), and the combination (4.2%) of bumblebees and honeybees. The use rate of insect pollinators was 10.5% for 15 fruit tree crops and the colony number of insect pollinators used for 15 fruit tree crops was 33,974, which include honeybees (70.2%), bumblebees (24.1%), mason bees (0.0%), flies (0.8%), and the combination (4.9%) of bumblebees, honeybees, and mason bees. Together, most of farms (98.9%) showed positive effect for the use of insect pollinators and farms of 98.4% planed for the continuous use of insect pollinators.

Key words: Insect pollinator, Honeybee, Bumblebee, Mason bee, Horticultural crops, Vegetable crops, Fruit tree crops

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The pollination activity of honeybees (*Apis mellifera* L.) and bumblebees (*Bombus terrestris* L.) in the cultivation environment of neotropical fruits

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We studied the activity of insect pollinators(*Apis mellifera* and *Bombus terrestris*) in passionfruit(*Passiflora edulis*) pollination to investigate the possibility of insect pollination in greenhouse-cultivated neo-tropical fruits. The bee traffic and foraging activity of *A. mellifera* were 3.6 and 7 times greater than those of *B. terrestris*, respectively. However, when this result was converted into a percentage to colony size, the ratio of *B. terrestris* was 19.1, and was 10.2 times higher than that of *A. mellifera*. In addition, to confirm the pollination activity of insect pollinators, the climatic condition inside the greenhouse during the flowering of passionfruit and the bee traffic and foraging activity of each insect pollinator were investigated. the activity of *A. mellifera* was affected by the illumination level (R = 0.593) and ultraviolet rays (R = 0.647), but the activity of *B. terrestris* was less affected by light. Therefore, we considered *B. terrestris* to be more suitable for the pollination of passionfruit than *A. mellifera*.

Key words: pollination, honeybee, bumblebee, neotropical

P184

Pollination effect and nesting behavior of Hornfaced bee(*Osmia cornifrons*) on 'Hongro' and 'Fuji' apple cultivars

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In order to use *O. cornifrons* more effectively in apples, we investigated the pollination effect and nesting activity of the bee on "Hongro", the middle-season cultivar and "Fuji", late-season cultivar. The nesting activity, rate of trap nesting, and reproduction in "Fuji" were 2.5, 1.5, and 3.8 times greater than in "Hongro". As a result of investigating the pollination effect according to the cultivars, "Fuji" was 1.6 times greater than that of "Hongro" in the central fruit set. In terms of the quality of fruit, Asymmetric index of 'Fuji' was 2.5 times lower than that of "Hongro", and the number of apple seeds of "Fuji" was 1.9 times more than that of "Hongro". In contrast, there were no significant differences in weight, shape index, and oblate index by cultivars. Because the temperature during the blooming period of apples affects the activity of the *O. cornifrons* (R^2=0.578), it is expected that the nesting activity and pollination effect are great in "Fuji" (17.4°C), when the temperature during the blooming period is higher than that of "Hongro" (12.5°C). Therefore, for stable fruit production of apples in "Hongro" cultivar, it is recommended to use a *Bombus terrestris*, which is less affected by the weather environment than *O. corinfrons*. However, it is considered that *O. cornifrons* can be used in the "Fuji" cultivar which was high temperatures and stable weather conditions.

Key words: *O. cornifrons,* apple, cultivar, pollination

P185

Development of artificial silkworm feed to reduce labor of farmhouse and to raise silkworm regardless of seasons

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Recently, silkworm, mulberry and mulberry leaf products have been found to contain many physiologically active substances, the demand for the sericulture industry is increasing as a new vitality business for the functional material industry and experiential learning and healing agriculture. However, overall production is decreasing due to the aging of silkworm farmhouse and reduced labor, and mulberry leaves that can be used as natural feed can only be produced in spring and autumn, which is an obstacle to silkworm breeding throughout the year, and commercial artificial silkworm diet used for 1st or 2nd instar silkworms needs to be supplemented. Therefore, as a result of increasing the content of mulberry leaves in commercial artificial diet, there was no significant difference from the commercial artificial diet, but as a result of feeding artificial feed with Wesson's Salt Mixture(WSM), the development was relatively good up to 3rd to 5th instar silkworm. However, the development of silkworms that feeding for commercial artificial diet and new combinations of artificial feed was weaker than general breeding silkworms that feed mulberry leaves, an overall review of additional ingredients is needed, and additional experiments will be conducted.

Key words: silkworm, artificial feed, mulberry leaf, breeding silkworm

P186

Characteristics of heavy metal metastasis according to the larva food source on the white-spotted flower chafer larval, *Protaetia brevitarsis*

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국내외 식용곤충으로 가장 많이 이용되고 있는 흰점박이꽃무지에 대한 사육기술과 사료배지에 관한 연구는 많이 진행되어 왔으나 식용굼벵이류에 대한 유해물질 안전성 평가에 관한 연구는 미흡한 실정이다. 본 연구는 미래의 식•약용 곤충에 대한 소비자들의 식품안전성을 도모하고자 흰점박이꽃무지 유충 먹이원에 따른 중금속 전이 특성을 구명하기 위하여 수행하였다. 유충 사육배지로 참나무톱밥발효배지, 느타리버섯수확후배지, 표고수확후배지를 사용하였고, 각 처리구별 유충 1령 100마리를 3반복으로 50일간 사육하였다. 또한 도내 흰점박이꽃무지 유충 사육농가 20곳을 선정하여 사용하는 배지에 대하여 비소, 카드뮴, 납 등 중금속 8성분을 조사하였다. 시험용 사육배지 시료 3점과 농가 사육배지 시료 20점에 대한 분석결과 비소, 카드뮴, 납의 식품의약품안전처 중금속 함량 0.3 mg kg-1이하 기준에 적합하였다. 또한 50일간 사육한 흰점박이꽃무지 유충 건조물에 대한 중금속은 불검출로 조사되었다. 시험에 사용된 배지별 유충의 생체중은 느타리버섯수확후배지 > 참나무톱밥발효배지 > 표고버섯수확후배지 순으로 높았다. 따라서 흰점박이꽃무지 유충 사육농가는 유충 먹이원 배지의 사전 중금속 안전성을 분석하여 검토할 경우 식용 굼벵이에 대한 중금속 흡수와 관련하여 식품의약품안전처 기준에 안전할 것으로 사료된다.

검색어: 식용곤충, 흰점박이꽃무지, 중금속, 배지, 안전성

P187

Effect of oviposition efficiency on flavoring substances of black soldier fly(*Hermetia illucens*)

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아메리카동애등에 성충은 유기성폐기물이 많은 곳에 산란을 하기 때문에 이런 특성을 이용하여 산란유도 배지에 유기성폐기물을 처리하여 산란을 유도한다. 그러나 산란유도 배지를 유기성폐기물로 처리를 할 경우 악취 문제 및 주기적으로 교체를 해야 하는 번거로움이 있다.. 이에 본 연구는 배지없이 산란처인 플로랄폼(oasismarket)에 향료처리를 통한 산란효율을 검정하였다. 성충사육상은 모기장 (2×2×2m)로 제작하였으며 번데기 투입양 5kg, 플로랄폼(20×5×5cm)에 지름 4mm, 깊이 10mm로 산란구멍을 뚫었다. 향료는 육가공향 5종, 곡물향 8종, 에센셜오일 3종으로 각각 물 1L에 1% 비율로 처리하였다. 평균 산란 난괴수는 유기성폐기물 배지는 1163.7±107.3, 육가공향 604.4±54.8, 곡물향은 936.1±129.2, 에센셜 오일은 18.1±3.7이었다. 유기성폐기물을 이용한 배지보다 향료를 이용한 경우 평균 산란 난괴수는 낮았지만 산란 간편성과 악취제거의 효과를 보았다. 이에 추가적인 향료 선정 및 비율 처리 등을 통한 추가조사가 필요할 것으로 사료된다.

검색어: 아메리카동애등에, 산란, 향료, 배지

P188

Correlations between pharmacological activities and nutrient compositions in ultrafine lyophilized powders of four different steamed mature silkworms, *Bombyx mori* L.

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Lyophilized powders of steamed mature silkworms (SMSPs) with different cocoon colors (e.g., white jade, yellow, pistachio, and red) have been suggested to have distinctive pharmacological activities. In our previous studies, “fine” SMSPs (fSMSPs) with an average particle size of 10 μm had higher contents of nutrients and enhanced their pharmacological activities, compared with “coarse” SMSPs (cSMSPs) with an average particle size of 120 μm. In this study, we analyzed contents of nutrients in “ultrafine” SMSPs (ufSMSPs), of which the particle size was around 1.1 μm, generated by four different varieties. Contents of most nutrients detected in four ufSMSPs showed significant differences in at least one or more of the four varieties. Pharmacological activities of fSMSP and ufSMSP obtained from the pistachio variety were also examined to determine the correlations between nutrient compositions and pharmacological activities. The ufSMSPs might have enhanced and/or unique pharmacological activities due to their smaller particle size, although their contents of nutrients were comparable to or slightly lower than those in fSMSPs.

Key words: *Bombyx mori*, mature silkworm, nutrient composition, pharmacological activity, ultrafine powder

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Characteristics of development of *Protaetia brevitarsis* (Coleoptera; Cetoniidae) in different fermentation periods of mulberry's sawdust

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Berry(mulberry, raspberry, blueberry) was bred *P. brevitarsis* larvae while feeding the berry-fermented sawdust fermented with sawdust made by pruning branches. The sawdust fermentation period was treated with 40 days and 60 days, and the development characteristics of the *P. brevitarsis* larvae were examined in contrast to oak fermentation sawdust (fermentation period 90 days). The development period of the *P. brevitarsis* larvae was shorter than the control oak fermentation sawdust 122.0 days in berry sawdust, and the fermentation period was about 60 days to 92 days. And the weight of the larvae was also best in the 60-day fermentation treatment of berry sawdust. The population of more than 2.6g of the forward crop-based larvae also exceeded 2.6g in 60 days from the 60-day fermentation of berry sawdust, and it took about 90 days in the 40-day fermentation, and it took more than 100 days for the oak fermentation sawdust. Mortality rates were also lower than oak-fermentation sawdust. Therefore, it is judged that the berry fermentation sawdust has a faster development speed of *P. brevitarsis* than oak fermentation sawdust.

Key words: *Protaetia brevitarsis*, berries, fermented sawdust, fermentation period, development of larvae

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Effects of using agricultural processing by-product on the fresh weight of white-spotted flower chafer larval, *Protaetia brevitarsis*

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흰점박이꽃무지는 식용곤충으로 건강보조식품 원료로 사용되며 전국에서 가장 많이 사육되고 있는 산업곤충이다. 현재 흰점박이꽃무지 사육 사료와 기능성 향상을 위한 첨가물에 대한 연구가 진행되고 있다. 본 시험에서는 농업 가공 부산물인 홍삼, 구기자, 마늘 등을 배변 유도 과정에 이용하여 흰점박이꽃무지의 기능성 향상 및 이취감 저감 등에 미치는 영향을 알아보기 위하여 수행하였다. 절식과정에 부산물 투입 무게별(0.5, 1, 2, 4배) 유충의 무게 변화 결과 찹쌀 1배, 비지 2배, 홍삼 0.5배, 구기자 1배, 마늘 1배, 흑마늘 0.5배에서 감소율이 낮았으며, 절식 밀도별(25, 50, 100, 200마리) 유충의 무게 변화 결과 50마리 투입시 평균 생체중이 가장 높았다. 추후 배변 유도 과정에서 농업 가공 부산물 급여시 흰점박이꽃무지 유충 체내 구성성분 및 부산물 지표물질의 함유량을 비교분석할 예정이다.

검색어: 식용곤충, 흰점박이꽃무지, 가공, 부산물

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Effect of rearing density of *Tenebrio molitor* Linnaeus depending on classification of developmental stages

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We investigate the effect of rearing density of *Tenebrio molitor* Linnaeus depending on developmental stages. Because of their many instars (usually 12 to 13), we designed the experiment by dividing it into three developmental stages based on the criteria of growth period, growth rate and easy identification with naked eye for this study: the early (1 to 5 instars), the middle (6 to 9 instars), and the late (10 to 13 instars) stages. In order to find out appropriate density of each stage of development, the experiment was constructed as follows: in the early stage, about 500, 250 and 125 larvae were reared at 4.7 cm^2, respectively. In the middle stage about 220, 110 and 55 larvae were reared at 4.7 cm^2, respectively and in the late stage about 300, 150 and 75 larvae were reared at 19.6 cm^2, respectively. For each density condition, 30 larvae were randomly selected at the beginning and the end of the developmental stages, and their weight and growth rate were compared. As a result, larval weight and growth rate of 500 larvae/4.7 cm^2 in the early stage, 55 larvae/4.7 cm^2 in the middle stage and 75 larvae/19.6 cm^2 in the late stage were higher than others, but no statistically significant differences were found. In conclusion, rearing at the highest density is the most effective at all three stages. Furthermore, a comparative study is needed at higher density conditions than those conducted in this study.

Key words: *Tenebrio molitor*, rearing density, developmental characteristics

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Production of recombinant human angiogenin using baculovirus expression system

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배큘로바이러스 발현계(Baculovirus Expression System:BES)는 강력한 진핵발현계에 속하며 외래 유전자의 발현에 활발하게 이용되고 있다. 최근 유용단백질의 생산량을 증대시키기 위하여 다양한 방법으로 배큘로바이러스 발현 시스템의 개량이 이루어지고 있으나, angiogenin과 같은 일부 인간 유래 단백질 생산에는 큰 어려움이 있다. 본 연구에서는 기존의 배큘로바이러스 발현계를 통해 발현이 어려웠던 인간 angiogenin을 새롭게 구축된 과발현 배큘로바이러스발현계(hyper enhanced baculovirus expression system)에 도입하여 곤충세포에서 인간 angiogenin의 효율적 생산 가능성을 평가하였다. 그 결과, 높은 발현은 아니었지만 곤충세포에서 재조합 angiogenin의 발현 가능성을 확인할 수 있었다.

검색어: 배큘로바이러스 발현계, 인간 angiogenin, 과발현

P193

Determination of optimal input of Bomblebee (*Bombus terrestris*) colonies in tomato greenhouse

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시설재배면적과 인건비의 증가로 화분매개곤충 특히 서양뒤영벌의 중요성이 대두되었다. 본 연구는 서양뒤영벌 봉군의 규모가 시설 토마토에 대한 방화활동에 미치는 영향을 청주와 진천 농가에서 조사하였다. 방울토마토와 완숙토마토 모두 1, 1.5, 2봉군 처리에서 방화 시간, 꽃 간 이동시간, 소문 출입활동의 차이는 나타나지 않았다. 방울토마토는 1.5 봉군 투입 시 과수정률이 낮아 수정률이 높았고, 완숙 토마토는 1 봉군 투입 시 과수정률이 가장 낮아 수정률이 높았다. 과실 특성은 방울토마토와 완숙토마토 모두 처리구간 차이가 없었지만 다른 처리구에 비해 1.5봉군의 당도가 다소 높게 분석되었다. 하우스 내 서양 뒤영벌의 방화 활동 온도는 15~28℃가 적합했고, 35℃ 이상에서는 활동을 멈추었다. 따라서 완숙과 방울 토마토에따라 꽃 수에 차이가 있어 봉군투입량 재설정과 품종, 주 수, 면적 등에 따른 추가 연구가 필요할 것으로 판단된다.

검색어: 시설토마토, 서양뒤영벌, 방화활동, 상품성

P194

Motivation and perception of insect exhibition center with preference of insect species for experience

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Insect exhibition center can serve as an insectarium or insect zoo which offers the visitors pleasant feeling of naturalness from diverse visual satisfaction as well as hand-on experiences of touching and feeling insects. Insect museum was built for better communication of the value and beauty of insects in the connection with the supporting center of industrialized insect resource in Sangju in 2019. Questionnaire study was conducted from the visitors of this museum during 2021 season to comprehend the perception and preferences of the insects for their motivation and satisfaction of this healing program. Most of people who respondent were women 69% and 30s (42%). The most of respondent resides rate was other regions 38% and Sangju, Gyeongsangbuk-do was 28%. The rate of exhibition on first visit was about 63% and 37% was revisitation from the near city. The 98% was an intention to revisit. It is a fairly highest rate. The rate of insect rearing experience was 45% and 55% was not experienced. The most preference insect was Coleoptera as 52%. The respondents of 59% were heard and all too aware about pet insect, healing insect and edible insect. The respondents think about the effectiveness of healing program of pet / healing insect were very effective as 58%. The respondents answered that Coleoptera is suitable for healing insects for an operation of the insect healing program. If The respondents want to rear, 72% was want to rear insect for healing and 28% was not. And preference insects are *Allomyrina dichotoma* (54%), *Dorcus titanus castanicolor* (18%) and *Papilio xuthus* (12%), respectively. The preferred healing programs were viewing fireflies 47% and collecting insect in spring and summer 26%. In this data we will be useful for development of healing program of insect in ecological garden.

Key words: insect ecological graden, healing, insect resources, agro-farming, pet insect

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Prevention of onset and progression of genetic or drug-induced sarcopenia by HongJam

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Sarcopenia induced by various causes is a disease in which muscle decreases faster than muscle loss observed in normal aging in the elderly. We conducted a study on the preventive effect on sarcopenia by treating HongJam in a genetic and a drug-induced sarcopenia mouse model. Sarcopenia model mice were investigated for the prevention of sarcopenia by conducting a study to confirm the change in body weight and muscle strength using various research methods. It is necessary to proceed with research on the therapeutic effect of sarcopenia of HongJam in the future. This work was supported by a grant from RDA (No. PJ0156592021)

Key words: Sarcopenia, SAMP8, Dexamethosane, HongJam, Muscle strength, body weight

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A study on the distribution of entomopathogenic nematodes in the areas around Japanese Larch (*Larix kaempferi*) habitat in Korea

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국내에 분포되어 있는 일본잎갈나무(*Larix kaempferi*) 서식지의 토양을 채집하여 곤충병원성 선충을 분리 동정하여 분포 조사를 실시하였다. 각 14개 지역(강원도 양구군, 원주시, 춘천시, 평창군, 화천군, 경상남도 산청군, 창녕군, 함양군, 경상북도 영덕군, 영양군, 전라북도 남원시, 무주군, 임실군, 장수군, 진안군)에서 토양 시료를 채집하여 미끼 곤충인 꿀벌부채명나방(*Galleria mellonella*) 유충을 이용하여 곤충병원성 선충 유무를 확인하였다. 토양 시료 300점 중에서 39종이 검출되었으며, 검출율은 13.0%였다. 곤충병원성 선충 신속한 분류를 위해, 침입태 유충의 DNA를 분리한 후 ITS 영역을 이용하여 염기서열을 분석한 후 *Heterorhabditis* 속 5개체와 *Steinernema* 속 34개체로 동정되었다. *Heterorhabditis* 속 5개체는 *H. nematodes*, *Steinernema* 속은 *S. carpocapsae* 1개체, *S. anenarium* 1개체, 그리고 32개체는 *S. monticolum*으로 판명되었다. 국내 일본잎갈나무 서식지의 토양에서 분리 동정된 *S. monticolum* 개체수는 82.1%의 높은 비율로 나타났다.

검색어: 일본잎갈나무, 곤충병원성 선충, 꿀벌부채명나방, *H. nematodes*, *S. carpocapsae*, *S. anenarium*, *S. monticolum*

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A survey of *Callipogon relictus* preference for fungal strains

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천연기념물 제 218호인 장수하늘소의 안정적인 사육체계 구축을 위하여 장수하늘소 유충의 인공사육에 필요한 먹이 제조와 관련하여, 균주에 대한 선호성이 있는지 균주별 대치 선호도를 조사하였다. 선호도 조사결과 선발된 균주에 대한 80일간의 증체효율을 검정하여 인공먹이의 안정성을 검정하였다. 조사결과 *Pleurotus*속을 비롯하여 3개의 균주에 대한 선호성이 확인되었다. 선발된 균주에 대한 장수하늘소 개체의 사육 안정성을 평가하기 위해 해당 균주로 제조된 인공먹이를 약 80일간 급이한 후 증체량을 비교하였으며 비교결과 2개의 균주가 인공먹이로서의 적합성이 가장 높은 것으로 확인되었다. 한편, *Lentinula*속 균주로 제조된 사료의 경우 80%가 넘는 치사율을 보여 인공먹이의 재료로서 부적합한 것으로 나타났다.

검색어: 장수하늘소, 균주, 선호도, 인공먹이, 증체율