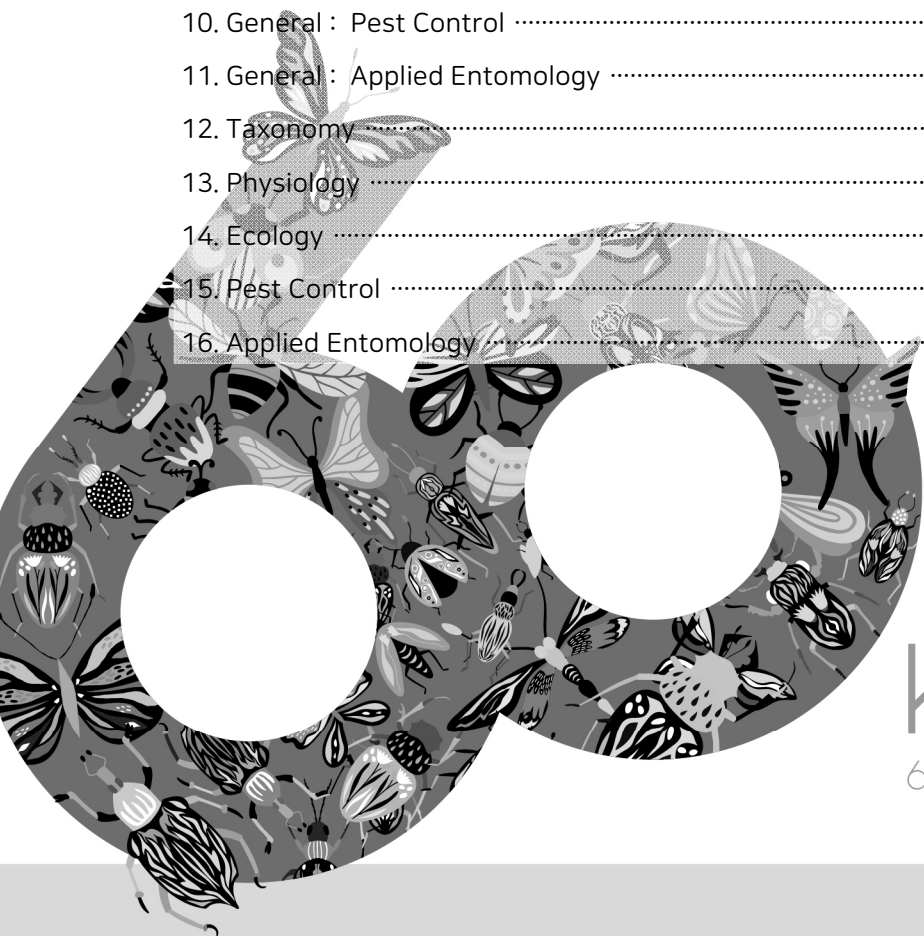


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P1

Survey on invasive exotic ants and the direction of early eradication

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세계자연보호연맹이 지정한 세계 100대 악성 침입 외래종 중 하나인 *Solenopsis invicta*(red imported fire ant)가 2017년도 9월 부산 감만 부두에서 처음 발견되어 2022년 9월을 기준으로 총 18회 유입된 적이 있으며 *Linepithema humile*(argentine ant)도 10회 발견되었다. 또한 20~21년 기준 농림축산검역본부의 관리병해충에 속하는 *Paratrechina longicornis*(138회), *Trichomyrmex destructor*(34회), *Solenopsis geminata*(3회), *Monomorium indicum*(5회), *Nylanderia vaga*(2회), *Tapinoma indicum*(1회)은 항만 내에서 백여 차례, 항만 외 내륙에서 몇 차례 발견되었으나 조기 방제하여 아직 내륙 서식 가능성은 희박하다 사료된다. 유령개미(2009년 보고)는 경기지역에 국한된 보고로 남부지역에는 분포하고 있지 않으므로 방제가 이뤄져야 할 관리급 외래 개미로 사료된다. 따라서 관리병해충 중 개미(31종)의 국내 주요 침입로인 무역항만의 정밀 조사를 통해 조사의 방법과 조기 방제에 대한 방향성을 제시하고자 한다.

검색어: 침입외래해충, 정밀조사, 조기방제, 관리병해충

P2

Assessment of internal status of *Prunus yedoensis* as roadside trees injured by *Aromia bungii* (Coleoptera: Cerambycidae)

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벚나무사향하늘소(*Aromia bungii* (Faldernann, 1835))는 체리, 살구, 복숭아를 포함하는 *Prunus*속 수목의 중요한 천공성 해충이며, 최근 일본과 유럽으로 침입하여 문제가 되고 있다. 최근 들어 국내에서도 왕벚나무 가로수를 중심으로 피해가 보고되고 있다. 벚나무사향하늘소의 피해는 톱밥 배출, 탈출공 등 외관상 특징으로 구분할 수 있지만, 수목 내부의 상태를 모르기 때문에 별채를 통한 피해 수목 제거는 거의 이뤄지지 않고 있다. 본 연구에서는 피해목의 내부 상태를 비파괴적인 방법으로 확인하기 위해 실시하였다. 2022년 7~8월 중 가평군과 춘천시에서 왕벚나무 가로수 피해목을 대상으로 톱밥 배출, 탈출공, 수지 분비 등 벚나무사향하늘소에 의한 피해 흔적을 조사하였고, 초음파 단층 촬영(Sonic Tomograph) 방법을 이용하여 수목의 내부 피해 상황을 조사하였다. 조사 결과, 수목 내부의 피해면적은 0.43%의 범위로 확인되었다. 외관상 확인된 피해 정도와 내부의 피해 상태는 정의 상관관계를 보였지만, 일부 수목에서는 부후 피해도 발생한 경우가 있어 벚나무사향하늘소 피해목을 대상으로 더 많은 조사가 요구된다.

검색어: 벚나무사향하늘소, 천공성 해충, 초음파 단층 촬영(Sonic Tomograph)

*본 연구는 한국연구재단(2022R1F1A1059681122182102130101)의 지원을 받아 수행하였습니다.

P3

A study on the virulence assay of entomopathogenic fungi against Japanese plum sawfly (*Monocellicampa pruni*)

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Japanese plum sawfly, *Monocellicampa pruni* is a pest that damages plums and was first reported in South Korea in 2018. These pests attacked the fruitlet of plums and caused great damage, especially serious production losses in organic orchards. Herein, we confirmed the possibility of controlling *M. pruni* using entomopathogenic fungi. First, we isolated 6 fungi from infected *M. pruni* and conducted a bioassay to the larva by the spraying method. Result showed that, 6 entomopathogenic fungi showed 80-90% mortality in laboratory conditions. Mycosis was observed on the insect cuticles under high humidity conditions. This work suggests that Japanese plum sawfly can be effectively controlled by entomopathogenic fungi.

Key words: Biological control, *Cordyceps fumosorosea*, entomopathogenic fungi, japanese plum sawfly, pest management

P4

Variation in the cuticular microstructure and its consequence in the coloration in *Cetonia aurata* (Cetoniinae: Scarabaeidae)

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Beetle's elytra exhibit a wide range of structural colors which result from variation in the microstructure of the exocuticle. The exocuticle contains helicoidal (bouligand) layers of chitin microfibers, whose arrangement varies both within and among the species. In this study, we aimed to find the correlation between the microstructure of the exocuticle and the characteristics of structural colors of the elytra among the individuals of *Cetonia aurata*. The elytra of *C. aurata* exhibit red, purple, and green iridescence, which can be also viewed as the distinct specular reflectance spectra. This color variation was related with the thickness variation in the helicoidal layers of chitin microfibers. Considering that the depth of exocuticle is beyond the limit where the wavelength of reflected or scattered light can be affected, our results suggest that the intraspecific variation in the microstructure of exocuticle has additional function than the color production.

Key words: structural color, iridescence, exocuticle, beetle, elytra

P5

A new record of *Ecopsocus briggsi* McLachlan, 1899 (Psocoptera: Ectopsocidae) from South Korea

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Ecopsocus briggsi McLachlan, 1899 is a worldwide species and has been recorded in Japan, Mongolia, Indonesia, the United States, Chile, South America, Australia, and Europe. We collected *E. briggsi* on Geoje-si, Jinju-si, and Jeju-do in 2022. In this study, *E. briggsi* is reported for the first time in Korea, and ecological photographs and illustrations of diagnostic characters are provided.

Key words: Psocoptera, new record, *Ecopsocus briggsi*, South Korea

P6

Faunistic survey on Lepidopteran insects (Lepidoptera) from Wando Island

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본 연구는 6월 말과 7월 말에 진행되었던 조사를 통해 채집된 나방 곤충류에 대한 보고이다. 종 동정 결과, 나비목 총 23과(가는나방과, 갈고리나방과, 갈고리좁나방과, 굴벌레나방과, 남방빨나방과, 명나방과, 밀두리빨나방과, 박각시과, 밤나방과, 빨나방과, 산누에나방과, 솔나방과, 원빨나방과, 잎말이나방과, 자나방과, 재주나방과, 창날개빨나방과, 큰원빨나방과, 털날개나방과, 태극나방과, 판날개빨나방과, 풀명나방과, 통나방과)에 속하는 216종이 확인되었다.

검색어: 완도, 채집조사, 나비목, 종 동정

P7

Effect of entomopathogenic fungus, *Metarhizium* spp., on survivorship of *Ramulus mikado* during summer season in Korea

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대벌레는 2020년과 2021년에 수도권 일부지역 산림에서 대발생하여 산림해충으로 주목받고 있다. 대벌레류는 녹강균에 의해 치사하는 것으로 보고되고 있는데 국내에서는 연구가 부족한 실정이다. 따라서 본 연구에서는 경기도 의왕시 청계산에서 대벌레를 시기별로 채집하고 14일 동안 실내사육을 하면서 치사율을 조사하였다. 2022년 6월 10일, 6월 24일, 7월 9일, 그리고 7월 22일에 대벌레 약충 또는 성충을 30~40개체 채집하였다. 2주 동안 6월 10일과 6월 24일 채집 개체는 각각 20%와 15%가 치사하였는데, 녹강균은 확인되지 않았다. 이에 비해 7월 9일과 7월 22일 채집 개체는 각각 97.3%와 92.5%가 치사하였으며, 50% 이상의 사체에서 녹강균이 확인되었다. 결론적으로 장마기간이 시작된 6월 23일 이후 고온다습한 환경이 조성되면서 녹강균에 의한 대벌레의 생존기간 감소 현상이 유발된 것으로 판단되며, 이는 향후 대벌레 개체군 크기의 감소에 중요한 역할을 할 것이다.

검색어: 곤충병원성 곰팡이, 녹강균, 생존곡선, 장마, 산림해충, 대발생

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P8

Comparison of insect fauna between transgenic rice and common rice in Gyeongsang-do, South Korea

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형질전환작물(Living Genetically Modified Organism; LMO)은 작물 소비자에게 주는 부작용 가능성과 더불어 장기적으로 대상 농업생태계를 서서히 변화시킬 가능성을 내포한다. 따라서 환경 방출과정에서 발생하는 위해성을 생태적 측면에서 평가하고 이에 대한 대책을 마련하기 위해 경남지역에서 연속으로 9년간(2013-2021년), 경북지역에서 3년간(2015년, 2016년, 2020년), 각 7월부터 10월까지 형질전환벼와 일반재배벼에 발생하는 곤충상 변동 양상을 비교하였다. 사천시 형질전환 벼는 경상국립대학교 LMO 격리포장 내에서 재배되었고, 일반 벼는 경상남도 사천시에서 재배되었다. 군위군에서 형질전환 벼는 경북대학교 LMO 격리포장 내에서 재배되었고, 일반 벼는 경상북도 군위군에서 재배되었다. 채집방법으로 직접관찰방법인 육안조사 및 포충망 조사와 유인관찰방법인 유아등 트랩 및 끈끈이 트랩을 이용하였다. 직접관찰방법은 실제 실험 포장에서 서식하는 곤충을 채집하며, 유인관찰방법은 주변 다른 지역의 곤충들을 유인하여 채집한다. 그렇기에 직접관찰방법을 중심으로 채집하고, 실험 포장의 중 밀도를 확인하기 위해 부가적으로 유인관찰방법을 사용하는 것이 가장 적합한 것으로 판단된다.

검색어: 형질전환벼, 포충망 조사, 육안조사, 유아등 조사, 끈끈이 트랩

P9

First Record of the Family Olpiidae Banks, 1895 (Arachnida: Pseudoscorpiones) from Korea

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Olpiidae, which includes 24 genera, and 212 species, is a family of Pseudoscorpiones. Olpiidae distributes in almost every country, including Japan and China. However, seven families were discovered in Korea, except for Olpiidae. We sampled seven specimens of *Nipponogarypus* sp. nov., which is a group of Olpiidae from Ganwoldo. *Nipponogarypus* sp. nov. lives in the supralittoral zone, the second recorded supralittoral species found in Korea, after *Anchigarypus japonicus* (Beier, 1952). Herein, we described a new species, *Nipponogarypus* sp. nov., with the key to the species of *Nipponogarypus*.

Key words: Pseudoscorpiones, Olpiidae, *Nipponogarypus*, New record, New species, Taxonomy

P10

Geographical distribution of two reproductive systems for the Asian longhorned tick, *Haemaphysalis longicornis*, in the Republic of Korea

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The Asian longhorned tick, *Haemaphysalis longicornis*, is an obligate ectoparasite transmitting various pathogens, including Severe Fever with Thrombocytopenia Syndrome Virus (SFTSV) and is widely distributed throughout Rep. of Korea. *H. longicornis* reproduces offspring in bisexual or parthenogenesis systems. It is hard to find morphological differences between two reproductive individuals even though their fitness is quite different. In this study, we analyzed the partial sequences of 16s rDNA to see the distribution of bisexual and parthenogenesis individuals of *H. longicornis* collected from nine cities in Korea: Goseong[GS], Sokcho[SC], Ganghwa[GH], Sangju[SJ], Ulsan[US], Yangsan[YS], Jindo[JD], Jeju[JJ], and Seogwipo[SG]. Parthenogenesis individuals dominated northern populations, including Goseong, Sokcho, Ganghwa, and Sangju. Whereas in southern populations, including Yangsan, Jindo, and Jeju, bisexual individuals were dominant. Additionally, the analysis of population genetics using mitochondrial cytochrome B (CytB) revealed that *H. longicornis* population in Korea consists of two major haplotypes (Hap_1 and Hap_3) and are divided into two clades. *H. longicornis* individuals in the Rep. of Korea divided into two reproductive systems, parthenogenesis and bisexual, and the dominant reproductive individuals were different in southern and northern populations. We expected that the present study would provide insights for a better understanding on the vectorial capacity and bacterial community of *H. longicornis*.

Key words: Asian longhorned tick, reproductive system, DNA barcode, population genetics

P11

The effect of temperature on the rate of RSV acquisition in the small brown planthopper, *Laodelphax striatellus*

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The small brown planthopper (SBPH, *Laodelphax striatellus*) is a major pest insect found in rice fields. SBPH directly feeds on phloem sap and transmits rice stripe virus (RSV), causing rice stripe disease in temperate and subtropical regions. SBPH is known to migrate from China to the west coast of Republic of Korea, i.e., Seocheon and Gunsan. An increase in average temperature due to climate change will accelerate the emergence of SBPH. In this study, we investigated how different temperatures (24, 27, and 30°C) affect the RSV acquisition capability of SBPH. RSV acquisition rate of SBPH was compared from different developmental stages, i.e., nymphal stages (1st to 5th) and adults. At 27°C, the RSV acquisition rate was the lowest in 1st instar nymphs (45%) and the highest in 4th and 5th instar nymphs (100%). It was suggested that aged SBPH had a higher chance of virus acquisition compared to younger SBPH. Taken together, the rate of RSV acquisition of SBPH varies with temperature and developmental stage.

Key words: *Laodelphax striatellus*, Rice stripe virus

P12

Discovery of Butterflies (Lepidoptera) from Bach Ma National Park in Southern Vietnam

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Bach Ma 국립공원은 베트남의 남부의 주, 투안티엔 후에(Thua Thien Hue)에 위치한 생태 보호지역이다. Bach Ma 국립공원은 높은 고도와 낮은 고도가 공존하는 지형을 가지고 있으며, 저지대 지역에 비해 고지대 지역은 7도 정도 온도가 낮다. 5월에서 8월 사이에 가장 더운 기후를 나타내며, 하루 동안에도 몇 번이나 바뀌는 기상 조건을 갖고 있다. 고도 900m 미만의 열대성 저지대 숲과 900~1,450m 사이 고도의 아열대성 숲이 존재하며 2,000여 종이 넘는 식물이 자생하는 종 다양성 높은 곳으로 알려져 있다. 본 연구는, 7월 초에 진행되었던 조사를 통해 채집된 나비 곤충류에 대한 보고이다. 종 동정 결과, 나비목 4과(호랑나비과, 흰나비과, 부전나비과와 네발나비과)에 속하는 17종으로 확인되었다.

검색어: 베트남, 채집조사, 나비목, 종 동정

P13

***Bemisia tabaci* biological control using entomopathogenic fungi and efficiency of grain media**

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Whitefly (*Bemisia tabaci*) is an economically significant insect pest to greenhouse plants. They feed on nutrients and indirect damage to the crops as a virus vector. These days biological control with entomopathogenic fungi is a suggested alternative to integrated pest management instead of chemical pesticides. To successfully control pests by using entomopathogenic fungi, not only the pathogenicity of fungi but also mass production is crucial. Therefore, we investigated the effectiveness of spore quantities mass production through different grain media. In this study, we assayed 10 entomopathogenic fungi against *B. tabaci* nymphs and selected the three strains with high virulence. Based on its result, we investigated the production efficiency of selected strains which are millet, Vietnamese rice, and coffee grounds.

Key words: entomopathogenic fungi, *Bemisia tabaci*, grain media

P14

Macronutrient regulation in the superworm, *Zophobas atratus* (Coleoptera: Tenebrionidae)

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The larvae of *Zophobas atratus* F. (Coleoptera: Tenebrionidae) are a promising source of dietary protein for animal feed. However, there has been no detailed investigation on macronutrient selection and requirement in *Z. atratus* larvae. Here, we used the geometric framework to explore the behavioural and physiological regulation of protein and carbohydrate in *Z. atratus* larvae. When provided with pairs of nutritionally imbalanced but complementary foods (choice experiment), *Z. atratus* larvae self-composed a diet with a protein-to-carbohydrate (P:C) ratio of 1.47:1 or 1.19:1 throughout the experimental period. When confined to one of six foods imbalanced with respect to P:C ratio (no-choice experiment), *Z. atratus* larvae regulated their protein-carbohydrate intake to form linear intake arrays across nutrient space in a manner similar to those previously described for other nutritional generalists. The nutritional landscapes fitted for larval performance traits exhibited that the performance of *Z. atratus* larvae was maximized at the P:C ratio of 2:1 and fell rapidly as the P:C ratio decreased below 1:1. Our results represent the most comprehensive analysis of macronutrient regulation in *Z. atratus* and have implications for designing an optimal diet for this beneficial insect.

Key words: Beetle, Protein, Carbohydrate, Geometric framework, Nutritional landscape, Nutrient self-selection

P15

Taxonomic study of the genus *Mastax* Fischer von Waldheim, 1828 (Coleoptera: Carabidae: Brachininae) in Korea

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The genus *Mastax* Fischer von Waldheim, 1828 (Coleoptera: Carabidae: Brachininae) in Korea is reviewed. Previous Korean record of *Mastax thermarum egorovi* Lafer, 1973 was an error due to misidentification of *Mastax poecila* Schaum, 1863. *Mastax formosana* Dupis, 1912 distributed only in Taiwan is considered a subspecies of *M. poecila*. *M. poecila* is redescribed based on recently collected specimens and added in detail for variation.

Key words: Brachininae, New record, New status, *Mastax*, Variation

P16

Morphological and molecular characteristics of *Sympetrum depressiusculum* (Sélys, 1841) occurring in Korea (Odonata: Libellulidae)

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Species identity in relationships to geographic boundary of *Sympetrum depressiusculum* (Sélys, 1841) (Odonata, Libellulidae), which is distributed throughout Europe to Korean Peninsula and *S. frequens* (Sélys, 1883), which is endemic to Japan has long been unsettled. Several conflicting opinions are existing: identical one species or independent two species; Korean populations being closer to those of Japan or Europe; and clinal variation among populations of Europe, Korea, and Japan. In this study, we collected a total of 61 individuals from Korea, Japan, Russia, and Netherlands; sequenced for the fragments of *COI*, *16S rRNA*, *ITS1*, and *ITS2*; and obtained available sequences of the four regions from public data. Each fragment and concatenated sequences consistently suggest that the divergence of the two species in terms of phylogeny and population genetics is too low or minor.

Key words: Odonata, Dragonfly, *Sympetrum depressiusculum*, *Sympetrum frequens*, *COI*, *ITS1*, *ITS2*, *16S rRNA*, Korean Peninsula

P17

Mitochondrial *COI*-based population genetic analysis of the grasshopper, *Patanga japonica* Bolívar, 1898 (Acrididae: Orthoptera), which is a climate-sensitive indicator species in Korea

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기후온난화에 따른 북위로의 서식처 확장과 이에 따른 집단의 유전적 다양성 변동 특징에 대한 이해는 장기적 측면의 한반도 생물다양성 이해를 위한 초석이라고 할 수 있다. 본 연구에서는 mitochondrial *COI* 유전자의 염기서열을 이용하여 우리나라 100종의 기후변화지표종 중 유일한 메뚜기목 곤충인 각시메뚜기(*Patanga japonica* Bolívar, 1898) 집단(제주도, 담양, 하동, 무안, 밀양, 평택, 영월; 총 125개체)의 유전적 다양성, haplotype 계통, 집단 구조 등에 대한 분석을 수행하였다. 그 결과, 북위로의 이동은 가장 빈도가 높은 haplotype만을 동반하며 haplotype 다양성이 감소하는 등 core 집단의 일부 유전적 다양성만을 동반하는 특징을 나타내었다. 이로써 북위의 양질 서식처 유무와 이에 따른 이동집단의 정착 및 활성이 각시메뚜기의 유전적 다양성 회복에 중요한 관건이 될 것으로 사료된다. 아울러 유전체 기반의 연구를 통한 심도있는 결과 도출이 필요한 실정이다.

검색어: 각시메뚜기, 기후변화지표종, 북위이동, 유전적 다양성

P18

Addition of 46 new complete mitochondrial genome sequences of the wild silkworm, *Bombyx mandarina* (Lepidoptera: Bombycidae), from Korea and Japan for population genetic analyses

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Bombyx mandarina (Lepidoptera: Bombycidae), the presumed ancestor of *B. mori*, has long been a subject of study to illustrate the geographic relationships, along with the origin of *B. mori*. We report 46 mitochondrial genome (mitogenome) sequences of *B. mandarina* collected from Korea and Japan. Phylogenetic and population genetic analyses strongly showed that all individuals of *B. mandarina* collected in Korean localities formed a strong group together with those originated from northern China and this group was placed as the sister group to *B. mori*. This result suggests that gene flow between the two regions was substantial enough to prevent genetic isolation, even though the two regions are currently separated by the Yellow Sea.

Key words: Mitochondrial genome, *Bombyx mandarina*, Wild silkworm, Phylogeny, Population structure

[†]These authors contributed equally to this presentation

P19

Efficient control strategy of black stink bug, *Scotinophara lurida* (Burmeister) (Hemiptera: Pentatomidae) in peddy field

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친환경 벼 재배면적의 증가로 먹노린재의 발생량이 증가하고 있고 최근에는 일반 관행적 벼 재배지역에서도 먹노린재의 발생량이 꾸준히 증가하고 있다. 화학방제에도 불구하고 먹노린재의 밀도가 꾸준히 증가하고 있어 기존의 방제방법으로는 한계가 있을 것으로 판단되어 효율적인 방제전략을 구축하고자 본 연구를 수행하였다. 먹노린재에 방제효과가 확인된 방제제를 이용하여 포트 검정을 시행한 결과, 낙수 시 80% 이상의 효과를 보인 반면 낙수를 하지 않았을 경우 방제효과는 저조하였다. 이전 연구에서 CDD(누적유효적산온도)를 이용한 2022년도 월동충의 발생을 예측한 결과 2021년에 비하여 활동 시기가 지연될 것으로 나타났고 실제 관측 결과도 동일하였다. 먹노린재 월동충의 활동시기와 벼 재배 농사일정을 고려하여 낙수가 일어나는 시점에 방제를 추진하는 전략을 수립한 결과, 모내기전 5월 월동처 방제 1차, 중간물때기 시기인 6월 중하순 2차 본답방제를 실시할 경우 방제효율이 가장 좋을 것으로 판단되었다.

Key words: 먹노린재, 방제전략, 논

P20

New record of *Bruchidius siliquastris* Delobel (Coleoptera, Chrysomelidae, Bruchinae) in Korea

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Bruchidius siliquastris Delobel, 2007 belongs to the subfamily Bruchinae (Chrysomelidae) supposed an eastern Asian origin, is recently regarded as an invasive species that infests the seeds of the leguminous plant *Cercis siliquastrum* L. (Fabaceae) in Europe. On the other hand, this bruchid species has recently been uploaded by domestic bloggers without precise identification of adult photos in Korea and observed by authors in the spring of 2022 on the *C. chinensis* Bunge planted on the campus of Sunchon National University. In this study, we present new ecological data of a bruchid beetle, *B. siliquastris* Delobel from Korea and suggest that the Korean peninsula should be excluded from East Asia where it is assumed to be the origin.

Key words: Chrysomelidae, Bruchinae, *Bruchidius siliquastris*, *Cercis chinensis*, Korea

P21

Taxonomic study on the monotypic ant genera, *Dacatria* and *Proatta*

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The monotypic ant genera *Dacatria* Rigato, 1994 and *Proatta* Forel, 1912 have been drawn attention by many myrmecologists because of the remarkable morphological similarity with Neotropical fungus-growing ants, although it has been revealed that there are no actual distinct relationships. The genus *Dacatria* was originally recorded from Mt. Jirisan, South Korea with a species: *D. templaris*, and the author mentioned the similarity with the genus *Proatta*, which is widely distributed throughout Southeast Asia in the original description. Despite the significant morphological and ecological similarity, and overlapped distribution ranges, there were no approaches discussing the generic positions of these ant genera. After the taxonomical examination using geometric morphometric analysis and phylogenetic study, I suggest that the genus *Dacatria* should be synonymized into *Proatta* based on worker geometric morphometrics, male taxonomy, ecological traits, distribution ranges, and phylogenetic relationships. Photographs of workers and males, phylogenetic relationships, and morphometric relationships of two genera are provided in this study.

Key words: *Dacatria*, *Proatta*, formicidae, taxonomy, integrative taxonomy, geometric morphometrics

P22

First record of the genus *Anaclastoctedon* Plant (Diptera: Empididae) from Korea with a new species

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Up to now, only 4 species of the genera *Chelifera* and *Chelipoda* of subfamily Hemerodromiinae are recorded in Korea Fauna. In the course of taxonomic survey on the empidid flies in Korean peninsula, the authors have found a firstly recorded genus *Anaclastoctedon* with a new species *A. koreanum* sp. nov. Morphological characteristics of a newly recorded species are provided here.

Key words: Dance fly, Hemerodromiinae, New species, Taxonomy

* This work was supported by a grant from the National Institute of Biological Resources (NIBR), funded by the Ministry of Environment (MOE) of the Republic of Korea (NIBR202231206).

P23

Complete mitochondrial genome of *Aromia bungii* Faldermann, 1835 (Coleoptera: Chrysomeloidea: Cerambycidae) collected in Korea

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The red-necked longhorn beetle, *Aromia bungii* is a wood-borer pest of *Prunus* spp.. We determined the complete mitochondrial genome of *A. bungii* collected from the Korean Peninsula. We sequenced the 15,759 bp long complete mitochondrial genome of this species; it comprises a typical set of genes (13 protein-coding genes (PCGs), 2 rRNA genes (rRNAs) and 22 tRNA genes (tRNAs)) and one non-coding region. Phylogenetic trees show that two *A. bungii* mitogenomes were clustered in one clade and are sister to *Xystrocera globosa* within the subfamily Cerambycinae

Key words: *Aromia bungii*, Cerambycidae, Mitochondrial genome, Korea

P24

Two newly recorded species of the Erebidae (Lepidoptera: Noctuoidea) from Korea

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The Erebidae are one of most diverse families of Lepidoptera, with over 24,500 described species in about 1,750 genera and 18 subfamilies worldwide. The monophyly of the family was well defined but the phylogenetic relationships at the subfamily level are currently poorly resolved. In Korea, approximately 500 species of the Erebidae are known, and here we report two additional species, *Sinarella itoi* Owada, 1987 and *Hadennia nakatanii* Owada, 1979 for the first time from South Korea. We provide the diagnosis, description, and the taxonomic position of these species within the Erebidae. This work was supported by a grant from the National Institute of Biological Resources (NIBR), funded by the Ministry of Environment (MOE) of the Republic of Korea (NIBR202231206).

Key words: Lepidoptera, Erebidae, *Sinarella itoi*, *Hadennia nakatanii*, new record, Korea

P25

Additional records of Orthothyline plant bug (Hemiptera: Heteroptera: Miridae) in Korea

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Two species of orthothyline plant bugs recognized from the Korean Peninsula including of the first record of *Blepharidopterus angulatus* (Fallén, 1807) and *Ulmica baicalica* (Kulik, 1965). Diagnostic characters of the species are discussed with the illustrations of adult male specimen and genitalic structures. A key to the Korean *Blepharidopterus* and *Ulmica* species are also presented.

Key words: Hemiptera, Miridae, Orthothylinae, *Blepharidopterus*, *Ulmica*, new record.

P26

A New Species of Genus *Conapium* Motschulsky in Korea (Coleoptera, Brentidae: Apioninae)

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The genus *Conapium* Motschulsky, 1866 is a genus of the Piezotrachelini tribe, which is diverse in Paleotropics including the Afrotropical and Oriental regions. Although *Conapium* is unknown from the Palaearctic, they are very close to the genera *Protapion* Schilsky, 1908 and *Pseudoprotapion* Ehret, 1990 those have distributed in the western part of the Palaearctic. Recently, a new species, *Conapium koreanum* n. sp., has been found in Korea. This is the first report of the genus in the Palaearctic realm, from the northernmost part of the Northern Hemisphere. We provide DNA and morphological information of new species with a key to the tribe Piezotrachelini in Korean fauna.

Key words: Apioninae, Piezotrachelini, *Conapium*, Korea, new species.

P27

Molecular Phylogeny of the *Coptolabrus smaragdinus* (Coleoptera: Carabidae) from South Korea

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Family Carabidae is one of the largest group with more than 40,000 species recorded worldwide. Among this group, many subspecies have been recorded in different regions, often separated by geographical barriers such as valleys, water systems and mountain ranges. This is because species belonging to subtribe Carabina have degraded hindwings and their dispersal rely mainly on walking. Due to these characteristics, there is high intraspecific diversity depending on the region or habitat.

Among them, *Coptolabrus smaragdinus* ssp., has very high intraspecific variation, including ambiguous in morphological characters such as the reproductive genitalia structure, body color, etc., that is mainly used for classification and identification. Therefore, the current study intended to compare and analyze the mitochondrial *COI* by region to confirm the genetic variation according to geographic barriers, and to identify the genetic relevance in the Jeju Island population and inland populations which is geographically isolated area.

Key words: Carabidae, Carabina, *Coptolabrus smaragdinus*, mitochondrial *COI*, Molecular Phylogeny

P28

Taxonomic revision of the tribe Dyschiriini H.J Kolbe, 1880 (Coleoptera: Carabidae) from Korea.

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Hee Soo Lee and Jong Kyun Park**

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Tribe Dyschiriini has been recorded with 9 species, 2 subgenera, 1 genus in Korea. This tribe is well known as hygrophilous pedunculate carabid beetle with body length of 1.95 – 7.5mm. They occurs on wetland such as riverside and intertidal zone, etc. Although they are a rather well-studied group, still difficult to identify them because of their very small size body and morphological similarity. In addition, previous studies for this group are poorly known in Korea.

In this study, taxonomic key, photographs of habitus and diagnosis of each species are provided herein.

Key words: Carabidae, Scaritinae, Dyschiriini, taxonomic key, Korea.

P29

A new record of the genus *Kamendaka* Distant (Hemiptera: Fulgoroidea: Derbidae) from the Korean Peninsula with a key to the Korean species

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The derbid species *Kamendaka annulata* Yang & Wu, 1993 is recognized from the Korean Peninsula for the first time. The morphological information such as diagnosis and redescription of male habitus and genitalia are presented with photographs and a key to the Korean species of genus *Kamendaka* is provided.

Key words: Fulgoromorpha, *Kamendaka annulata*, Kamendakini, Korea, new record

P30

A checklist of the family Coleophoridae in Korea, with two unrecorded species of the genus *Coleophora* Hübner

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The family Coleophoridae is one of the poorly known lepidopteran groups in Korea, with only 35 species known so far. Here we present two unrecorded species of *Coleophora* Hübner, 1822, *C. serinipennella* Christoph, 1872 and *C. uliginosella* Glitz, 1872, as well as a checklist of Korean Coleophoridae. Diagnostic characteristics and photographs of adults and genitalia for the two species are given.

Key words: Microlepidoptera, casebearers, new record, Korean fauna

P31

Review of the Korean species of the genus *Euconnus* Thomson (Coleoptera: Staphylinidae: Scydmaeninae)

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The Scydmaeninae genus, *Euconnus* Thomson, 1859 comprises 37 subgenera approximately 2,500 species worldwide and only four species, *E. impar* Sharp, *E. lijingkei* Franz, *E. rudimentalis* Jałoszyński, and *E. odaesanensis* Hoshina & Park, were known from South Korea. Additional species of the *Euconnus* has not been recorded in South Korea since *E. odaesanensis* Hoshina & Park recorded in 2020. In this study, we discovered two unrecorded species *E. fustiger* (sharp) and *E. dulcis* Sharp. This is the increasing the number of the *Euconnus* species indentified in South Korea to six.

Key words: ant-like stone beetle, unrecorded, taxonomy, South Korea

P32

Two new records of genus *Drabescus* Stål (Hemiptera: Auchenorrhyncha: Cicadellidae) from Korea

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The leafhopper genus *Drabescus* Stål is the largest group in the tribe Drabescini of the subfamily Deltocephalinae (Hemiptera: Auchenorrhyncha: Cicadellidae). So far, the genus contains 63 species from Afrotropical, Palaearctic, Oriental and Australian regions.

In this study, two species of the genus *Drabescus* are reported for the first time from Korea. Re-descriptions and photographs of habitus and male genitalia are given. A key to eight species from Korea is also provided.

Key words: Auchenorrhyncha, distribution, Drabescini, identification, morphology

P33

Taxonomic review of the genus *Lachnus* Burmeister, 1835 (Hemiptera: Aphididae) from Korea

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The Holarctic genus *Lachnus* Burmeister, 1835 comprises about 23 valid species and mostly associated with *Quercus* spp. (Fagaceae). This genus is morphologically distinguished from other Lachnid genera by the alatae having dark pigmented wings. To date, three species of *Lachnus* have been documented in Korea: *Lachnus chosoni* Szelegiewicz, 1975; *L. quercihabitans* (Takahashi, 1924) and *L. tropicalis* (van der Goot, 1916). We report *Lachnus takahashii* Sorin, 1980 on *Quercus* sp. for the first time in Korea and describe the hitherto unknown alatae of *L. chosoni*.

Key words: Aphids, Lachninae, new record, Korean Peninsula

P34

Review of the Genus *Setolebia* Jedlicka, 1941 (Coleoptera: Carabidae: Lebiini) from Korea

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The genus *Setolebia* contains 5 species worldwide and is distributed in North Eastern Asia. In this study, we have recognised the distribution of the genus *Setolebia* from Korean peninsula, based on *S. caligata* (Bates, 1888).

A diagnostic key for related Korean genera, photographs of the species and host information are provided.

Key words: *Setolebia*, Carabidae, Lebiini

P35

The first record of *Pemphigus bursarius* Linnaeus, 1758 (Hemiptera: Aphididae: Eriosomatinae) in Korea Peninsula

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The genus *Pemphigus* Harting, 1839 is belonging to the subfamily Eriosomatinae (Hemiptera: Aphididae) including over 70 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, two species of the genus have been recorded from Korea. In this study, a total of three species of the genus is revised. Among them, one species *Pemphigus bursarius* Linnaeus, 1758 was recognized for the first time in Korea. We provide a key to the Korean species and redesciptions in detail.

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

P36

First record of Genus *Bruchophagus* (Hymenoptera: Chalcidoidea: Eurytomidae) in Korea, with three newly recorded species

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The genus *Bruchophagus* Ashmead, 1888 is a comparatively large group with 168 valid species in the family Eurytomidae. This genus is well known as a major phytophagous group that eats the seed of Fabaceae. In East Asia, each 8 and 13 species are recorded in China and Mongolia, but no records in Korea and Japan.

Here, we report the first record of the genus *Bruchophagus* in Korea, with three newly recorded species. Key to Korean species, diagnoses and photos of diagnostic characteristics are provided.

Key words: Chalcidoidea, Phytophagous, new record, taxonomy

P37

Revealing phylogenetic position of Anoplophilinae (Orthoptera: Rhaphidophoridae) with biogeographic history

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Anoplophilinae is an endemic group of Cave crickets (Raphidophoridae) in East Asia, but its phylogenetic position within the family had been controversial. To shed light on the systematic problems, we performed the molecular phylogenetic analysis for the family Raphidophoridae using multi-locus data including all subfamilies for the first time. We reconstructed the phylogenetic position of all subfamilies including Anoplophilinae and suggested new synapomorphies. By biogeography analyses with divergence time estimation, we suggested the narrative hypothesis that the ancestor lineage of Anoplophilinae migrated to America by crossing the Beringia.

Key words: Raphidophoridae, Anoplophilinae, Phylogeny, Biogeography, Beringia

P38

Discovery of a newly recorded species of family Choreutidae (Lepidoptera) in Korea, with an annotated checklist

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The family Choreutidae is one of the small sized moths, comprising 406 species of 18 genera worldwide. In Korea, in total, 10 species, 5 genera under the family Choreutidae have been known to date. This study is aimed to report a newly recorded species of the family Choreutidae; *Prochoreutis delicata* (Arita, 1976), and provide the checklist of all known species from Korea.

Key words: Choreutidae, *Prochoreutis*, new record, Korea

P39

A newly recorded species of the genus *Bucculatrix* Zeller (Lepidoptera: Bucculatricidae) from Korea

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The family Bucculatricidae (Lepidoptera: Gracillarioidea) is one of the small family. Bucculatricidae comprising more than 300 species worldwide (Liu, 2020). In Korea, only two species have been reported to date (Park, 2013; Lee and Jeun, 2022).

In this study, one species *Bucculatrix duanwuia* Liu, 2020 is reported for the first time from Korea. It is very similar to *B. notella* in appearance, but it can be distinguished by the valva with rather widened terminal part and aedeagus with strongly curved apex. It shows the different DNA sequence (COI) with each other. Consequently, totally 3 species (Bucculatricidae) are recorded in Korea. All available information, host plants and images of adults and genitalia for species is provided.

Key words: Bucculatricidae, *Bucculatrix*, new record, leaf-miners, Korea

P40

Molecular approach to Korean mosquitoes (Culicidae: Diptera) using rRNA-ITS2 and mtDNA-COI

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The family Culicidae, commonly referred to as mosquitoes, is one of the earliest-branching lineages in lower Diptera, and it can transmit various diseases through blood-feeding habits. In Korea, the genus *Anopheles* is known as a main vector of malaria in the demilitarized zone (DMZ) and genus *Culex* caused a pandemic of Japanese encephalitis in the 1960s. In addition, *Aedes albopictus*, a potential vector for Zika and dengue virus, is known to be widely distributed across the Korean peninsula. Although the endemic mosquitoes of Korea are spreading worldwide, most studies on the Korean culids have been limited to a few taxa (*Aedes*, *Anopheles* and *Culex* spp.) for devising control measures, with no emphasis on underlying molecular basis. In this study, we designed new primers for 11 genera of Korean mosquitoes between the 5.8S and 28S region of the ribosomal RNA (rRNA) to facilitate species identification and tested the utility of the targeted gene region for phylogenetic analysis. In this study, we generated DNA sequence data of 13 species in six genera, and conducted a phylogenetic analysis of 40 species in 10 genera based on ribosomal ITS2 and mitochondrial COI sequence data available in the NCBI GenBank database. This study represents the first attempt to analyze a molecular phylogeny of Korean mosquitoes using two molecular makers with ecological traits, providing clearer systematic relations than using single mtCOI marker.

Key words: Culicidae, molecular phylogeny, mosquito, ITS2

P41

A taxonomic review of the order Mantodea in Korea based on morphological and molecular characters

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A taxonomic study of Korean Mantodea is present. Eight species [*Amantis nawai* (Shiraki, 1908), *Acromantis japonica* Westwood, 1889, *Mantis religiosa sinica* Bazyluk, 1960, *Statilia maculata* (Thunberg, 1784), *Tenodera angustipennis* Saussure, 1869, *T. sinensis* Saussure, 1871, *Hierodula chinensis* Werner, 1929, *H. patellifera* (Audinet-Serville, 1839)] belonging to six genera in three families are recognized based on morphological and molecular characters. Genetic divergence of *COI* using uncorrected *p*-distance among the eight Mantodea species ranged from 6.3% to 13.1%, while intraspecific divergence ranged from 0% to 0.3%. All eight species were strongly supported as a single lineage on the neighbor-joining tree. Keys, habitus photographs and illustrations of the diagnoses of the species are provided to facilitate identification.

Key words: Mantodea, taxonomy, review, Korea, molecular characters

P42

Morphological characteristics of larval stages in Neocarabi group from South Korea

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In South Korea, a total of 2 genera, 5 species in the division Neocarabi are known. This group is known as a biological indicator that can evaluate forest ecosystems. Among them, *A. changeonleei* and *A. mirabilissimus mirabilissimus* are legally as endangered species, and *A. leechi yooni* has also been confirmed to be like that recently. Morphological studies related to adults of this group are still being actively conducted, while studies on the immature stage of larval stage are poorly known.

In this study, the morphological characteristics, photographs and taxonomic keys of larvae of 5 species belonging to this group are provided.

Key words: Carabidae, endangered species, larva, taxonomy, Korea.

P43

A taxonomic revision of the genus *Macrotomoxia* Pic, 1922 (Coleoptera: Mordellidae: Mordellinae: Mordellini)

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The genus *Macrotomoxia* Pic, 1922 is one of the most enigmatic genera of the family Mordellidae, and characterized by the unicolor body with brownish setae, eyes with hypocranial extension, maxillary palps with tentacular appendages in male, stout pygidium, and symmetric parameres. Only two species of *Macrotomoxia*, *M. castanea* Pic, 1922 and *M. gardneri* (Blair, 1931), have been reported in the Oriental region. Furthermore, *Higehananomia palpalis* Kôno, 1935 was synonymized to *M. castanea* and the monotypic genus, *Higehananomia* Kôno, 1935 was treated as a junior synonym of *Macrotomoxia* by Horák (1999). However, during examination of Japanese specimens and type series for this genus, the senior synonym of *H. palpalis* turns out to be *M. gardneri*. We revise the synonymy of Horák (1999) and discuss about distributions between both species.

Key words: Taxonomy, Synonym, Coleoptera, Mordellidae, Mordellini, *Macrotomoxia*

P44

Complete Mitochondrial Genome of the Gypsy Moth, *Lymantria dispar* (Lepidoptera: Erebidae)

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The Gypsy moth, *Lymantria dispar* (Linnaeus, 1758) (Lepidoptera: Erebidae) is a serious pest that attacks forest as well as fruit trees. We sequenced the 15,548 bp long complete mitochondrial genome (mitogenome) of this species. It consists of a typical set of genes (13 protein-coding genes, 2 rRNA genes, and 22 tRNA genes) and one major non-coding A + T-rich region. The orientation and gene order of the *L. dispar* mitogenome are identical to that of the ancestral type found in majority of the insects. Phylogenetic analyses using concatenated sequences of 13 PCGs and 2 rRNAs (13,568 bp including gaps) revealed that the *L. dispar* examined in our study, together with other geographical samples of *L. dispar* in a group forming the family Erebidae and consistently supported the monophyly of each family (Erebidae, Euteliidae, Noctuidae, Nolidae and Notodontidae), generally with the highest nodal supports.

Key words: Mitochondrial genome, *Lymantria dispar*, Erebidae, Republic of Korea

P45

Genetic comparisons of *Spodoptera litura* populations (Lepidoptera: Noctuidae), in South Korea using mitochondrial DNA sequences

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Spodoptera litura Fabricius, 1775 (Lepidoptera: Noctuidae) is a serious crop pest with a long-distance migratory flight. We investigated pattern of occurrence to trace invasion characteristics and genetic divergence using pheromone trap. So far, we analyzed the genetic diversity and the relationships of *S. litura* 11 populations in South Korea using COI sequences. The 11 populations as a result of analyzing the COI sequences for 133 individuals, a total of 7 haplotypes were identified. The genetic divergence between haplotypes ranged from 0.152% to 0.456%. In the F_{ST} results between populations to compare genetic isolation, it was confirmed that there was a meaningful genetic divergence in Seocheon and Anseong.

Key words: *Spodoptera litura*, Population genetic analysis, Mitochondrial DNA, COI

P46

A new species of *Trissemus* Jeannel, 1949 (Coleoptera: Staphylinidae: Pselaphinae) from Korea

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The genus *Trissemus* Jeannel is one of the largest genera in the subfamily Pselaphinae. There are 175 species worldwide including 45 Palearctic species. Nine, two, and one species were recorded in Japan, the Russian Far East, and Taiwan, respectively. This genus was first recorded in Korea in 1973 by Löbl with a report of *T. crassipes*. Six subgenera, *Trissemus* Jeannel, *Trissemmites* Jeannel, *Trissemellus* Jeannel, *Trissemodes* Jeannel, *Trissemosus* Jeannel, and *Trissemidius* Jeannel are currently known. Three species (*T. alienus* (Sharp), *T. crassipes* (Sharp), and *T. peninsulanus* Nomura and Lee) belonging to the subgenus *Trissemus* are distributed in Korea. In this study, we report a new species represented by four specimens from the Chungbuk National University Insect Collection (CBNUIC). Illustrations of the habitus and diagnostic characters including male genitalia are also provided. The specimens were collected by sifting clay and reed debris around a swamp.

Key words: ant-loving beetle, taxonomy, new species, swamp

P47

A newly recorded species of *Hexencyrtus* Girault (Hymenoptera: Chalcidoidea: Encyrtidae: Encyrtinae) from Korea

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The genus *Hexencyrtus* Girault, 1915 is a comparatively small group with 3 valid species in the world. In this study, we report a new record of *Hexencyrtus* from Korea. The descriptions and photos of diagnostic characters of the species are provided.

Key words: Encyrtid, new record, parasitoid, taxonomy

P48

Complete mitochondrial genome of the carrion beetle, *Necrodes nigricornis* (Coleoptera: Silphidae), which is forensically important for estimating postmortem intervals in decomposed corpses

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The carrion beetle, *Necrodes nigricornis* Harold, 1875 (Coleoptera: Silphidae) is one of the most frequently attracted species to the animal cadavers among Silphidae in Korea. In this study, we present mitogenome characteristics of *N. nigricornis* to increase the genomic data pools of the family Silphidae, which has forensic importance. The full-length circular genome was 18,503 bp. It contained the typical set of 37 metazoan genes. The maximum-likelihood tree revealed the *N. nigricornis* belonging to Silphinae was placed as the sister to congeneric *N. littoralis*. We hope this mitogenome sequences of the carrion beetle become an important baseline information for future studies on phylogeny at various levels of taxonomic diversity.

Key words: *Necrodes nigricornis*, mitochondrial genome, forensically significant species, phylogeny

P49

Development of diagnostic and prescription technology for fruit insect pests using image information

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기후변화에 따른 이상고온, 작물 환경변화 등으로 해충 발생 양상이 달라지면서 기존 잠재 해충의 발생 등으로 농작물의 피해 증가와 작물의 생산량 감소가 크게 우려되고 있다. 오늘날 병해충의 신속한 진단과 진단시스템의 구축의 필요성이 요구되고 있으며, 최근 인공지능(AI) 기술을 활용하여 병해충을 진단할 수 있는 기술이 주목받고 있다. 이에, 과수류 해충의 영상진단 이미지를 확보하기 위해 배, 사과, 포도, 감귤, 자두, 매실, 복숭아, 감 8개의 과수류 작물에서 발생하는 주요 해충 24종의 다양한 태벌, 피해 기주 등에 대한 영상진단 이미지 17,000매 생성하였다. 생성된 이미지는 영상정보 라벨링 및 검수할 예정이며 추후 28,000매 이상을 확보하고자 한다. 이러한 자료는 딥러닝 기반 영상학습을 통하여 해충 영상 진단 시스템에 활용될 것이다.

검색어: 인공지능, 과수류, 병해충, 진단 시스템

P50

Discovering misidentified *Nola* sp. (Lepidoptera, Nolidae), new subconscious natural enemy for some gall aphid

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For a long time, the East Asiatic nolid moths identified based on especially Japanese literatures. Among them, the genus *Nola* Leach [1815] is one of the most dependent taxon on those references. As a result of our recent study, a *Nola* species discovered as new species. Additionally, this new species host information should be subconscious natural enemy of forest gall aphid.

Key words: Nolinae, host plant, kleptoparasitic moth

P51

A new record of *Habroloma (Parahabroloma) yuasai* (Coleoptera: Buprestidae), leaf-miner of *Platycarya strobilacea* (Juglandaceae) from Korea, with biological notes

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Until now, *Habroloma (Parahabroloma) yuasai* Kurosawa, 1976 which is known as a leaf-miner of *Platycarya strobilacea* has been reported only in Japan. Moreover, neither the descriptions nor photographs of male genitalia were known hitherto, and biological information was less known. In this study, *H. (P.) yuasai* is reported for the first time from Korea, with the first description and photograph of male genitalia. Also, their biological notes are presented.

Key words: Buprestidae, jewel beetle, *Habroloma*, leaf miner, new record

P52

Taxonomy of the genus *Coenosia* Meigen (Diptera: Muscidae) from Korea

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The genus *Coenosia* Meigen, 1826 known as "hunter fly" is a predatory fly belonging to the family Muscidae. Until now, more than 350 species in this genus are known worldwide, but there are no records in Korea yet. This study contains taxonomic information with the 6 unrecorded *Coenosia* species from Korea and the key to these species.

Key words: hunterfly, *Coenosia*, Muscidae, Diptera, new record, Korea

P53

A new species of the Genus *Diastata* Meigen (Diptera: Diastatidae) from Korea

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The genus *Diastata* Meigen, 1830 is mainly found in the temperate region, and so far, 35 species have been recorded worldwide. In this study, the genus *Diastata* is reported for the first time in Korean fauna, with a new science species, *Diastata koreana* sp. nov. External photographs, diagnosis as well as taxonomic remarks of this new species and key to Palaearctic species are presented herein.

Key words: new species, *Diastata*, Diastatidae, Diptera, Korea

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P54

A new species of genus *Notodoma* Lacordaire, 1854 (Coleoptera: Histeridae) from Korea

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The genus *Notodoma* Lacordaire, 1854 is one of small mycophile groups of the histerids. This genus consists of six species worldwide. Among them, only one species, *Notodoma fungorum* Lewis, 1884, has been reported from Korea. We recognize a new species, *Notodoma jejuensis* sp. nov., from Jeju-Island in this study. Herein, we provide a key to species of Korean *Notodoma* with diagnosis and photographs of adult for a new species.

Key words: Taxonomy, Histeridae, *Notodoma*, New species, Korea

P55

Microsatellite marker development for *Conogethes punctiferalis* and its application to regional populations in Korea

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The yellow peach moth, *Conogethes punctiferalis* (Guénee) (Lepidoptera: Crambidae) is one of the most destructive pests damaging more than 120 host plants. However, a lack of genetic information on this pest has hindered population genomics researches on population genetic structure, diversity, relationship, and gene flow between diverse populations. In this study, we developed 10 microsatellite markers for *C. punctiferalis* using a transcriptome data, which can provide a resolution to determine the various genetic events. The polymorphisms of simple sequence repeats in these markers were investigated among seven regional populations of *C. punctiferalis* and proved to be polymorphic enough to distinguish regional populations. This study presents the first development of microsatellite markers of *C. punctiferalis* using de novo assembly. These microsatellite markers would be a valuable tool for future geographic genetic structure and diversity between diverse populations of *C. punctiferalis*.

Key words: microsatellite marker, population genetics, geographic genetic structure, *Conogethes punctiferalis*

P56

First report of *Euderomphalini* Shafee, Rizvi and Khan (Hymenoptera: Eulophidae) from South Korea

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Euderomphalini Shafee, Rizvi and Khan (Hymenoptera: Eulophidae) is newly recognized from South Korea. In the present study, we report a newly recorded species of the genus *Euderomphale* with description and its figures.

Key words: taxonomy, new record, Chalcidoidea, Entedoninae, the Korean Peninsula

P57

Three new records of the genus *Cosmolaelaps* (Mesostigmata: Laelapidae) in Korea

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Genus *Cosmolaelaps* is one of the most abundant groups among the family Laelapidae (Acari: Mesostigmata), it contains at least over a hundred species in the world. In Korea, five species of the genus were recorded. They usually live on the surface of the ground, while some of them are strictly associated with Formicidae (Hymenoptera: Formicoidea) and their nest. Although this genus is widely distributed in various habitats, all of them shared the same morphological character “modified dorsal setae”. In this study, line-drawing plates with captured images and a brief diagnosis of *Cosmolaelaps* sp.1 nov., *Cosmolaelaps* sp.2 nov., and *Cosmolaelaps robustochaetes* Ma & Lin, 2009 moreover, key to the Korean species of *Cosmolaelaps* will be provided.

Key words: *Cosmolaelaps*, Laelapidae, Formicidae, New record, Taxonomy

P58

First record of the family Telemidae (Arachnida: Araneae) from Korea

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The family Telemidae Fage, 1913 is a tiny (0.9–2.2 mm) haplogyne spider, currently containing 104 species in 16 genera worldwide. Most of the species live in caves, usually having six eyes, though some of them are completely eyeless. In this study, new species of the genus *Telema* Simon, 1882 are described from Korea. This species is also the first recorded family from Korea and the first record as an eyeless spider of Korean species. The specimens were collected from Baetishale cave located in Hapcheon-gun (Gyeongsangnam-do). Description of the new species is provided with a diagnosis and microscopic photographs.

Key words: Telemidae, *Telema*, new record, new species, taxonomy, morphology, eyeless

P59

Three new species of the genera *Nossidium* and *Sindosium* (Coleoptera: Ptiliidae: Nossidiinae) from South Korea

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The family Ptiliidae includes approximately 1,000 valid species within approximately 100 genera, but they are one of the most poorly-known coleopteran families in Korea. Ptiliid beetles are readily distinguished from other beetles based on minute body size (usually less than 2 mm long), feather-like hindwings, as well as peculiar setae on antennomeres. They were originally divided into three subfamilies, Acrotichinae, Cephaloplectinae and Ptiliinae. However, in 2019, Acrotichinae and Cephaloplectinae moved into the subfamily Ptiliinae and the new subfamily Nossidiinae was described. In subfamily Nossidiinae, only two species of the genus *Nossidium*, *N. flachi* and *N. pilosellum* are recorded in the palearctic region. In this study, we report three new Nossidiinae-species from Korea for the first time.

Key words: *Nossidium*, *Sindosium*; new species; featherwing beetle; taxonomy.

P60

The microbiome profile of *Culex tritaeniorhynchus* and *Culex orientalis* from the Republic of Korea

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Mosquitoes, the major vectors of arboviruses, are naturally host to diverse microbiome which play an important role in their development, immunity, and vector competence. The composition of the mosquito microbiome is strongly influenced by the environment, particularly depending on the habitat. *Culex tritaeniorhynchus* is main vector for Japanese encephalitis virus transmission. Moreover, recent study revealed that Japanese encephalitis virus is identified from *Culex orientalis*. Using 16S rRNA Illumina sequencing, we investigate the microbial profiles in the adult female *Culex tritaeniorhynchus* and *Culex orientalis* from Korea. We identified 86 bacterial families that were prevalent in the *Culex tritaeniorhynchus* and *Culex orientalis* microbiome. Most abundant bacteria were *Asaia bogorensis* and *Pantoea agglomerans* which are known to affect vector competence. Furthermore, the microbiome profiles of *Culex tritaeniorhynchus* and *Culex orientalis* represent high similarity, and thus *Culex orientalis* may share ecological niche with *Culex tritaeniorhynchus*. Our findings show that mosquitoes have region-specific microbiomes depending on their habitat.

Key words: microbiome, mosquito, vector competence, Japanese encephalitis virus

P61

Molecular characterization of two acetylcholinesterases from the western flower thrips, *Frankliniella occidentalis*

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We investigated the molecular properties of two acetylcholinesterases (FoAChE1 and FoAChE2) from the Western flower thrips, *Frankliniella occidentalis*. Polyacrylamide gel electrophoresis in conjunction with western blotting with AChE1- or AChE2-specific antibodies suggested that both FoAChE1 and FoAChE2 exist in membrane anchored forms. In particular, FoAChE2 appears to be present in an amphiphilic form with a glycosylphosphatidylinositol anchor. The migration pattern of FoAChE2 in the presence of Triton X-100 or phosphatidylinositol-specific phospholipase C resembled with that of the bands in activity stained gel. Taken together, FoAChE2 may be the main enzyme for synaptic transmission. Further investigation of kinetic and inhibitory properties of recombinant FoAChEs expressed by baculovirus expression system in sf9 cells is essential to clearly identify the major form of AChE in western flower thrips.

Key words: Acetylcholinesterase, Western flower thrips, *Frankliniella occidentalis*, Native-PAGE, Activity staining, Western blot

P62

Labor-specific gene expression profile in the heads of honey bee, *Apis mellifera*, treated with pesticides

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Honey bee, *Apis mellifera*, is an economically important insect in ecosystem and agriculture, however, a significant decline in their population has been recently reported due to exposure to various pesticides. Pesticides have been reported to negatively affect foraging activities, such as food orientation, navigation, learning, and memory in honey bee. Therefore, in this study, we investigated the expression levels of genes putatively involved in foraging, learning, and memory in the heads of nurse and forager bee exposed to seven insecticides by qRT-PCR. Although the gene expression pattern was different depending on the type of pesticides, pesticides belonging to organophosphate and pyrethroid generally reduced expression levels of the genes, suggesting that foraging activities could be damaged by these pesticides.

Key words: honey bee, pesticide, foraging, learning and memory

P63

Function of *yellow-y* in adult cuticle melanization of *Monochamus alternatus*

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Cuticle tanning (pigmentation and sclerotization) is an important physiological event in insect development. In this vital metabolism initiated with tyrosine, dopachrome conversion enzymes (DCEs) encoded by the *yellow* genes accelerate significantly melanization reaction. Insect *yellow* is a rapidly evolving gene family generating functionally diverse paralogs. In this study we identified, cloned cDNA and investigated the function of *yellow-y* (*MaY-y*) in adult cuticle melanin-type pigmentation of the Japanese pine sawyer beetle, *Monochamus alternatus*, which is a major vector of the pinewood nematode, *Bursaphelenchus xylophilus* that causes Pine wilt disease. Real-time qPCR revealed that *MaY-y* was sharply induced in day 9 pupae and declined thereafter during late developmental stages. Loss of function of *MaY-y* caused by RNAi had no effect on larval and pupal development. However, the resulting adults exhibited a reddish-brown body wall and elytra as well as bristles instead of a black coloration in the control animals. These results indicate that *MaY-y* has a critical role in normal black pigmentation of *M. alternatus* adult.

P64

Selection of stable reference genes for qRT-PCR in *Haemaphysalis longicornis*

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The Asian longhorned tick, *Haemaphysalis longicornis*, that is the most important vector of severe fever with thrombocytopenia syndrome virus (SFTSV) is the dominant species of Ixodidae in Korea. Considering its medical importance, to understand the physiology of *H. longicornis*, it is essential to determine the expression of the genes of interest. To analyze gene expression, qRT-PCR has been widely used. However, selection of reliable reference gene across samples of various condition is necessary for the accurate normalization of target gene expression levels. In this study, we analyzed the transcript levels and expression stabilities of five candidate reference genes (*ACT*, *RPP0*, *RPL23*, *TUB*, and *GAPDH*) in *H. longicornis* under different conditions (different collection months, developmental stages, and SFTSV infection status) with various methods (C_q distribution, NormFinder, BestKeeper, geNorm, and RefFinder). Consequently, a single gene between *RPP0* and *RPL23* was determined to be the optimal reference gene in *H. longicornis* under various conditions by comparing expression level of *HSP70* was normalized with candidate reference genes.

Key words: *Haemaphysalis longicornis*, reference gene, quantitative real-time PCR

P65

Relationship between thrips population size and TSWV infection in hot pepper

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Tomato spotted wilt virus (TSWV) is one of the most serious plant diseases and causes massive economic damage on high value crops. TSWV is transmitted by specific thrips including *Frankliniella occidentalis*. Our previous study showed that *F. occidentalis* exhibits two main peaks in June and September in hot pepper. However, the TSWV infected hot peppers were noticed in April and May. This discrepancy raised a doubt about the coincidence of the thrips and the plant disease. To test this hypothesis, we compared the thrips occurrence with the frequencies of TSWV infected thrips and hot peppers. The TSWV infected thrips occurred mainly earlier than the main thrips peaks in the two fields. Moreover, a specific field did not have any TSWV infected hot peppers even though there were several thrips peaks. From these observations, we suggest out the TSWV infection on hot pepper depends on the frequency of TSWV infected thrips, but not on the thrips density.

Key words: TSWV, *F. occidentalis*, *F. intonsa*, and Hot pepper.

P66

Analysis of the benthic invertebrates community changes responding to climate changes

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Climate change affects the community structure and ecosystem processes. Therefore, predicting how communities will respond to climate change is important for ecosystem management and conservation planning. The community temperature index (CTI) is a good index to estimate changes of the community according to temperature changes because CTI reflects the thermal preferences of the species in community. In this study, we aimed to identify difference of community structure according to CTI and examined environmental variables that affect CTI. Community changes of Ephemeroptera, Tricoptera and Plecoptera according to changes in CTI were investigated and a structural equation model was used to determine the influence of environmental variables on CTI. As a result of the study, the composition of species and functional feeding groups in community varied by the change of the CTI. In the structural equation model, the influence of each environmental variable on the determination of CTI was identified. It will be useful to predict changes in community composition accompanied with climate change.

Key words: community temperature index, structure equation model, climate change, headwater invertebrates

P67

Analysis of length-mass relationship for freshwater macroinvertebrates

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In order to understand energy flow in food web, biomass is required. However, the process takes a lot of time and cost. If biomass can be inferred from the body length, it will be save the effort. We investigated length-mass relationship for freshwater macroinvertebrates using literature study and direct measurement. In addition, equations according to characteristics such as body length of taxa were compared. Total 29 articles were collected. Body length of more than 17 taxa were directly measured and most of them showed that abundance was decreased as length increased or unimodal length-abundance distribution. In direct mass measurement, most taxa were fitted in $M=aL^b$ equation.

Key words: body length, dry mass, biomass, aquatic insect, length-mass regression, body mass estimation, energy flow

P68

Analysis of North Korean research literature on forest insects from 2000 to 2019

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2000~2019년도까지 20년 동안의 북한의 연구보고서를 대상으로 북한 내 산림곤충/산림해충과 관련된 문헌을 조사하여 분석하였다. 한국과학기술정보연구원(KISTI)에서 구축한 북한과학기술원문정보 디지털 라이브러리(NKscholar)에 게재된 논문들 중 해당 기간 동안 산림곤충 혹은 산림해충과 관련된 논문을 전수조사하였다. 이 중 원본을 확인할 수 있는 논문만을 수집한 결과, 총 5개의 자연과학 북한 내 학술지에서 총 71개의 연구논문을 수집하였다. 71개의 연구논문을 대상으로 학술지별, 연도별, 분야별, 주제 곤충/해충별(중, 목) 논문의 동향을 중복 포함하여 분석하였다. 학술지 중에서는 산림과학 학술지에서 가장 많은 산림곤충 관련 논문이 게재되어 있었고 매년 평균 3.9건의 논문이 발표되었다. 분야별로는 곤충 분류와 관련된 논문이 45건으로 가장 많았으며, 방제 분야가 15건, 생태분야가 9건 있었다. 가장 많이 연구된 곤충 목은 나비목 25건이며, 그 다음으로 딱정벌레목 15건, 노린재목 14건으로 많았다. 특히 방제 분야 연구로는 유기합성농약 뿐만 아니라 곤충병원성균과 천적 곤충을 이용한 방제 방법 연구가 주를 이루었다. 북한 내 주요 산림해충 중에는 솔나방(*Dendrolimus spectabilis*)과 관련된 연구가 제일 많았으며, 진긴수염돌드레(북방수염하늘소), 털벌레(미국흰불나방), 긴나무좀류(참긴나무좀속) 등 남한에서 문제되는 산림해충과 유사한 해충 역시 발견되는 것으로 분석되었다.

검색어: 북한 산림 곤충, 진긴수염돌드레, 털벌레, 산림과학

P69

Geographic distribution and genetic diversity of the invasive fall armyworm, *Spodoptera frugiperda* in Nepal

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Since 2016, the fall armyworm (FAW), *Spodoptera frugiperda*, has been invaded into most African and Asian countries, causing significant losses to various crop plants such as corns. In Nepal, it was firstly recorded on 9th May 2019, from the southern part and spread all over the country within the year. We analyzed the geographic distribution of invaded populations collected from different locations in Nepal and genetic variation using the triose phosphate isomerase (*Tpi*) gene sequences. The analysis of the fourth exon and intron region of *Tpi* gene sequences revealed that all the samples were the corn strain but not the rice strain, and identified at least three subgroups, *Tpi*-Ca1, *Tpi*-Ca2a and *Tpi*-Ca2b. Among the three subgroups, *Tpi*-Ca1 was most prevalent in Nepal consisting of 87% of all the samples. Our study provides useful information on the genetic diversity of fall armyworms in Nepal.

Key words: *Spodeptera frugiperda*, invasion, *Tpi* gene, corn strain, genetic diversity

P70

Relationship among the temperature, the density of insect pest and damage of host plant: case study of whitefly in tomato greenhouse

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Insect pest causes to damage to the host plant and changes the health of the plant as the density fluctuates. Insects are sensitive to environmental factors including temperature and humidity to maintain energy and moisture balance, Among them, temperature change affects the activity and reproduction of insects. Thus, the optimal temperature would be shown the higher density of insect pest, and the more severe damage to the host plants. In this study, the experiment is conducted to measure the difference in damage to the greenhouse tomatoes according to the density of *Bemisia tabaci*, in different growing season (*i.e.* different temperature of atmosphere). This study aims to analysis the difference in damage of host plant and then, analysis of causal relationship among the temperature, the density of insect pest and damage of host plant.

Key words: insect pest density, temperature, plant health, *Bemisia tabaci*, greenhouse tomatoes

P71

Population dynamics of ticks (Acari: Ixodidae) and their SFTS virus-harboring rates from 2019 to 2021 in Gyeonggi-do, South Korea

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Ticks are the medically important vectors which transmit diseases to human including Severe Fever with Thrombocytopenia Syndrome (SFTS). Given that there is no vaccine for SFTS currently available, prevention of SFTS is important and this can be achieved by monitoring the SFTS virus vectors. Therefore, this study reports the results of three-year field survey using CO₂ bait traps to characterize the species composition of the SFTS-vector ticks and their seasonal abundance in diverse landscapes. In addition, the minimum infection rate (MIR) of SFTS virus in the ticks was estimated. From the field survey, *Haemaphysalis longicornis* Neumann was the most dominant species. With regard to seasonal population dynamics, *H. longicornis* nymphs peaked in spring and adults peaked subsequently in summer. In addition, the MIR of SFTS virus was highest in 2020 yielding 0.96 and no SFTS virus was detected in 2021.

Key words: Asian longhorned tick, monitoring, tick-borne disease, MIR

P72

Biological control of ragweed requires timing: Field tests by the ragweed leaf beetle

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Ambrosia artemisiifolia L. (common ragweed) is a globally invasive, allergenic, troublesome weed. Korean rural areas are also inundated with ragweed. Ragweed leaf beetle, *Ophraella communa*, has been tested as a biological control agent for ragweed, but its effective release timing and density not been investigated in Korea. The effectiveness of biological control by the ragweed leaf beetle in controlling ragweed in the field can only be proven if an environment for controlling insects has been created. For herbivore exclusion experiments, we built twelve greenhouses measuring 4m x 4m which were covered with insect-proof nets of 20-40 mesh. This led us to conduct an experiment to measure the control efficiency based on the densities of the beetle and developmental stages of ragweed in the field. Young ragweeds are susceptible to the beetle attack, demonstrating the importance of early control.

Key words: plant ontogeny, herbivore density, field test, insect-proof net greenhouse

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P73

Effects of six soybean cultivars on development and reproduction of bean bug, *Riptortus pedestris* and *Halyomorpha halys*

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재배되고 있는 6개 품종의 콩으로 톱다리개미허리노린재와 썩덩나무노린재의 발육, 생존율 그리고 산란수에 미치는 영향과 개체군의 생명표를 작성하였다. 톱다리개미허리노린재의 발육기간은 대풍 2호와 풍산나물에서 짧았고 선풍에서 가장 길었다. 썩덩나무노린재도 풍산나물에서 가장 짧았고 대찬에서 가장 길었다. 생존율은 두 종 모두 대풍 2호에서 가장 낮았고 풍산나물에서 가장 높았다. 성충수명과 산란수도 두 노린재 모두 풍산나물에서 가장 길고 많았으며, 대풍 2호에서 가장 짧고 적었다. 생명표 분석에서 순증가율(R_0)과 내적증가율(r_m)은 풍산나물에서 가장 높았고 대풍 2호에서 가장 낮았다. 이상의 결과에서 대풍 2호가 가장 내충성을 띄는 것으로 나타났다.

검색어: 썩덩나무노린재, 톱다리개미허리노린재, 발육기간, 산란수, 생명표

P74

Feeding behavior and infestation of bean bugs, *Riptortus pedestris* and *Halyomorpha halys* on different soybean cultivars

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To understand the feeding behaviour of *Riptortus pedestris* and *Halyomorpha halys*, stylet penetration behaviour was studied on six soybean cultivars with an Electropetrography (EPG) system and created the waveforms for both species. Infestation and damaging natures were examined in the soybean fields. The present study reports three EPG waveforms relative to both bug species: NP (non-penetration), Pb (phloem feeding: E1-Salivation and E2-Sap feeding), and G (xylem feeding). The waveforms NP, Pb, and G varied significantly among soybean cultivars. The NP was the shortest in the Pungsannamul and the longest in the Daepung 2ho. The feeding waveforms Pb and G were the longest in the Pungsannamul and the shortest in Daepung 2-ho. In the soybean field, the proportions of damage B- and C-type were highest in the Pungsannamul and the lowest in Daepung 2ho. This study provides perceptive information to understand the feeding behaviour, and field occurrence and damaging patterns of *R. pedestris* and *H. halys*, which may have key implications for the management of hemipteran pests via determining the specificity and susceptibility of host plants.

Key words: electrical penetration graph, soybean bugs, seed damage

P75

Comparison of endosymbiotic bacteria profiles of various whitefly species collected in Korea

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Whiteflies are phloem-feeding pest insects distributed worldwide. They possess multiple endosymbiotic bacteria which affect various biological characteristics of whiteflies such as development, resistance against environmental stress and pesticides, and efficiency of plant virus transmission. We compared the profiles of 5 secondary endosymbionts [*Arsenophonus* (A), *Cardinium* (C), *Hamiltonella* (H), *Rickettsia* (R), *Wolbachia* (W)] from several whitefly species in Korea. *Bemisia tabaci* is a species complex consisting of various cryptic species. MED/Q1 which is the dominant group in Korea, possessed C, H, R, while MED/Q2 had A, C, R. MEAM1 possessed H, R, W, but JpL had A, C, W. *Bemisia afer* possessed A, C, R. The boxtree whitefly *Aleuroclava hikosanensis* had C, H, R but *Trialeurodes vaporariorum* possessed C, R. The endosymbiont profiles were highly various from each species, even in different strains of MED cryptic species. These results suggest that the relationship between endosymbionts and whiteflies is highly specific in each genetically different groups of whiteflies.

Key words: Bemisia, cryptic species, endosymbionts, vector insects, whitefly

A platform design for the Korean Species Distribution Model (K-SDM) System

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최근 기후변화로 인한 외래 곤충의 돌발발생 가능성이 높아지면서(Bale, 2002) 이들의 확산 및 변화예측 진단을 통한 조기방제의 중요성이 대두되고 있다. 유입된 외래 해충의 경우 대부분 유충 및 약충으로 발견되며, 기초생태 및 기주식물 등의 정보가 미비하여 초기대응 및 방제에 어려움을 겪는 경우가 대부분이다. 따라서, 국내에 유입된 외래 해충의 대한 체계적인 데이터 확보를 통해 이들의 정착, 확산, 생태계 영향 예측모델 개발 및 활용시스템의 구축이 절실히 요구되는 실정이다. 본 연구를 통해 K-SDM(Korean Species Distribution Model) 시스템을 구축하여 국내 침입 외래 곤충 및 외래 해충의 조사데이터 확보 및 활용서비스 제공기반을 마련하고자 시스템 구성을 제안한다. 본 플랫폼은 각 참여기관 실무자 및 일반인용 2가지 버전으로 구축될 예정이며, 관리자용 페이지에서는 앱(App) 또는 웹(Web)을 통한 조사데이터 등록 또는 조건 선택에 따른 DB목록 출력 등의 기능이 가능토록 하고, 일반 방문자들에게는 국내 외래 곤충의 현 양상 및 차후 예측정보를 제공할 것으로 기대된다.

검색어: 외래곤충, 외래해충, 분포조사, 침입종, DB시스템

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Monitoring of invasive species, *Leptoglossus occidentalis* Heidemann (Hemiptera, Coreidae) of Province Chungcheong and Jeolla, Korea in 2021

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최근 기후변화와 발달된 교통수단 등으로 인한 외래해충의 침입이 우리나라의 생태계 교란을 유발하며 생물 다양성에 큰 위협이 되고 있다. 또한 외래해충은 새로운 지역으로의 유입 및 확산이 가속화되며 대발생 가능성이 높아지는 추세이다(Bale, 2002). 소나무허리노린재는 북미 원산으로 빠르게 전 세계적으로 전파되고 있는 산림 해충으로 2010년 가을 이전에 한국에 유입된 것으로 보고된 바 있다(Yoon, 2012). 본 종의 기주식물은 전체 소나무 과 식물로 알려져 있으며 소나무류, 가문비나무류 및 낙엽송 등 광범위한 기주분포를 나타내고 있다(Mariann, 2006; Manastryski, 2010). 따라서, 침입외래해충의 집중적인 연구와 모니터링은 매우 중요한 과제라 할 수 있다. 본 연구는 전형적인 흡즙성 해충이며 국내 침입외래해충으로 알려져 있는 소나무허리노린재를 대상으로 충청 및 전라지역에서의 발생분포를 확인코자 수행되었다. 이를 위해 2021년 3월부터 10월까지 충청·전라권 주요 행정구역을 중심으로 소나무허리노린재 발생여부를 조사하였다. 조사결과 총 2개 지역 6개소에서 발생여부를 확인하였다.

검색어: 외래해충, 모니터링, 소나무허리노린재, 채집조사, 분포

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The Occurrence of Mites in 3 Grape varieties in ChungCheongbuk-do

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청포도인 샤인머스켓은 2022년 5,241ha(38.9%) 재배면적을 차지할 정도로 인기가 높은 품종이며, 캠벨얼리는 4,397ha(32.7%)이지만, 과거 우리나라에서 가장 많이 재배했던 품종이다. 또한 총량은 2018년에 품종등록된 3배 체 포도로 신품종 연구가 필요한 품종이다. 2022년 충북의 샤인머스켓 5농가, 캠벨얼리 5농가, 총량 5농가 포도원에서 응애류 발생생태를 조사한 결과 샤인머스켓은 8월 초 42.2마리/잎, 캠벨얼리는 6월 초 2마리/잎, 총량은 6월 말 8.7마리/잎의 최고밀도를 보였다. 응애 방제를 위해 샤인머스켓 포도원에서는 0~9회의 살비제를 살포하였고, 캠벨얼리와 총량은 0~1회 살비제를 살포하였다. 품종별 응애 발생밀도의 차이는 샤인머스켓 잎은 다른 품종과 달리 잎 뒷면에 잎털이 많아 응애 은신이 쉽고, 약제 방제시 잎털에 의해 닿지 않는 경우가 발생해 방제가 어렵기 때문이며, 그에 비해 캠벨얼리와 총량의 잎 뒷면에 털이 적어 응애의 은신처를 제공하지 않기 때문으로 판단된다. 또한 샤인머스켓 포도잎이 연하여 흡즙성 곤충의 구기가 잎을 뚫을 수 있기 때문으로 사료된다.

검색어: 포도, 응애, 품종, 발생, 밀도

P79

Insects community survey as an environmental indicator of agricultural ecosystem in Jeju Island

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In the agricultural ecosystem, various types of environments are formed by many variables such as crop type, farming method, and location. In conventional farmland, chemicals are artificially added for the purpose of increasing the yield while decreasing pest populations, which directly affects the ecosystem. It is clear that these side effects pose many problems in terms of sustainable agriculture and biodiversity conservation. In this study, six representative crops in Jeju Island were selected (i.e., sweet corn, pumpkin, sesame, island starwort, bean and proso millet) and classified into organic and conventional farmlands. Then, insects were set as environmental indicators to analyze changes in each insect community. Redundancy analysis (RDA) was used to integrate the different variables and insects investigated. In this study, the difference in insect diversity and community structure between crop types in conventional agriculture and organic agriculture is indicated and suggested the potential of organic farming for biodiversity.

Key words: Agricultural ecosystem, Biodiversity, RDA, Sustainable agriculture

P80

Development of models for egg hatching and first instar dispersal of *Ramulus irregulariterdentatus* (Phasmida: Phasmatidae)

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The stick insect, *Ramulus irregulariterdentatus*, is a native species to Korea and is sometimes considered as a forest pest due to its occasional mass occurrence. It overwinters as egg stage in the soil and polyphagous first instar climbs up to its host trees in the spring season. For realistic phenological prediction which could be helpful for its management, experiments on temperature-dependent development for eggs of laboratory population were performed under three constant temperatures to improve previously reported phenology models. The development times of overwintered eggs collected from the field were also compared by sampling periods, and the emergence and dispersal of the first instar were monitored in three mountainous regions. The starting point when the eggs are under the affection of effective temperature was determined by semi-field experimental data based on the results of the development experiment. There was good agreement between the developed phenology model and the emergence of the first instar in the field. Finally, optimal management time in degree days was suggested based on observed nymphal dispersal.

Key words: stick insect, egg hatch, first instar, dispersal

P81

Temperature-dependent development model and Seasonal occurrence of *Pseudococcus comstocki* (Hemiptera: Pseudococcidae)

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The *Pseudococcus comstocki* has been known as a pest that could cause damages to pears, apples, and citrus. However, there is a lack of information on ecological characteristics and spraying timing on the pest. We conducted a temperature-dependent development experiments for the nymphs under five temperature conditions and monitored density changes in four pear orchards using sex pheromone trap during 2022. As a result, the lower threshold temperature was 10.9°C and the effective accumulated temperature was 333.3DD of the nymphs. Occurrence data showed that the earliest occurrence date of the adult was on April 27 in Naju, May 17 in Wanju, May 20 in Cheonan, May 23 in Hwaseong, and the peak occurrence date was June 24, June 11, June 12, and June 13, respectively.

Key words: *Pseudococcus comstocki*, lower threshold temperature, effective accumulated temperature

P82

Relationship between secondary metabolites of Kimchi cabbage and fitness of Diamondback moth

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Plutella xylostella, known as diamondback moth (DBM), is one of the most destructive pests of brassicaceae crops including *Brassica rapa subsp. pekinensis*, known as Kimchi cabbage. Kimchi cabbage have Glucosinolates (GSLs) as their primary defensive metabolites. Despite the economic importance, how GSLs of Kimchi cabbage affect DBM fitness was largely unknown. Here, we measured the fitness of DBM on 8 different cultivars of Kimchi cabbage by life table parameters. Life table parameters are useful in that they represent population growth rate. 10 GSLs and 3 stress phytohormones of each cultivar were measured by Ultra high performance liquid chromatography – Triple quadruple mass spectrometry (UHPLC-TQMS) system. The relevance of all data was calculated by PCA, and we found out fitness of DBM shows positive correlation with total aliphatic GSLs, and negative correlation with total indole GSLs.

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A long-horn beetle's behavior sabotage and its ecological consequences

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In the long evolutionary process of plants and insects, herbivorous insects have adapted in various ways to plant defenses. Nevertheless, herbivore adaptations against plant defenses have only focused on how herbivores detoxify plant toxic metabolites. Behavior adaptation is another strategy herbivores used to adapt to their host plants. *Phytoecia rufiventris*, a long-horn beetle, has a unique oviposition-associated behavior which called girdling; it cuts off vascular bundles on the stem to wither the upper part of the stem. Although the girdling behavior changes morphological and physiological changes of host plants, ecological consequences of the girdling has not been experimentally tested yet. Our results showed that upper part of girdled stem accumulated nutrients and decreased defensive compounds. Also, morphological changes of plants decrease appearance to other herbivores sharing the host plant. Our study suggest that herbivores are behaviorally able to neutralize plant defenses, which can also affect individual and community interactions.

Key words: *Phytoecia rufiventris*, counter-adaptation, girdling, plant resistance, plant-herbivore interaction

P84

Investigation of the occurrence and damage caused by *Limassolla koreana* in persimmon trees

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Limassolla koreana has been associated with significant damage of persimmon, a major product in Korea. The damage inflicted through sucking persimmon leaves affects fruit production due to early deciduous leaves. In this study, density and rate of leaf damage were investigated by monitoring the leafhopper through yellow sticky traps over a period of time. Highest densities were recorded at the end of June, and damage was more evident in August, possibly due to the accumulative effect of the population.

Key words: leafhopper, persimmon, *Limassolla koreana*

P85

Surveillance of hard ticks in southern part of Gyeongsangbuk-do in Korea, 2022

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SFTS 바이러스의 매개체는 참진드기로, 바이러스를 보유한 참진드기가 숙주를 흡혈할 때 전파된다고 알려져 있다. 이러한 참진드기를 조사하기 위해 발생 감시를 4월부터 7월까지 매달 1회씩 실시하였다. 이를 위해, 김천시의 무덤, 산길, 잡목림, 초지 4곳에 각각 Dry ice trap을 3개씩 설치해 채집하였다. 채집된 참진드기는 1속 3종 1,912마리로 무덤에서 895마리(46.8%), 잡목림에서 425마리(22.2%), 초지에서 301마리(15.7%), 산길에서 291마리(15.2%) 채집되었다. 각 발생단계별로는 암컷 521마리(27.2%), 수컷 229마리(12.0%), 약충 836마리(43.7%), 유충 326마리(17.1%)가 채집되었다. 종별로는 *Haemaphysalis longicornis*가 1,897마리(99.2%)로 가장 많이 채집되었고 그 외에 *Amblyomma testidunarium* 12마리(0.6%), *Haemaphysalis flava* 3마리(0.2%)가 채집되었다. 채집된 참진드기의 SFTS 감염여부를 확인하기 위해 성충은 최대 5마리, 약충은 최대 30마리, 유충은 50마리씩 pooling하여 Nested PCR을 실시한 결과 모두 음성으로 확인되었다. 인간이 SFTS에 감염되었을 때 치사율이 높은 편이며, 백신과 치료제가 없기 때문에 참진드기에 대한 지속적인 감시가 필요할 것으로 생각된다.

검색어: 참진드기, *Haemaphysalis longicornis*, *Haemaphysalis flava*, *Amblyomma testidunarium*, SFTS

P86

Six insect pests on a seasoned vegetable, the Welsh onion, and their occurrence during spring onion culture

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Welsh onion (*Allium fistulosum* L.) has been cultured in open field or greenhouse conditions in Korea. Spring onions are usually cultured in both conditions from April to August while autumn onions are cultured in greenhouses from October to March. This study reports insect pests on the onions during spring culture. Sex pheromone and yellow sticky traps were used to monitor the insect pests. Six insect species were observed during the cultivating seasons and included three flies (*Delia antiqua*, *Bradysia agrestis*, and *Liriomyza chinensis*), two moths (*Spodoptera exigua* and *Acrolepiopsis sapporensis*), and one thrips (*Thrips tabaci*). Most insects except *T. tabaci* were captured at early season before transplanting the onions, suggesting the overwintering populations. Three flies were captured without significant fluctuation in their capture numbers. *S. exigua* showed three occurrence peaks at April, June, and July/August until harvest at August. The last peak was prolonged until harvest. *A. sapporensis* showed a high overwintering population at March and April. Then, it was followed by at least three peaks during the onion cultivation. *T. tabaci* adults were captured just after the transplanting and increased the population size during the onion culture.

Key words: Welsh onion, insect pest, sex pheromone, yellow sticky, monitoring

P87

Surveillance of Mosquitoes (Diptera: Culicidae) in southern part of Gyeongsangbuk-do in Korea, 2022

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모기에 의해 전파되는 질병은 Flavivirus에 의한 것으로, 암컷 모기가 숙주의 혈액을 흡혈하는 과정에서 질병이 전파된다고 알려져 있다. 모기가 매개하는 대표적인 질병은 *Anopheles*속이 매개하는 말라리아, *Culex*속 모기가 매개하는 일본뇌염, 그리고 *Aedes*속이 매개하는 땀기열, 지카바이러스감염증이 있다. 이러한 모기 조사를 위하여 2022년 3월부터 7월까지 도심(대구 북구 및 서구), 철새도래지(군위), 축사(대구 현풍) 3곳의 환경에서 채집을 진행하였다. 채집된 모기는 총 6속 9종 6,596마리로 이 중 도심지역에서는 총 556마리 중 *Culex pipiens complex*가 400마리(71.9%)로 가장 많이 채집되었고, 다음으로 *Aedes albopictus*가 90마리(16.2%) 채집되었다. 철새도래지에서는 총 18마리 중 *Culex pipiens complex*가 13마리(72.2%)로 가장 많이 채집되었다. 축사에서는 총 6,022마리의 모기가 채집되었으며 *Anopheles* spp.가 4,117마리(68.4%)로 가장 많이 채집되었고, *Culex pipiens complex* 959마리(15.9%), *Aedes vexans* 552마리(9.1%), 일본뇌염 주요 매개모기인 *Culex tritaeniorhynchus*는 402마리(6.6%)가 채집되었다. 채집된 모기의 Flavivirus 감염 여부를 확인하기 위하여 최대 30마리씩 pooling하여 Real-time PCR을 이용해 조사한 결과 모두 음성으로 확인되었다. 모기에 의한 질병은 매해 지속적으로 발생하므로 체계적인 감시와 조사가 필요할 것으로 생각된다.

검색어: Mosquitoes, Flavivirus, *Aedes albopictus*, *Anopheles* spp., *Culex pipiens complex*

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Effect of salinity stress on oviposition and growth of *Ochlerotatus togoi*

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토고숲모기(*Ochlerotatus togoi*)는 인간에게 flavivirus와 사상충을 매개하는 위생 곤충으로 주로 해안가에 서식한다. 전 세계적으로 해수면이 상승하여 연안 담수 환경의 염도가 증가하고 있으며, 이로 인해 내염성 모기의 서식지가 늘어나 개체수가 증가할 것으로 우려된다. 이에 본 연구는 염도에 따른 토고숲모기의 산란 습성과 발달 조건에 대한 실험을 진행하여 부족한 생태적 정보를 제공하고자 한다. 샘플 채집은 포항, 거제도, 제주도에서 수행했으며, 0-35psu 범위의 염도를 5psu씩 8개의 구간으로 나누어 실험을 진행하였다. 실험 결과 0psu의 산란율이 27.66%로 산란선호도가 가장 높았으며, 염도가 높을수록 산란을 기피하는 경향을 보였다. 부화율은 10psu(69.08%)에서 가장 높았고, 이후 염도가 높아질수록 감소하였다. 용화율의 경우 염도가 높아질수록 증가하여 25psu(29.73%)에서 가장 높았으며, 이후 감소하였다. 우화율은 염도가 증가함에 따라 감소하였으며 35psu에서 78.53%로 가장 낮은 수치를 보였다. 이러한 결과는 향후 토고숲모기의 방제에 대응하기 위한 기초자료로 활용될 것으로 기대된다.

검색어: 토고숲모기, 산란선호도, 부화율, 용화율, 우화율

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Hatching rate of *Aedes albopictus* by temperature stress

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땡기열, 지카바이러스감염증 등 다양한 플라비바이러스를 매개하는 *Aedes albopictus*는 산란 시 기온, 습도, 광주기 등의 환경요소에 따라 휴면알과 비휴면알을 산란하는 습성이 있다. 본 연구를 통해 이들의 저온스트레스에 대한 부화율을 측정하여 저온 내성에 대한 연구를 수행하였다. 휴면알의 경우 21°C, 8:16(L:D)의 광주기, 40%의 습도에서, 비휴면알은 26°C, 16:8(L:D) 광주기, 70%의 습도에서 취득 후 실험에 이용하였다. 1회 실험당 100개씩 선별하여 저온 스트레스를 6단계의 온도(0°C/-2°C/-4°C/-6°C/-8°C/-10°C)와 8단계의 노출 시간(1h/2h/4h/8h/16h/24h/48h/72h)을 부여하여 부화율을 측정하였다. 이후 다중선행회귀분석을 통해 해당 변수들과 부화율 간에 회귀식을 도출하여 상관관계를 알아보았다. 비휴면알과 휴면알에 저온 스트레스를 부여하지 않았을 때 부화율은 각각 약 51.1%, 50.6%로 나타났다. 휴면알은 -6°C 그리고 24h 이상 노출될 경우, 비휴면알에 비해 부화율이 평균 약 16.8% 상승하였다. 다중선행회귀분석을 통해 부화율은 저온 온도, 노출 시간, 휴면 유무 3개의 변수 중 휴면 유무에 가장 큰 영향을 받는 것을 확인하였다. 본 연구를 통해 비휴면알에 비해 휴면알의 저온스트레스 내성이 강한 것을 확인하였고, 추후 *Aedes albopictus* 생태 연구의 기초자료로 활용될 것으로 기대한다.

검색어: *Aedes albopictus*, hatching rate, temperature stress, 휴면알

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Evaluation of flora and insect fauna according to cultivation type of pear orchard in Chugcheongnam-do

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본 연구는 배 생육초기 과원의 유기재배 및 관행재배 두곳에서 식물상 및 곤충상 조사를 수행하였다. 각각 과원의 내부 및 외부에서 조사를 실시하였으며 식물상은 Braun-blanket 방법으로 3반복 수행하였고, 곤충상은 트랩조사 및 스위핑 조사를 통해 식물상과 동일한 3반복으로 수행하였다. 배과원의 식물상 전체 조사결과 26개 과 36종의 식물상이 관찰 되었으며, 유기포장은 17개과 26종이, 관행포장은 19개과 27종이 조사 되었다. 두포장의 식물상 우점도는 여뀌가 가장 높게 나타났으며, 각각 포장에서는 관행은 토끼풀이, 유기에서 여뀌가 가장 높게 나타났다. 곤충상은 전체포장에서 4가지목이 뚜렷하게 관찰 되었으며 각각포장에서 파리목이 가장 밀도가 높게 나타났다. 노린재목은 유기, 관행모두 중간정도로 비슷했으나, 진딧물의 밀도는 관행에서 좀더 높게 나타났다. 딱정벌레목은 관행보다 유기포장에서 밀도는 낮았으나 대부분 포식성이어서 천적활용에 도움이 될 것으로 보여진다. 총채벌레목은 관행, 유기 모두 중간정도의 밀도를 보였다. 이러한 조사결과는 차후 배 재배농가의 생육초기 병해충 방제 연구의 기초 자료로 제공될 수 있을 것으로 기대된다.

Key words: 배 과수원, 식물상, 곤충상

P91

Occurrence status of *Metcalfa pruinosa* (Say) (Hemiptera: Flatidae) in Chugcheongnam-do

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미국선녀벌레(*Metcalfa pruinosa*)는 외래해충으로 2009년 발생 이후 지속적인 발생증가가 이루어져 왔고 산림뿐만 아니라 농경지에서도 큰 피해를 야기하고 있다. 충청남도내에서 미국선녀벌레는 최초 발생이 확인된 충북지역과 경기지역에서 밀도가 증가하기 시작하여 현재는 충남 전역에 확산되어 있는 그 확산 정도를 파악하고 2017년, 2020년, 2022년 3개년 데이터를 비교하였다. 2017년도에는 아산과 예산을 중심으로 밀도가 높았으며 평균 밀도는 50cm 가지내 평균 1.9마리 수준이었다. 2020년에는 예산, 아산보다 금산지역에서 밀도가 급격히 증가하였으며 평균 밀도는 8.0마리 였다. 2022년에는 금산과 인접한 논산, 당진에서 밀도가 급격히 증가하였다. 충청남도내 전역에서 확인되었으며 평균밀도는 13.4마리 였다. 미국선녀벌레의 충청남도내 평균 밀도는 2017년보다 2020년 4배, 2020년보다 2022년 2배의 밀도증가를 보이고 있어 충청남도내에서 미국선녀벌레는 지속적인 밀도증가가 있을 것으로 생각된다.

Key words: 미국선녀벌레, 충청남도, 발생현황

P92

Development of candidate molecular marker for emamectin benzoate resistance in *Spodoptera exigua* (Lepidoptera: Noctuidae)

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The Beet armyworm, *Spodoptera exigua* is a polyphagous pest causing world-wide economic loss. To control this pest, various synthetic insecticides including diamides are heavily used: however, indiscriminate use of insecticides has resulted in the development of resistance. For proper management of *S. exigua* insecticide resistance it is imperative to monitor resistance level at the early stage of development, which requires the development of robust molecular markers for rapid and accurate detection of resistance. In this study, we focused on the molecular mechanisms of *S. exigua* tolerance to emamectin benzoate (EB), a promising insecticide to control diamide-resistant. To this end, the molecular properties of putative two glutamate-gated chloride channel genes from *S. exigua* (*SeGluCl-a* and *SeGluCl-b*), the genes encoding the molecular target of EB, were characterized. Unlike *SeGluCl-b* only expressed in the head, *SeGluCl-a* was expressed in the cuticle as well as in the head, suggesting its extra role other than synaptic transmission. Injection RNA interference of *SeGluCl-a* in conjunction with bioassay suggested that *SeGluCl-a* likely function as a tolerance factor against EB contact toxicity. Current findings provide new insights into the defensive function of *SeGluCl-a* against EB and further suggest that the expression level of *SeGluCl-a* can be utilized as putative molecular marker for detecting EB resistance in *S. exigua*.

Key words: emamectin benzoate, glutamate-gated chloride channel, insecticide resistance, molecular marker

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Comparison of Control Effect of Drone and Pesticide Sprayer on *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae)

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대파(*Allium fistulosum* L.)는 동양에서 옛날부터 중요한 식재료로 재배되어온 중국 원산지의 향신 채소이다. 적어도 통일신라시대부터 재배되어 온 기록이 있으며 현재에도 식재료로 수요가 많아 전국적으로 재배면적이 넓어지고 있고, 종자의 유통량 또한 많다. 대파에는 파굴파리(*Liriomyza chinensis*), 파좀나방(*Acrolepiopsis sapporensis*), 파밤나방(*Spodoptera exigua*) 등이 주요 해충으로 알려져 있다. 그 중에서도 가장 우점하는 파밤나방을 대상으로 하여 3종의 방제약제를 선발하여 기존 전통적인 방제 방법인 농약분무기를 이용한 방제와 드론(무인항공기)을 이용한 방제의 효과를 비교하고자 하였다. 실험은 국내의 대파주 생산단지인 전남 진도에서 진행하였으며, 약효 평가는 7일간격 3회 약제를 처리 후 마지막 약제처리를 기준으로 7일 후에 피해엽수를 조사하였다. 본 연구에서 드론(무인항공기)의 방제력이 농약분무기의 방제력과 비등한 효과를 낼 수 있는지 확인하고자 실험을 실시하였고, 그 결과, 드론(무인항공기)은 방제 노동력 및 시간 절감에 효과가 있을 것으로 확인되었다.

검색어: 대파, 파밤나방, 방제, 드론, 농약분무기

Application of soybean-based semiochemicals as a push-pull strategy to control the bean bug, *Riptortus pedestris*

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The bean bug, *Riptortus pedestris*, is a major pest of soybean (*Glycine max*) and other fruit crops. Push-pull method, as a part of integrated pest management strategies is often applied to agricultural fields as an alternative to traditional chemical-based pest control methods. In a previous research, we have found a specific blend of soybean volatile organic compounds that induce orientation behavior of the bean bug in the lab conditions. This blend has a strong synergy in attracting the bean bugs in the field when mixed with commercial aggregation pheromone. We also found a specific blend of soybean semiochemicals to which the bean bugs show a strong repulsive behavior in the laboratory conditions. Here, we introduce an automated vertical olfactometer, a bioassay method where the behavioral responses of an insect to different mixtures of host-plant volatiles can be tested much faster and easier compared to conventional behavioral bioassays. This experimental setup controls the flow and ratio of testing compounds computationally. We also suggest a Deep-Learning based three-dimensional object tracking, which can capture the three-dimensional movement pattern of a target insect. Significantly less number of the bean bugs were attracted to a soybean plant where this repulsive blend was treated compared to when only the attractant is treated. The application of the findings may further contribute to a development of a solid environmentally friendly integrated pest management against the bean bug.

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Construction of entomopathogenic fungal library to control melon thrips, *Thrips palmi*

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Melon thrips, *thrips palmi* is a pest that damage crops and a vector of plant viruses. Chemicals are mostly used to control *T. palmi* but they developed resistance. Therefore, alternatives control are needed. Entomopathogenic fungi could be used to control *T. palmi*, but further research is still being developed. In this study, we constructed entomopathogenic fungal library and investigated the virulence against *T. palmi*. We isolated 27 isolates from soil in Red Oreum Mountain and 18 isolates in Jeju Gyorae. For the virulence test against *T. palmi* using a leaf-dipping method, we investigated 27 isolates from Red Oreum Mountain and 18 isolates from Jeju Gyorae. As a result, eight isolates from Red Oreum Mountain and ten isolates from Jeju Gyorae, showed 100% mortality in six days after treatment. This study represents that our fungal library isolates could be potential for biological control of *T. palmi*.

Key words: Entomopathogenic fungi, *Thrips palmi*, fungal library, virulence tests

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Detection of pesticide resistance mutations in *Haemaphysalis longicornis* and *Anopheles sinensis* with droplet digital PCR

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Droplet digital PCR (ddPCR) enables precise and sensitive quantification of gene expression levels, and a highly sensitive diagnostic method using ddPCR for accurate detection of low-frequency mutations associated with pesticide resistance has been recently developed in our previous study. In this study, we investigated pesticide resistance mutations in acetylcholinesterase 1 (AChE1) and voltage-sensitive sodium channel (VSSC) of *Haemaphysalis longicornis* and *Anopheles sinensis* collected from 17 and 25 sites in Korea, respectively, using ddPCR. No mutations were detected in *H. longicornis*, whereas resistance mutations were detected in *A. sinensis* population in the range of 20-90%, depending on the collection sites.

Key words: droplet digital PCR, mutation, detection, acetylcholinesterase 1, voltage-sensitive sodium channel

Insecticide resistance monitoring in *Bemisia tabaci* in the Republic of Korea

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담배가루이(*Bemisia tabaci*)는 오이와 토마토, 고추 등 주요 시설재배 작물을 흡즙하여 식물 생장을 억제하고 감로를 배설함으로써 그을음병을 유발하는 주요 농업 해충이다. 또한 Tomato yellow leaf curl virus (TYLCV)를 포함한 100여종의 바이러스를 매개하여 심각한 경제적 피해를 유발한다. 고추는 배추, 무, 마늘, 양파와 함께 국내 소비 5대 작물 중 하나로 온실과 노지에서 재배되고 있다. 고추 시설재배지에서 담배가루이는 연간 10세대 이상 발생하며 화학적 방제법으로 관리되고 있다. 지속적인 살충제 살포는 담배가루이의 약제 저항성 발달로 이어져 효율적인 방제를 방해하는 주요 요인이 된다. 따라서 전국 고추 시설재배지에서 발생하는 담배가루이의 약제저항성 평가를 통해 약제 선정 및 대체 약제 제시 등 지속가능한 해충관리법을 제시하고자 한다. 본 연구에서는 작용기작별 사용량이 많은 8종의 살충제를 선발하여 영남권(사천), 호남권(나주), 그리고 충청권(당진)에서 채집된 담배가루이의 약제저항성을 평가하였다. 담배가루이 3령 약충을 대상으로 엽침지법을 통해 약제 권장 사용 농도의 1/4배 및 1/2배, 1배, 2배, 4배의 살충률을 조사하였다. 가장 높은 살충률을 보이는 약제는 아버멕틴으로 약제 권장 사용 농도의 4배에서 나주, 당진, 사천이 각각 100%, 100%, 94.1%의 살충률을 보였다. 피리프록시펜은 나주와 사천이 각각 72.7%, 65%로 7.7%의 차이를 보였고 당진이 28.6%로 가장 낮은 살충률을 보였다. 비스파스피노신 또한 나주와 사천에서 각각 70%, 69.2%로 0.8%의 근소한 차이를 보였고 당진이 33.3%로 가장 낮은 살충률을 보였다. 설폭시민은 나주의 살충률이 55.5%로 가장 높았으며 다음으로 당진과 사천이 각각 30%, 21.1%이다. 네오니코티노이드는 나주, 당진, 사천이 각각 40%, 33.3%, 34.5%의 살충률을 보였다. 나주와 당진, 사천 담배가루이 개체군은 아버멕틴 약제 처리에서 가장 낮은 생존율을 보였다. 지역별 가장 낮은 살충률을 보인 약제는 나주와 당진, 사천에서 각각 네오니코티노이드, 피리프록시펜, 설폭시민이다. 향후 연구에서는 경기권, 강원권 담배가루이 개체군 채집 및 생물검정을 통해 전국 고추 시설 재배지에서 발생하는 담배가루이의 약제 저항성 지도 제작 및 지역별 효과적인 살충제를 선정하고자 한다.

검색어: 담배가루이, 고추, 약제저항성, 살충제, 생물검정

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Colonization of *Beauveria bassiana* on cucumber phyllosphere for cotton aphid control

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Cotton aphid, *Aphis gossypii* is a pest that causes serious damage by sucking plant sap as well as transmitting plant viruses. Chemical insecticides have been used to control cotton aphids, but they lead to resistance in aphid population. Alternatively, entomopathogenic fungi could be used to control cotton aphid. Some of entomopathogenic fungi, including *Beauveria bassiana*, are known to be endophytically colonized on phyllosphere. In this study, it was investigated whether *B. bassiana* isolates with insecticidal activity against cotton aphids could colonize on the phyllosphere. Cotton aphid-pathogenic fungal isolates were treated on cucumber leaves and in two weeks cotton aphids were infested on the incubated leaves. The treated aphids were killed much faster than non-incubated treatment. In addition, phyllosphere colonization was observed using egfp tagging fungal isolates generated by *Agrobacterium tumefaciens* mediated transformation. This work suggests that the *B. bassiana* could colonize on the cucumber leaves and it could be used to control cotton aphids for a long-term management.

Key words: AtMT, *Beauveria bassiana*, Cotton aphid, Entomopathogenic fungi, Phyllosphere colonization

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Biological control of root-knot nematode using *Beauveria bassiana* JEF-503

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Root-knot nematode (RKN) cause damages many crops which is about 40% of total of greenhouse farming and forms huge galls by attacking the roots of crops. The problem of most chemical nematicides is that they have residual toxicity in soil and crops. In this study, nematicidal activity of entomopathogenic fungi (EPF) was investigated in *in vivo* and *in vitro* bioassay. A total of ten isolates were used for the nematicidal activity test, and *Beauveria bassiana* JEF-503 treatment significantly decreased the production of RKN eggs. In the *in vitro* test, *B. bassiana* JEF-503 showed nematicidal activity against juvenile and adult stages. In the pot test, the number of RKN eggs decreased in the JEF-503 treatment. In summary, JEF-503 could be used to manage root-knot nematode with an environmentally sound way.

Key words: Plant parasitic nematodes, Root-knot nematodes, entomopathogenic fungi, biological control

P100

Transcriptome analysis of *Spodoptera frugiperda* exposed to *Beauveria bassiana* JEF-492

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Fall armyworm, *Spodoptera frugiperda* is an invasive polyphagous pest that cause severe yield loss of crops. Long-term and overuse of insecticides makes fall armyworm develop resistance. The use of entomopathogenic fungi is an alternative method to control fall armyworm. Herein, the response of fall armyworm to infection by *Beauveria bassiana* JEF-492 at two different time courses (2 days, 4 days) was analyzed at a transcriptional level. At 2 days post-infection, differentially expressed genes (DEGs) from immune were mostly enriched to ECM-receptor interaction and Toll and Imd signaling pathways when compared to non-infected control. The DEGs from 4 days post-infection were significantly enriched to Wnt signaling pathway. This study will provide the knowledge how fall armyworm is responding to the fungal infection.

Key words: biological control, entomopathogenic fungi, RNA-seq, *Spodoptera frugiperda*

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Effect of LdMNPV and *Bacillus thuringiensis* var. *kurstaki* on *Lymantria dispar asiatica* in Korea

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아시아매미나방(*Lymantria dispar asiatica*)은 2019~2020년에 경기, 충북, 경북, 강원 등 지역에서 돌발적으로 대발생한 바 있다. 매미나방의 알 및 유충을 채집하여 살펴본 결과 곤충병원성곰팡이, 핵다각체병바이러스, 기생 파리, 알좀벌과 같은 다양한 천적이 발견되었다. 곤충병원성 방제인자로서 핵다각체병바이러스(LdMNPV)와 *Bacillus thuringiensis kurstaki* (Btk)를 농도별로 유충에 처리하여 살충률과 살충기간을 조사해 본 결과 LdMNPV는 3×10^6 POB/ml에서 평균 10일 이내에 100%의 살충률을 나타냈다. Btk는 $1.6 \times 10^3 - 10^5$ IU/ml 수준에서 2-4일 이내에 100% 살충되었다. 두 제제를 혼합하여 처리한 결과 Btk 단일 처리와 유사하게 나타났다. 본 연구 결과를 바탕으로 아시아매미나방의 생물적 방제를 위한 기초자료로 활용할 수 있다.

검색어: 기후변화, 돌발 해충, 생물적 방제, 천적, 곤충병원성 미생물

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Screening of feeding deterrent activity of plant essential oils in the tobacco cutworm, *Spodoptera litura*

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에센셜 오일은 합성 살충제의 대안이 될 수 있는 휘발성 화합물로 살충제, 기피제, 섭식저해제 등으로 사용된다. 그러나 에센셜 오일은 해충에게 지속적인 미각 자극을 주었을 때, 습관화(habituation)가 발생하여 섭식저해 및 기피력이 감소하는 단점이 있다. 따라서 본 연구에서는 미각 수준에서 에센셜 오일의 습관화 현상과 작용기작을 확인하기 위해 담배거세미나방(*Spodoptera litura*)의 3령 유충에 대해 평가했다. 30가지 오일의 섭식저해도와 살충력을 확인하기 위해 non-choice 실험과 접촉 및 혼증 실험을 진행한 결과, lemongrass, fennel sweet, geranium 순으로 효과가 좋았으며, 살충력과 섭식저해 간의 상관관계가 있었다. 또한, 습관화 현상을 확인하기 위해 3가지 오일을 사료에 1 mg/g 농도로 섞어 48시간 동안 유충에게 급여한 후, choice 실험을 진행한 결과 3가지 오일 모두 대조군과 비교하였을 때 섭식저해도와 기피력에서 유의미한 감소를 보였다.

검색어: 담배거세미나방, 섭식저해, 미각자극, 습관화

P103

Acute toxicity of Ethyl formate fumigation towards silkworm (*bombyx mori*) larvae

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Due to climate change and the increase in international trade, sucking insect pests are being introduced to our agricultural environments. Application for controlling sucking insect pests using ethyl formate (EF) in the greenhouse has recently been studied, but studies on the toxicity of EF to useful insects are insufficient. In this study, the acute toxicity of EF to silkworms was performed at two time points (2h and 4h) on a lab scale. As a result of 2h-EF fumigation for controlling agricultural insect pests, the lethal concentration-time (LCT)₉₀ value was reached to 41.14 mg·h/L. With the result of 4h-EF fumigation in relation to quarantine level, LCT₉₉ value was 68.85 mg·h/L. Each LCT value confirms that the silkworm is more resistant to EF than the major sucking insect pests, implying that EF may be safe to use it in the field.

Key words: green house, ethyl formate, pest control, silkworm, acute toxicity

P104

Ethyl formate, a new fumigant against Chestnut weevil, *Curculio sikkimensis*

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Castanea crenata Siebold & Zucc. (Fagales: Fagaceae), a species of chestnut native to Korea and Japan, is distributed in Korea, Japan, and northeastern China, where chestnuts are a major economic agroforest product. *Curculio* spp. is among the main known pests of chestnuts around the world. In Korea, only phosphine (PH3) is permitted for the fumigation of *C. sikkimensis* larva-infested chestnuts. However, it is applied for large-scale fumigation, and its use is restricted. Moreover, it requires a long exposure time and an application device; thus, it cannot be used by small-scale farmers. In this study, the activity of ethyl formate (EF) as a fumigant against *C. sikkimensis* in chestnuts was investigated, and its potential for practical use by farmers was evaluated. The sorption of EF according to the filling ratio (FR) and fumigation time was tested, and the results revealed that 2.5% FR was the most effective. According to the time–dose mortality data collected over 12 h of fumigation, the LCT₉₀ and LCT₉₉ values were estimated as 1052.0 and 1952.0 g·h/m³. Based on the LCT values, a dose of 180.0 g/m³ and 12 h of fumigation resulted in 100% mortality on a small scale (2 m³). The results of this experiment indicate that EF could be conveniently used as a fumigant by farmers.

Key words: Chestnut; *Castanea crenata*; fumigation; safety

P105

Changes in microbiome of *Tetranychus urticae* according to entomopathogenic fungal infection

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Two-spotted spider mite (*Tetranychus urticae*, TSSM) is a polyphagous pest that occurs in fruit and vegetable crops. TSSM has acquired acaricide resistance because of its short life cycle and continuous exposure to acaricides. Therefore, we tried to solve this problem with the entomopathogenic fungal group. TSSM has symbiotic microorganisms and they are involved in TSSM survival against unfavorable abiotic stresses. In this study, entomopathogenic fungi showing high acaricidal activity were selected and microbiome change of the TSSM infected with entomopathogenic fungi is being under analysis. The acaricidal activity of 77 fungal isolates was tested under laboratory conditions. On the 7th day of treatment, 15 isolates showed 100% acaricidal activity. For microbiome analysis, TSSM 16S rRNA and ITS gene sequencing was performed. It is planned to be compared to the infected TSSM. This study will provide an understanding of TSSM symbiotic system against entomopathogenic fungi infection.

Key words: Acaricidal activity, biological control, entomopathogenic fungi, microbiome, *Tetranychus urticae*

P106

Evaluation of the efficacy of Emamectin benzoate and Acetamiprid Mixed pesticides on Japanese Pine Sawyer, *Monochamus alternatus*, by branch spray

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Mixed pesticides which control pine wood nematode (PWN) and Japanese pine sawyer, the vector insect, are an efficient control method to prevent PWD. However, evaluation of pesticidal effect of each formula and their respective active ingredient has not been widely done. This study was conducted to evaluate the potency of emamectin benzoate and acetamiprid single compounds, and their mixtures on Japanese pine sawyer. Result shows that acetamiprid as the single compound was the most effective formulation, with an LC₅₀ of 2.065ppm at 1 day after treatment. Moderate efficacy was evident in mixed compounds, and emamectin benzoate single compound was the least effective formulation.

Key words: *Monochamus alternatus*, mortality, nematicidal, emamectin benzoate, acetamiprid

P107

Oral administration of *Beauveria pseudobassiana* inactivate blood-feeding behavior and reproduction capability against *Anopheles stephensi*

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Entomopathogenic fungi infect insects through oral ingestion of and cuticle contact with conidia. Our previous study showed the direct lethal effect of oral administration of *Beauveria pseudobassiana* on *Anopheles stephensi*. In this study, the sub-lethal effects of orally administered fungus were evaluated on blood feeding and egg production. Decreased rates of blood feeding behavior and follicle development were observed 2 days after oral conidial suspension administration. However, the amount of blood feeding was not changed. These results show sub-lethal effects of oral administration of fungus against mosquitoes, including inactivation of blood feeding behavior and reproduction capability.

Key words: *Anopheles stephensi*, *Beauveria pseudobassiana*, oral administration, blood feeding, reproduction, behavioral change

P108

Changes in the responsiveness of honey bee umami receptors induced through bio-structure modeling and point mutation

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Honey bees need essential nutrients such as proteins, minerals, lipids, and vitamins to survive. Some of these amino acids are only present in pollen, among the food resources that honey bee usually gathers. In order to obtain pollen with these essential nutrients, it is important to sense it through chemosensory organs such as taste and smell. Among them, gustatory receptor 10 (Gr10) in honeybees is known to detect umami. However, it is nearly unknown about the interaction between the three-dimensional structure of Gr10 and its ligand in honeybees. The molecular interactions of Gr10 with umami amino acids were studied *in silico* and *in vivo* in this study. First, we explored the binding site of ligand and Gr10, and investigated the binding pose and binding energy. Based on this *in silico* modeling, *in vivo* experiments were carried out, and Gr10 was expressed in HEK-293T cells, and calcium imaging experiments were performed on monosodium glutamate (MSG), a representative umami amino acid. From this, it was found that the response of the Gr10 mutant to MSG was lower than that of the wild-type Gr10 or no response at all. As a result, our research is expected to add to the basic knowledge of the molecular biology of honey bee chemosensory receptors through mutations in the Grs gene in honey bees.

Key words: *Apis mellifera*, chemosensory, gustatory receptor, binding energy, cell calcium imaging

P109

Population genetics study for tracing the origin of *Solenopsis geminata* in South Korea, using 66 microsatellite markers

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The managed pest tropical fire ant (*Solenopsis geminata*) is known to be native to South America, and since the 16th century, global trade has been active and has spread to each region through container cargo. Currently, it is reported that damage such as ecosystem disturbance occurs in the area where this species has invaded, and many studies are being conducted. In Korea, it was found in Busan and Gwangyang ports and inland containers. In this study, in order to analyze the genetic structure of these populations and trace their origin, we used 66 *Solenopsis* microsatellite markers for 25 populations, including Korea, Taiwan, and the United States, and 157 individuals. The genetic structure of each group was compared. As a result of the analysis, it was confirmed that the tropical fire ants found in Korea were very similar to the populations of Southeast Asian countries such as Thailand, Laos, and Vietnam, and showed a genetic difference from the populations of the United States.

Key words: *Solenopsis geminata*, microsatellite, population genetics, epidemiology, quarantine, trace origin

P110

Population genetics study of Red imported fire ant, *Solenopsis invicta*, for tracing the origin of the population of invaded South Korea, using microsatellite markers

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The red fire ant (*Solenopsis invicta* (RIFA: Red imported fire ant)) is native to Central America. It is an invasive pest that spreads to countries around the world by hitchhiking traded products, disturbs the ecosystem, and causes damage by attacking people and livestock. In Korea, since the first discovery at Gamman port in Busan in 2017, as of 2022, it was found 19 times in yards and import cargo containers at trade ports such as Incheon, Pyeongtaek, and Gwangyang. In this study, population genetic analysis was performed using 66 microsatellite markers on samples of 47 groups collected domestically and abroad to identify the origin of red fire ants that invaded Korea. As a result of the analysis, the red fire ant colony that invaded Korea was genetically similar to East Asian populations such as Taiwan and China, and was different from the American population. These results indicate that the red imported fire ant groups found in Korea are likely to invade from East Asia, such as China and Taiwan.

Key words: *Solenopsis invicta*, microsatellite, population genetics, molecular epidemiology, trace origin

P111

Haplotype Network Analyses of Two Fire ants Species in genus *Solenopsis* Based on Sequences of COI-COII

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Global climate change and human trade expansion have caused intercontinental migration of various species. These moved pests are causing various problems in the invaded area. *Solenopsis invicta* and *S. geminata* are causing many problems, such as agricultural and ecological damage, in the infested areas. This study was conducted to trace the origin of two fire ants invading Korea and to identify the haplotype differences by group. In *S. invicta*, the 770bp region of the COI-II region was barcoded for 170 individuals from 4 countries. As a result, two types of haplotypes were identified in the intrusion group in Korea. For *S. geminata*, the 567bp nucleotide sequence of the COI region of 167 individuals from 8 countries. As a result of the analysis, they showed a clear haplotype difference between the Southeast Asian population and the American population, and the Korean individuals were similar to the Southeast Asian haplotype population.

Key words: *Solenopsis invicta*, *Solenopsis geminata*, haplotype network, barcoding, COI, COII, trace origin

P112

Identification of domesticated silkworm varieties using single nucleotide polymorphisms detected from mitochondrial genomes

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Different varieties of silkworms have functional differences; thus, there is an emerging need for variety identification. In this study, we sequenced complete mitochondrial genomes (mitogenomes) of ten government-recommended silkworm varieties. Comparison of these sequences allowed us to select the single nucleotide polymorphisms (SNPs) in 34 sites that are specific to six silkworm varieties. Among these each one SNP per variety was amplified by preparing variety-specific primers and then using tetra-primer amplification refractory mutation system PCR (Tetra-ARMS-PCR). As a result, it was possible to identify these six varieties among the ten silkworm varieties, evidencing that SNPs developed from mitogenomes are useful marker for the discrimination of genetically closer silkworm varieties.

Key words: Silkworm, Mitochondrial genome, Single Nucleotide Polymorphism, Tetra-ARMS-PCR

P113

Development of a loop-mediated isothermal amplification assay for the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae), using species-specific inserted sequences

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The fall armyworm (*Spodoptera frugiperda*, FAW) is now annually arrives in Korea from China with the assistance of seasonal wind. We developed loop-mediated isothermal amplification (LAMP) assay which is a rapid identification of target species. To design LAMP primers whole genomes were sequenced by NGS method. LAMP assay provided consistent amplification reaction in five loci when ten FAWs, and collected from eight localities in four countries were tested, in contrast to 13 non-target lepidopteran species. To increase in-field applicability of the method life stages, outdoor exposure time, reaction time, DNA concentration, and stability of pre-mixed primer plus isothermal master mixture are in the middle of testing using the quick extracted DNA.

Key words: Fall armyworm, *Spodoptera frugiperda*, Loop-mediated isothermal amplification

P114

Exploration for genes related to climate change adaptation of *Cryptotympana atrata* Fabricius, 1775 (Hemiptera: Cicadidae)

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곤충은 변온동물로 발생 및 생활주기가 기후와 밀접하게 연관되어 지구온난화의 영향에 매우 민감한 것으로 알려져 있다. 본 연구에서는 대표적인 남방계 매미로 기후변화민감종인 말매미의 기후 변화 적응과 관련하여 높은 연관성을 가지는 기후요인 추론 및 이와 연관된 유전자를 알아보고자 하였다. 평균온도 및 강수량 비교를 통해 통계적으로 유의한 4개 지역의 말매미를 확보하여 전장유전체 비교 분석을 통해 지역에 따른 유전적 차이를 보이는 SNP를 선별하였다. 기후 변화 적응과 연관된 유전자를 알아보고자 기후요인에 따라 4개 집단을 그룹화하고 선별된 SNP를 이용하여 F_{ST} 분석을 통해 그룹 간 확실한 차이를 보이는 SNP를 재선별하였으며, 이들을 이용한 pathway 분석 결과 말매미의 기후 변화 적응은 온도와 큰 연관성이 있음을 추론하였다.

검색어: 말매미, 기후변화민감종, 전장유전체, SNP, 기후 변화 적응

P115

Mitochondrial *COI*-based population genetic analysis of the cicada, *Cryptotympana atrata* Fabricius, 1775 (Hemiptera: Cicadidae), which is a climate-sensitive indicator species in Korea

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기후온난화에 따른 북위로의 서식처 확장과 이에 따른 집단의 유전적 다양성 변동 특징에 대한 이해는 장기적 측면의 한반도 생물다양성 이해를 위한 초석이라고 할 수 있다. 본 연구에서는 우리나라 100종의 기후변화민감종 중 유일한 노린재목 곤충이자 도심 고온 환경에 잘 적응한 곤충인 말매미 (*Cryptotympana atrata* Fabricius, 1775)의 mitochondrial *COI* 유전자의 염기서열을 이용하여 11개 집단의 유전적 다양성, haplotype 계통, 집단구조 등에 대한 분석을 수행하였다. 그 결과, 내륙에서 가장 높은 빈도로 광범위하게 발견되는 haplotype은 제주도에서는 전혀 발견되지 않고 제주도에서 가장 높은 빈도로 발견되는 haplotype은 내륙 내 부산과 광주에서 소수로 발견되어 제주도와 내륙은 다른 유전자풀을 구성하였다. 향후 이에 대한 지속적인 모니터링이 필요하고 아울러 유전체 기반의 연구를 통한 심도있는 결과 도출이 필요한 실정이다.

검색어: 말매미, 기후변화민감종, *COI*, 유전자풀

P116

Development of diagnosis method for the Korea endemic silkworm strains of *Bombyx mori* (Lepidoptera: Bombycidae) using whole genome sequences

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The endemic silkworm strains are important biological resources to breed new silkworm strains which have new traits. Silkworm strains are very difficult to distinguish due to the morphological similarity of larvae and adults. Thus, We developed molecular diagnosis method to distinguish five silkworm strains, which are endemic to Korea using whole genome sequences. The diagnosis method was developed using "Decision tree model" to distinguish each endemic strain from four endemic and 35 stock strains due to difficulty in applying one shot diagnosis method, caused by genetic similarity among silkworm strains. This method is reliable and efficient, so can be used to identify the five endemic silkworm strains, preserved in Korea.

Key words: Silkworm, Whole-genome, Single nucleotide polymorphism, Decision tree, Molecular diagnosis

P117

Comparison of surface display efficiency of target protein by GP64 and VSV-G in insect cells

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Surface display is a valuable protein engineering technology that maintains a relatively independent spatial structure and biological activity for proteins by anchoring target proteins on the surfaces of cell or virus. Surface display technology in baculovirus expression system (BES) is more efficient than other host-based systems because it allows post-translational modification and the expression of complex folding proteins. GP64 from baculovirus or vesicular stomatitis virus glycoprotein (VSV-G) has been used for surface display expression in BES. However, comparative evaluation of the surface expression efficiency between them has not been conducted so far. In this study, the production and surface display efficiency of the target protein according to the use of GP64 or VSV-G for the surface expression were compared.

Key words: surface display, baculovirus, GP64, VSV-G

P118

Construction of the recombinant bacmids for the stabilized protein expression in insect cell

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The baculovirus expression system (BES) is widely used for the production of useful proteins through the construction of recombinant viruses. Recombinant viruses are generated using a method of homologous recombination or Tn7 site-specific transposition between a target gene and viral DNA. In particular, a bacmid is conveniently used in BES because it can easily produce a recombinant virus by transposition of a target gene in *Escherichia coli*, but the low stability of the recombinant virus by this method is pointed out as a problem. In this study, the stability of the recombinant virus according to various transposition locations of the target gene in bacmid was evaluated, and the transposition site of the target gene was determined to produce a recombinant virus with increased stability.

검색어: Baculovirus expression system, Bacmid, Stability, Protein expression

P119

Nanoparticlization of Recombinant Protein by Polyhedrin-Fused Expression in Baculovirus Expression System

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The baculovirus expression system (BES) is widely used for the production of recombinant antigen proteins for various vaccines. It has been reported that recombinant antigen proteins have high stability and immunogenicity when they exist in the size of nanoparticles (1-100 nm). In addition, when partial polyhedrin of *Autographa californica* multiple nucleopolyhedrovirus (AcMNPV) and target protein are fused, fused protein aggregation has occurred, raising the possibility that the recombinant proteins exist as nanoparticles. Therefore, this study evaluated the possibility of nanoparticlization of recombinant proteins by fusing enhanced green fluorescent protein (EGFP) and partial polyhedrin.

Key words: BES, polyhedrin, recombinant antigen, nano particle

P120

Effect of actin overexpression on the activity of *p10* and *polh* promoters in Sf9 cells

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The baculovirus expression vector system (BEVS) primarily utilizes the *p10* or *polh* promoters of *Autographa californica* nucleopolyhedrovirus (AcNPV) or *Bombyx mori* NPV (BmNPV) to produce a lot of useful recombinant proteins. Various studies have been conducted to increase the yield of recombinant proteins produced by BEVS, and it has recently been reported that the target protein production by recombinant BmNPV is increased through overexpression of actin in BmN cells. In this study, we evaluated the effect of actin on the production of target proteins by recombinant AcNPV in Sf9 cells.

Key words: baculovirus, actin, *p10* promoter, *polh* promoter, Sf9

P121

A report on the complete mitochondrial genome sequence of *Vespula shidai* (Hymenoptera: Vespidae)

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For an ongoing systematic study of the Korean Vespidae, we analyzed the complete mitochondrial genome of a social wasp, *Vespula shidai* Ishikawa, Yamane & Wagnert, 1980 from the Korean Peninsula. This species is distributed in East Asia, including Korea, China, Japan and the Russian Far East. It can be distinguished from other species of the genus *Vespula* by having the distinct white stripes on the abdomen. The mitogenome is 17,527 bp in length, includes 13 protein-coding genes, 24 transfer RNA genes, and two ribosomal RNA genes. The overall base composition is 83.5% AT and 16.5% GC.

Key words: Hymenoptera, Vespidae, Mitochondrial genome, *Vespula shidai*

P122

A taxonomic study of the genus *Opesia* Robineau-Desvoidy (Diptera: Tachinidae) based on DNA barcoding and morphological analyses

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The Genus *Opesia* Robineau-Desvoidy currently includes four valid species worldwide, of which three are known from Palaearctic region. We have recognized all the previously known Palaearctic species as well as a new species from Korea: *Opesia cana* (Meigen, 1824), *O. descendens* Herting, 1973, *O. grandis* (Egger, 1860), and *O. sp. nov.-A*. We conducted a DNA barcoding analysis of all these *Opesia* species as well as the sequences of *O. americana* and selected related species retrieved from BOLD Systems. We also provide body and genitalic photographs of the Palaearctic *Opesia* species. An identification key to the Palaearctic *Opesia* species is also presented.

Key words: Tachinidae, Phasiinae, *Opesia*, Taxonomy, DNA barcoding

P123

Discovery of an additional nematine sawfly, *Euura tibialis* (Newman) (Hymenoptera, Tenthredinidae) associated with false acacia in South Korea

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The genus *Euura* Newman, 1837 is a group with high species diversity of the subfamily Nematinae, comprising over 650 species worldwide. It inhabits the Holarctic and Oriental regions, but more than 430 species are known in the Palaearctic region. This genus is currently separated from genus *Nematus* Panzer, 1801 only by genetic data, and the taxonomic problem has not been resolved due to the high morphological similarity with many species. Although a large number of species have been recorded and species diversity is highest in the Palaearctic region, only one species, *E. laeta* (Brischke, 1883), is known in South Korea.

Here, we newly add *E. tibialis* (Newman, 1837) to South Korean fauna. This species was described from Germany, but it is native to North America and is considered to be an invasive alien sawfly introduced into Europe and Japan. Its larva is related to false acacia trees without gall-inducing, whereas *E. laeta* induces bud gall on *Salix viminalis*. Adults of *E. tibialis* can also be easily distinguished morphologically from the latter by the predominantly yellow body.

Key words: exotic sawfly, Nematinae, *Robinia pseudoacacia*, Symphyta, Tenthredinoidea

P124

Status of inflow of Invasive ants into Korea

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2017년 부산항에서 붉은불개미가 처음 발견된 이후 2019년 10월 「생물다양성 보전 및 이용에 관한 법률」 개정에 따라 외래생물 예찰과 대응이 강화되었다. 2017년부터 2022년까지 국내 자연생태계에서 발견된 외래개미는 *Linepithema humile*, *Paratrechina longicornis*, *Solenopsis geminata*, *Trichomyrmex destructor* 3아과 4속 4종, 수입 컨테이너에서 발견된 외래개미는 *Anoplolepis gracilipes*, *Camponotus compressus*, *Solenopsis invicta* 2아과 3속 3종이 발견되었다. 그 중에서 *Paratrechina longicornis*의 경우 주요 항만 주변으로 확산되고 있는 실정이다.

검색어: Invasive alien species, *Solenopsis invicta*, *Paratrechina longicornis*, Natural ecosystem

P125

Third Invasive Alien Species of *Anoplophora*: Establishment of *Anoplophora horsfieldii* in South Korea

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The genus *Anoplophora* is undoubtedly the most well-known longhorned beetle genera in pest science because of the notorious IASs, Asian longhorned beetle (ALB: *A. glabripennis*) and Citrus longhorned beetle (CLB: *A. chinensis*). In this paper, we report the third invasive alien species of the genus *Anoplophora* with the establishment of *Anoplophora horsfieldii* in South Korea. The species was first accidentally discovered in Jeju Island in September 2019. However, no additional specimens had been found since then and whether the species were established or intercepted by chance remains unknown until recently. With the discovery of multiple beetles, emergence holes, and an ovipositing female in 2022, we confirmed that the species was completely settled in Jeju Island. We hereby provide 1) the current status of *A. horsfieldii* in Jeju including their utilizing host plant, and the extent of damage, 2) the most probable origin of invasion by comparing the mtDNA of Korean samples with those from various regions across Southeast Asia, and 3) infer the phylogenetic position of *A. horsfieldii* within the genus using a single locus phylogeny of *Anoplophora*.

Key words: Cerambycidae, *Anoplophora*, Invasive alien species, South Korea, COI

[#]Equal contribution

P126

New hosts of two species of Ichneumonidae (Hymenoptera) from South Korea

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The members of family Ichneumonidae usually attack other insects or spiders. Most of all, many ichneumon wasps are parasitoids of lepidopteran larvae or pupae. In this study, we report new host of two ichneumon species (*Apophua evanescens evanescens* and *Trathala flavoorbitalis*) from South Korea. A member of subfamily Banchinae, *A. evanescens e.*, is easily distinguished from other species follows; without areolet, simply convex clypeus, 2-4 tergites with oblique grooves and long second tergite than its apical width. The other species belonging to Cremastinae, *T. flavoorbitalis*, is also easily distinguished having visible sternite, complete occipital carina and entirely yellow body color. These species are discovered from *Cleora leucophaea* (Butler) (Lepidoptera: Geometridae) and *Pyrausta phoenicealis* (Hübner) (Lepidoptera: Crambidae) each other. The latter one is well known as pest of Labiatae, especially green perilla plants (*Perilla frutescens*). We provide diagnosis, plate and host record of two parasitoids, *A. evanescens e.* and *T. flavoorbitalis*.

Key words: Taxonomy, parasitic wasps, eastern palaeartic region

P127

New Records of 10 Species of the subfamily Ctenopelmatinae (Hymenoptera: Ichneumonidae) from Korea

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The subfamily Ctenopelmatinae are one of the large families consist of approximately 1,500 species in 107 genera. In Korea 46 species in 23 genera have been recorded. the ctenopelmatine species are usually koinobiont, endoparasitoids of Hymenoptera (especially sawflies).

In this study, report 10 unrecorded species of Ctenopelmatinae from Korea. These species belong to eight genera (*Glyptorhaestus*, *Hadrodactylus*, *Lethades*, *Metopheltes*, *Perilissus*, *Pion*, *Sympherta* and *Xenoschesis*). Among them, two genera (*Metopheltes* and *Pion*) were newly recorded for the first time from Korean fauna. Diagnoses of those 10 species and illustrations of diagnostic characters are provided.

Key words: Taxonomy, parasitic wasps, unrecorded species, eastern palaeartic region

P128

Study on Spawning and Breeding Techniques of *Prosopocoilus astacooides blanchardi* (Coleoptera: Lucanidae)

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두점박이사슴벌레는 멸종위기야생생물 2급으로 지정되어있으며, 국내 제주도에 서식하고 있는 사슴벌레과의 곤충이다. 현재 무분별한 포획·채취를 방지하고 야생생물 복원 취지에 맞는 포획·채취 등의 행위 관리를 통해 「야생생물 보호 및 관리에 관한 법률」로 보호받고 있다. 본 연구에서는 두점박이사슴벌레의 실내 사육을 통한 생활사와 사육배지 발효기간이 산란수에 미치는 영향을 알아보기 위하여 수행하였다. 산란된 알을 부화하여 실내 사육한 결과 유충 생육은 5일차 1령(0.01±0.00g), 10일차 2령(0.03±0.02g), 30일차 3령(0.19±0.11g)이었으며, 최대 90일경과시 4.06±0.95g으로 생육이 조사되었다. 또한 발효기간별 3주간 누적 산란수를 조사한 결과 2차 발효 20일 경과된 사육배지에서 평균 21±8.7마리로 산란량이 가장 높았다.

검색어: 두점박이사슴벌레, 사육, 산란

P129

Nano-injection technique for western flower thrips, *Frankliniella occidentalis*

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Micro-injection techniques are valuable in entomological research as they allow for direct treatment of biological substance in the body of specimens at controlled volumes. Most of current micro-injections for live insects are limited to insects over 4 mm in size. Most of micro-injection methods utilize immobilization strategy that may affect specimen fitness and physiology. This conversion can cause inconclusive interpretation of phenotypic reactions post-injection. In this test, we elaborate an improved nano-volume injection technique for micro-insects (< 3 mm) using the western flower thrips, *Frankliniella occidentalis* (Thysanoptera: Thripidae), as a model. By constructing and using a modified vacuum system, injections were performed on live thrips, without anaesthetic and physical injury. A simple survivorship test in which the thrips were injected with 10 nl of pure water into the thorax or abdomen showed that thoracic injections yield similar survival rates to control thrips that were not injected, while abdominal injections severely limited survivorship. Here we suggest an integrative method that customizes the vacuum system, nano-injection tools, injection volume, and other specifications for live micro-insects (< 3 mm).

Key words: Nano-injector, no sedation, vacuum stage, thoracic injection, hemocoel delivery

P130

Study on attractants for the red imported fire ant, *Solenopsis invicta*

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The red imported fire ant (RIFA), *Solenopsis invicta*, is omnivore and native to South America. RIFA has been expanding their habitat through international trade routes to Asia and Oceania. In plant quarantine, RIFA surveillance is important to implement for preventing the risk of biological invasion to Korea. RIFA workers are female ants, so it is difficult to apply the sex pheromone in existing surveillance traps. This study is focusing to select attractants for RIFA trap. As an initial step, we have tested 5 pheromone compounds and 13 poisoning baits to RIFA and 2 native ants. Allofarnesene and 2,5-dimethyl-3-pyrazine in pheromone compounds and InTice in poisoning baits showed most effective rate of attraction to RIFA. Based on the results, selected 3 attractants show the possibility to use in RIFA traps for surveillance.

Key words: *Solenopsis invicta*, plant quarantine, surveillance, pheromone, trap, attractant

P131

Models for spring emergence prediction of the apricot seed wasp *Eurytoma maslovskii* (Hymenoptera: Eurytomidae) in South Korea

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Eurytoma maslovskii Nikol'skaya (Hymenoptera: Eurytomidae) is an important stone fruit pest. Control of the pest relies on application timing, which requires a reliable tool for predicting spring emergence. The most common approach in insect phenological modeling is based on temperature-dependent development and thermal bioparameters. However, not a lot is known regarding *E. maslovskii*. In the present study, we investigate the development of *E. maslovskii* after diapause breaks at various temperatures. The lower, upper temperature threshold and thermal constant of the species after diapause are estimated. The results confirm that the field emergence of *E. maslovskii* can be predicted by a model using accumulated degree days starting from 1 January, thereby providing an efficient tool for pest-control decision making.

Key words: cumulative flight; degree day; development rate; lower threshold; upper threshold, model selection.

P132

Improvement methods for imbalanced ecological data to enhance the modeling performance

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Most of the ecological data obtained through field surveys have the form of imbalanced data because most measured variables are skewed. These data cause bias in learning data during modeling for classification and prediction, and act as a major factor hindering the model performance. The purposes of this study are improvement of the modeling performance used these imbalanced ecological data and to find an improvement method suitable for ecological data. To do this, the change in modeling performance was evaluated and compared by applying several improvement methods of imbalanced data to the actual ecological data. The methods for improving imbalanced data used in this study were synthesis methods of over-sampling types using 1) the k-nearest neighbor, 2) smoothed bootstrap and 3) data-based polynomial regression with Monte-Carlo simulation.

Keywords: data bias, improving skewed data, over-sampling method

P133

Temperature and plant host mediated development parameters of *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae)

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The tobacco cutworm, *Spodoptera litura* is a serious and devastating polyphagous pest causing significant damages and economic losses to many important crops. Temperature (15, 20, 25, 27, 30, 35, and 40 °C) dependent developmental parameters and survival of *S. litura* were studied on the plant hosts (soybean and maize) and artificial diet. 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 the plant hosts and artificial diet. The linear model estimated the lower temperature thresholds (T_{min}) and the thermal constants (K) for each life stage. Temperature and plant host also influenced the adults longevity. Estimated parameters can be used in predicting occurrence, number of generations and population dynamics of *S. litura*.

P134

Physiology estimation of the *Apis cerana koreana* honey bees to honey yield

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The research shows the relation between practical methods to estimate the honey yield and the physiology of honey bees. The capacity of the honey stomach of the X-line compared to R-line *Apis cerana koreana* honey bees had significant differences and they were (42.60 ± 12.82) and (37.68 ± 11.53) μg on 1 bee respectively. Despite it, the honey productivity between X and R lines of honey bees during the Acacia honey production season in May 2022 was not found. The physiology evaluation is the simplest characteristic to test the superiority of honey bees for potential honey yield which carries out regardless of the weather.

Key words: honey bee, honey productivity, honey stomach

P135

Gene expression profiling of the worker bees according to the honey bee, *Apis mellifera*, swarming phenomenon

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The honey bee, *Apis mellifera*, is a social insect that lives in the colony with the three different castes, a queen, workers and drones. Swarming phenomenon of the honey bee is division of the original colony into the two different colonies. It is one of the important social behavior that can be considered as a true reproduction of the honey bee. To investigate the gene expression changes that occur according to the flow of the honey bee swarming, transcriptome analysis of the worker bees from the pre-swarming colonies (PSC), post-swarming colonies (swarming group: SG and remaining group: RG) and stabilized post-swarming colonies (stabilized swarming group: SSG and stabilized remaining-group: SRG) were conducted.

Key words: *Apis mellifera*, Honey bee, Social insect, Swarming, Transcriptome analysis

P136

Effects of pupa rearing condition (temperature) on queen weight at emergence raised initially from queenright and queenless colonies (*Apis mellifera* L.)

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Poor queens have been reported as the primary problem in a number of beekeeping operations, which ranks among the top reasons for colony failure and is attributed to body weight at emergence. Much is still undefined on pupa rearing condition especially ecological factors affecting queen weight at emergence. We reared <20 h old larvae in queenright and queenless colonies and transferred 50% each of the pupae into an incubator (34.7±0.42 °C and 80±5 % RH). Highest queen weight (208.16±3.67mg) and low rate of emergence was measured from the incubator. Emergence rate was low in incubator while queen survival rate was high in the queenless colony. Increasing queen weight at emergence is beneficial to beekeepers for improving queen quality.

Key words: Queen quality, weight at emergence, pupa, ecological factor, honeybee queens

P137

Adaptability of the endangered dung beetle *Gymnopleurus mopsus* (Coleoptera: Scarabaeidae) in response to habitat migration

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The dung beetle, *Gymnopleurus mopsus* is an endangered species that has not been observed in South Korea since 1970s. In the recovery process of endangered species, one of the most important factors for successful habitat settlement of populations is their ability to adapt to changing environments. In this study, we assessed whether Mongolian dung beetles introduced into South Korea can adapt to the domestic environmental conditions. Following hibernation, the adult *G. mopsus* showed reproductive behaviour between late May and early August, and the population increased about three times accordingly. Although a threefold population increase cannot be judged as a criterion for successful settlement, it does suggest the possibility of adaptation in the domestic environmental conditions.

Key words: endangered dung beetle, environmental adaptation, *Gymnopleurus mopsus*, restoration

P138

The Effect of suppressing Mites density in Shine musket vineyards by restoring the ecosystem in ChungCheongbuk-do

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샤인머스켓은 가격이 높게 형성되어 재배면적이 증가하는 추세로 전국 재배면적('22)은 5,241ha 정도로 포도 면적 38.9%에 재배하는 1위 품종이다. 샤인머스켓 잎은 다른 품종과 달리 잎 뒷면에 잎털이 많아 응애 은신이 쉽고, 약제 방제시 잎털의 간섭으로 응애에 닿지 않아 방제가 어렵게 된다. 2022년 충북 샤인머스켓 포도원에서 응애류 발생생태를 조사한 결과 관행 가온재배에서 3월부터 살비제를 살포하더라도 5월 중순부터 개체수가 늘어나 8월 상순 52.6마리/잎의 최고밀도를 보였다. 그에 비해 유기재배 포도원에서는 살비제를 살포하지 않더라도 5월 하순 0.4마리/잎이 발견된 이후 8월 중순 6.8마리/잎의 최고밀도를 보였다. 이는 유기포도원에서 응애의 천적이 보호되어 응애 발생을 억제하기 때문으로 보인다. 관행 가온재배 포도원이지만 2020년까지 유기재배를 했던 포도원에서 2022년에 살충제를 사용하지 않고, 살비제를 5월 하순, 6월 중순 2회 살포해 수확기인 8월 상순 4.2마리/잎 밀도를 유지하였다. 따라서 관행 가온재배 포도원 중 응애 피해가 심한 농가에서 살충제 사용을 줄이고, 적기 살비제를 사용하면 경제적 피해를 줄일 수 있을 것으로 보인다.

검색어: 포도, 응애, 샤인머스켓, 발생, 생태

P139

Growth period by temperature of *Aphis nerii* Boyer De Fonscolombe(Hemiptera: Aphididae) occurring on medicinal crop *Cynanchum wilfordii* Hemsley

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Cynanchum wilfordii Hemsley is a perennial tendril plant belonging to the family Apocynaceae, subfamily Asclepiadoideae, and it is distributed in sunny mountains and fields in Northeast Asia. Tubers grown for 2-3 years are used as herbal medicines in oriental medicine. As a major pest, *Aphis nerii* gathers on new branches or the underside of leaves from May and sucks on it. The belly is yellow and there is a black pattern at the bottom of the horn. *A. nerii* was studied at five constant temperatures (15.0, 20.0, 25.0, 30.0, and 35.0°C), 65±5% relative humidity (RH), and 14L:10D photoperiods. The growth period of nymphs by temperature was 15.2, 9.8, 5.1, 4.7, and 5.7 days, respectively, which shortened as the temperature increased, but became longer at 35°C. The lower threshold temperature of nymphs was 10.0°C and the thermal constant was 116.3DD. The survival period of adults by temperature was 10.1, 32.6, 30.5, 28.8, and 8.2 days, respectively.

Key words: *Aphis nerii*, *Cynanchum wilfordii*, Growth period, Survival period

P140

A pilot surveys on insect pests of three conifer trees from six high mountains in Korea

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Insects have various host ranges and they can cause serious economic and ecological damages to agriculture and forestry. Recently, many cases of damaged coniferous forest have reported in Korea and most of them caused by climate changes and the other reasons including insect pests. Korea Forest Service designated seven coniferous trees in high mountains as Endangered species because their distribution ranges are rapidly decreased by interruption of our activities and climate changes. In the present study, we carried out pilot surveys on insect pests of three coniferous trees: *Abies koreana*, *A. nephrolepis* and *Picea jezoensis* from six high mountains in Gangwon (three localities), Gyeongnam (one locality) and Jeonnam provinces (two localities) by Malaise trap and Lindgren funnel trap. Although we started this surveys from July in this year, we present the list of insect pests and discuss on the ecological importance of them.

Key words: *Abies koreana*, *Abies nephrolepis*, high mountain, insect pests, *Picea jezoensis*

P141

Occurrence of insect pests from urban parks in Honam regions

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Street trees refers to trees that are planted in harmony with roadsides in urban areas, rural areas, mountains, coasts and riverside areas for national reforestations, landscape creation and pollution prevention. Recently, various insect pests frequently cause economic damage due to fragmentary planting of street trees, occurrence of exotic insects and introduction of foreign tree species into Korea. In this study, we investigated fauna of insect pests from main street tree species are planted in a total of six localities in Honam regions: three localities in Gwangju; two localities in Iksan; one locality in Gimje. As results of the present study, we provided a species list of insect pests for each main host (street tree) and damaged plants.

Key words: Honam, insect pest, street tree, urban park

P142

Soil ecosystem multifunctionality of gold mining area based on the energy flux

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For a better understanding of the role of the soil ecosystem, it is essential to consider the various functions provided by the soil ecosystem based on overall biodiversity. This recognition has increased the number of studies on the relationship between soil biodiversity and soil ecosystem multifunctionality (SEM), but there is still no consensus on how to evaluate this relationship. In this study, the SEM of five sites in the gold mining area was quantitatively assessed based on the energy flux of soil food web. The SEM of each site was highly correlated with the heavy metal concentrations of each site. This study will be used as scientific background for developing the assessment method on the overall soil ecosystem functions.

Key words: soil fauna, food web, ecosystem services, invertebrates, soil function

P143

First report of tropical fire ant, *Solenopsis geminata* (Fabricius, 1804) from South Korea

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The invasive alien species, *Solenopsis geminata* (Fabricius, 1804) is reported for the first time in Korea. The ants was found on the surface of the Roadside near Busan port. This detection was first occurrence in natural habitat. We provided distribution, illustration, morphological characteristics and management methods for this species.

검색어: Tropical fire ant, *Solenopsis geminata*, Invasive alien species, Busan port

P144

Characteristics of appearance of land insect resources in organic agricultural complexes for organic agro-ecosystems

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This study was carried out to investigate the changes in insect diversity including biodiversity using biotop (e.g. eco-bridge, buffer zone) for the construction of DB for the ecological resource in the organic rice farming system. We collected samples from the organic rice paddy three times using sweeping and brandishing. As a result of examining insects, total 399 individuals from 9 orders, 46 families and 78 species were collected. The abundant families in the organic rice farming system were *Coleoptera*(21.8%), *Hemiptera*(21.8%), *Diptera*(19.2%), *Orthoptera* (11.5%), *Odonata*(9.0%), *Lepidoptera*(9.0%), *Homoptera*(3.8%) and *Hymenoptera*(2.6%). And *Diptera*(28.6%), *Hemiptera*(19.0%), *Coleoptera*(14.3%), *Orthoptera*(14.3%) and *Odonata*(9.5%) have been observed repeatedly.

검색어: Land Insect, Agro-Ecosystem, Organic, Paddy Field

P145

Aspects of the occurrence of Planthopper Species in Rice Production Regions in Asia

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Major pests occurring in rice production regions in Asia include *Nilaparvata lugens*, *Laodelphax stratellus*, and *Sogatella furcifera*. *Nilaparvata lugens* is a key pest that causes direct or indirect damage by viruses and causes economic losses of more than 3 million dollars annually in tropical and subtropical regions (Bae et al., 1995; RDA, 1998). Accordingly, this study was conducted to examine the pattern of occurrence of these migratory pests to protect rice production. In Korea, the occurrence of *Sogatella furcifera* started on June 28, 2022, and it was confirmed that the trend was gradually increasing. In the Chai Nat region of Thailand, there were some *Nilaparvata lugens* and *Sogatella furcifera*, and in the Chiang Rai region, *Sogatella furcifera* appeared from early February. The Tien Giang region of Vietnam had a large amount of *Nilaparvata lugens*, and it was confirmed that the Batalagoda region of Sri Lanka also had a large amount of *Nilaparvata lugens*. Continuous monitoring is necessary for the management of Planthopper Species in rice production regions in Asia, and it is important to exchange occurrence information among countries to prevent outbreaks of planthoppers.

Key words: *Laodelphax stratellus*, *Sogatella furcifera*, *Nilaparvata lugens*

P146

Presence of honeybee pathogen in apirais during blooming Acacia (*Robinia pseudoacacia*) in 2021-2022, Korea

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The purpose of this study was to provide information on the change in disease occurrence during the blooming period of Acacia in 2021-2022. The honeybee samples were collected from 1 farm in Sejong City, 6 in Gyeonggi-do, 3 in Gangwon-do, 2 in Chungcheongbuk-do, 9 in Gyeongsangbuk-do, and 3 in Gyeongsangnam-do for a total of 24 farms. As a result using PCR analysis, black queen bee virus and *Nosema* sp. showed high infection rates for 2 years. There estimated to be chronically present in honeybees. In addition, in 2022, compared to last year, the infection rate of viral diseases increased (17-21%). It was estimated that some farms occurred a lot of *Varroa destructor* during the blooming of the acacia in 2022.

Key words: Honeybee, Disease, Blooming, Acacia, Korea

P147

Confirming insect pathogenicity of *Metarhizium phasmatodeae* isolated from forest insect pest, *Ramulus mikado* (Phasmidae)

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Stick insects are recently well-known forest insect pests, especially, damaged to broadleaf trees. From the last three years to the present sporadic insect pests have caused damage in various areas, especially in Gyeonggi-do and Seoul city. Currently, insect pesticide spraying is mainly used to control stick insects. This causes damage not only to target insect pests but also to other organisms, so other alternatives are needed. In this study, the entomopathogenic fungus was isolated from the cadaver of an adult *Ramulus mikado* supporting fungal conidiation. This fungus was identified as *Metarhizium phasmatodeae* by microscopic examination and genetic sequencing of the EF1- α regions. Following our result, this fungus showed pathogenicity only to stick insects. We provide fungal spores photo, host range, pathogenicity and molecular phylogenetic relationship.

Key words: stick insect, *Ramulus mikado*, entomopathogenic fungus, *Metarhizium*, *Metarhizium phasmatodeae*

P148

Proposal of yellow sticky roll trap for the control of thrips in pepper greenhouse

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총채벌레는 세계적으로 약 6,000종이 알려진 가운데, 이 중 약 20종이 작물의 수확량과 상품성을 크게 떨어뜨릴 뿐만 아니라, 토마토반점위조바이러스(TSWV)와 같은 식물 바이러스의 매개체로서 농업해충으로 인식되고 있다. 현재 총채벌레 방제를 위해서 예찰용 평판 끈끈이트랩, 방충망, 화학농약, 그리고 최근에는 곤충병원성 미생물과 천적 뿌리이리응애를 지하부 총채벌레 방제용으로 활용되고 있으나, 고추와 같이 멀칭재배하는 경우 추가 투입의 한계가 있다. 본 연구에서는 지상부와 토양을 이동하는 총채벌레의 생태적 특성을 고려하여 예찰용 황색롤끈끈이트랩을 지재부에 설치함으로써 물리적으로 방제하는 방법을 제안하고자 한다. 황색롤끈끈이트랩 설치만으로도 45.3%의 방제효과를 보였으며, 유기농업자재를 추가로 살포했을 경우 무처리(최소방제) 대비 74.4%의 방제효과를 보였다.

검색어: 총채벌레, 황색끈끈이롤트랩, 친환경, 방제

P149

Evaluation of the susceptibility to abamectin in field population of the two-spotted spider mite, *Tetranychus urticae* Koch

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The two-spotted spider mite, *Tetranychus urticae* Koch, is one of the most damaging ornamental and horticultural plant pests. Control of this pest has been heavily dependent upon chemical acaricides. The aim of this study was to evaluate the susceptibility baseline of field populations of *T. urticae* to abamectin. A total of five field populations of *T. urticae* were collected in 2022 and the susceptibility of these populations to abamectin was determined in the laboratory using a direct spray application method. Variation of susceptibility was observed among populations with LC₅₀ values ranging from 5.02 to 15.36 ppm for abamectin. Our results revealed that Damyang populations (LC₅₀ = 5.02 ppm) were more susceptible to abamectin compared to Hadong (9.45 ppm), Iksan (10.33 ppm), Cheongdo (12.88 ppm), and Goryeong (15.36 ppm). The findings of our study will help future efforts to monitor *T. urticae* resistance to abamectin.

Key words: two-spotted spider mite, abamectin, resistance monitoring, insecticide resistance, susceptibility

P150

The effect of Chinese cabbage and tobacco as banker plants for natural enemy in tomato greenhouse

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This experiment was carried out to test whether the banker plant can be used for *Orius laevigatus* and *Nesidiocoris tenuis*, the main natural enemies used in the tomato greenhouse. In the *O. laevigatus* case, after inoculation with *Myzus persicae* on Chinese cabbage placed with moss rose together, and the density of *O. laevigatus* was investigated. The density of *O. laevigatus* was higher in Chinese cabbage compared to moss rose, and it seems that Chinese cabbage can be used as a banker plant for *O. laevigatus*. In the *N. tenuis* case, tobacco inoculated with *M. persicae* was placed with Chinese cabbage together, and the density of *N. tenuis* was investigated. The density of *N. tenuis* in tobacco was higher than that of Chinese cabbage, but its density was similar between two banker plants in the tomato greenhouse. So Chinese cabbage and tobacco would be expected to be used as a banker plant of *N. tenuis*. In addition, tobacco showed an attractive effect on white fly. Therefore, tobacco would be expected to be used as a banker plant of *N. tenuis* and a trap plant of white fly.

검색어: banker plant, natural enemy, *Nesidiocoris tenuis*, *Orius laevigatus*

P151

Development of molecular based species identification tools for three major plant hoppers, BPH, SBPH, and WBPH (Hemiptera: Delphacidae)

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The planthoppers (Hemiptera: Delphacidae) are one of the primary sucking type pests in rice (mainly Southeast Asian countries including Korea) and are comprised of three morphologically similar species, including brown planthopper (BPH, *Nilaparvata lugens*, Stål), white-backed planthopper (WBPH, *Sogatella furcifera*, Horváth), and small brown planthopper (SBPH, *Laodelphax striatellus*, Fallén). Species diagnosis is important because insecticide resistance patterns and control strategies vary according to species, but accurate species diagnosis is not easy due to morphological similarities and sequence similarities. Here, multiplex PCR, which can analyze the composition and density of each species after mass collection in the field, and the Loop-Mediated Isothermal Amplification (LAMP) assay, which can diagnose within 1 hour without a separate DNA extraction process in the field, were developed based on the partial mitochondrial genome sequence. This simple and accurate multiplex PCR and LAMP assay can be used for intensive field monitoring of integrated management of these species.

Key words: Plant hopper, LAMP, Multiplex PCR, Mitochondrial genome

P152

Comparative transcriptome analysis of type II sex pheromone-related genes in two whitefly species, *Bemisia tabaci* and *Trialeurodes vaporariorum*

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Whiteflies are worldwide polyphagous pests that reduce crop yields through direct sucking or viral transmission. In this study, in order to identify understand the sex pheromone of whitefly, we identified genes related to type II sex pheromone via transcriptome analysis from two species of female adults, *Bemisia tabaci* and *Trialeurodes vaporariorum*. Approximately, 10.8Gb and 12.8Gb of data were obtained from *B. tabaci* and *T. vaporariorum*, respectively. Compared to *T. vaporariorum*, 2,590 contigs were up-regulated and 2,203 contigs were down-regulated in *B. tabaci*. Forty three cytochrome P450 monooxygenases (CYPs) and 6 odorant-binding proteins (OBPs) were found as type II sex pheromone-related genes from two species. *B. tabaci* revealed specific expression of 20 CYPs and two OBPs. These genes are likely to be involved in the species-specific sex pheromone biosynthesis.

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

P153

Seasonal monitoring of the striped fruit flies, *Zeugodacus scutellata* using different forms of attractant, cuelure

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The striped fruit fly, *Zeugodacus scutellata* (Diptera: Tephritidae), is one of important pests in Cucurbitaceae plants. The cuelure is currently using with various forms for surveillance to the striped fruit fly including *Z. cucurbitae*, *Z. tau*, and *Bactrocera tryoni*, which are categorized as prohibited-quarantine pests in Korea. In this study, we investigated attraction effect on cuelure by 3 different forms as solid, liquid, and wax to striped fruit flies using the Steiner trap. The trap was placed in two Jeju and one Gyungbuk regions and the number of attracted flies by each cuelure form is monitored by every 2 weeks during 2021. There is significant difference on attraction effect to *Z. scutellata* by different form in two Jeju regions. Liquid and wax form of cuelure showed high attraction number to the *Z. scutellata* compared with solid form when flies were occurred with high population in July to August. However, there is no significant difference on attraction effect at low population in Juju and Gyungbuk by different forms. Based on field assay, liquid and wax form of cuelure are recommended for surveillance against *Z. scutellata*. Furthermore, these results also strongly indicates that cuelure is effective to quarantine pests including *Z. cucurbitae*, *Z. tau*, and *B. tryoni*.

Key words: *Zeugodacus scutellata*, cuelure, quarantine, surveillance, attractant

P154

Evaluation of soil microorganisms for the management of root-knot nematode

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Root-knot nematodes (RKNs) are plant parasitic nematodes that infect many plant species and cause significant economic losses worldwide. The development of novel biological control agents for the prevention and control of root-knot nematodes is becoming important. In this study, the possibility of nematicidal agents was confirmed by screening the soil microorganisms. Among them, it has been confirmed that *Burkholderia* spp. separated from domestic soil has the ability to control Root-knot nematodes. *In vitro* assay, it showed up to 80% mortality against four RKNs. The result of pot test showed that the RKN penetration and egg mass formation was significantly reduced in the treatment group compared to the control group. In addition, it was confirmed that plant growth increased about 7.6-fold compared to control groups. This suggests that it could be an effective biological control agent and a potent alternative to chemical nematicides.

Key words: Root-knot nematode, nematicidal activity, biological control, Plant growth

P155

Library Construction for microbial resources with plant parasitic nematode activity

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The annual loss alone is about 250 billion won, and the cost of nematodes for nematode control is also estimated at 70 billion won. Methods of controlling nematodes are largely divided into chemical control, physical control, and biological control. Of these, the chemical control effect is the greatest, but because pesticides can cause residual problems, organic farming materials are expensive and the efficacy of drugs is inferior, but many farmers are looking for organic farming materials. Therefore, we sought to find a resource for controlling nematodes from natural products. Among natural products, microorganisms produce a variety of beneficial secondary metabolites. In this study, potential nematode control microorganisms were searched from a microbial library, and the possibility of natural organic materials was suggested. In addition, through this study, we propose the value of microorganisms for the control of plant diseases in the future.

Key words: plant parasitic nematode, nematicidal activity, biological control, library construction

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Selection of organic agricultural materials for the control of black cutworm, *Agrotis ipsilon* (Lepidoptera: Noctuidae)

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검거세미밤나방 3령 이상의 유충은 토양의 3~5cm 깊이에 서식하며 옥수수, 감자 등 80종 이상의 작물의 새싹과 줄기를 왕성하게 가해하는 습성이 있어 작물의 유묘기에 발생하면 막대한 경제적 손실을 불러오는 농업해충으로 알려져 있다. 이들의 방제를 위한 화학 살충제는 매우 효과적인 도구이지만 환경 오염, 천적 개체수의 파괴 및 살충제 저항성과 같은 심각한 부정적 결과를 초래한다. 이와 같은 부작용에 대한 대안으로 28종의 식물 유래 살충제(시판 유기농업자재)의 검거세미밤나방에 대한 살충활성을 조사하였다. 이 중 80% 이상의 높은 살충률을 보인 제품은 4종, 특히 화학농약 수준의 90% 이상의 살충률을 보인 제품도 1종을 선발하였다. 따라서 본 연구결과 생물농약으로써 50% 이상의 살충률을 보인 유기농업자재 제품 9종을 검거세미밤나방 방제용 농자재로 제안하고자 한다.

검색어: 검거세미밤나방, 유기농업자재, 살충활성, 방제

P157

Relationship of different drying conditions and functional healthful substances of the White-spotted Flower Chafer Larval (*Protaetia brevitarsis*)

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충남 지역특산품 중 인삼과 마늘의 농업부산물인 홍삼박과 흑마늘박 건조분말을 1일 절식한 흰점박이꽃무지 3령 유충의 배변유도용으로 3일간 급이하였고, 살처리 후 흰점박이꽃무지 유충의 건조 방법별 기능성 지표물질의 상관성을 구명하고자 수행하게 되었다. 살처리 및 건조 방법별 기능성 지표물질을 HPLC로 분석한 결과, 홍삼박을 섭취한 처리구 중 끓는 물에 60초 침지하여 열풍식 건조를 한 굽병이 건조물에서 Saponin 함량이 50.75±1.97 mg 100g⁻¹로 홍삼박 대비 1.78배 높게 나타났고, 흑마늘박을 섭취한 처리구에서도 열풍 건조를 통한 굽병이 건조물에서 Pyruvate 함량이 45.93±0.05 mg 100g⁻¹로 흑마늘박 대비 1.2배 높은 결과를 보였다. 또한 홍삼박 급여 후 유충 살처리 및 건조 조건별 Saponin 성분 특성 중 홍삼박은 Rb1 8.97 가 가장 많이 함유하고 있었던 반면, 열풍식 굽병이에서는 피부보호 효능이 있는 F4 성분이 15.52 mg 100g⁻¹를 보였고, -40°C로 살처리 후 동결건조식 굽병이에서는 F4와 유사한 기능을 갖는 F1 7.87 mg 100g⁻¹로 가장 높게 검출되었다. 그리고 흰점박이꽃무지 절식 유충의 배변 유도 및 기능성 향상을 위한 지역특산품 부산물을 급여한 굽병이의 살처리 및 건조 조건별 관능평가 선호도 설문조사 결과, 끓는 물에 60초 침지하여 살처리 한 후 열풍건조를 하였을 때 풍미와 외형 및 색깔에서 모두 우수하였을 뿐만 아니라 식미감을 떨어뜨리는 이취감 감소효과에도 가장 긍정적이었다.

검색어: 흰점박이꽃무지, 홍삼박, 흑마늘박, 사포닌, 피부르산

P158

A comparison of the rate of mating success between honeybee (*Apis mellifera* L.) lineages bred in the Wangdeung-do and Sik-do Island, Korea

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꿀벌의 유전자원을 보존 및 증식하기 위해서는 목표 계통에 다른 유전자가 오염이 되지 않도록 격리된 지역에서 이루어져야 한다. 본 실험은 양봉꿀벌을 육종하기 위하여 서해안 도서지역인 부안군 위도면 식도와 같은 지역 왕등도에서 격리육종을 수행하였으며, 이에 대한 교미 성공률을 분석하였다. 육종기간은 2021년부터 2022년까지 총 2년간 수행되었으며, 장원, C, D, V, F, A, AC, AD, FD, VD, CD, VF 계통을 교미시켰다. 그 결과, V 계통이 78.6%로 성공률이 가장 높았으며, C 계통과 D 계통은 각각 32.1%, 30.6%로 가장 낮은 성공률을 보였다. C 계통의 경우, 21년 왕등도에서 같은 날 동일 조건으로 교미시킨 AC 계통과 비교하였을 때, 각각 20%(n=20)와 80%(n=20)의 교미성공률을 보이며 확연한 차이를 나타냈다. 장소별로는 왕등도와 식도의 교미율은 각각 60.2%와 62.3%로 큰 차이를 나타내지 않았으나, 교미성공률의 편차는 각각 $\pm 31.1, \pm 17$ 로 식도가 작게 나타났다. 식도는 아까시나무, 유채꽃 등의 밀원수가 풍부한 반면, 왕등도의 식생은 주로 조릿대가 우점하여 밀원수가 식도에 비해서는 부족한 실정이다. 밀원수의 조건이 극명하게 차이남에도 불구하고 장소별 교미성공률에는 차이가 나지 않았다. 이를 통하여 밀원수의 분포는 교미 성공률에 영향을 미치지 않는다는 추측을 할 수 있었으며, 이에 대한 추가적인 연구를 통하여 도서지역 육종후보지 선정에 기초자료로 활용할 수 있을 것으로 판단된다.

검색어: 꿀벌육종, 격리육종, 자연교미, 양봉꿀벌, 유전자원

P159

Anti-inflammatory activity of Extracts from *cordyceps militaris* cultivated as hosts of *Tenebrio molitor* and *Gryllus bimaculatus*

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Cordyceps militaris is a fungus belonging to the Class Ascomycetes, Order Clavicipitales, and Family Clavicipitaceae, which are mostly parasitic in insects and form the fruit body from host insects. We measured NO production inhibition ability by inducing NO synthetics in RAW 264.7 cells to confirm the anti-inflammatory effects of the fruit body and culture medium formed from major industrial insects, mealworm (*Tenebrio molitor*) and two-spotted cricket (*Gryllus bimaculatus*). As a result, it was confirmed that the fruit body of *T. molitor* and culture medium of *G. bimaculatus* had NO synthesis inhibitory effect and no cytotoxicity. This study was conducted to promote the consumption of industrial insects and contribute to farm income.

Key words: Industrial insects, *Cordyceps militaris*, anti-inflammatory effects

P160

Genetic diversity of *Gryllus bimaculatus* De Geer, 1773(Orthoptera, Gryllidae) in South Korea

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Gryllus bimaculatus (GB), as known as Ssang-byeol-gwi-ttu-ra-mi, has being important role in the Korean insect industry, especially in edible insects market. Because of this importance, physiological studies on GB has been mainly focused on mass rearing techniques, but there is no comprehensive study of the genetic diversity within the Korean GB population. We here examined how many genetically different haplotypes distributed in the reared GB collected from five insect farms, two national insect rearing facilities with 12 foreign GB using mitochondrial *COI* gene sequences (DNA barcoding region). As a results, six haplotypes were detected from 111 specimens with low intraspecific genetic distance (~1.8%). Among them the most dominant haplotype was overwhelmingly detected as haplotype 1 (H1), consisting of all Korean specimens and four specimens from China, Indonesia, and Germany. Based on this study, the reason for the low genetic diversity of Korean GB is thought to be that the GB population imported for feed from Japan in the early 2000s became a maternal group and then spread throughout cricket farms in Korea.

Key words: *Gryllus bimaculatus*, genetic diversity, *COI*, haplotype, Korea

P161

Anti-inflammatory effect of *Hermetia illucens* larvae extract

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Inflammation is an immune response that protects the body from damage caused by external stimulation, and it is an important system for reducing tissue damage and maintaining homeostasis. However, when it is excessively activated, it may act as a factor for the onset of various diseases. In this study, we confirmed the anti-inflammatory effect of *Hermetia illucens* larvae ethanol extract (HIE) and confirmed its influence on pro-inflammatory factors. The NO expression was inhibited by 41.74±8.99% at HIE 400 µg/ml when compared to LPS treatment. The expression of TNF-α, IL-1β and IL-6 was suppressed by 76.60±2.04%, 67.06±2.36% and 96.56±0.41% at HIE 400 µg/ml when compared with the LPS treatment. Therefore, it was confirmed that HIE has the effect of suppressing the expression of pro-inflammatory cytokines. And the protein expression of iNOS and COX-2 were confirmed to be suppressed by 93.58±1.42% and 96.42±0.82% with HIE 400 ug/ml when compared with LPS treatment. Thus, ethanol extract of *Hermetia illucens* larvae (HIE) is expected to have high utility value as an anti-inflammatory material.

Key words: *Hermetia illucens*, Anti-inflammatory, COX-2

P162

**Development of SNP-based CAPS markers distinguishing four fruit flies
(*Bactrocera scutellata*, *B.depressa*, *B.cucurbitae*, and *B.dorsalis*)**

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Over the 25 years, Seven exotic *Bactrocera* species have been detected by quarantine procedure, none of them has been established in Korea. To prevent the possibility of invasion by exotic fruit fly species, about 1,000 surveillance traps are set up and maintained from April to November of each year. Traps are placed in the canopy of fruit fly host plants near the airport, bay, and areas with high concentration of foreigners. The quarantine inspectors check the steiner traps at 2-weekly intervals. Sometimes, two *Bactrocera* species, the striped fruit fly(*B.scutellata*) and the pumpkin fruit fly(*B.depressa*) are known to naturally occur throughout Korea, were captured in the steiner traps for the oriental fruit fly(*B.dorsalis*) and the melon fruit fly(*B.cucurbitae*), respectively. It is difficult to distinguish among four fruit flies because of similar morphological characteristics and this needs highly trained experts for the identification. To overcome this diagnosis method, we performed whole genome sequencing of collected *B.scutellata* and *B.depressa*. The reference genome for *B.scutellata* was perfectly matched with reads from *B.cucurbitae*, and 90% of paired reads were correctly paired. Based on the next generation sequencing data, we developed Cleaved Amplified Polymorphic Sequences(CAPS) markers as key genes to distinguish four fruit flies in a few hours. This would enable efficient in-and-out for the quarantine procedure and reduce the importing delays. It will be a basic and essential marker not only rapid identification of *B.scutellata*, *B.depressa*, *B.cucurbitae*, and *B.dorsalis* but also environmental protection of Korea from fruit flies.

Key words: exotic fruit fly, whole genome sequencing, CAPS,

P163

The reoccurrence case of the tropical bed bug *Cimex hemipterus* (Heteroptera: Cimicidae) with *super-kdr* mutations in the Republic of Korea

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Infestations of the common bed bug, *Cimex lectularius* (L.) and the tropical bed bug, *Cimex hemipterus* (F.) (Hemiptera: Cimicidae) have resurfaced globally in the last two decades, due to increased international travel and trade in conjunction with the development of pesticide resistance. *C. hemipterus* has recently been detected in temperate locations, indicating the possibility of its spread outside of tropical areas. Since its description in 1934, *Cimex hemipterus* has not been officially recorded in Korea. Here, we report the first reoccurrence case of *C. hemipterus* in Korea based on morphological and molecular identification. *Super-kdr* mutations (M918I and L1014F) related with pyrethroid resistance were determined by partial sequencing of the voltage-sensitive sodium channel gene. This case report serves as a warning to intensify the bed bug surveillance system in Korea regarding the existence of *C. hemipterus* and to prepare effective alternative insecticides to pyrethroids.

Key words: *Cimex hemipterus*, bed bug, mtCOI, voltage-sensitive sodium channel, insecticide resistance

P164

Molecular identification of the fall armyworm, *Spodoptera frugiperda* (Smith) in South Korea

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The fall armyworm, *Spodoptera frugiperda* (Smith), first found in 2019 has become an important migratory insect pests in South Korea. Corn was the most affected crop occasionally with severe damage. Besides of morphological identification, the populations of *S. frugiperda* in South Korea were genetically identified using triosephosphate isomerase (*Tpi*) genes and mtDNA cytochrome oxidase subunit I (*COI*). During four years (2019-2022), *Tpi* gene analysis shows that all larval or adult samples collected nationwide belong to sub-population of “corn strain”. Mitochondrial *COI* gene analysis, however, indicates that the ratio of *COI* genetic groups, COI-A and COI-B, has been changed, of which COI-B group increased from 5% in 2019 to about 40% in 2022.

Key words: *Spodoptera frugiperda*, molecular identification, migration, Korea

P165

Colour variation of vertex and pronotum of *Bothrogonia ferruginea* (Hemiptera: Auchenorrhyncha: Cicadellidae: Cicadellinae)

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Genus *Bothrogonia* Melichar, 1926 belongs to the tribe Cicadellini under the subfamily Cicadellinae (Hemiptera: Auchenorrhyncha: Cicadellidae). A total of 47 species have been recorded in the whole world. While in Korea, only one species, *Bothrogonia ferruginea* has been recorded so far. Some species of this genus can cause injuries to plant species such as pear tree and various berries. The species of *Bothrogonia* are known to have broad colouration of vertex or pronotum, and they are very similar in appearance which make it difficult to be identified by morphological characters only. In this study, we provide a description and illustration of the variations.

Key words: Cicadellinae, variations, taxonomy, *Bothrogonia*

P166

Genetic diversity and population structure of *Maruca vitrata* (Fabricius) in India

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Maruca vitrata is one of the major biotic constraints for pigeonpea production in India. A detailed understanding of the population genetic structure of this pest species in the country is essential to design better strategies for its management. Here, we explored the genetic diversity among *M. vitrata* populations collected from diverse agro-ecologies using mitochondrial cytochrome c oxidase I (*COX-I*) gene. The study showed a low number of segregating sites (10), haplotypes (13), nucleotide diversity (0.00136) and overall mean genetic distance (0.0013) among the populations. The negative values of neutrality tests supported the demographic expansion theory in Indian *M. vitrata*. Analysis of the molecular variance revealed that variations among populations or groups were only 13.91%. The pairwise genetic differentiation was also found to be low to moderate between most of the populations. Further isolation by distance analysis using Mantel's test ($R^2 = 0.0024$, $p = 0.280$) indicated that geographical distance did not significantly contribute to the genetic differentiation. Both neighbour-joining tree and the haplotype network also showed that clustering of the haplotypes was independent of the geographical location. There is a possible occurrence of stable inherited gene flow among populations, thereby reducing genetic variation of *M. vitrata* in India.

Key words: *COX-I* gene, diversity, haplotype, *Maruca vitrata*, pigeonpea, phylogeny

P167

Newly recorded species of the genus *Latuspina* Monzen (Hymenoptera: Cynipidae: Cynipini) from Korea

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The genus *Latuspina* Monzen, one of the Cynipini (Hymenoptera: Cynipidae) genera, and it contains of nine species in the Palaearctic and Oriental region. In Korea, only two species are known to date; *L. abemakiphila*, *L. kofuensis*. We herein describe and illustrate a newly recorded species of the genus from Korea.

Key words: Hymenoptera, Cynipidae, Oak gall wasp

P168

COI Barcoding and Taxonomic Study of Korean Cyclostome Wasps (Hymenoptera: Braconidae)

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Most parasitic insects are known as hymenopterans, of which main hosts are Diptera, Coleoptera and Lepidoptera. Among them, the braconidae family has about 21,000 species recorded worldwide, subdivided to more than 40 subfamilies, occurring broadly in tropical, temperate or dry habitats. Cyclostome braconids with concave clypeus are a monophyletic group of parasitic wasps, characterized by a various parasitic strategy in koinobiont or idiobiont ecto/endo-parasitoid. It also includes five relatively well-known and species-rich subfamilies (Alysiinae, Braconinae, Doryctinae, Opiinae and Rogadinae), comprising with more or less 15 subfamilies, but comparison of morphological features and phylogenetic relationships of family-level of cyclostome braconids remain unclear even although previous molecular phylogenetics were performed. In this study, for 157 morphospecies samples as MOTU, we phylogenetically compare and analyze the posterior probability values of the three results, ABGD, bPTP and GMYC, in order to evaluate and delimit species for the relationship of cyclostome braconids based on COI barcoding analysis.

Key words: Natural enemy, Phylogeny, Tribes, Taxonomy, Host range

P169

First record of a parasitoid wasp, *Neastymachus japonicus* (Chalcidoidea: Encyrtidae) from South Korea

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The genus *Neastymachus japonicus*, 1915 belonging to the family Encyrtidae is known to include 20 species worldwide. This genus is a perparasitic wasp on scale insects. *Neastymachus japonicus* Tachikawa, 1970 is recognized for the first time in South Korea, of which specimens were firstly collected from Seocheon, South Korea. *Neastymachus japonicus* is a parasitic *Nipponaclerda biwakoensis*, based on *Phragmites australis*. Descriptions, diagnosis, distribution and illustration are provided.

Key words: Hymenoptera, Natural enemy, Taxonomy, Unrecorded species

P170

A newly record of the genus *Ephedrus* (Hymenoptera, Braconidae, Aphidiinae) from South Korea

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The genus *Ephedrus* Haliday, 1833 is a taxon of Aphidiinae (Hymenoptera: Braconidae), consisting of 49 species in the worldwide. To date, only 5 *Ephedrus* species have been recorded in South Korea. In this study, newly recorded species, *E. lacertosus*, is reported. In addition, their descriptions and illustration are provided.

Key words: Ephedrini, unrecorded species, DNA barcoding, parasitoid wasps, systematics, taxonomy

P171

The first record of the Genus *Caelius* Lewis, 1895(Coleoptera: Scarabaeidae: Aegialiinae) from South Korea

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Caelius Lewis, 1895 contained only five species worldwide. Most species mainly distributed in the Nearctic region. In the neighboring countries of Korea, only one species, *Caelius denticollis* Lewis, 1895, was recorded in Japan. In this study, the genus *Caelius* was newly recognized from South Korea, with *Caelius denticollis* Lewis, 1895. The description and images of adults are provided. Also, a key to the Korean genus in Aegialiinae is presented.

Key words: *Caelius*, Aegialiinae, newly record, Korea

P172

Review of *Stigmella* leaf-mining moth (Lepidoptera, Nepticulidae) feeding on Oak (*Quercus* spp.) in South Korea, with a newly recorded species

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The present study reviewed the recent findings of nepticulid species feeding on Oak leaves from South Korea, in particular focused on the genus *Stigmella* Schrank, 1802, which contains six species: *S. aladina*, *S. dentatae*, *S. fumida*, *S. kurokoi*, *S. omelkoi* and *S. clisiotophora*. Among them, *S. clisiotophora* was new to South Korean insect fauna. In addition, female *S. fumida* and male *S. aladina*, which were not previously unknown to science, were described in the present study, and the images of leaf-mines for each species were given for the first time. The brief morphological diagnosis includes host plants and leaf-mines of each species. A check list is also provided along with a key to the Oak feeding *Stigmella* species in South Korea.

Key words: Lepidoptera, Nepticulidae, *Stigmella*, Fagaceae, newly record, Korea

P173

New record of *Nematus tibialis* Newman, 1837 (Hymenoptera: Tenthredinidae) from South Korea

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In this study, the subfamily Nematinae, *Nematus Tibialis* Newman, 1837, is firstly reported in South Korea. Photographs and diagnosis of the species are provided. It also provides morphological variations, life history, and distribution of species.

Key words: Hymenoptera, Nematinae, *Nematus tibialis*, New record, South Korea

P174

Two new species of the genus *Cratospila* Foester (Hymenoptera, Braconidae, Alysiinae) from South Korea

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Two new species of the genus *Cratospila* Foerster, 1863 (Braconidae: Alysiinae), *Cratospila albosignata* sp. nov. and *C. longivena* sp. nov., are described and illustrated from South Korea. In addition, the DNA barcode region of the mitochondrial cytochrome *c* oxidase subunit I (COI) of both species has been sequenced. *Alysia ponerola* Papp, 2009 which was recorded from North Korea is transferred in *Cratospila* (*C. ponerola* (Papp, 2009) comb. nov.).

Key words: Alysiini, COI, Hymenoptera, new combination, new record, new species, taxonomy

P175

Comparative characteristics of complete mitochondrial genome of *Carpophilus obsoletus*

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The dried-fruit beetles, *Carpophilus* (Coleoptera: Nitidulidae), are worldwide pests of fruits, frequently detected during the quarantine process of dried distillers grains with solubles (DDGS) and wood pellet and some species are treated as Managed pest for protecting us agri environment in South Korea. Moreover, they are identifiable based on several morphological keys, but are difficult to diagnose promptly as species level if they are detected as immature stages such as larvae and pupae. In order to overcome such difficulty and complement identification method, thus, alternative diagnostics technique would be necessary. In this study, we sequenced and characterized complete mitochondrial genome (mitogenome) of *C. obsoletus* and are in the middle of scrutinizing the genomic characteristics of the family.

Key words: sap-feeding beetle, immature stage, molecular diagnostics, quarantine pest

P176

Taxonomic study of the genus *Agriotypus* Curtis, 1832 (Hymenoptera, Ichneumonidae, Agriotypinae) from South Korea

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The subfamily Agriotypinae is a small group of aquatic parasitoid wasps which is known as parasitize trichopteran pupae and prepupae in fast-running water. *Agriotypus* Curtis is the monotypic genus in this subfamily Agriotypinae (Hymenoptera, Ichneumonidae), comprising 16 species from the Palearctic and Oriental Regions. In this study, two new species, *A. sp. n. 1* and *A. sp. n. 2* are described. We also provide diagnoses of adults and larva with photographs and an identification key to South Korean species.

Key words: *Agriotypus*, Aquatic wasp, DNA barcode, taxonomy, Trichoptera.

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P177

New record of fungus weevils (Coleoptera, Anthribidae) to Korean Korean peninsula

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소바구미과의 종들은 일부 포식성인 종과 유충이 식물의 열매를 가해하는 종들을 제외하고는 주로 고사목에서 자라는 균류를 먹고 생활한다. 현재까지 우리나라에는 총 47종의 소바구미과에 속하는 종들이 기록되어 있다. 최근 흑산도 및 제주도 등 남부 도서지역에서 곤충상 조사를 진행하던 중, 소바구미과 (Anthribidae)의 1 미기록종 (*Dendropemon nagaai* (Morimoto, 1972),) 1 신종 (*Xanthoderopygus jejuensis* Sp. nov.)을 발견하였다. 이들에 대한 형태 및 간략한 정보를 제공하고자 한다.

검색어: *Dendropemon nagaai*, *Xanthoderopygus jejuensis*, Anthribidae, 소바구미과, 미기록종, 신종

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Comparison between recently introduced bark and ambrosia beetles and closely related species

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2020년대에 들어오면서 과거에 국내에서 알려지지 않았던 나무좀아과 또는 긴나무좀아과에 속하는 해충들의 국내 분포가 밝혀지고 있다. 이들은 그 분포가 정확하게 알려지지 않았던 미기록종과 목재 등의 수입 또는 선박에 편승하여 국내에 정착하게 된 침입종으로 구분할 수 있다. 최근 국내에도 분포하는 것으로 알려진 님은왕 나무좀 (*Eurwallacea interjectus* (Blandford))은 일본과 중국에서 처음 보고된 종으로 최근 일본에서는 무화과나무 (*Ficus carica*)의 시들음병 문제를 야기하고 있다. 왕털소나무좀 (*Hylurgus ligniperda* (Fabricius))은 독일에서 처음 보고되었으며, 유라시아가 원산지로 아메리카 대륙 및 오세아니아에 확산되었다. 이 종은 일본 및 중국에도 침입한 종으로 여겨지고 있으며, 이들의 생물지리학적 분포 및 확산 등에 대한 연구가 진행되고 있다. 본 연구에서는 최근 국내에 분포가 보고된 종 가운데에 검역과 관련된 나무좀 및 긴나무좀의 목록과 이들의 현재 국내 분포상황 및 근연종에 대한 간략한 정보를 제공하고자 한다.

검색어: 님은왕나무좀, 왕털소나무좀, 나무좀아과, 긴나무좀아과, 근연종, 침입종

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**External characters for the identificaion between
Euwallacea validus and *E. interjectus***

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2020년 우리나라의 제주도에 분포하는 것으로 기록된 닳은왕나무좀 (*Euwallacea interjectus* (Blandford, 1894)) 가 올해 여러 곳자왓 지대를 포함하여, 한라산 둘레를 따라 넓게 분포하는 것이 확인되었다. 국내에 분포하는 *Euwallacea* 속의 본 종을 포함하여, 1930년 제주도에 기록되었으나 그 이후 채집기록이 없는 애나무좀 (*E. praeivius* (Blandford, 1894)) 및 전국에 분포하고 있는 가문비왕나무좀 (*E. validus* (Blandford, 1874)) 등 총 3종이 기록되어 있다. 가문비왕나무좀은 주로 소나무 등의 침엽수 고사목에서 확인되는 것에 반하여, 닳은왕나무좀은 활엽수를 주로 가해하는데 올해 생강나무, 붉가시나무의 생목에 침입하여 고사시키는 것이 확인되었으며, 제주도에서 점차 그 분포가 넓어지고 있고, 이후 내륙지방에도 확산될 가능성이 있다. 따라서, 닳은왕나무좀의 활엽수에 대한 피해 양상을 보고하여 추가 연구에 도움이 되고자 하며, 국내에 분포하는 것으로 알려진 *Euwallacea*속 3종을 쉽게 구분하는 형질을 제공하고자 한다.

검색어: 닳은왕나무좀, 제주도, *Euwallacea interjectus*, *E. praeivius*, *E. validus*

*본 연구는 농림축산검역본부의 지원을 받아 수행하였습니다(PQ20170B013).

P180

**Four newly recorded species of the genus *Microplitis* Förster (Hymenoptera:
Braconidae: Microgastrinae) from Korea**

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Microplitis is cosmopolitan genus of the subfamily Microgastrinae. This genus comprises more than 192 described species in the world (Fernandez-Triana et al. 2020). A number of *Microplitis* are solitary endoparasitoids of Macrolepidoptera larvae: Sphingidae, Noctuidae and Geometridae.

To date, 20 Korean species were recorded by Papp (1987), Belokobylskij (2012) and Choi & Kim (2018). In this study, four species of *Microplitis* are reported for the first time from Korea. Diagnosis, distribution and host information are provided for each species.

Key words: *Microplitis*, Braconidae, Hymenoptera, Korea, Parasitic wasp

P181

One new species of the genus *Dayus* Mahmood (Hemiptera: Auchenorrhyncha: Cicadellidae: Typhlocybinae) from Korea

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One new leafhopper species, *Dayus* sp. nov. is described from Korea. In this work, description, photographs, and illustrations of the new species are provided. And a key to the Palearctic *Dayus* species is also given.

Key words: Emposcini, leafhopper, *Dayus*, key

P182

***Acleris notana* (Lepidoptera: Tortricidae: Tortricinae) new to Korea**

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The genus *Acleris* is a large group of the tribe Tortricini. They are occurring from all regions except the Australian. The genus contains 261 species worldwide, and is mainly reported from the Palearctic region with 147 species. Among them, 45 species are recorded in Korea. In this study, *Acleris notana* (Donovan) 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, Tortricini

P183

The First Report of the Subfamily Paramacronychiinae with Genus *Goniophyto* Townsend, 1927 (Diptera: Sarcophagidae) from Korea

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The family Sarcophagidae commonly known as flesh flies, contains three subfamilies Miltogramminae, Paramacronychiinae, Sarcophaginae with more than 3,000 species worldwide. To date, only two subfamilies Miltogramminae and Sarcophaginae with 43 species are described in Korea. In this study, subfamily Paramacronychiinae is reported for the first time from Korea, with two nominated species: *Goniophyto honshuensis* Rohdendorf, 1962 and *Goniophyto horii* Kurahashi & Suenaga, 1994. The descriptions, photographs to the Korean species are provided herein.

Key words: Taxonomy, Diptera, Sarcophagidae, Paramacronychiinae, *Goniophyto*

P184

A new species of the genus *Olethreutes* (Lepidoptera: Tortricidae: Olethreutinae) from South Korea

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The genus *Olethreutes* was established by Hübner (1822) based on the type species *Phalaena arcuella* Clerk, 1759. To date, this genus comprises more than 230 species in the world. Among them, 30 species of the genus *Olethreutes* have been reported in the Korean peninsula. The proposes of this study is to describe one new species, with two similar species for Korea.

Key words: Tortricoidea, Palearctic Region, taxonomy, n. sp.

P185

Taxonomic notes on the genus *Endotricha* Zeller (Lepidoptera, Pyralidae) in Korea

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The genus *Endotricha* was established by Zeller (1847), with type species *Pyralis flammealis* [Denis & Schiffermüller], 1775. *Endotricha* is characterized by the laterally large uncus arms and present of saccular process in the male genitalia. More than 100 described species of this genus have been recorded worldwide (Nuss *et al.*, 2003-2022), and eight species have been recorded in Korea (Kim & Paek, 2020). In this study, we reexamined checklist of Korea, based on external characters of the genus *Endotricha*.

Key words: Pyraloidea, Pyralinae, Endotrichini, taxonomy, checklist.

P186

Recent status of the tribe Nomophilini (Spilomelinae, Crambidae) in Korea

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The tribe Nomophilini was established by Kuznetsov & Stekolnikov (1979). Mally *et al.* (2019) placed two sister clades in Nomophilini, based on 10 genera. Among them, seven species of four genera have been recorded in Korea. In this study, we report the current status of the tribe Nomophilini fauna of Korea, with a newly recorded genus *Syngamia* Guenée, 1854 for one species *Syngamia falsidicalis* (Walker, 1859) from Korea.

Key words: checklist, Lepidoptera, *Syngamia*, newly recorded, illustration

P187

The first complete mitochondrial genome in the family Attevidae (*Atteva aurea*) of the order Lepidoptera

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The superfamily Yponomeutoidea, one of the early-derived groups in the order Lepidoptera, consists of 11 families. In this study, we present the complete mitogenome of *Atteva aurea* (Fitch, 1856), the first species in the family Attevidae to be sequenced. Within Yponomeutoidea, the mitogenome of *A. aurea* has a unique trnI-trnM-trnQ and trnA-ND3 arrangement. Phylogenetic analyses (ML) based on the concatenated sequences of 13 PCGs and two rRNA genes, revealed a sister relationship between Attevidae and Praydidae with high nodal support (bootstrap support = 80%).

Key words: mitochondrial genome, Yponomeutoidea, arrangement, Phylogenetic analyses

P188

First report of complete mitochondrial genome analysis of blueberry pest, *Dasineura oxycoccana*

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2000년대 중반 우리나라에서 재배가 시작된 블루베리는 이후 수요의 급증으로 현재 초기 재배면적의 4배 이상에 달하고 있으며 이로 인해 다양한 해충이 발생하는 것으로 확인되었다. 그 중, 외래해충인 블루베리혹파리는 국내 유입시기와 경로는 불분명하지만, 2010년 국내 블루베리 재배지에서 첫 피해가 보고된 이후 전국적인 분포가 확인되고 있다. 이에 본 연구에서는 추후 지역변이 및 국가별 종 확인 등을 위한 기초정보를 확보하고자 완전 미토콘드리아 유전체 정보를 분석하였다. 블루베리혹파리의 전체 미토콘드리아 유전체는 13개의 PCGs(Protein coding gene), 2개의 rRNA(ribosomal RNA), 22개의 tRNA(transfer RNA), 1개의 A+T-rich region으로 구성되어 있으며 현재 보다 특징적인 구조에 대한 분석이 진행 중이다.

검색어: 외래해충, 블루베리혹파리, 블루베리, 미토콘드리아 유전체

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P189

Comparative analysis of two pear pests, *Cacopsylla jukyungi* and *Cacopsylla burckhardti* (Hemiptera: Psyllidae), based on complete mitochondrial genomes and comparison to confamilial species

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Mitochondrial genome(mitogenome) sequences have been used for a diverse field of biology. The two complete mitogenomes of *Cacopsylla jukyungi* (15,438 bp) and *Cacopsylla burckhardti* (14,799 bp) (Hemiptera: Psyllidae) were compared to confamilial species to accumulate genetic information and understand evolutionary characteristics of the family Psyllidae. The complete mitogenomes of *C. jukyungi* and *C. burckhardti* had many features typical of insect mitogenomes; however, at 1,283 bp, the *C. jukyungi* mitogenome had an unusually long A+T-rich region, which was composed of two identical 540-bp repeat sequences. Though the A+T-rich region in available Psyllidae mitogenomes varied substantially in length (662–1,430 bp) and sequence divergence. Our data evidence that the family Psyllidae including current *C. jukyungi* and *C. burckhardti* have evolutionary unique features that were previously undetected, along with the unique A+T-rich region structure in the *C. jukyungi*.

Key words: Mitochondrial genome, *Cacopsylla burckhardti*, *Cacopsylla jukyungi*, Pear

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P190

Drone pupa (*Apis mellifera*) extract inhibits cell proliferation and induced cell death in HepG2 liver cancer cells

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In 2021, the drone pupa was approved as a new food ingredient based on the record of used for medicinal purpose and scientific data that is nutritionally excellent. According to a recent studies of edible insects, they are paying attention to their potential as nutraceuticals as well as food. To investigate the possibility of antiproliferative effect for malignancy, we observed the viability of HepG2 cells by treating the extract. When the extract was treated in HepG2 cells at 10mg/ml and 5mg/ml for 24 hours, the cell viability were 49.33 and 66.98%, respectively. Detection nucleosomes in cytoplasmic fractions showed that drone pupa extract induced apoptosis in HepG2. Western blotting was used to evaluate apoptosis-related protein expression such as Bcl-2, Bcl-xL, Bax, caspase 3. The result of our study showed that drone pupa extract might provide antiproliferative effect against liver cancer.

Key words: antiproliferative effect, drone pupa(*Apis mellifera* L.).

P191

Molecular and kinetic properties of three acetylcholinesterases in *Varroa destructor*

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Although coumaphos, an anticholinesterase pesticide, is widely used for *Varroa* mite, *Varroa destructor*, control, little information is available on the properties of *Varroa* mite acetylcholinesterases (VdAChEs). In this study, three putative VdAChEs were annotated. All VdAChEs possessed most of the functionally important domains, suggesting that they are catalytically active. In phylogenetic analysis, dAChE1 was clustered into a clade containing most arthropod AChE1s, whereas VdAChE2 and VdAChE3 formed a unique clade with other arachnid AChEs. VdAChE1 was determined to be membrane-anchored, but both VdAChE2 and VdAChE3 be soluble. Tissue-specific transcription profiling revealed that VdAChE1 was most predominantly expressed in the synganglion. In contrast, VdAChE2 was predominantly expressed in the legs and cuticle. VdAChE3 showed negligible expression levels in all the tissues examined. VdAChE1 exhibited the highest catalytic efficiency followed by VdAChE2 and VdAChE3. Inhibition experiments revealed that VdAChE1 was most sensitive to all tested inhibitors. Taken together, VdAChE1 appeared to be the major synaptic enzyme, whereas VdAChE2 be involved in other non-catalytic functions including chemical defense against xenobiotics.

Key words: *Varroa destructor*, honey bee, acetylcholinesterase, organophosphate, carbamate, selective toxicity

P192

Tyrosine hydroxylase and DOPA decarboxylase are required for adult cuticle morphology and pigmentation of *Monochamus alternatus*

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In insects, tanning is a complex and vital physiological process in cuticle coloration (pigmentation) and hardening (sclerotization). With tyrosine as the initial substrate, the early steps in the tanning pathway are the hydroxylation of tyrosine to produced 3,4-dihydroxyphenylalanine (DOPA) by tyrosine hydroxylase (TH), followed by the decarboxylation of DOPA to dopamine by DOPA decarboxylase (DDC). In this study, we report the physiological functions of MaTH and MaDDC from the Japanese pine sawyer beetle, *Monochamus alternatus*, which is a major vector of the pinewood nematode, *Bursaphelenchus xylophilus* that causes Pine wilt disease. We identify, clone and characterize the *MaTH* and *MaDDC* cDNAs. Loss of function(s) of *MaTH* and *MaDDC* by RNA interference (RNAi) causes abnormally pale/white and light yellow-brown cuticle of *M. alternatus* adults, respectively. These results indicate that both MaTH and MaDDC play critical roles in normal cuticle coloration of *M. alternatus* adult.

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Effect of organic waste resource moisture content on larval development of the Black Soldier Fly (*Hermetia illucens*(L.))

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아메리카동애등에 유충은 음식물폐기물 등 유기성폐자원을 효과적으로 분해할 수 생물로 친환경적 처리방법으로 주목을 받고 있다. 그러나 동애등에를 사육하기 위한 먹이원인 단미사료는 구성 성분과 성상이 다양하며 먹이원의 표준화가 이루어지지 않아 대량사육 시 성장률 차이가 나타나는 문제점이 있었다. 이에 본 연구에서는 동애등에 사육을 위한 주요 먹이원인 습식사료와 건식사료의 적정 수분함량을 밝히고자 하였다. 습식사료과 건식사료 500g당 수분함량을 각각 30%, 50%, 70%, 90%로 조성 후 부화한 지 5일 된 동애등에 유충 3,500마리를 투입 후 7일간 발육상태를 조사하였다. 조사 결과 습식사료의 경우 90%는 6.2배, 70%는 9.5배로 먹이활동을 왕성히 한 반면 50%는 -0.4배, 30%는 -0.5배로 발육이 저하되었다. 건식사료의 경우는 90%는 1.8배, 70%는 2.1배, 50%는 0.5배, 30%는 0.07배였다.

검색어: 아메리카동애등에, 유기성폐자원, 먹이원, 수분함량

P194

Antimicrobial activity of apidermin 2 from the honeybee *Apis mellifera*

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Apidermins (APDs) are known as structural cuticular proteins in insects, but their additional roles are poorly understood. In this study, we characterized the honeybee, *Apis mellifera*, APD 2 (AmAPD 2), which displays activity suggesting antimicrobial properties. In *A. mellifera* worker bees, the *AmAPD 2* gene is transcribed in the epidermis, hypopharyngeal glands, and fat body, and induced upon microbial ingestion. Particularly in the epidermis of *A. mellifera* worker bees, the *AmAPD 2* gene showed high expression and responded strongly to microbial challenge. Using a recombinant AmAPD 2 peptide, which was produced in baculovirus-infected insect cells, we showed that AmAPD 2 is heat-stable and binds to live bacteria and fungi as well as carbohydrates of microbial cell wall molecules. This binding action ultimately induced structural damage to microbial cell walls, which resulted in microbicidal activity. These findings demonstrate the antimicrobial role of AmAPD 2 in honeybees.

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P195

Characterization of Single Crossed Honey bee (*Apis mellifera*, AC Lines) in Gyeong-buk Province

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우수한 꿀벌 신품종 육성을 위해 국립농업과학원에서 호주이탈리안계통(A)과 황색계통(C)으로 교배조합된 AC계통을 분양받아, 농가에서 사육하고 있는 일반꿀벌을 대조구로 '21년 4월~10월까지 수밀력, 봉군발육, 질병저항성(청소력), 온순성, 프로폴리스 생산량, 플라보노이드 함량을 평가하였다. 일반벌과 AC계통 벌통은 경상북도 예천지역의 양봉사에 고정하여 관행사육하며 조사하였다. 수밀력은 일반벌 16.7mg/마리, AC계통 18.3mg/마리로 AC가 더 무거웠으며, 유밀기 일벌 수는 일반벌은 농가일반벌 약 7,766마리/통, AC계통 약 6,569마리/통으로 조사되어 일반벌과 AC계통의 봉군발육상 유의한 차이는 없었고, 청소능력과 온순성은 AC계통이 우수하였다. 프로폴리스 생산량은 AC계통 64g, 일반벌 38.3g으로 AC계통이 59.8% 증수되었고, 플라보노이드 함량은 AC계통이 5.47 μ g/g, 일반벌 3.86 μ g/g으로 AC계통이 70.6% 높았다. 결론적으로 프로폴리스 생산량 및 프로폴리스의 기능성 물질인 플라보노이드 함량은 우수하여 프로폴리스 다수확 특성을 지닌 것으로 판단된다.

검색어: 프로폴리스 생산성, 플라보노이드 함량, 수밀력, 봉군발육, 질병저항성, 온순성

P196

Epidemiological monitoring of chigger mite vectors for tsutsugamushi disease in the northwestern region of south Korea, 2018-2020

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Scrub typhus, known as tsutsugamushi disease, is a vector-borne disease transmitted by chigger mites. The chigger mites were collected from wild rodents in the Paju area and then assayed by nested PCR for detection of *O. tsutsugamushi*. The captured rodents were 57 *Apodemus agrarius* and 17 *Crocidura* spp., and the trapping rate of the rodents was 6.17% (200 traps per day). The mean CI (Chigger mite Index) was 93.06. The CI was highest in April and the CI of the waterway was highest than in other environments. The main species was *L. palidum* (25%), and followed by *N. kwangneungensis* (23.8%). We tested 276 pools of chigger mites to detect *O. tsutsugamushi* and detected 37 positive pools. Main strain was Youngwori strain. In this study, the parasitic chigger mites were found in spring and autumn. However, The incidence of scrub typhus has been occurred in the late fall to winter. Therefore, we need further study to find factors such as seasonal changes in human behavior and the height of the grass. These results provide basic information about the occurrence of chigger mites to devise precautionary measures for tsutsugamushi disease in the Republic of Korea.

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Monitoring of visiting insects according to the planting area of *Dendranthema zawadskii* var. *lucida* on garden in the Korea National Arboretum

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화분매개곤충의 수분은 충매 식물의 생존, 인류의 식량자원 생산 등 많은 역할을 하며 식물과 화분매개곤충의 관련성 연구를 통한 화분매개곤충의 보존은 중요하다. 따라서 본 연구에서는 식물 면적에 따른 화분매개곤충의 개체수 변화를 파악하기 위하여 국립수목원 전시원에 식재된 울릉국화를 대상으로 조사하였다. 조사 방법은 2021년 9~10월에 총 4회 실시하였고, 면적은 1x1m, 2x2m, 4x4m로 하였다. 울릉국화가 70% 이상 개화했을 때 포충망을 이용하여 곤충을 채집하였다. 조사 결과 울릉국화의 식재 면적이 넓어짐에 따라 방문 곤충의 종은 증가하지 않았고 개체수는 증가하였다. 6종의 우점종 중에서 점박이꽃검정파리, 호리꽃등에, 배짚은꽃등에 3종은 울릉국화의 식재 면적이 넓어짐에 따라 개체수가 점차 증가하였다. 꽃등에는 1x1m 3개체, 2x2m 23개체, 4x4m 21개체로 2x2m와 4x4m가 비슷하지만 2x2m에서 더 많았다. 꼬마꽃등에와 애긴노린재는 1x1m와 2x2m에서 개체수가 비슷하다가 4x4m에서 증가하며 일정한 경향을 보이지 않았다. 식재 면적은 방문 곤충의 개체수에 영향을 미치는 것으로 판단되며 다양한 화분매개곤충을 유도할 수 있는 추가적인 연구가 필요하다.

검색어: 울릉국화, 식재 면적, 화분매개곤충

P198

Hibernation experiment of larvae of *Callipogon relictus* Semenov

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The Korea National Arboretum has established a habitat-customized breeding system for the conservation and breeding of *Callipogon relictus*. Under this system, we conducted hibernation experiments on the *C. relictus* larvae in order to understand the ecological characteristics as well as breeding at the appropriate temperature and humidity. The experiment was carried out only with the last instar larvae. As a result of the experiment, the survival rate, emergence rate, and malformation rate of the larvae were recorded. In addition, by measuring the head capsule width and weight of the last instar larvae, the correlation between the body length and weight of the adult was also confirmed.

Key words: *Callipogon relictus*, conservation, ecology, hibernation

P199

Confirmation and comparison of flight and dispersal ability of the *Callipogon relictus* Semenov using flight mill and radio telemetry

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Callipogon relictus is an insect that has many difficulties in restoration and conservation as the exact ecology is not known until now. The Korea National Arboretum conducted flight mill experiment and radio telemetry tracking experiment to understand ecological characteristics such as the ability to flight and dispersal of *C. relictus* inhabiting in Gwangneung forest. The experiments were compared the results of flight mill experiment in laboratory and a tracking experiment using a radio tag in Gwangneung forest. Also, as a result of the experiments, it were confirmed whether there were differences in flight and dispersal abilities according to biological characters such as the sex, body length, elytra length, elytra width, weight and etc.

Key words: *Callipogon relictus*, flight mill, radio telemetry, ecological study, dispersal capacity

P200

Corn leaf feeding amount by the development stages of *Spodoptera frugiperda* according to temperature

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Spodoptera frugiperda Smith (Lepidoptera: Noctuidae) is a lepidopteran pest that infests more than 80 crops, including corn, rice, sorghum, sugarcane, cotton, and other vegetable crops. The larvae of *S. frugiperda*, in particular, have caused severe damage to monoculture crops such as corn, sorghum, cotton, and soybean. The highest amount of feeding (6.6 g) was observed at 16°C at 6.6 g and the lowest (0.9 g) was observed at 36°C. According to the feeding amounts, the damage seems to be most severe at 16°C, which is natural because the growth period is the longest at 16°C as the growth is reduced owing to low temperature. The daily corn leaf feeding amount of *S. frugiperda* was compared to determine the temperature at which feeding is most active.

Key words: *Spodoptera frugiperda*, corn feeding amount, damage

P201

Occurrence patterns of major moth by region in soybeans (2022)

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파밤나방과, 담배거세미나방은 기주범위가 넓은 잡식성 나방류 해충으로, 콩의 주요 해충이다. 비래 해충으로 알려져 있지만 시설재배가 늘어나면서 국내에서 월동 가능성 높은 해충이기도 하다. 콩에는 연 2~3회 발생하며 지역별로 발생양상에 차이를 보인다. 콩은 주요 식량작물로 기후를 고려해 중부, 영남, 호남지역에서 품종 육성이 이루어지고 있다. 이에 각각의 지역에서 두 나방의 발생양상을 조사하였다.

파밤나방의 경우 중부(수원), 영남(밀양), 호남(부안) 지역에서 4월부터 성충이 발생해 밀도가 서서히 증가하다가 7월중순 1차 최대성기를 나타냈다. 담배거세미나방의 경우 5월부터 성충이 발생하기 시작해 6월하순에서 7월상순 1차 최대성기를 보였다. 파밤나방과 비교했을 때 약 10일 정도 빨랐다. 콩은 이 시기 생육 초·중기로 섭식에 의한 엽 피해가 클 경우 생육이 지연되고, 수량에 영향을 준다. 따라서 7월상순에서 중순에는 유충의 발생 정도를 주의깊게 관찰해 적기에 방제토록 해야 한다.

검색어: 파밤나방, 담배거세미나방, 발생양상

P202

Occurrence of thrips and chemical control on red pepper in Yeongyang, Gyeongbuk Province

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경북 영양지역 노지고추 재배지에서 2019년부터 2021년까지 총채벌레의 발생양상을 조사하고 피해를 줄이기 위한 방제시기를 설정하기 위해 수행하였다. 발생조사는 영양지역 임의 10개 포장을 선정하여 5월부터 9월까지 실시하였다. 총채벌레의 발생소장은 6월 하순~7월 상순, 7월 하순~8월 상순, 8월 하순에 걸쳐 총 3회의 발생최성기를 보였고, 대만총채벌레가 93.1%로 우점하였다. 총채벌레에 의한 피해과율은 연도에 따라 6.7~9.8%로 나타났다. 또한, 총채벌레 발생소장 조사결과를 토대로 약제방제 시험을 수행한 결과, 6월 중순 1회, 7월 상순부터 10일 간격 3회 약제살포가 효과적인 것으로 나타났다.

검색어: 고추, 총채벌레, 발생양상, 방제

P203

Preliminary study of parasitic rate of *Anastatus orientalis* (Hymenoptera: Eupelmidae) on eggmass of spotted lanternfly for spring-to-summer collection

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To find out how *Lycorma delicatula* (spotted lanternfly; SLF) population is parasitized by *A. orientalis* as a bio-control agency, we investigated the parasitic rate of *A. orientalis* on SLF eggmass. In addition, the emergence patterns of *A. orientalis* were determined to investigate the eggmass in spring-to-summer collection. SLF eggmasses were collected in Buyeo per a month from March to June. In laboratory, each collected eggmass was placed in a cage and recorded emergence of both parasitoid and SLF nymph per a week. *A. orientalis* emerged mid-April to late-May. In SLF, there were few emergences from mid-April to early-May, when *A. orientalis* emerged most, and more emergences in mid-May. However, from May, we found many eggs were already hatched or emerged, and there was no emergence in the lab in June. In July and August, newly laid eggmasses were neither found or collected.

Key words: biological control, egg parasitoid, life-table, natural enemy

P204

Surveillance 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 미국선녀벌레, 썩덩나무노린재, 담배거세미나방 등 3종을 경남 18시·군에서 조사하였다. 미국선녀벌레는 약충기(6월), 성충기(9월) 조사를 진행하였고, 길이가 50cm 이상되는 가지의 밀동에서 위쪽으로 50cm 내 개체를 육안조사하였다. 썩덩나무노린재는 콩 개화기(7월), 등숙기(9월) 조사를 진행하였고 지점당 집합페로몬 트랩 1개를 설치하고 1주 후 채집된 마리 수를 조사하였다. 담배거세미나방은 성페로몬 트랩 1개를 설치한 뒤 1주 후 채집된 마리 수를 조사하였다. 미국선녀벌레는 산청 고성, 함안, 의령 등에서 발생이 많았고, 전년대비 발생이 소폭 증가하였다. 썩덩나무노린재는 남해에서 가장 발생이 많았고, 함천, 거제, 밀양, 창녕, 의령 순으로 발생하였다. 담배거세미나방은 전시군에서 발생이 확인되었으며, 특히 의령, 거제, 밀양, 진주 등에서 밀도가 높았다.

검색어: 경남지역, 돌발해충, 남방계 해충, 발생조사

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

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Rubus crataegifolius is a shrub species and primarily distributed throughout Asia and Europe. As cultivation area of *Rubus crataegifolius* increases, the damage caused by insect pest is also increasing. But, 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 investigated. In particular, *Aceria kuko* occurred throughout the growing season. Damaged leaves are reduced in growth and the amount of photosynthesis is greatly reduced. *Frankliniella occidentalis* mainly lives 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*, *Aceria kuko*, *Frankliniella occidentalis*, *Drosophila suzukii*

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Occurrences of insect pests in *Mangifera indica* in Gyeongnam Province

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최근 기후변화에 따라 아열대 작물 재배가 증가하면서 경남지역 망고 재배면적도 크게 증가하고 있다. 하지만 망고에 발생하는 병해충 발생 정보가 부족해 방제에 어려움을 겪고 있으며, 병해충 방제를 위한 기초자료를 제공하고자 본 연구를 수행하였다.

2022년 1월부터 9월 상순까지 통영, 김해, 밀양, 함안 등에서 망고에 발생하는 병해충 발생조사를 수행하였다. 경남지역 망고재배지에서 발생하는 병해는 잣빛곰팡이병, 탄저병, 가지마름병, 그을음병, 줄기마름병 등 5종이 확인되었고, 해충은 목화진딧물, 꽃노랑총채벌레, 담배가루이, 점박이응애, 담배거세미나방, 깍지벌레류 6종이 확인되었다. 특히 꽃노랑총채벌레의 경우 가온을 하는 망고 포장 특성상 연중 발생하여 농가에 피해를 주고 있고, 꽃노랑총채벌레가 흡즙한 과실은 과피 변형이 일어나 상품성이 저하되었다.

Key words: *Mangifera indica*, *Frankliniella occidentalis*, *Aphis gossypii*

P207

Current Status of Candidate list of Alert Alien Insect Species in South Korea

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「생물다양성 보전 및 이용에 관한 법률」에 따라 환경부는 국내에 유입될 경우 생태계에 위해를 미칠 우려가 있는 외래생물을 유입주의 생물(398종)로 지정·고시하여 관리하고 있다. 하지만 식물방역법상 살아있는 병해충은 수입이 금지되어 있어 곤충류는 유입주의 생물에서 제외되었다. 그러나 침입외래종에 대한 사전 관리 강화 및 법정관리종 지정 확대를 위해 2014년부터 2022년까지 곤충류에 대한 유입주의 생물 후보를 목록화하여 총 655종을 발굴하였다. 바구미과(Curculionidae)가 90종(14%)으로 가장 높은 비율을 차지하였고, 그 다음으로 과실파리과(Tephritidae) 63종(10%), 하늘소과(Cerambycidae) 50종(8%), 잎벌레과(Chrysomelidae) 37종(5%), 잎말이나방과(Tortricidae) 31종(4%) 등의 순이었다. 이 결과로 발굴된 곤충류에 대해 전문가 검토를 거쳐 유입주의 생물로 지정·고시하고 국내 유입을 사전에 차단하여 생물다양성 보전에 기여할 것으로 기대된다.

검색어: 유입주의 생물, 외래생물, 생태계위해성평가, 법정관리종

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Effects of antiparasitic drugs(Ivermectin) via food chain on dung beetle *Onthophagus lenzii*

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가축에 투여하는 구충제는 가축 배설물을 먹이로 하는 곤충에게 노출 될 수 있으며, 이러한 약물의 사용은 그들의 개체군에 부정적인 영향을 미칠 수 있다. 본 연구는 국내에서 사용되는 대표적 동물용 구충제인 Ivermectin 을 이용하여 렌지소똥똥똥이(*Onthophagus lenzii*)를 대상으로 가축 배설물에 잔류하는 구충제의 잠재적 위해성을 조사하였다. 분변을 통해 노출되는 Ivermectin은 투약 후 1일차에 가장 높은 농도를 보였고 16일 차 이후 더 이상 검출되지 않았다. 또한 Ivermectin이 포함된 분변과 그렇지 않은 분변을 섭취한 렌지소똥똥똥이의 생활사적 특성을 비교한 결과, 생존에 유의미한 차이가 있는 것을 확인 할 수 있었다. 이를 통해 분식성 곤충에 대한 위해성을 최소화 할 수 있는 구충제의 적정 투약시기를 제시할 수 있을 것으로 기대한다.

검색어: Ivermectin, 구충제, 렌지소똥똥똥이, 분식성 곤충, 생태 위해성

P209

Occurrence Pattern of Insect Pest in Citrus Orchards in Jeju, Korea

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기후변화에 따라 변화하는 해충 발생 양상을 평가하기 위해 2020년부터 2021년까지 도내 감귤원을 대상으로 발생 해충 종류 및 피해를 조사하였다. 감귤에 발생하는 해충으로 총 7목 30과 55종이 조사되었으며, 본 조사에서 산둥날개매미충, 식나무가루이 발생이 새롭게 확인되었다. 일반재배 감귤원에서 주요 피해 해충은 굴응애, 조팝나무진딧물, 굴굴나방이었으며, 과거에 비해 호랑나비의 발생과 피해가 증가하였다. 유기재배 감귤원에서는 진딧물류, 각지벌레류, 굴굴나방 등에 의한 피해가 심했으며, 일부 과수원에서는 알락하늘소 피해가 심한 경우도 있었다.

검색어: 감귤, 해충종류, 주요해충, 피해

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Occurrence of *Ricania shantungensis* (Hemiptera: Ricaniidae), a New Insect Pest in Citrus Orchards in Jeju, Korea

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제주지역 감귤원에서 산동날개매미충(*Ricania shantungensis*)의 피해가 새롭게 확인되어 2019~2020년에 걸쳐 그 발생생태 및 분포상황을 조사하였다. 제주지역에서 산동날개매미충은 3월까지 휴면 알 형태로 월동하며, 월동세대는 4월~9월, 1세대는 8월~12월까지 연 2회 발생하고 있었다. 감귤에서는 신초를 흡즙하거나 8월부터 10월까지 봄과 여름에 발생한 가지에 산란하여 피해를 주었다. 제주지역에서 산란 및 흡즙 기주식물은 아왜나무 등 16종이 확인되었다. 산동날개매미충의 도내 분포지역을 황색끈끈이트랩을 이용하여 조사한 결과 제주시 한림읍과 한경면 지역에 분포하고 있었다.

검색어: 산동날개매미충, 감귤, 해충, 분포

P211

Host-biased aggregation of *Ramulus mikado* on *Robinia pseudoacacia*, but why?

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Since 2020, *Ramulus mikado* (Insecta: Phasmatodea) was one of tremendous defoliators in central Korea, but knowledges in relationship between *R. mikado* and environmental conditions were lacking. From April to July in 2022, we investigated number of individuals of *R. mikado* in three main host tree species, such as *Prunus serrulata* var. *pubescens*, *Quercus mongolica*, and *Robinia pseudoacacia*, in Cheonggy mountain, and we also analysed carbon:nitrogen ratio of those tree species. As a result, cumulative number of individuals of *R. mikado* was significantly higher in *R. pseudoacacia* compared to others, while C/N ratio of *R. pseudoacacia* was significantly lower than others, which indicated that *R. pseudoacacia* was nitrogen-rich species. Therefore, *R. pseudoacacia* may be an important host plant species in rapid completion of *R. mikado* development.

Key words: Stick insect; Outbreak; Population density; Host plant; C/N ratio

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Surveillance of Sporadic Insect Pests in Jeonbuk Province

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The Surveillance of sporadic insect pest in Jeonbuk province was confirmed. In June and July 2022, the incidence of *Halyomorpha halys*, *Metcalfa pruinosa*, and *Spodoptera litura* was investigated in the persimmon tree and soybean cultivation packaging in 14 counties in Jeonbuk province. The *Metcalfa pruinosa* was visually inspected, and the *Metcalfa pruinosa* and *Spodoptera litura* were counted 7 days once after the installation of the pheromone trap. The nymph of the *Metcalfa pruinosa* occurred in 7 counties. The *Halyomorpha halys* was most common in the plains such as Gunsan and Iksan. *Spodoptera litura* was most common in Gimje and Buan.

Key words: Sporadic insect pest, *Metcalfa pruinosa*, *Halyomorpha halys*, *Spodoptera litura*

P213

Insect fauna in the Honam region upland crop fields

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As part of Assessment of biological variation in agricultural land, we report the results of the survey on insect fauna in eco-friendly and conventional upland fields in Honam area. The occurrence survey of arthropod was conducted using traps and sweeping for five crops, including cabbage, red pepper, beans, ginger, and taro. We identified 23,235 individuals of 25 orders, 149 families and 362 species. We collected a total of 13,303 individuals from conventional fields and a total of 9,932 individuals from eco-friendly fields. Excluding the Collembola, we collected a 3,312 individuals from conventional fields and a total of 8,501 individuals from eco-friendly fields. In collecting from eco-friendly fields, the four representative orders are the Hemiptera(2,958 individuals), Hymenoptera(1,993), Diptera(1,591), Thysanoptera(1,092). In insects collected from conventional fields, the four representative orders are the Collembola(9,968 individuals), Hymenoptera(995), Hemiptera(889), Diptera(629).

Key words: upland crop field, eco-friendly fields, conventional fields, insect fauna

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Hemistepta lyrata use as *Harmonia axyridis* banker plant in agricultural ecosystem

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Most of the natural enemies that can be purchased to control agricultural pest aphids are parasitic wasps. If farmers fails aphid control using the purchased natural enemy parasitic wasps, they want to increase the control effect by ladybugs release. Currently, ladybugs are difficult to purchase in Korea. They go out to the field to capture them. Therefore, this experiment was conducted to provide information on plants in which ladybugs are attracted in spring. From March to June, *Hemistepta lyrata*. is one of the plants in which ladybugs were captured in agricultural land. Ladybugs were able to capture up to 18 per square meter in the native habitat of *Hemistepta lyrata*. Ladybugs are attracted by aphids *Uroleucon* spp. that occur in *Hemistepta lyrata*. Some farmers think that all aphids generated from plants in the agricultural ecosystem damage crops. They are removed when aphids are generated in *Hemistepta lyrata*. Therefore, we need research and promotion to change the perception of farmers.

Key words: ecosystem, banker plant, ladybug, aphid, *Hemistepta lyrata*

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Diversity of ground dwelling carabid beetle community by altitude of Mt. Yuhaksan, Chilgok-gun (Coleoptera: Carabidae)

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경상북도 칠곡군 석적읍과 가산면 경계에 위치한 유학산(해발 839m)의 북사면에서 해발고도 400m~800m까지 총 6지점을 설정하여 지표보행성 딱정벌레과 군집의 다양성을 조사하였다. 그 결과 전체 지점 및 조사 기간 동안 총 16종 1,123개체가 채집되었고, 붉은칠납작먼지벌레가 879개체로 가장 많았으며, 팔공우리딱정벌레 100개체, 진흥단딱정벌레 97개체, 운납작먼지벌레 22개체, 멧쟁이딱정벌레 6개체, 기타 먼지벌레류 19개체 순으로 채집되었다. 고도별 종수는 '700m'이 9종 167개체로 가장 높게 나타났고 다음으로 '자작나무갱신지' 9종 124개체, '800m' 7종 130개체, '400m' 7종 67개체, '500m' 6종 194개체, '600m' 5종 441개체, 월별 종수는 7월 10종 306개체로 가장 높게 나타났고 다음으로 6월 9종 671개체, 5월 9종 146개체로 나타났다. 전체 조사 기간 동안 모든 지점에서 우점종은 붉은칠납작먼지벌레, 아우점종은 '400m', '500m', '자작나무갱신지'에서 진흥단딱정벌레가, '600m', '700m', '800m'에서 팔공우리딱정벌레로 조사되었으며, 모든 지점에서 우점도가 다소 높으나 특히 '400m'~'600m'에서 매우 높게 나타났다. 지점별 다양도, 균등도 및 종풍부도는 우점도가 가장 높은 '600m' 지점에 가장 낮았으나, 다양도가 가장 높은 곳은 '자작나무갱신지'와 '800m', 균등도가 가장 높은 곳은 '800m', 종풍부도가 가장 높은 곳은 '자작나무갱신지'로 출현종수에 따라 각각 다르게 나타났다.

검색어: 딱정벌레과, 다양성, 군집분석

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Arthropods' discovered in Incheon port containers

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세계화로 인해 활발해진 교역, 수송 등으로 외래종의 유입과 확산이 증가하고 있는 실정이다. 선박을 통해 수출입되는 화물량의 증가로 국내 항만에서 발견되는 붉은불개미(*Solenopsis invicta*), 긴다리비틀개미(*Anoplolepis gracilipes*) 등 위해 외래곤충이 증가하고 있다. 위해 외래생물의 유입을 막고 확산 방지를 위한 선제적 대응으로 인천항으로 반입되는 수입 공컨테이너 실태조사를 실시하였다. 2020년 하반기부터 2022년 상반기까지 총 4차례 조사한 결과 거미류 24종, 곤충류 21종, 지네류 1종이 확인되었다.

검색어: Arthropods, Invasive alien species, Empty containers

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Host preference and development of *Spodoptera frugiperda* (Smith) on different crops (Lepidoptera: Noctuidae)

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The fall armyworm, *Spodoptera frugiperda*, is a polyphagous invasive migratory pest native to the tropics that has recently invaded Korea with subsequent damage to cornfield. Up to now, no crops damaged by this species have been identified in addition to corn, sorghum, sudangrass and ginger in Korea. The host preference and development characteristics of the five crops such as peanut, soybean, tomato, red pepper and watermelon have been investigated to confirm the possibility of the crops with a large cultivation area among the crops in Jeonbuk area. The host preference of *S. frugiperda* was highest on soybean, followed on peanut and low on watermelon and tomato. The larval and pupal development periods was 23.7 days/11.3 days, 23.3 days/11.3 days, 36.2 days/12.8 days, 34.0 days/12.2 days and 31.5 days/12.7 days in peanut, soybean, tomato, red pepper and watermelon, respectively, which was longer than 19.8 days/10.8 days in corn.

Key words: *Spodoptera frugiperda*, host preference, development

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Predation and life table of *Feltiella acarisuga* (Diptera: Cecidomyiidae) preying on eggs of *Tetranychus urticae* (Acari: Tetranychidae)

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Feltiella acarisuga (Vallot) is a common gall midge that feeds on many species of spider mites. Predation and all major biological and life table of *F. acarisuga* were determined using eggs of the twospotted spider mite, *Tetranychus urticae* (Koch), as prey under laboratory condition (27.9±0.5°C, 90% RH, and 14:10 [L:D] h). First-, second-, and third-instar *F. acarisuga* larvae consumed an average of 41.6, 63.6, and 91.9 *T. urticae* eggs, respectively. Larvae consumed a total of 193.7 eggs each from first to third instars, and female larvae consumed 206.1 spider mite eggs, 13.7% more than male larvae. Developmental time of *F. acarisuga* was 1.7, 5.8, and 4.3 d for eggs, larvae, and pupae, respectively, with an average of 20.4 d from oviposition to adult emergence. Female immatures developed slightly slower (1 d) than males.

Key words: Cucumber, *Orius laevigatus*, *Ocimum basilicum*, Banker plant, Biological control

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Species identification of stink bugs and ear damage in sweet corn fields, Suwon

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최근 국내 단옥수수 및 초당옥수수 재배지가 증가하여 2021년 현재 680 ha가 재배되고 있다. 2022년 7월 초 수원 지역의 옥수수포장에서 재배 중인 8 품종/계통의 옥수수 (메가골드, 고당옥 등)에서 노린재류가 발견되었다. 채집한 노린재는 알락수염노린재(*Dolycoris baccarum*), 풀색노린재(*Nezara antennata*), 시골가시허리노린재(*Cletus punctiger*), 홍색얼룩장님노린재(*Stenotus rubrovittatus*) 4종으로, 미토콘드리아 사이토크롬 c산화효소 I(COXI) 염기서열 분석을 통해 종을 확인하였다. 야외에서 채집한 풀색노린재(성충 23마리, 약충 10마리), 알락수염노린재(성충 6마리)를 실험실에서 수확기 초당옥수수 이삭 알갱이를 1일간 제공하였을 때, 알갱이 피해율은 약 65%, 27%로 이삭을 가해할 수 있는 것이 확인되었다. 같은 시기 옥수수 포장 내 초당옥수수(반딧불이초당 품종) 출사일 2일 후 이삭에 망을 씌워 알락수염노린재와 풀색노린재를 각각 마리수별(1, 5, 10마리)로 접종하고, 15일 후 살아있는 노린재와 이삭 가해 흔적을 확인하였다.

Key words: 초당옥수수, 노린재, 종동정, 이삭피해

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Patterns of insect pests occurrences on *Allium microdictyon* in Gangwon Province

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9년간(2014~2022년) 강원도 지역(평창군, 횡성군, 홍천군 등)의 산마늘 포장에서 산마늘의 꽃, 꽃대, 잎, 줄기, 뿌리를 가해하여 피해를 주는 해충류를 조사하였다. 나비목 2종(도둑나방, 파좁나방), 딱정벌레목 3종(참검정풍뎅이, 청동방아벌레, 파잎벌레), 파리목 1종(작은뿌리파리), 총채벌레목 1종, 전기문목 1종(클로버응애) 등 총 5목 8과 8종의 해충을 확인하였다. 이 가운데 경제적으로 큰 피해를 주는 종류는 참검정풍뎅이, 파잎벌레, 파좁나방, 클로버응애 등 4종이었다. 파잎벌레는 횡성지역에서 4-5월에 발생하여 잎, 꽃, 꽃대를 남김없이 모두 가해하였고, 참검정풍뎅이는 평창지역에서 4-5월에 발생하여 뿌리를 가해하여 지상부 잎을 노랗게 변하게 하였다. 파좁나방은 꽃봉오리를 가해하여 종자 결실에 큰 피해를 주었다. 클로버응애는 홍천지역에서 4-5월에 발생하여 잎을 가해하여 상품성이 크게 하락하였다. 모두 개별 사육을 통해 성충 발생을 확인 후, 종 동정하였고, 산마늘에 피해를 주는 발생시기와 가해부위 그리고 피해정도 등을 조사하여 관련 정보를 확보하였다.

검색어: 산마늘, 참검정풍뎅이, 파잎벌레, 파좁나방, 클로버응애

P221

Seasonal occurrence of endangered grasshopper *Haplotropis brunneriana* Saussure, 1888 in Korea

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똥보주름메뚜기(*Haplotropis brunneriana*)는 서식지가 줄어들고 개체군이 감소하여, 환경부 지정 멸종위기 야생생물 II급으로 법적 보호를 받고 있다. 하지만 멸종위기종인 똥보주름메뚜기에 대한 개체군 크기 변화, 분포 현황, 서식지 특성 등 연구자료는 부족한 상황이다. 따라서 본 연구는 똥보주름메뚜기의 개체군 발생 현황을 조사하여, 멸종위기종 복원에 필요한 기초자료로 활용하고자 수행하였다. 연구는 강원도 영월, 충청북도 제천, 경상북도 의성 등 3개 지역에서 선조사법(Line transect)을 이용해 각각 880m², 960m², 320m² 크기의 조사지를 3월부터 6월까지 월 3회 조사하였다. 조사 결과 야생에서 똥보주름메뚜기는 3월 초순부터 활동하기 시작했으며, 6월에는 개체가 거의 나타나지 않았다. 또한 3개 지역 모두 5, 6월보다 3, 4월에 많은 개체가 확인되었다. 확인된 총 개체수는 영월 51개체, 제천 27개체, 의성 28개체였으며, 개체군 밀도는 조사지 중 제천 지역이 면적에 비해 적은 수의 개체가 확인되어 낮게 나타났다.

검색어: 똥보주름메뚜기, 개체군 밀도, 멸종위기 야생생물, 선조사법

P222

Surveillance of sporadic insect pests in Gyeonggi Province

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기후 변화에 따라 외국에서 유입된 매미충류의 국내 토착화가 진행되고 있으며, 이로 인한 농경지 피해가 증가하고 있는 추세이나 이에 대한 실태 조사는 부족한 실정이다. 따라서 본 조사에서는 경기지역에 발생하는 돌발해충 매미충류 2종(미국선녀벌레, 갈색날개매미충)에 대해 월동기(2월), 약충기(6월), 성충기(9월) 밀도 조사를 수행하였다. 조사지역은 경기도 주요 농경지역 17개 시.군을 대상으로 하였으며 기주 식물인 감나무를 정점조사하였다. 갈색날개매미충은 약충기 화성, 성충기 평택, 미국선녀벌레는 약충기 가평, 성충기 광주지역에서 높은 밀도로 확인되었다. 특히 미국선녀벌레 조사결과 약.성충기 모두 고속도로 주위 지역이 타지역에 비해 밀도가 높아 추후 공동방제시 활용할 경우 효과를 극대화할 수 있을 것이라 기대한다.

검색어: 돌발해충, 기후변화, 분포조사, 경기지역

P223

Analysis of Relationship between Land Cover Types and Appearance of Terrestrial Insects in the Civilian Control Zone (CCZ) of South Korea

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The region north of the Civilian Control Zone (CCZ) of South Korea is about 8km long and 1,133km² in area from the Southern Limit Line (SLL) to the Civilian Control Line (CCL), accounting for 1.13% of the national territory. And it accounts for 16.1% of all species identified in Korea. The CCZ is an area where authorized civilians and restricted agricultural activities are allowed, and unauthorized civilians are restricted from access. The CCZ serves as a buffer zone for wildlife inhabiting the Demilitarized Zone (DMZ), and is a very important habitat for large mammals and endangered wildlife.

This study divided the CCZ into five survey areas from 2015 to 2020 and analyzed the relationship between land cover types and appearance of terrestrial insects.

Key words: Civilian Control Zone (CCZ), Demilitarized Zone (DMZ), land cover, terrestrial insects, South Korea

P224

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

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벚초파리는 핵과류와 베리류에 큰 피해를 주는 해충으로 알려져 있으며 아시아 원산으로 현재 북미와 유럽에도 침입하여 피해를 주고 있다. 과거 우리나라에서는 농작물에 대한 이 해충의 피해와 경제적 중요성이 미미하였으나, 최근 체리와 블루베리의 재배가 확산되면서 일부 지역에서 큰 피해가 발생하고 있다. 2020~2022년에 걸쳐 국내 체리 과수원을 대상으로 벚초파리 발생분포를 조사한 결과, 이천, 예산, 완주, 곡성, 순천, 김천, 창녕, 하동, 경주에서 벚초파리 발생을 확인하였다. 벚초파리가 발생하는 6월 상순경과 중순경에 순천의 체리과원에서 아바멕틴 유제 약제를 살포하여 방제 효과를 조사하였다. 피해과율 조사시 1회 살포는 49%, 2회 살포 12.8%로 무처리 피해과율 93% 대비 효과가 좋았으며, 체리가 익어갈 때 주로 날아와서 피해를 주므로 농약의 안전사용일수를 확인하여 수확기 근처까지 살포할 수 있는 약제로 2회 살포하여 초파리를 방제하는 것이 효과적이다.

검색어: 벚초파리, 체리, 분포, 살충제, 방제

P225

Density and age of *Spodoptera frugiperda* larvae influences on *Meteorus pulchricornis* parasitism

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The solitary larval endoparasitoid, *Meteorus pulchricornis* showed 63.1% parasitism on average against *Spodoptera frugiperda* larvae in laboratory. However, parasitism of *M. pulchricornis* varied with different densities and developmental instars of host larvae. This parasitoid preferred to oviposit younger instar larvae than old ones. Among different host larva instars, on 3rd instar larvae of *S. frugiperda*, this parasitoid showed high parasitism with statistically significant difference. The number of parasitized larvae by *M. pulchricornis* increased proportionately with the host density.

Key words: larval parasitoid, parasitism, Braconidae, Noctuidae

P226

Spatial and temporal dispersion of Whitefly-Predators under different micro-climates in Paprika greenhouse

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Whiteflies and their predatory mite, *Amblyseius swirskii* densities were investigated in 660m² Paprika greenhouse from early March after planting in late February to late August. As a result of analyzing the environmental condition with the HOBO data logger installed at each point within the greenhouse, the maximum temperature at the initial occurrence point was 35.6°C, 1.3°C lower than other points. Whiteflies began to occur in part at the end of March, but the pests were not captured at the point above 37°C maximum temperature. As soon as the average relative humidity exceeded 60%, the number of whiteflies captured on yellow sticky traps began to dramatically increase. Relative humidity positively influences the densities of whiteflies and predatory mites. Maximum and average temperatures showed a significant negative effect on the density of predatory mites, *A. swirskii*.

Key words: Whitefly-predator dispersion, *Bemisia tabaci*, *Amblyseius swirskii*, Micro-climate

P227

Temperature-dependent development of *Mythinna loreyi*

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딴흰가는줄무늬밤나방은 국내에서 월동하지 못하는 비래해충으로 알려져 있으며, 최근 그 발생량이 증가하고 있는 해충이다. 이번 연구에서는 이러한 딴흰가는줄무늬밤나방의 온도 의존적인 발육 모델을 개발하고자 하였다. 온도 모델은 15°C부터 35°C까지 5°C 간격으로 5개 항온 온도 조건에서 발육 속도를 이용하여 개발하였다. 딴흰가는줄무늬밤나방의 발육 속도는 선형 모델과 비선형 모델 모두에 잘 예측되었다. 1령, 2령, 3령, 4령, 5령, 6령, 전체 유충기간, 번데기의 발육 영점 온도는 각각 10.8, 10.2, 10.5, 11.0, 11.5, 9.7, 10.3, 11.7°C로 추정되었으며, 발육에 필요한 온일도는 각각 42.2, 41.5, 38.5, 38.9, 52.1, 137.0, 344.8, 166.7 온일도로 추정되었다. 각 발육단계별 발육최적온도는 각각 32.6, 33.7, 31.9, 30.4, 30.4, 29.4, 29.6, 30.0°C로 추정되었으며, 발육상한 온도는 각각 38.8, 38.1, 38.1, 36.1, 35.7, 35.0, 35.0, 35.0°C로 추정되었다. 이번 연구 결과는 딴흰가는줄무늬밤나방의 기본적인 생태 정보를 제공에 거치지 않고, 외국에서 월동을 마치고 비래한 개체군의 다음 세대 발생 시기를 예측하는데 활용되어 질 수 있을 것으로 기대된다.

검색어: 딴흰가는줄무늬밤나방, 발육모델, 발육영점온도, 발육최적온도, 발육상한온도

P228

Prediction of domestic habitability of *Procambarus clarkii* by ensemble species distribution modeling

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Procambarus clarkii is an ecosystem-disrupting organism that has recently introduced into South Korea. Because distribution of an alien organism is affected by climatic and environmental variables of the habitat, we attempted to evaluate the potential distribution of *P. clarkii* according to climate change by using two different algorithms; CLIMEX and random forest (RF). In the RF model, AUC and TSS were 0.825 and 0.695, respectively, and bio6, elevation, and bio1 had great importance in variable importance evaluation. The occurrence possibility was relatively low in Gangwon-do, Sobaek Mountains, and Jeju island, and it would not significantly change by climate change. The result of the CLIMEX was similar to that of the RF model, showing low climatic suitability in mountainous areas. By developing the ensemble model, 29% of the country was evaluated to be high-risky, but it would decrease to 24% in 2050 with similar distribution pattern.

Key words: CLIMEX, ensemble model, random forest, red swamp crawfish

P229

Occurrence of western conifer seed bugs from Incheon National University in 2022 and illustrations of each stages

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Western conifer seed bug (*Leptoglossus occidentalis* Heidemann, 1910) is firstly recorded in 2010, Changwon-Masan region as an invasive pest insect. For the last 12 years, this species has dispersed to the almost over the country. Since 2018, western conifer seed bugs were observed and monitored by property of Incheon National University. In this study, we report the occurrence pattern from university property in this year. Additionally, we provide illustrations of egg, nymphs and adult.

Key words: *Leptoglossus occidentalis*, monitoring, nymph, morphological characters

P230

Monitoring of oviposition in rearing western conifer seed bugs

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Western conifer seed bug (*Leptoglossus occidentalis* Heidemann, 1910) is a serious invasive pest of pine trees in recent years. This species mainly feed on cones of several coniferous trees including the genus *Pinus* L. In Korea, production of pine nuts of *Pinus koraiensis* Siebold & Zucc. were recently damaged seriously by western conifer seed bugs. Despite various attempts for pest control, there still remains concern because no pesticides officially registered in Korea, neither in the country of origin. In this study, we monitored spawning behavior of reared western conifer seed bugs using the alternative food with almond and pistachio.

Key words: *Leptoglossus occidentalis*, fertility, alternative food

P231

Co-occurrence of *Matsumuraeses falcana* and *M. phaseoli* (Tortricidae) larvae in soybean fields, and polymorphism in their DNA sequences of barcoding region

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Nucleotide sequences of the barcoding region of cytochrome oxidase I gene were acquired from larvae of *Matsumuraeses* sp. collected in soybean fields, and were compared with the reference sequences of *M. falcana* and *M. phaseoli* in laboratory stocks. Both species were identified from the samples simultaneously collected in the same fields in Baengnyeong and Yeoncheon, respectively. The results showed that the two species injured soybean, same organs of leaves and pods, at the same time. *M. falcana* was identified as the dominant species between the two insects. Ten variants with different nucleic acids on one or two positions (minimum 99.5% identity each other) were found in the sequences of *M. falcana*, whereas only one sequence (95.6~96% identities with *M. falcana*) was found in the samples of *M. phaseoli*. Amino acid sequences translated from all the sequences were identical in all samples of both species.

Key words: *Matsumuraeses falcana*, *M. phaseoli*, soybean, co-occurrence, partial COXI gene sequence

P232

Density and distribution of *Ricania shantungensis* (Hemiptera: Ricaniidae) nymph in sweet persimmon orchard

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갈색날개매미충은 농경지와 농경지 주변 산지를 이동하며 경제적 과수와 조경수 등에 피해를 주어 방제가 어려운 대표적인 돌발해충이다. 갈색날개매미충은 1년생 어린 나뭇가지를 뚫고 가지 속에 알을 낳아 가지 30~50%에 상처를 입히고 양분과 수분의 이동을 불량하게 한다. 또한, 약충과 성충은 작물의 수액을 빨아먹고 분비물을 배출해 그을음병을 일으켜 식물 성장을 방해한다. 2022년 사천 단감원 내 단감나무와 주변 기주식물에서의 갈색날개매미충 밀도와 분포를 6-10일 간격으로 조사하였다. 단감나무에서 갈색날개매미충 1령기 약충의 약 77%가 잎과 감쪽지에서 관찰되었으며, 2-4령기 약충은 대부분 감쪽지에서 관찰되었고, 5령기 약충의 약 79%가 줄기와 감쪽지에서 관찰되었다. 단감원 주변 기주식물인 매실나무, 대추나무, 복사나무에서 갈색날개매미충 약충은 대부분 줄기에서 관찰되었다. 이와 같은 결과는 갈색날개매미충의 이동과 관련된 기초 생태 연구에 참고 자료로 활용될 것으로 사료된다.

검색어: 갈색날개매미충, 단감나무, 밀도, 분포, 기주식물

P233

Analysis of distribution of major rice insect pests using forecasting fields information

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농촌진흥청은 벼에 가해하는 병해충 발생 예측을 통해 병해충 방제 정보를 제공함으로써 쌀을 안정생산하고자 전국 156개 시군 농업기술센터에서 예찰포를 운영 중이다. 다양한 예찰 장비 중에서 해충 예찰을 위해서는 유아등 트랩이 주로 활용되고 있다. 유아등 조사는 매년 5월 1일부터 8월 31일까지 4개월간 매일 실시하여 조사 결과를 국가농작물병해충관리시스템(NCPMS)에 등록하므로써 전국 발생상황을 실시간으로 확인할 수 있어 대책 수립에 활용되고 있다. 본 연구에서는 2000년부터 2020년까지의 벼 기본예찰일보를 바탕으로 유아등 조사 대상 해충인 흑명나방, 애멸구, 벼멸구, 흰등멸구, 벼물바구미, 먹노린재, 이화명나방, 멸강나방, 끝동매미충 등 총 9종의 지역별 분포를 분석하였다. 결과에 따르면, 비래해충 중 벼멸구는 남부 지방에 집중적으로 발생하는 반면, 흑명나방, 멸강나방, 애멸구, 흰등멸구는 전국적으로 발생하는 것으로 나타났다. 한편 같은 종이라도 지역 별로 발생 양상이 다른 것으로 나타났다. 이 결과를 활용하면 벼 해충 예찰업무에 도움이 될 것으로 기대된다.

검색어: 벼, 해충, 예찰포, 유아등, 국가농작물병해충관리시스템

P234

An easy to distinguish between male and female silkworm, Yanghyeonjam

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농가소득 향상을 위해 기능성 양잠산물 생산용 누에품종의 육종 목표도 변화되고 있으며, 용도에 따라 혈당강 하제용 누에분말, 누에 동충하초, 수번데기 생산용 등 다양한 누에품종이 육성되고 있다. 이러한 육종목표에 의해서 양친한성 품종인 양현잠을 육성하게 되었다.

양현잠은 2018년 춘잠기에 교배조합 능력검정을 통해 우수 교배조합으로 선발되어 2020년에서 2021년까지 춘·추잠기에 국립농업과학원과 전국 7개도 잠업 관련 기관과 공동으로 누에사육시험, 사질조사 및 동충하초 생산력 검정을 수행하였다. 국립농업과학원에서 원종의 특성조사, DNJ(1-Deoxynojirimycin) 함량 검정을 실시한 결과, 양현잠은 화용비율이 대조 품종보다 높은 강건성 품종으로 견사량 많고, 견충중이 무거운 다사량계 품종으로, 춘·추잠기의 품종으로서의 우수성이 인정되었다. 본 품종은 누에장려품종 지정심의회에서 교배조합 “JS227×CS240”을 양현잠으로 명명하였고, 교배조합 각각의 원종명은 잠163과 잠164로 하여 춘·추잠기 누에장려품종으로 지정하였다.

검색어: 누에, 암수감별, 한성반문, 양잠, 동충하초

P235

Biological performance of *Myzus persicae* (Sulzer) (Hemiptera: Aphididae) is differentially constrained by short-term exposure to high CO₂ concentration

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The green peach aphid, *Myzus persicae*, is one of the significant aphid pests of several crops, damaging various tissues of plants, and acting as a vector for the transport of plant viruses. We investigated the effect of short-term exposure to high CO₂ concentration (1000ppm) on development, longevity and fertility of *M. persicae*. We applied the computer programs – TWSEX-MSChart and TIMING-MSChart - to analyze the data. We obtained the life table parameters and population projections using two computer programs.

Key words: *Myzus persicae*, Carbon dioxide, Life table parameters, Short-term exposure

Acknowledgements: This research was supported by the research program of RDA (PJ01606001).

P236

Two-phase oviposition model of *Zeugodacus cucurbitae* (Coquillett) (Diptera: Tephritidae)

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The melon fruit fly *Zeugodacus cucurbitae* infests fruit and vegetables of more than 125 plant species, predominantly those from the family Cucurbitaceae. We investigated the longevity and fecundity of *Z. cucurbitae* at five different temperatures and organized female oviposition model using two-phase oviposition model, which modified the logic structure of the current model by separating pre-oviposition. The results of the two-phase oviposition model provided more realistic outputs at lower and higher temperatures than those of the current model.

Key words: *Zeugodacus cucurbitae*, Fecundity, Longevity, Survivorship, Temperature

Acknowledgements: This research was supported by an international cooperative research project (PJ01420201)

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Analysis of the population parameters and growth on *Zeugodacus cucurbitae* (Coquillett) (Diptera: Tephritidae) using the age-stage, two-sex life table

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The melon fruit fly *Zeugodacus cucurbitae* is major invasive and polyphagous insect pest with a worldwide distribution. We investigated the development time, survivorship, longevity and fecundity of *Z. cucurbitae* at five different temperatures. We applied the computer programs, TWSEX-MSChart and TIMING-MSChart, to obtain the population parameters and life table parameters. The highest intrinsic rate of increase and finite rate for *Z. cucurbitae* were observed at 32°C.

Key words: *Zeugodacus cucurbitae*, Life table parameters, Population projection, Temperature

Acknowledgements: This research was supported by an international cooperative research project (PJ01420201).

P238

Parameter Estimation for a Temperature-dependent Development Model of Chilli Thrips (*Scirtothrips dorsalis* Hood) on Satsuma Mandarin

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Scirtothrips dorsalis is an important citrus pest. A thorough understanding of the biology and population dynamics of *S. dorsalis* is essential for development of reliable pest population prediction system. We investigated the developmental periods of the species under ten constant temperature schemes (12.5°C~33°C). Furthermore, we established a development model of *S. dorsalis*, based on the result of a laboratory experiment. The immature developmental duration of *S. dorsalis* at constant temperatures shows statistically significant difference among temperature regimes. In relation to temperature, non-linear development models were established for each developmental stage of *S. dorsalis*.

Key words: *Phyllocnistis citrella*, temperature-dependent development, development model, citrus pest

*This research was conducted with the support of the National Institute of Horticultural & Herbal Science and the Agenda Project (PJ01515001), RDA.

P239

Fungal insecticidal activity of *Metarhizium anisopliae* against Asian tiger mosquito, *Aedes albopictus*

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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 virulence. 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*, entomopathogenic fungi, fungal insecticide, *Metarhizium anisopliae*

P240

A study on the Status of Agricultural Population and Usage Status of Agricultural Antibiotics in Korea

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본 연구는 국내 농업인구 변화에 따른 농용 항생제 사용량 변화를 분석하는데 목적을 두었다. 이를 위해 2000~2020년 통계청 자료를 활용하여 농업 인구와 농업인의 중위연령을 조사하였다. 최근 20년간 국내의 농업 인구는 감소하고 있으나 60세 이상 농업인은 증가함에 따라 국내 농업인의 중위연령이 높아지고 있는 추세이다. 최근 귀농의 대한 관심의 증가와 베이비붐 세대의 은퇴로 인해 귀농인수가 증가하고 있으며, 특히 2020년에는 30대 이하 귀농 가구수가 1,362가구로 역대 최대치를 기록하였다. 청년농의 증가 원인으로 영농정착지원사업 등 정책적 유인과 청년들의 인식의 변화 등이 있는 것으로 추정된다. 이처럼 새로운 귀농인들의 유입과 농업인의 고령화로 인하여 병해충에 대한 적절한 대응이 어려운 상태이다. 국내 등록된 농용항생제는 식물병 방제용 polyoxin, oxytetracycline, oxolinic acid, validamycin, streptomycin, kasugamycin과 해충 방제용 spinetoram, spinosad, abamectin, emamectin이 있으며, 농용 항생제의 전체 시장규모는 660억원으로, 연간 300톤 이상이 생산되고 약 100개 이상의 농작물에서 항생제 사용이 추천되고 있으나, 전문성 부족으로 인해 사용량 초과, 혼용, 중복사용 등 부적절한 사용의 사례가 빈번히 발생되고 있다.

검색어: 귀농, 농업인구, 농용 항생제, 농업인의 고령화

P241

Insecticidal control of nematode (*Meloidogyne* spp.) in chinese yam (*Dioscorea opposita*) cultivation area

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Chinese yam (*Dioscorea opposita*) is a regional specialty crop in Andong, Gyeongsangbuk-do, and the cultivated area is 559ha, which is a major crop accounting for 76% of in the whole country cultivated area. The nematode (*Meloidogyne* spp.) that occur on chinese yam are root-knot nematodes, which cause root knots or rot roots, which reduces the value of products and causes economic loss to farms. And occurrence of nematode by continuous cultivation is increasing every year, it is necessary to control them. In order to control of nematodes, before planting root-knot nematode-infected chinese yam soak by pesticide(fosthiazate (SL), dimethyl disulfide (SL)), NaOCL, and heat treatment and then seeded to test their effectiveness. And in order to investigate the effect of soil disinfection before planting, the effects of dimethyl disulfide (SL) and fosthiazate (SL) were treated and tested. As a result, it was possible to obtain an excellent control effect by showing more than 90% medicinal efficacy without any damage in fosthiazate (SL) + heating (51°C) treatment, and the soil disinfection effect showed 100% control effect in dimethyl disulfide (SL).

Key words: Chinese yam, nematodes, pesticide

P242

Buckwheat as a companion plant in soybean fields

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Several studies have examined the effects of companion plants to conserve indigenous populations of natural enemies in agricultural lands. In this study, to find a new companion plant for soybean, we investigated the effect of planting buckwheat on the population dynamics of arthropod pest and natural enemy species in soybean fields. The numbers of major pests and natural enemies were recorded at 9-10 days intervals from 20 soybean plants during the cropping season. The dominant pest species were *Riptortus pedestris* and *Medythia nigrobilineata* while the dominant natural enemy species were *Yemma exilis* and *Orius* sp. There was no significant difference in both pest and natural enemy populations between the fields with or without buckwheat. Potentials of buckwheat as companion plants were discussed.

Key words: Landscape structure, *Glycine max*, Conservation biological control, Arthropod, Non-crop habitat

P243

Effects of commercial insecticides on germination rate of *Beauveria bassiana* ARP14

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Beauveria bassiana ARP14, a native entomopathogenic fungus strain in Korea, is an effective microbial agent to control stink bugs and whiteflies. However, little is known about the compatibility of insecticides with *B. bassiana* ARP14. In this study, the effects of four commercial synthetic insecticides, each containing the active ingredients abamectin, spinosad, thiamethoxam, cypermethrin, and one organic insecticide containing the active ingredient azadirachtin, on the germination rate of *B. bassiana* ARP14 were tested. Our results indicate that the mean germination rate of fungus spores in the controls did not differ much from that of treatments. Therefore, those chemical insecticides could be used simultaneously with *B. bassiana* ARP14 in the management of insect pests after field evaluation in future studies.

Key words: microbial agent, biological control, entomopathogenic fungus, compatibility

P244

Control efficacies of metabolites from *Metarhizium pinghaense* 15R on several pests

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생화학농약은 자연계에서 생성된 천연 화합물을 추출하여 이용하는 등 천연자원으로부터 기원한 생물 농약을 의미한다. *Metarhizium pinghaense*은 녹강균으로 알려진 *M. anisopliae*와 분류학적으로 매우 유사한 토양미생물로 곤충병원성 곰팡이이다. *M. pinghaense*은 destruxin이라는 대사물질을 생산한다. 이는 나비목, 파리목 등 해충에 대하여 약효가 있다고 보고되어 있다. 본 시험은 목화진딧물과 복숭아혹진딧물과 무테두리진딧물, 파밤나방, 점박이응애를 채집, 실내 사육 후 *M. pinghaense* 15R 배양여액에 대한 약효를 확인하기 위한 기초자료로써 활용하고자 시험을 수행하였다. 진딧물은 성충, 파밤나방은 2-3령 유충, 점박이응애는 암컷 성충과 약충을 대상으로 하여 진행하였다. *M. pinghaense* 15R 균주를 Sabouraud broth에 기본으로 하여 shaking incubator에서 150rpm 조건으로 6-8일 간 배양 후 filter paper로 여과를 하여 시료를 제조하였다. 목화진딧물, 복숭아혹진딧물, 무테두리진딧물은 배양여액에 대하여 경엽처리 5일 후 90% 이상의 방제가를 나타냈다. 파밤나방은 배양여액 침지처리 7일 후 80%의 방제가를 보였다. 또한, 점박이응애는 경엽처리 2일 후 암컷 성충과 약충 모두 97% 이상의 방제가를 나타냈다. *M. pinghaense* 15R 배양여액을 DCM으로 액-액 분배하여 HPLC로 분석하여 destruxin 함량을 확인하였다. *M. pinghaense* 15R의 대사물질인 destruxin은 진딧물류, 파밤나방, 점박이응애에 대하여 약효를 확인할 수 있으며, 이는 다양한 해충군에 대하여 생화학농약으로서 가능성이 있다고 판단된다.

검색어: *Metarhizium pinghaense*, destruxin, 진딧물, 파밤나방, 점박이응애

P245

Virulence Assay of Entomopathogenic Fungus *Metarhizium* for the Microbial Control of *Ramulus mikado*

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대벌레(*Ramulus mikado*)는 1990년 이후 산림에서 돌발적으로 발생하여 피해가 발생하고 있다. 최근에는 서울의 은평구 봉산, 경기도 의왕의 청계산, 경기도 군포시의 수리산 등 도심과 가까운 산림지역에서 대발생하여 피해를 주고 있다. 대벌레의 방제를 위해 끈끈이트랩과 약제살포 등의 방제가 이루어지고 있으나, 산림지역내에서 효율적인 방제를 기대하기 어려운 실정이다. 대벌레의 생물적 방제를 위해 곤충 병원성 곰팡이에 대한 병원성을 검정하였다. 곤충병원성 곰팡이는 2021년 대벌레 피해가 대발생한 경기도 의왕시 청계산 지역에서 폐사한 대벌레를 채집하여, *Metarhizium quizhouense*와 *M. anisopliae* 2종의 곤충병원성 곰팡이를 분리 동정하여 병원성 검정에 활용하였다. 병원성 검정을 위해 사육한 대벌레 성충을 대상으로 각 균주를 1×10^5 conidia/ml의 농도로 먹이식물인 콩잎에 살포하고, 대벌레 충체에 붓으로 직접적으로 도포하였다. 살포 후 2균주 모두 11일차에 전부 살충되어 대벌레에 대한 병원성을 확인할 수 있었으며, 특히 *M. anisopliae*를 잎에 분무한 처리구는 5일차에서부터 초기 살충효과가 우수한 것으로 나타났다. 처리방법별 비교에서는 2균주 모두 충체도포 보다는 먹이식물에 살포가 살충효과가 조금 더 빠르게 나타났다.

검색어: 대벌레, *Metarhizium quizhouense*, *Metarhizium anisopliae*, 곤충병원성 곰팡이

P246

Investigation of pest control methods and Phytotoxicity against garlic bulbils pest

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마늘은 백합과 알리움 속에 속하는 식물로 과거부터 약용식물로 쓰여져 왔으며, 현대에는 양념채소로 재배 및 소비되고 있다. 마늘은 영양체 작물이기 때문에 바이러스의 수직감염에 굉장히 취약한 특성을 보인다. 마늘의 주아를 종구로 사용했을 때 바이러스의 감염율이 낮아지고, 수세가 회복 된다는 연구문헌에 따라 농가들은 주아 재배를 시행하고 있는 실정이다.

마늘의 주아에는 파좀나방, 파총채벌레 등의 해충이 발생된다는 보고가 있으나, 해충 생태와 방제법에 대한 대한연구가 미비한 실정이다. 본 연구에서는 마늘에 발생하는 해충의 발생생태와 주아 해충의 피해를 경감시키기 위해서 수확 후 주아 절단방법별 침지소독후 해충의 발생밀도를 관찰하였다.

관찰결과 파총채벌레, 파좀나방 등 2종의 해충이 발생하였으며, 파좀나방은 8월상순 파총채벌레는 7월중순 까지 출현하였고, 그 이후 발생은 조사되지 않았다. 3종 약제를 처리하였을 때 방제가가 90% 이상 관찰되어 밀도 감소 효과가 있었으며, 약제 침지된 주아를 파종하였을 때, 약해는 관찰되지 않았다.

검색어: 마늘, 주아, 저장, 파총채벌레, 파좀나방

P247

Development of management tools for controlling invaded insect pests by double-stranded RNAs

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Crop protection agents currently used have problems such as inducing pesticide resistance to target insects when they are repeatedly and excessively used or damaging non-target beneficial insects, animals, and plants. Recently, double-stranded (ds) RNAs have been shown to control target insect pests with great species specificities. In this study, we present and discuss the results of our recent studies using ds-RNAs for controlling invaded insect pests such as fall webworms (Grant No. J014845032022).

Key words: Fall webworms, double-stranded RNAs, management, species-specificities

P248

Scaled-up fumigation using ethyl formate for passionfruit under plantation and post-harvest conditions against *Aphis spiraeicola*

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As the plantation of subtropical crops increases in South Korea, the damage to insects pests is also increasing. In case of insect pests that damage tropical fruits, they overwinter in a vinyl house, so both the plantation and post harvest conditions must be disinfected. Passionfruit (*Passiflora edulis*) is an important ingredient for juice and wine as its rich aroma and various nutrients. In this study, the efficacy of ethyl formate (EF) as methyl bromide (MB) alternatives was evaluated against *A. spiraeicola*, a insect pests commonly detected in passionfruit. Based on efficacy data, scaled-up fumigation were conducted on passion fruit under plantation condition (Vinyl house) and post-harvest condition for domestic distribution. It was carried out 100% mortality of insect pests, and there was no phytotoxic damage.

Key words: ethyl formate, alternatives, passion fruit, cultivation condition, storage condition

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Control of *Varroa destructor* via RNA interference: lethal effects of knockdown of coatomer proteins

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RNA interference (RNAi) is an efficient approach as a potential strategy for selectively controlling pests. The *Varroa* mite, (*Varroa destructor*), is the worst threat to honey bee health worldwide. To explore the possibility of using RNAi to control this pest, we determined the effects of knocking down genes encodes a subunit of the cytoplasmic coatomer protein complex on varroa mite survival. Injection of dsRNA for COPB, COPD, and COPE caused a significant reduction in *Varroa* mite survival based on lethal time 50 (hour) after post-injection (hpi), respectively as compared to control mites injected with green fluorescent protein (GFP)-dsRNA, water, and untreated mites. Knockdown of the target genes was verified by qrt-PCR for three genes important for survival. Our finding indicate that coatomer proteins play an important role in the survival, suggesting that these genes could explored as a potential target for the development of RNAi-based control strategies in *Varroa* mite in the future.

Key words: RNA interference, *Varroa destructor*, Honey bee, Coatomer protein, Gene knockdown

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Occurrence probability of pine wilt disease predicted by three different algorithms

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Pine wilt disease (PWD) is a notorious *Pinus* disease that has caused severe economic and ecological losses in South Korea. In this study, the potential distribution of PWD in South Korea was predicted by using three different species distribution models; MaxEnt, random forest (RF) and deep feed forward network (DEF). Each model was developed based on actual occurrence records of PWD surveyed from 2016 to 2020, and operated with bioclimatic variables coded by using the monthly climate data. As a result, the occurrence possibility was evaluated and concentrated around the occurrence records that are largely distributed in the middle and southeast parts of South Korea. In addition, compared to previous model with monthly climatic data, this model with bioclimatic variables showed higher model performance.

Key words: bioclimatic variable, deep learning, machine learning, occurrence possibility, pine wilt disease

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Studis on labor saving-pesticide application method to control *Thrips palmi*

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최근 시설원에 농가에서 총채벌레류 살충제 약효 미흡이 이슈된 바 있다. 저항성이 원인인 농가 이외의 경우를 확인한 결과, 고농도 저물량으로 약제가 처리됨을 확인하였다. 일반적으로 원예작물은 ha당 2000L의 물량을 사용하나, 이슈 농가들은 ha당 약 1000L이하로 처리되고 있었다. 이를 주요 원인으로 추정하고, 물량별 차이를 검증하였다. 검증은 오이총채벌레를 대상으로 Broflanilide+Emamectin benzoate 4.5+2.15% EC 제품을 사용하였다. 면적당 동일 약량의 약제를 ha당 2000L, 1000L 처리시 각 97.4%, 72.4%의 방제가를 나타내어 물량이 적으면 활성이 떨어짐을 확인하였다.

저물량 살포의 대안으로 생력화 처리방법인 연막처리 적용 가능성을 검토하였다. 시험결과 경엽처리 97.1%, 연막처리 96.6%의 방제가를 나타내어 경엽처리 대비 비등한 수준으로 나타났다. 뿐만 아니라 담배가루이에서 각 92.1%, 89.3%, 담배거세미나방에서 두 처리군 모두 100%의 방제가를 나타내어 본 연구에 적용된 본 제품의 경우 연막처리가 저물량 살포의 대안이 될 수 있는 가능성을 확인하였다.

검색어: 오이총채벌레, 연막처리, 생력화, 살포물량

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Laboratory Testing: Differences between contact and feeding of *Spodoptera frugiperda* insecticides

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열대거세미나방은 편서풍을 타고 비래하는 해충으로 2019년 국내 최초 유입된 것으로 확인되고, 2019년 6월 제주에서 처음 발견된 이후 보통 4-6월에 제주에서 처음 발생되어, 남부지방부터 중부지방으로 확산되는 양상을 보인다. 강원도내 비래한 열대거세미나방을 조사한 결과 강원도는 남부지방에 비해 약 1달~2달 정도 느린 7월 초·중순 정선일대에서 처음 발생되어 동해·영월·홍천으로 확산되는 양상을 보이고 있다. 열대거세미나방은 발생 즉시 약제 방제가 중요하다. 현재 옥수수를 기준으로 열대거세미나방에 효과 있는 섭식·접촉 모두 효과있는 약제 5종을 선택해서 약제에 접촉만 했을 때와 섭식만 했을 때, 그리고 3령 이하 유충과 4령 이상 노령유충에 약제 방제효과의 차이점을 알아 본 결과 접촉보다는 섭식했을 때 효과가 더 좋고, 3령 이하보다 노령유충에도 충분한 효과가 있는 것을 확인 하였다. 밀도가 높으면 서로 포식하는 습성과 낮에는 잎안에 숨어있다 밤에 밖에 나와 가해하는 습성을 생각하면 작물에 골고루 약제만 살포하여도 충분히 방제효과가 있는 것을 확인 할 수 있었다.

검색어: 열대거세미나방, 강원도, 비래해충, 옥수수 해충, 약제방제

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Confirmation of plant extract activity against *Spodoptera frugiperda*

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Spodoptera frugiperda is a pest that injures more than 80 species of plants, causing great damage to economically important crops. We formed a complex make use of Met (methoprene tolerant), known as a juvenile hormone receptor, and SRC (steroid receptor coactivator), which forms a heterodimer. The plant extract activity was analyzed through screening using the met/SRC complex. In the plant extract activity assay, we tested 100 plant extracts in transformants bearing Met and SRC. We identified 7 plant extracts with high JH disruptor (JHD) activity in *Spodoptera frugiperda*, and bio-assayed using the identified substances. Based on these results, the selected substances show potential as eco-friendly agents for use in the future.

Key words: *Spodoptera frugiperda*, Juvenile hormone, Methoprene-tolerant, SRC, Plant extract

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Insecticidal efficacy of natural plant extracts against green peach aphids and two spotted spider mites

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It is necessary to develop new natural pesticides and replace existing chemical pesticides because pesticide resistance is continuously increasing due to excessive use of chemical substances. Here we studied about insecticidal efficacy of natural plant extracts against peach aphids and tow spotted spider mites. 14 kinds of plant extracts were tested for insecticidal activity. *Torilis japonica*, *rheum undulatum*, clove, shrubby sophora, *cinnamomum cassia* were good candidate for natural pesticides against aphid and mite. Especially, clove and shrubby sophora showed more than 80% insecticidal ability at 3day after treatment. We expect to be able to develop new natural plant protection agents based on these studies

Key words: natural plant extracts, bark beetle, green peach aphid, two spotted spider mite

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Natural enemy use characteristics for environment-friendly cultivation of red pepper in greenhouse

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There are cases of successful pest control using natural enemies in greenhouse red pepper cultivation, focusing on eco-friendly farmers in Jeollabuk-do. In red peppers, eco-friendly pest control should be carried out by adding fruits along with leaves. The 4 problematic pests, such as whiteflies, aphids, leaf mites, and thrips, mainly damage leaves. They can be controlled using natural enemies. However, in the case of aphids, control is difficult if initial release is delayed. *Helicoverpa* spp. causing damage to fruits are still difficult to apply to natural enemies. For *Helicoverpa* spp. control, we need installation of insect screen net, spraying organic agro-materials such as *Bacillus thuringiensis*, and moth mating disruption agents. We intend to present a field application model based on the results of analyzing the factors occurring in the field.

Key words: red pepper, greenhouse, environment-friendly cultivation, natural enemy

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Screening for effective organic farming materials for the control of *Planococcus citri*

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꿀가루깍지벌레(*Planococcus citri*)는 패션프루트(*Passiflora edulis*)의 가지 사이나 겹쳐진 잎 사이, 과실과 잎의 겹쳐진 틈 등에 집단적으로 서식하여 피해를 주며, 배설물로 그을음병이 유발되어 과실의 상품 가치를 저하시키는 해충이다. 전남지역 패션프루트 재배 농가의 병해충 발생 조사 결과 꿀가루깍지벌레가 주요 해충이었다. 꿀가루깍지벌레의 친환경 방제를 위하여 효과적인 유기농업자재를 선발하였다. 고삼추출물 90% 등 10품목의 유기농업자재를 대상으로 방제효과 실내검정을 3반복 실시하였다. 유기농업자재는 마늘추출물 80% 등 3종이 방제가 61.4% 이상 효과가 있었다.

검색어: 꿀가루깍지벌레, 패션프루트, 유기농업자재, 방제

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Susceptibility of Red pepper chemical insecticides to *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) 등을 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. 고추에 등록된 유기합성 살충제 39종에 대한 꽃노랑총채벌레의 약제 감수성을 실내 검정한 결과 deltamethrin(합성피레로이드계)+profenofos(유기인계)를 함유한 살충제가 살포 1일 후 성충, 약충 모두 다 100%, clothianidin(네오니코티노이드계)+spinetoram(스피노신계)는 성충 97%, 약충 92%, imidacloprid(네오니코티노이드계)+spinetoram(스피노신계)는 성충 98%, 약충 92%의 살충력을 보였다. 꽃노랑총채벌레의 발생 밀도가 높을 경우 이러한 속효성 약제 살포로 효율적인 방제가 가능할 것으로 판단된다.

검색어 : Wsetern flower thrips, Insecticide, deltamethrin+profenofos

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Control of *Eurytoma maslovskii* in *Prunus mume* using the mating disruption technique

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복숭아씨살이좀벌(*Eurytoma maslovskii* Nikolskaya)은 매실, 살구, 자두 등 핵과류의 종자를 가해하여 과실의 상품가치를 떨어뜨리고 줄기를 마르게 하여 큰 경제적 손실을 유발하는 해충으로 매실의 경우 성충이 4월부터 발생해 매실 열매 속에 산란을 하고 약 15일 후 부화 유충이 매실 씨방을 먹고 자란다. 이렇게 피해를 본 매실은 껍질이 썩어 마르면서 함몰되거나 수확 전에 낙과가 많아진다. 매실 주산지인 전남지역에서는 최근까지 재배면적의 30% 이상 피해를 입었으며 매실 재배농가는 복숭아씨살이좀벌 방제를 위해 8~10회 약제를 살포하나 방제 효과가 미미하다. 광양 매실 재배농가에서 복숭아씨살이좀벌의 성페로몬인 2,10-dimethyldodecyl propionate와 2,8-dimethyldecyl propionate을 조합한 교미교란 방제효과를 조사한 결과 무처리 77% 이상의 과실 피해를 보였으나 성페로몬 시험구에서는 36%의 과실 피해가 보여졌다.

검색어 : *Eurytoma maslovskii*, *Prunus mume*, mating disruption

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Susceptibility of chemical insecticides to *Tetranychus urticae* Kochi

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점박이응애는 기주범위가 넓어 고추, 파프리카, 가지, 수박, 오이, 참외, 멜론, 딸기, 토마토 등의 과채류 외에도 국화, 장미 등의 화훼류, 사과, 복숭아 등의 과수류, 콩류, 약초류 등 다양한 작물을 흡즙하여 생육, 상품성을 저하시키고 특히 겨울철 참외, 딸기, 토마토, 오이 등 고수익 시설작물에 큰 피해를 준다. 점박이응애 방제를 위한 장기간 무분별한 화학 약제 사용이 약제 저항성 발현 개체 출현과 다른 약제에 대한 교차저항성 유발로 점차 사용할 수 있는 살비제 종류가 감소하여 농가 현장에서는 이로 인한 약제 효력 저하에 대한 의구심 증대와 함께 해충 방제의 어려움을 호소하고 있다. 고추에 등록된 유기합성 살충제 39종에 대한 점박이응애의 약제 감수성을 실내 검정한 결과 deltamethrin(합성피레로이드계)+profenofos(유기인계)와 abamectin(아버멕틴계)+sulfoxaflor(설포시민계)를 함유한 살충제가 살포 1일 후 100%, acetamiprid(네오니코티노이드계)+emamectin benzoate(아버멕틴계)는 88%의 살충효과를 나타냈다. 점박이응애의 발생 밀도가 높을 경우 이러한 속효성 약제 살포로 효율적인 방제가 가능할 것으로 판단된다.

검색어 : Two spotted spider mite, Insecticide, deltamethrin+profenofos, esfenvalerate

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Insecticidal Effects of Domestic Natural Plant Extract on Major Pests in Horticultural Crops

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유기농업자재 제조 원료가 되는 주요 식물추출물은 제충국, 고삼, 데리스, 님 등으로 대부분 국외에서 수입에 의존하고 있는 실정으로 제품수급, 효용성 및 안전성 등에 빈번한 문제가 발생되고 있다. 이러한 문제점을 해결하기 위하여 제충국, 고삼, 차나무, 때죽나무 등 국내 자생식물의 에탄올추출물로 원예작물 주요해충인 담배거세미나방, 파밤나방, 점박이용애 등에 대한 살충효과를 조사하였다. 식물추출물 제조방법은 추출원료 300g에 70% 에탄올 2700ml을 넣고 60°C에서 3시간 고온추출 후 냉장보관하며 사용하였다. 담배거세미나방은 대부분의 식물추출물에서 살충력이 낮은 경향으로 50배 단독처리에서 50% 미만으로 낮았지만 천연유화제를 혼합하여 처리한 경우 진딧물, 응애류의 살충효과가 다소 향상되었다.

검색어: 자생식물, 식물추출물, 해충, 살충효과

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A comprehensive management method of rice paddies to prevent inflow and outflow of Golden Apple Snail (*Pomacea canaliculata*)

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왕우렁이(*Pomacea canaliculata*)는 우리나라 벼 친환경 재배에 있어서 제초제 대신 논 잡초 제거수단으로 가장 경제적이고 효율적인 방법으로 30여 년간 사용한 방법이다. 최근 환경부의 생태계 교란생물 지정과 관련하여 농림축산식품부에서는 논 투입 왕우렁이의 생태계 유출방지를 위하여 의무적으로 수거하도록 하였다. 따라서 본 연구에서는 논 투입 왕우렁이의 유입·유출방지를 위한 시기별 논 관리방법을 제시하고 그에 따른 수거량과 생태계 유출방지효과를 조사하였다. 왕우렁이 유출입방지를 위하여 이앙 전 논두렁을 정비하고 입수구에 구리 테이프부착망을 설치하여 물과 함께 들어오는 우렁이를 차단하였으며, 배수구에는 개량물꼬를 설치하여 유출을 차단하였다. 중간물떼기시 논 가장자리에 물길을 조성하여 왕우렁이 수거결과 45%가 수거되었으며, 수확전 논 건조시 2차로 수거하면 80% 이상 수거 가능할 것으로 판단된다.

검색어: 왕우렁이, 유입방지, 유출방지, 논 종합관리방법

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Golden Apple Snail (*Pomacea canaliculata*) Killing Effect of Several Plant Extracts

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왕우렁이(*Pomacea canaliculata*)가 국내에서 논 제초제 대응으로 사용된지 30여년이 지나면서 내한성이 발달하여 해에 따라 월동 후 생존개체에 의한 벼 어린모 피해가 발생하는 실정이다. 왕우렁이의 생태계 유출방지 및 월동 왕우렁이에 의한 벼 피해를 방지하기 위하여 친환경 방제수단이 필요하다. 현재 유기농업자재로 등록된 왕우렁이 방제제는 황산동, 차추출물제 등 6종이 있는데, 이들의 살패효과를 조사하였고 알의 부화를 억제시킬 수 있는 자재를 선발하였다. 또한, 차나무, 동백나무, 자리공, 때죽나무 열매 등 식물체 에탄올추출물의 왕우렁이 살패효과를 조사하였다. 기존 생산된 유기농업자재 중 왕우렁이 방제에 효과적인 유기농업자재는 황산동, 차추출물제, 님추출물제 등 3종이 80% 이상 방제효과가 있었고, 천연유화제 5배, 빙초산 15배처리하는 부화억제효과가 높았고, 차나무, 때죽나무, 자리공 에탄올추출물의 왕우렁이 살패효과가 높았다.

검색어: 왕우렁이, 식물추출물, 살패효과, 방제

P263

Interactive effects of application time and cross treatment of pesticides in soybean plant for the management of *Spodoptera exigua* (Hubner)

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콩 재배지에서 파밤나방이 대발생되고 있으나 동일 약제 연용함에 따라 해충의 저항성이 증가될 우려가 있다. 본 연구는 살충제의 처리시기, 횃수, 교차살포에 따른 효과를 비교하였다. 2021년 국립식량과학원 남부작물부 시험포장에서 수행하였으며 청자5호 품종을 사용하였다. 파밤나방 트랩조사 시 7월 5일, 8월 5일, 9월 15일 시기 성충이 다발생하였으며 6월 하순, 8월 상순, 9월 초순 최성기 전후로 약제를 처리하였다. 처리 횃수 및 교차살포에 따른 살충효과를 비교하기 위해 세대별 1~2회 변량 처리하였고 1차 인독사카브, 2차 에마펙틴벤조에이트, 3차 루페뉴론을 각각 살포하였다.

그 결과 살충제 교차살포 및 단일 살포에 따른 피해율 차이는 없었지만 무처리의 피해율은 10% 높았다. 7일 간격으로 2회 반복 처리하였을 때 살포횃수에 따른 피해율 차이는 없었다. 무처리의 피해율은 10%이상 차이가 났다. 살충제 처리횃수나 방법에 따른 수량은 차이가 나지 않아 약제별 처리효과 구명에 어려움이 있어 2022년 반복 실험중이며, 접종구 및 무처리구 간 비교실험 추가 진행하고 있다.

검색어: 파밤나방, 방제, 복합처리, 교차살포

P264

Host plants preference of the *Spodoptera frugiperda* larvae and the comparison of its control effect by chemical spraying method

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열대거세미나방(*Spodoptera frugiperda*)에 의한 작물 피해를 최소화하고자 벼과 식물 6종(벼, 기장, 옥수수, 수수, 피, 조)에 대한 기주 섭식량을 확인하고, 사료용 옥수수 포장에서 약제 살포방법에 따른 방제효과를 조사하였다. 3령~6령 유충을 대상으로 기주 섭식량을 3일간 확인한 결과, 옥수수에서 가장 많은 섭식량을 나타내었고 유충의 무게 증가는 옥수수 > 피 > 기장 > 수수 > 조 > 벼 순으로 나타났다. 이는 국내 열대거세미나방이 주로 옥수수에서 채집되는 결과와 상응하는 것으로 생각된다. 한편, 옥수수의 열대거세미나방에 등록된 인독사카브 액상수화제와 클로란트라닐리프롤 입상수화제를 대상으로 사료용 옥수수 출사 전 인력방제와 항공방제를 각각 7일 간격으로 2회 실시한 결과, 인력방제의 효과가 평균 67.4% 높은 것으로 나타났다. 열대거세미나방은 출사 전 신초 속이나 지제부 근처에 주로 분포하므로 항공방제 시 약제 노출 가능성이 떨어지기 때문인 것으로 생각된다. 이에 따라 노동력 부족으로 항공방제 등 인력방제 대체수단을 많이 사용하는 최근 상황에서 방제 효과를 제고할 수 있는 방안 마련이 필요한 것으로 사료된다.

검색어: 열대거세미나방, 기주섭식량, 인력방제, 항공방제, 방제가

P265

Effect of reflective film mulching for the control of *Frankliniella occidentalis* in pepper greenhouse cultivation

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총채벌레는 고추의 열매 끝부분에 부착된 꽃잎 밑에서 가해하여 검은색의 가해흔을 남기며 고추가 붉게 변해 감에 따라 피해 부위가 백색으로 변색되어 상품가치가 하락되게 된다. 또한, 직접적인 섭식 피해 이외에 토마토반점위조바이러스(TSWV)를 매개하는 간접적인 피해도 유발한다. 이러한 문제를 해결할 수 있는 새로운 대안으로 2021년 고창과 합천의 고추 하우스에서 12가지 색상 트랩을 설치하여 총채벌레 포획량을 비교한 결과, 검은색, 분홍색, 빨간색 트랩에서는 거의 포획되지 않아 상대적으로 기피 효과가 높은 것으로 조사되었다. 이러한 결과를 토대로 반사필름, 검은색, 빨간색의 멀칭필름을 재료로 이용하여 바닥에 설치한 뒤 고추를 정식하여 총채벌레의 발생 밀도를 조사하였다. 반사필름, 빨간색, 검은색 순서로 총채벌레의 발생 밀도가 낮았다. 약제 방제는 하지 않았으며 특히, 반사필름의 경우 2배 이상 밀도가 낮게 나타났다. 현재 반사필름이 고추 생육에 미치는 영향에 관한 조사가 진행중에 있으며 추후 총채벌레의 방제를 위해 효과적으로 활용될 것으로 기대한다.

검색어: 고추, 총채벌레, 반사필름, 밀도, 억제

P266

Effect of *Paeonia suffruticosa* for the control of *Frankliniella occidentalis* that occur on red pepper

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총채벌레는 우리나라에 60여 종이 알려져 있으며 다양한 시설작물에서 직접적인 섭식 피해 이외에 토마토반 점위조바이러스(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 대안으로 내성 회피를 위한 물질을 선발하였다. 실내검정으로 약용작물 67종을 추출하여 꽃노랑총채벌레 성충에 처리한 결과 목단피 추출물을 처리 후 1일차에 100%의 살충효과를 보였다. 또한, 목화진딧물은 3일차 83%, 복숭아혹진딧물 3일차 97%, 점박이응애 1일차 100%의 살충효과를 보였다. 고추 포트 검정에서 꽃노랑총채벌레 방제가는 1일차 77.6%, 2일차 40%의 효과가 나타났다. 현재 추가적으로 효과를 증대시킬 수 있는 물질을 탐색하고 있으며, 총채벌레 방제에 본 추출물을 활용한다면 효과적인 것으로 기대된다.

검색어: 고추, 총채벌레, 목단피, 방제

P267

Monitoring of major insect in Field-Cultivated Pepper

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기후변화에 따른 노지 고추에 발생하는 주요 해충의 발생 양상과 변동 분석을 위해 고추 재배기간인 2022년 5월부터 9월까지 전북 고창, 충남 청양, 충북 괴산지역 고추 포장에서 2주 간격으로 황색끈끈이트랩을 이용하여 주요 해충 발생현황을 조사하였다. 주로 총채벌레, 담배나방, 진딧물이 발생하였으며 담배나방은 주로 7월 하순, 8월 상순~중순, 9월 상순에 밀도가 높았다. 총채벌레는 6월 상순부터 증가하기 시작하여 7월 중순에 밀도가 가장 높았다. 시기별로 총채벌레를 채집하여 동정한 결과 꽃노랑총채벌레, 대만총채벌레, 파총채벌레의 발생이 확인되었고, 이들 3종 중 대만총채벌레가 시기별로 가장 발생 밀도가 높았다. 방제를 위해 노지 고추에서 총채벌레는 6월 상순 이전부터 모니터링하고, 담배나방은 연 4회에 걸쳐 살충제를 살포하는 방제전략을 수립하는 것이 좋을 것으로 판단된다.

검색어: 노지, 고추, 총채벌레, 담배나방, 발생

P268

Effect of a commercial clove essential oils against the green peach aphid *Myzus persicae* Sulzer (Homoptera: Aphidiae)

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Green peach aphid is an insect that causes significant economic losses in crops. The plant-based biopesticides is a promising environment friendly insecticide as an alternative for chemical insecticide. In this study, we evaluated efficacy of commercial clove essential oil (EO) against green peach aphid for their aphicidal activity under lab conditions. ODS-HPLC analysis of clove EO showed that eugenol (6.1 ± 0.1 g/100ml) was a major compound. The lethal concentrations and times (LC and LT) of the clove EO at different concentrations (1:50, 1:100 and 1:200) were determined on 3rd and 4th nymphal instars after exposure to different concentrations at different times. The clove EO exhibited strong aphicidal activity against the nymphs of the green peach aphid with median lethal concentration (LC50) of 262.0 ppm at 24 h exposure, and medial lethal time (LT50) of 1.6 h at 250 ppm exposure. Our results indicated the clove essential oil as promising insecticide and may be used effectively in the management of aphids as alternative tool to provide environment friendly approach.

Key words: clove oil, eugenol, essential oil, green peach aphid

P269

Developing eco-friendly management methods for the fall armyworm, *Spodoptera frugiperda*

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The fall armyworm (FAW, *Spodoptera frugiperda*) is an invasive insect pest that migrates from Southeast Asia and southern China. FAW has a wide host range, causing great damage to various crops. From the end of May to July, the FAW adults flew to Korea, lays eggs, and reproduce, causing serious damage. Although there are crop protection agents approved for the control of FAW, no eco-friendly management technology has been developed so far. In this study, we developed eco-friendly control technologies that can be used to control the FAW. The technologies presented in this study will help develop methods to avoid developing drug resistance induced by repeated application of crop protection agents (Grant No.J014845032022).

Key words: fall armyworm, migratory pest, crop protectin, eco-friendly

P270

Investigation of phosphine resistance of stored-product insects of collection by Rice Processing Complex(RPC) in Korea during 2021 to 2022

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Animal and Plant Quarantine Agency, Republic of Korea

Recently, the occurrence of phosphine resistant pests is increasing as the use of aluminium phosphide continues to increase due to the prohibition of the use of methyl bromide. In this study, phosphine resistance to pests collected from RPC in Korea during 2021 to 2022 was investigated. Phosphine resistance was investigated with FAO No. 16, Dihydropyrimidinase dehydrogenase(DLD), and amino acid mutation analysis. The pests collected in the 8 province 32 region were 2 order 12 family 22 species. As a result of the FAO test of 15 regions in which 200 insects were secured, all of them were sensitive, but the survival rate in Jincheon was high at 58.96%. As a result of the DLD test, some areas were moderate resistance. As a result of amino acid analysis, they were all sensitive. It is required to inspect the RPC and other grain storage continuously to inhibit the widespread of resistant pest.

Key words: Phosphine, Resistance, Rice processing complex, Fumigant

P271

Comparative efficacy of single and combined treatment of fumigants and low temperature to the green peach aphid, *Myzus persicae* (Sulzer)

Youn-sun Chang, Bong-su Kim, Young-mi Moon and Jun-Ran Kim

Animal and Plant Quarantine Agency, Republic of Korea

Aphids are one of the most important agricultural pest groups in the world. Some aphids can be a problem when importing or exporting 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, ethyl formate and phosphine, mixed with cold treatment to control green peach aphid, *Myzus persicae*. Methyl bromide was treated for 2h and ethyl formate was treated for 4h at 20°C and phosphane treated for 2h, followed by 3 days cold (1°C) treatment. Combined treatment of fumigants and cold treatment showed less efficacy on *Myzus persicae* 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: *Myzus persicae*, phosphine, ethyl formate, methyl bromide, low temperature treatment

P272

Phytotoxicity evaluation of two seedlings (*Aralia elata*, *Echeveria metallica*) treated with ethyl formate fumigant

Jinsung Yoo, Bong-su Kim and Jun-Ran Kim*

Animal and Plant Quarantine Agency, Republic of Korea

The cumulative number of regulated pests detected in seedlings over the past 10 years is 7,688, and the number of pests is steadily increasing. To control pests, disinfection using a fumigant was performed based on the disinfection treatment standards of the Quarantine Headquarters, but the damage caused by phytotoxicity during this disinfection process is rapidly increasing. In this study, ethyl formate fumigant was treated on *Aralia elata* and *Echeveria metallica* seedlings, which show phytotoxicity among imported seedlings, and then the degree of damage was observed. For EF, 10, 35, and 50 mg/L were treated for 4 hours, and in the case of *A. elata* after 3 days of treatment, fallen leaves occurred in all treatment groups. Afterwards, new leaves and stems grew, but the stems grew in an abnormal position, resulting in poor marketability. In the case of *E. metallica*, a visual inspection was conducted, and it was confirmed that the degree of phytotoxicity increased as the concentration of the fumigant increased. Since the treatment of fumigant according to the current disinfection treatment standard is a concentration that can cause phytotoxicity, it is necessary to review the treatment standard again for the treatment of the fumigant alone.

Key words: Ethyl formate, phytotoxicity, plant quarantine, disinfection treatment standards

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Individual treatment and complex treatment for phosphine, ethyl formate, and low temperature treatment for *Planococcus citri*

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Methyl bromide is a fumigant designated as an ozone-depleting substance, and several alternative fumigants have been used since methyl bromide was designated as an ozone-depleting substance. Phosphine and ethyl formate are used as alternative fumigants for methyl bromide. Among them, phosphine has the disadvantage that it needs to be treated for a long time, and ethyl formate has the disadvantage that it may cause phytotoxicity at high concentration, but these disadvantages can offset the shortcomings when both fumigants are treated together. In this study, phosphine, ethyl formate, and 5°C low-temperature treatment were performed on *Planococcus citri*, respectively, and they were treated together. As a result of the experiment, eggs showed the highest resistance to each fumigant, but showed the highest sensitivity to temperature treatment at 5°C. The nymphs showed the lowest resistance at fumigation treatment and 5°C temperature treatment, and the adults showed the highest resistance at 5°C. The best effect was achieved when both low-temperature treatment and both fumigants were combined in all stages.

Key words: Phosphine, Ethyl formate, Methyl bromide, Fumigation, *Planococcus citri*

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Screening test of Chinese herbal medicines for *Varroa* mites controlling

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The *varroa* mite is major pest to *Apis mellifera*. Normally, many beekeepers was used chemical insecticidal materials for controlling number of *varroa* mite. Resently, many *varroa* mites were get resistance of chemical insecticidal materials. We want development of natural insecticidal materials to control of *varroa* mite by Chinese herbal medicines. At 48 h and 72 h, the corrected mites drop rates of the groups exposed to *Melia azedarach* L., *Foeniculum vulgare* Mill., *Eugenia caryophyllata* Thunb., *Thymus serpyllum* L. and *Macleaya cordata*(Willd.) R. Br. were about 40% higher than that of negative control group. In contrast, groups exposed to *Stemona japonica* (Bl.) Miq., *Strychnos nux-vomica* L., *Mentha haplocalyx* Briq. and *Illicium verum* Hook.f. had a lower mite drop rates. The survival rate of honeybees exposed *Thymus serpyllum* L. ($P < 0.0001$) and *Macleaya cordata*(Willd.) R. Br ($P = 0.0004$) was significantly lower than that of negative control. However, there is no significant difference in survival rate was observed between the honeybees exposed other seven herbs and negative control.

Key words: *Apis mellifera*; *Varroa* mite; *Thymus serpyllum* L.; *Macleaya cordata*

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Effect of natural enemy application model using ecological engineering technique in smart farm strawberry

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생태공학적 접근을 통한 농업생태계 다양성 유지로 생물 저항성을 극대화하는 지속가능한 작물 보호 체계 수립의 필요성이 증대되고 있다. 이에 본 연구에서는 스마트팜형 시설 딸기에 ‘Natural Enemy in First’ (NEF) 기법과 약제를 혼합 적용하여 주요해충의 밀도에 미치는 영향을 확인하였다. 대조구는 친환경자재를 처리하여 비교하였다. 스마트팜형 시설 딸기 4개소에서 발생한 해충의 밀도는 잎응애류, 총채벌레류, 진딧물류와 가루이류 순으로 높게 확인되었다. NEF 처리구에서 총채벌레와 진딧물의 천적으로 참뽕애꽃노린재(+*Portulaca* sp.)를, 잎응애류의 천적으로 칠레이리응애를 적용하여 해충의 밀도를 효과적으로 관리하였다. 특히, 1개소에서는 잎응애류 잎당 밀도가 대조구의 25% 수준으로 낮게 유지되었다.

검색어: 딸기, 서식처, 스마트팜, 천적, Natural Enemy in First (NEF)

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The effect of UV-LED lighting on *Phyllocnistis citrella* in Citrus

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지속가능한 해충관리를 위해 최첨단 혁신기술과 융합된 새로운 방제전략 수립이 중요해지고 있다. 이에 본 연구에서는 UV-LED 광원을 이용한 시설 감귤 해충관리 기술을 구축하고자 385nm LED 광원이 귤굴나방 밀도에 미치는 영향을 확인하였다. UV-LED 광원 설치 3개월 후, 감귤 잎의 귤굴나방 피해율은 무처리구의 57.8% 수준으로 낮게 유지되었다. 또한, 새순에 90% 수준으로 귤굴나방 피해를 유발한 후 UV-LED 광원을 설치한 처리구의 천적 발생률(기생률)은 무처리구의 1.97배 수준으로 높게 확인되었다. UV-LED 광원과 더불어 귤굴나방 밀도억제에 효과적인 약제와 천적이 혼합 적용된다면, 시설 감귤에서 귤굴나방의 밀도를 안정적으로 관리할 수 있을 것이다.

검색어: 감귤, 귤굴나방, 천적, 해충관리, UV-LED 광원

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CLIMEX modeling for predicting domestic spatial distribution of *Cicadella viridis*

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Cicadella viridis is a crop pest distributed in Europe and Asia. This pest is also a vector of *Xylella fastidiosa* that causes a severe damage to fruits. In this study, the potential distribution of *C. viridis* was domestically predicted by developing a CLIMEX model. Parameters were estimated based on climatic condition of *C. viridis* habitats, and optimal parameter values were finally determined by adjusting parameter values until the best fit to actual distribution was shown. The developed model was simulated under the current climate and future climate change scenario of 2050 (SSP245, and SSP585). As a result, high climatic suitability was predicted throughout the country, consistent with the current actual distribution of the pest. In 2050, a slight decrease in climate suitability was expected compared to the present, but the difference was not significant.

Key words: climate change, CLIMEX, green leafhopper, species distribution modeling, spatial distribution

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Analysis that thrips dominant species and test of pesticide resistant in occur of horticultural crops in Gangwon province

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총채벌레(Thrips)는 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 동일약제 연용으로 인해 일부 품목에서는 저항성이 발생하고 있고, 종에 따라 처리약제에 대한 저항성이 각각 다르게 나타나기도 한다. 따라서 지역별 총채벌레 우점종 분석과 약제저항성 검정을 통해 효과적인 방제전략을 수립하기 위해 본 연구를 수행하였다. 총채벌레 우점종 분석은 도내 토마토, 파프리카 주요 재배지역인 춘천, 횡성, 평창, 철원의 주요 재배지점을 선정하여 작목에 발생한 총채벌레에 대해 종별 특이 프라이머를 활용한 PCR 분석으로 우점종 분석을 실시하였다. 그 결과 춘천 토마토에서는 대만총채벌레, 평창 파프리카는 꽃노랑총채벌레가 동정되었다. 횡성 파프리카 우점종은 꽃노랑총채벌레였으며, 철원 파프리카는 꽃노랑 및 대만 총채벌레가 혼재하고 있었다. 이렇게 분석한 우점종 중 횡성 파프리카 꽃노랑총채벌레에 대해 약제 저항성 검정을 수행하였다. 시험약제는 전년도 농가 방제력 조사 시 지역별로 가장 많이 사용한 약제 3종과 대조구로 약제저항성이 있는 네오니코티노이드계통 2종을 선발하였다. 그 결과 네오니코티노이드계통의 2약제는 방제가가 80%인 반면 시험약제 3종은 90% 이상의 방제가를 보여 실제로 약제 저항성이 있음을 확인하였다.

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

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Efficacy of commercial insecticides against Korean local populations of *Bemisia tabaci*

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2021년 6월부터 10월까지 경기도 광주시 등 전국 12개 지역의 시설 및 노지 채소재배지에서 채집한 담배가루이 지역집단에 대하여 etofenprox EC 등 12개 시판 약제들에 대하여 추천농도와 그 1/10, 1/100농도에서 약제 반응을 엽침지법으로 조사하고 지역별 약제별 살충효과를 비교하였다. Thiamethoxam WG (7지역), Pyriproxifen EC (6지역), Etofenprox EC (5지역), Pyridaben EC (2지역)들은 추천농도(RC)에서 70%미만의 살충력을 보여 저항성이 의심되는 약제들이었으며, 특히 창녕, 삼례, 안성, 논산, 순천, 경기도 광주지역에서 이들 약제에 대한 사용상에 주의가 필요할 것으로 판단되었다. 반면에, emamectin benzoate EC, flupyradifurone SL, spinetoram SC, pyrifluquinazone WG는 대부분의 지역에서 추천농도의 1/10농도 (0.1RC)에서도 70%이상의 살충력을 보여주어 국내에서 담배가루이 방제용으로 효과가 우수하였다.

검색어: 담배가루이, 살충제 약제반응, 지역계통, 한국, 중국

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Insecticidal activity of Fluxametamide against FAW

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Fall armyworm (FAW) has been a problem worldwide since its first outbreak in Africa in 2016. It also found in Korea by wind through China. Faw is euryphagous pest that harms about 80 kinds of crops. One female lays more than 1000 eggs at a time, so it is best to control it in a quick and correct way. Fluxametamide is an isoxazol based insecticide that blocks the transfer of GABA (Gamma-aminobutyric acid), disturbs nerves, and kills pests. It has high insecticidal effect on a wide range of pests, such as Lepidoptera, Thysanoptera, Hemiptera. In order to find out the bioactivity of Fluxametamide, dipping and spraying methods were compared for the FAW L3 and L5. The result of this study will be used as basic data to control methods for overseas pests that can occur in large numbers.

Key words: Fall armyworm, Fluxametamide, GABA receptor, Insecticidal activity

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Repellency effects of *Perilla frutescens* supercritical fluid extract against *Haemaphysalis Longicornis*

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Supercritical fluid extraction (SFE) is a rapid, selective and convenient method for sample preparation prior to the analysis of compounds in the volatile product of plant matrices. The hard tick, *Haemaphysalis longicornis*, which is widely distributed in East Asia and Oceania can act as a vector for viruses, chlamydia, rickettsia, bacteria, and protozoa. The repellencies of *P. frutescens* extract was evaluated in comparison with the two commercial repellency (Icaridin and DEET) against *H. longicornis*. In filter-paper diffusion method, *P. frutescens* extract ($3.2 \mu\text{g}/\text{cm}^2$) gave 100% repellency at 120 min after exposure. Whereas Icaridine ($3.2 \mu\text{g}/\text{cm}^2$) gave 96.1 % repellency, respectively, at 120 min. The repellency of the Peillaldehyde against *H. longicornis* was compared with that of DEET at $3.2 \text{mg}/\text{cm}^2$. Responses varied according to the test compound and exposure time. Peillaldehyde gave 100% repellency 30 min post-treatment but 75.1% repellency at 120 min, respectively. *P. frutescens* extract and Peillaldehyde described merit further study as potential fumigants or leads for the control of *H. longicornis*.

Key words: Supercritical fluid extraction, *Haemaphysalis longicornis*, *Perilla frutescens*, Peillaldehyde

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Repellency effects of *Chamaecyparis obtusa* supercritical fluid extract against *Haemaphysalis Longicornis*

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Supercritical fluid extraction (SFE) is a rapid, selective and convenient method for sample preparation prior to the analysis of compounds in the volatile product of plant matrices. The hard tick, *Haemaphysalis longicornis*, which is widely distributed in East Asia and Oceania can act as a vector for viruses, chlamydia, rickettsia, bacteria, and protozoa. The repellencies of *C. obtusa* oil was evaluated in comparison with the two commercial repellency (Icaridin and DEET) against *H. longicornis*. In filter-paper diffusion method, *C. obtusa* oil ($3.2 \mu\text{g}/\text{cm}^2$) gave 100% repellency at 120 min after exposure. Whereas Icaridine ($3.2 \mu\text{g}/\text{cm}^2$) gave 96.1 % repellency, respectively, at 120 min. The repellency of the 31 compounds against *H. longicornis* was compared with that of DEET at $3.2 \text{ mg}/\text{cm}^2$. Responses varied according to the test compound and exposure time. α -Terpinene, terpinene-4-ol and α -terpineol gave 100% repellency 30 min post-treatment but 85.5, 56.4 and 68.9% repellency at 120 min, respectively. α -Pinene and β -pinene gave 97.6 and 89.5 % repellency at 10 min, post-treatment but 67.4 and 0 % repellency at 120 min respectively. Limonene, γ -terpinene, terpinolene and terpinyl acetate gave 50% repellency at 30 min but repellency of these compounds was significantly low at 30 min. *C. obtusa* oil and α -terpinene, terpinene-4-ol and α -terpineol described merit further study as potential fumigants or leads for the control of *H. longicornis*.

Key words: Supercritical fluid extraction, *Chamaecyparis obtusa*, *Haemaphysalis longicornis*

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Analysis of attraction effect by pheromone product and height of fall armyworm, *Spodoptera frugiperda*

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아메리카 대륙이 원산지인 열대거세미나방은 2019년 제주도에서 최초 발견 후 전국 50.6ha(2019년 기준)에서 발생이 확인되었다. 최근 옥수수, 수수 등 잡곡의 수요 증가로 기주 작물 재배가 증가하여 전국적으로 피해가 발생하고 있으므로 열대거세미나방에 의한 피해를 예방하기 위해 효율적인 예찰법 개발이 필요한 상황이다. 이를 위해 국내외 시판 중인 성페로몬 제품 5종(미국산, 중국산, 네덜란드산, 코스타리카산, 한국산)별, 트랩 설치 높이별 성충 유인효과와 안테나 반응 분석을 실시하였다. 트랩은 편넬트랩을 이용하였으며, 2020년 7월부터 10월까지 조사하여 페로몬 종류에 따른 성충 유인량을 비교하였다. 총 포획수는 미국산(609마리) > 코스타리카산 > 중국산 > 네덜란드산 > 한국산의 순이었다. 트랩 설치 높이는 10cm, 80cm, 100cm, 120cm, 140cm에 설치하여 유인수를 비교한 결과 10cm를 제외하고 높이별로 차이는 거의 없으나 120cm에서 가장 많은 수의 성충이 포획되었다. 페로몬 제품에 따른 안테나 반응은 페로몬별로 유의한 차이는 없지만 미국산에서 반응이 가장 민감한 것으로 나타났다. 열대거세미나방의 효과적인 예찰을 위한 추가적인 연구가 필요한 것으로 사료된다.

검색어: 열대거세미나방, 페로몬 트랩, 루어, 예찰

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Investigation of occurrence of insect foreign materials claims in some kinds of processed food

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가공식품에서 발생하는 곤충이물 소비자 클레임을 저감화하는 허들방충포장을 개발하기 위해 곤충이물 발생빈도가 높은 가공식품(과자류, 봉지면류, 용기면)에서 2018년부터 2021년까지 최근 발생된 곤충이물 클레임 529건을 신고당시 소비자 증언, 클레임 발생 현물, 사진 등의 자료를 기반으로 분류학적 곤충 종, 생태학적 특성, 발생유형, 오염경로를 분석하였다. 분류학적으로 과자류에서는 파리목, 봉지면류에서는 나비목, 용기면류에서는 딱정벌레목의 빈도가 가장 높았으며 생태학적으로 모든 식품유형에서 야외해충이 가장 높은 빈도를 보였다. 발생유형은 모든 식품유형에서 치사성충 유형의 빈도가 높았으며 오염경로는 유통, 소비 단계에서 대부분 오염되는 것으로 조사되었다.

검색어: 허들방충포장, 가공식품, 소비자클레임, 곤충이물, 저장해충

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

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본 연구는 2025년 까지 우리 밀 자급률 5%를 달성하기 위한 밀산업 육성법의 일환으로 우리 밀 수확 후 비축 시 친환경 저장해충 방제 방법을 도출하기 위해 진행되었다. 1단계 연구로 현재 대부분 쌀, 보리, 밀을 수확 시기별로 톤 백 상태로 상온에서 혼합 보관하는 소규모 유통, 보관 시설과 밀을 수확, 건조 후 보관하는 톤 백 내부에서 연간 저장해충 발생양상을 조사하기 위해 부여의 영농조합 시설과 시설 내 보관 중인 톤 백 내부에서 페로몬 트랩과 probe 트랩, 자동온습도측정기를 활용하여 저장발생 해충양상과 온습도를 모니터링 하였다. 톤 백 내부에서의 저장해충 발생양상은 수확 후 보관 초기에 머리대장류, 곡식썩시기의 포획수가 높았으나 시간이 지남에 따라 어리쌀바구미의 포획수가 증가하는 경향을 보였으며 보관 후 1년경과 시점에서 화랑곡나방의 개체수가 급격히 증가하여 톤 백 내부가 화랑곡나방 유충 실크로 거의 대부분 오염되는 양상을 보였다.

검색어: 우리 밀, 톤 백, 저장해충, 모니터링, 페로몬 트랩, Probe 트랩

P286

Heavy metal reduction test for *Protaetia brevitarsis* larvae as edible insects using effective microorganisms

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Recently, as the scope of heavy metal management of edible insects has been expanded in Korea and the integrated standard for edible insect heavy metals has been needed. *Bacillus subtilis*, *Bacillus subtilis*, *Lactobacillus plantarum*, and *Saccharomyces cerevisiae* microbial mixture culture (BLS: diluted solution of concentration 5^{-1} , 2.5^{-1} , etc.) and weight, feces, and heavy metal content of *P. brevitarsis* larvae were measured. In the BLS-treated group, lead was detected 30 times lower, cadmium 11.7-35 times, and arsenic 1.8-3.5 times lower compared to control group, confirming that the larval heavy metal reduction efficacy was increased. In the experimental groups fed from egg stage, the arsenic content was lower than in the experimental group fed from the second instar larvae. On the other hand, in the fecal soil and food sources, the lowest levels of lead 0.1, cadmium 0.0, and arsenic 0.0 mg/kg were detected in the 2.5^{-1} dilution. Therefore, it was confirmed that the effective microorganisms were shown in the *P. brevitarsis* growth characteristics and heavy metal reduction efficacy.

Key words: heavy metal reduction, *Protaetia brevitarsis*, edible insects, effective microorganisms

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A study on entomopathogenic nematode symbiotic bacteria in Korea

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Entomopathogenic nematodes (*Heterorhabditis megidis*, *Steinernema carpocapsae*, *S. arenarium*, *S. monticolum*), which are pathogenic to bait insect *Galleria mellonella* larvae, were isolated and identified from soil samples collected from oak (*Quercus* sp.) and Japanese larch (*Larix kaempferi*) habitat across Korea. From the entomopathogenic symbiotic bacteria, the genomic DNA was isolated, and the amplification of the 16s rRNA region was performed to analyze the nucleic sequence and homology. Symbiotic bacteria of *H. megidis* isolated from the oak habitat soil samples were identified as *Photorhabdus temperata*. The bacterial symbiont of *H. megidis* isolated from soil samples of Japanese larch habitat was identified as *P. cinerea*. In addition, symbiotic bacteria isolated from *S. carpocapsae*, *S. arenarium*, *S. monticolum* of Japanese larch habitat soil samples were identified as *Xenorhabdus nematophila*, *X. kozodoii*, *X. hominickii* respectively. The number of entomopathogenic gene types of bacterial symbionts *P. temperata*, *P. cinerea*, *X. nematophila*, *X. kozodoii*, *X. hominickii* were turned out to be 8, 7, 10, 4, 7, respectively.

Key words: Oak, Japanese larch, Entomopathogenic nematode, Symbiotic bacteria, *Galleria mellonella*, *H. temperata*, *H. cinerea*, *S. carpocapsae*, *S. arenarium*, *S. monticolum*, *P. temperata*, *P. cinerea*, *X. nematophila*, *X. kozodoii*, *X. hominickii*

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Nutritional value of *Protaetia brevitarsis* larvae feeding a food source containing soybean curd cake

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비지박을 급이한 흰점박이꽃무지 유충의 영양학적 우수성과 안전성을 검증하고자 비지박 함유 먹이원과 참나무 발효톱밥만으로 사육한 유충의 영양성분과 유해물질을 비교분석하였다. 조단백질 함량은 비지박 함유 먹이원을 급이한 유충(SCC)에서 50.0%로 참나무 발효톱밥으로 사육한 유충(CTR) 44.7%보다 1.1배 많았다. 조지방은 SCC에서 8.1%로 CTR 13.5%보다 1.7배 더 적었다. 불포화지방산 중 올레산 함량은 SCC(44.0%)에서 CTR(61.1%)보다 1.4배 더 적게 나타났으나, 리놀레산은 SCC(26.4%)에서 CTR(5.2%)보다 5.0배 많은 것으로 확인되었다. 다량무기질 중 가장 많은 함량을 나타낸 칼륨은 SCC(3169.6 mg/100 g)에서 CTR(1245.9 mg/100 g)보다 2.5배 더 많았다. 미량무기질 중 아연은 SCC(103.0 mg/100 g)에서 CTR(8.2 mg/100 g)보다 12.6배 높은 함량을 나타냈다. 유해물질 분석 결과, 납, 카드뮴, 비소 모두 식용곤충 중금속 기준에 적합하였고, 병원성 미생물인 대장균, 살모넬라균 모두 불검출되었다. 위의 분석 결과로 볼 때, 비지박을 급이한 흰점박이꽃무지 유충은 다양한 영양성분을 포함하고 있으며, 안전성 또한 검증되었으므로 식용으로 활용하기에 적합할 것으로 판단된다.

검색어: 흰점박이꽃무지, 유충, 비지박, 먹이원, 영양 가치

P289

Analysis of spreading pattern by time series prediction of pine wilt disease

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Pine trees is one of the most important trees in South Korea, and many efforts are exerting to protect the trees. The damage to pine trees occurs in a variety of ways, but pine wilt disease (PWD) is the largest concern in these days. As an effective tool to protect pine trees from PWD, early monitoring of spread pattern has been emphasized. This study, hence, used monthly occurrence coordinates (2016—2021) to extract the time series pattern of PWD, and applied species distribution modeling (MaxEnt) to project the monthly potential distribution on the map. The maximum and minimum accuracies were 0.84 and 0.76, respectively. There was a difference in the PWD occurrence by months, and the occurrence density was changed by time. We expect that the present results are applicable for PWD monitoring, and control in the future.

Key words: pine wilt disease, species distribution modeling, spread pattern, time series data

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Developmental and reproductive characteristics following low-temperature storage of *Protaetia brevitarsis seulensis* larvae

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농산품의 출하 시기를 인위적으로 조절하기 위해 다양한 저장법이 개발되고 있다. 산업곤충 역시 장기저장을 통해 농장주가 원하는 시기에 맞춰 농산품을 생산할 필요성이 점차 커지고 있다. 그 중, 우리는 살아있는 흰점박이 꽃무지 유충을 대상으로 저온 저장 방법을 연구하였다. 흰점박이꽃무지 3령 초기 유충을 온도별로(15, 12, 10, 7.5, 5°C) 먹이원의 유무에 따라 3개월간 저온 저장 후 18, 25, 30°C로 옮겨 4주간 매주 무게를 측정하였다. 무게는 비모수 검정법을 이용하여 비교하였다. 그 결과, 7.5°C 이하의 온도에서는 먹이원 유무와 관계없이 유충이 모두 사망하였고, 10°C 이상의 온도에서는 먹이원이 없을 때 모두 사망하였다. 최적의 저장온도는 12°C로서 12°C 저온처리 후 30°C로 옮겨 사육하였을 때 유충의 증체율과 유충 시기 최대 무게가 높게 나타났다($p < 0.05$). 추가로 최적 저장온도(12°C)에서 저장기간에 따른 발육특성을 비교하였다. 3령 초기 유충을 12°C에서 2, 4, 6, 8주간 저장 후 유충과 번데기 기간, 최대 무게 도달 기간 그리고 산란율을 비교하였다. 생육특성은 ANOVA 검정을 통해 비교하였다. 그 결과, 8주간 저온 저장 시 유충 기간이 가장 짧았다(39.26일, $p < 0.05$). 유충의 최대 무게는 통계적으로 차이가 나타나지 않았다. 산란율은 저온처리 기간이 길수록 증가하는 경향을 보였다. 이 결과를 통해 12°C에서 3개월 이내로 저온 저장하여 출하 시기를 조절할 수 있고, 저온처리를 8주 이상 처리하여 산란율을 증대할 것으로 기대한다.

검색어: *Protaetia brevitarsis seulensis*, 발육특성, 저온 저장

P291

Effects of the healing agriculture program for elderly using the silkworm *Bombyx mori* (Linnaeus)

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대한민국은 초고령사회에 접어들었다. 수명이 증가하는 것에 비해 노인들의 경제활동과 보살핌은 부족한 상황이라서 사회적 불안감과 우울감이 증가하는 추세이다. 본 연구는 농촌마을의 노인들을 대상으로 '누에나방 [*Bombyx mori* (Linnaeus)]'을 이용하여 개발한 치유농업프로그램을 현장에 적용하고 효과를 측정하였다. 2022년 5월, 전북 고창군의 경로당을 이용하는 노인 20명이 대상자이며, 당일 프로그램으로 운영되었다. 누에나방은 나비목의 곤충으로 70~80년대 집집마다 누에를 키웠던 경험을 회상시켜주기 때문에 선호도가 높다는 장점이 있다. 주요 프로그램으로 에벌레 만져보기, 뽕잎 먹는 소리 듣기, 고치 잘라보기 등의 활동으로 구성하였다. 치유효과 검증에 위해 자기 기입식 설문지를 작성하였고 혈압을 측정하였다. 분석 결과, 사전 대비 사후에 스트레스는 25% 감소하였고, 수축기 혈압은 135.55→131.50(mmHg)으로 감소하였다($p < 0.05$). 프로그램에 대한 만족도는 100점 만점에 95.3점으로 나타났다. 이러한 결과 누에를 이용한 치유농업프로그램이 노인의 스트레스 감소와 혈압을 안정화시키는데 효과가 있음을 확인한 것으로, 향후 보다 체계적인 프로그램으로 적극 활용될 수 있을 것으로 기대한다.

검색어: 정서곤충, 누에나방, 치유농업프로그램, 치유효과

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Development and effectiveness of farm model insect healing program for developmental disorders

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2022년 1월 기준으로 전국에 등록된 발달장애인의 수는 255,207명이다. 이들은 사회 진출, 여가 생활, 경제활동 등의 기회가 적을 뿐 아니라 복지, 여가 프로그램도 매우 부족한 것이 현실이다. 이에 정서곤충을 활용한 농가형 곤충치유프로그램을 개발하여 현장에 적용하고 그 효과를 구명해 보았다. 전북 순창군의 치유농가에서 발달장애인 18명의 성인을 대상으로, 2022년 6월-8월간 매주 1회, 총 10회차 프로그램을 운영하였다. 주요 프로그램은 정서곤충(호랑나비, 왕귀뚜라미)을 돌보는 활동을 중심으로 먹이 식물 심기, 은신처 만들기, 곤충 캐릭터 부채 만들기 등이며, 특히 농가에서 보유하고 있는 자원을 활용한 프로그램인 '귀뚜라미 소리를 들으며 족욕 하기'와 '나비 모양 샌드위치 만들기' 등은 참여도가 높았다. 치유 효과 측정을 위해 심리 및 생리적 검사를 시행했으며, 분석 결과, 사전 대비 사후에 수축기 혈압은 138.3→127.9(mmHg)로 낮아졌고, 이완기 혈압은 83.9→80.2(mmHg)로 감소하였으며, 주관적 행복감은 18% 증가한 것으로 나타났다($p<0.05$). 이를 통해 발달장애인을 대상으로 한 곤충치유프로그램의 가능성을 확인할 수 있었다.

검색어: 정서곤충, 발달장애인, 치유프로그램, 치유효과

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Comparison of Growth on *Papilio xuthus* according to host plant preservation methods

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The yellow swallowtail butterfly (*Papilio xuthus*) is holometabolous that undergoes different stages. Larvae change shape and color during the larval period. Adults has wings with black stripes on a yellow background, so they have been called tiger-butterfly since ancient times. Recently, there have been previous studies showing that psychological healing programs using *Papilio xuthus* increase children's feelings of happiness and help relieve stress.

The Gyeongbuk Provincial Silkworm and Insect Management Center has been producing *Papilio xuthus* rearing kit for ecological experience education. But production was stopped since 2019 due to difficulties in host plant. In order to solve the problem, The host plant changed to *Phellodendron amurense* with LDPE BAG. In this study, an experiment was conducted to compare the growth differences of *Papilio xuthus* according to host plant preservation methods in rearing kit. As for the experimental conditions, host plants were subdivided into LDPE BAG for 20 branches and 10 branches. As a result of the experiment, the survival rate from larvae to adults was 33.3% for control group, 26.7% for A group(20 branches), and 13.3% for B group(10 branches). The pupation rate was 60% for control group, 60% for A group, and 50% for B group. The emergence rate was 40% for control group, 30% for group A, and 40% for group B.

Key words: *Papilio xuthus*, host plant, preservation methods

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Current status of pine wood nematode GeneBank in Korea

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Pine wilt disease (PWD) is mainly caused by *Bursaphelenchus xylophilus* (Pine wood nematode, PWN) which is known to be native to North America. It was introduced from North America to Japan in the early 1900s and reported to occur in 1988 in Korea. Currently, PWD is occurring in about 390 thousand infected trees in 136 administrative districts in Korea. GeneBank of PWN in NIFoS has been operating since 2006 to collect and maintain 192 Korean populations. These populations are cultured on the fungus *Botrytis cinerea* grown on barley grains. The maintained populations are being used for establishing a species diagnosis, integrated management, and discovering useful genes related to population genetics, phylogenetic studies, and epidemiological investigation.

Key words: *Bursaphelenchus xylophilus*, Culture, GeneBank, Pine wilt disease, Population genetics

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Effect of black soldier fly larvae manure application on lettuce growth

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아메리카동애등에 유충은 유기성폐기물을 먹이원으로 하며 그 분해산물인 동애등에분은 비료원료로 활용 가능하다. 하지만 농가에서 나오는 동애등에분의 염분은 비료공정규격인 2%를 초과하여 배출된다. 따라서 염분을 낮추기 위해 동애등에분과 흰점박이꽃무지분을 비율별로 혼합하여 총 5개 처리구(무처리, 동애등에분:흰점박이꽃무지분 10:0, 7:3, 4:6, 가축분퇴비)를 청치마 상추에 사용하였다. 상추 생육은 7일 간격으로 엽장, 엽폭, 엽수를 조사하였고, 수량은 5주차부터 8주차까지 조사하였다. 처리구별 상추수량(kg/10a)은 무처리구 253.8kg, 동애등에분:흰점박이꽃무지분 10:0처리구 356.3kg, 7:3처리구 286.7kg, 4:6처리구 267.0kg, 가축분퇴비구 266.0kg으로 나타났으며 증수율은 무처리 대비 동애등에분:흰점박이꽃무지분 10:0처리구는 40.4%, 7:3처리구 13%, 4:6처리구 5.2%, 가축분퇴비구는 4.8% 증수하였다. 상추 생육은 동애등에분 단독 사용이 효과가 가장 좋았으나 장기적인 실험을 통해 토양과 작물에 미치는 영향을 모니터링해야 될 것으로 판단된다.

검색어: 동애등에분, 흰점박이꽃무지분, 상추생육, 상추수량

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Swine edema disease recombinant antigen production using silkworm

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Pig edema disease is a bacterial infectious disease that causes diarrhea and edema in piglets after weaning and leads to death. Pathogenic *E. coli*, which produces a toxin called shiga-toxin, infects and proliferates in the intestine of an animal, and sends the toxin into the blood vessel. The simplest method for preventing edema caused by these bacterial toxins is to obtain immunogenicity against the toxin antigen by injecting a vaccine.

Therefore, in this study, the production of recombinant antigens usable as vaccines was studied by making a recombinant insect virus and infecting the silkworm pupa. After synthesizing the genes of the B subunit, the cell binding site of shiga-toxin, and the A subunit, the toxin active site, the genes were cloned into the pFast-Bac vector. After the cloned vector was prepared in the form of Bac-mid, it was infected with insect cells to produce a recombinant virus, and the produced virus was again infected with the pupae of silkworm to produce a recombinant protein. As a result, each gene for the recombinant protein was observed from the 2nd day and was maximally expressed on the 5th day, and the protein expression was also maximized on the 5th day. The expressed protein was successfully isolated through pupae and extracts prepared by ammonium sulfate fractionation method and NI-NTA chromatography. However, since the expression rate of the protein was low, the purification concentration was low, and in order to use it as a vaccine, it is judged that it is necessary to study a system that can express it at a high concentration.

Key words: Swine edema, silkworm, recombinant vaccine

P297

Growth effects of novel heating system using heater-installed rearing tray on silkworm, *Bombyx mori*

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Silkworms with high economic and industrial value are known to be easily damaged by environmental factors. It is very important to manage temperature and humidity for silkworm feeding facilities. In this study, the new rearing method that directly heats the bottom of the rearing tray was developed. The novel heater-installed tray (HIT) system significantly reduced the change in temperature during the experimental period. In addition, the number of days of silkworm growth up to harvest was shortened, and it was also found that silkworms grew more uniformly in HIT system than in previous system. In conclusion, the heater-installed rearing tray method greatly improves silkworm quality, increases weight of silkworms, and final profits compared to the previous room heating system with electric heaters.

Key words: *Bombyx mori*, Silkworm breeding seat, Heater-installed tray

P298

Psychological effects of healing program of insect with insect garden

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The study aims to examine the psychological effect of healing program of insect in ecological garden. A samples of 12 elementary students was participated for the study from near study area in Sangju. Students in the experimental group participated in healing program of insect-based experience activities using silkworm and butterfly. Collected data are transformed $\log(x+1)$ for analysis and analyzed with paired sample t-test in SAS program. The results of this study are healing program of insect-based experience activities show positive effects to some students in physiological aspects. And students and their parents showed high satisfaction in healing program of insect. In conclusion, this study contributes to providing fundamental information for the development of agro-healing programs with insect and insect ecological garden. Further research should be extended to different types of old adults and others.

Key words: Psychology, Insect, Silkworm, Agro-healing program, Ecology, Ecological psychology

This study was supported by a grant from the Rural Development Administration(RDA, PJ015738) of the Republic of Korea.

P299

The appropriate density of *Bombus terrestris* colonies in tomato greenhouse

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시설채소의 평균 재배면적이 넓어지고 인건비의 증가 및 코로나19로 인하여 인력수급이 어려워지면서 화분 매개곤충의 역할은 더욱 중요하게 되었다. 따라서 본 연구는 화분매개곤충인 서양뒤영벌을 방울토마토 단동하우스(550㎡) 재배시설에서 하우스별 1, 1.5, 2봉군까지 투입하여 수분활동 및 수확량 등을 조사하였다.

조숙재배(4-6월)시기 방울토마토에서 1봉군 투입 시 꽃 수량 증가가 상대적으로 높았으나, 봉군의 투입 밀도가 높을수록 수분활동이 높아 꽃 수량은 줄어드는 경향이였다. 착과율은 2봉군 투입시 96.4%로 가장 높게 나타났다. 수확 후 상품성 조사 결과 과립중은 2봉군에서 16.8g으로 가장 높았으나 당도는 1.5봉군에서 7.0Brix로 가장 높았다.

검색어: 시설토마토, 서양뒤영벌, 방화활동, 상품성

P300

Effects of a larval powder of steamed and lyophilized mature silkworms, *Bombyx mori*, L., on body weight gain and abdominal visceral fat in mice

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In East Asia, silkworms, *Bombyx mori* L., have been traditionally used as an oriental medicine to manage diverse pathological conditions including obesity-related diseases such as hyperglycemia. Therefore, the present study was performed to determine the effects of daily administration of a larval powder of steamed and lyophilized mature silkworms (SMSP) on body weight change, abdominal visceral fat, and its safety for long-term use in mice. SMSP (1 g/kg) was orally administered to mice on a daily basis for 12 weeks, and the mice's body weights and food intakes were measured throughout the period. The treatment of SMSP for 12 weeks significantly reduced body weight gain and abdominal visceral fat. There were no significant differences between in control and SMSP treated groups for the serum biochemical parameters and organ weights at necropsy. Further studies are needed on SMSP in high-fat diet-induced obese mice to elucidate the mechanisms of suppressing body weight gain and abdominal visceral fat.

Key words: Abdominal visceral fat, body weight gain, *Bombyx mori*, mature silkworm, obesity

P301

Similar nutrients and health improvement effect of HongJams made from mature silkworm weaving yellow cocoons

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HongJam is a natural health food made possible for human consumption by processing mature silkworms. For examples, HongJam produced with White Jade variety which made white cocoons has an excellent protective effect on the liver and gastrointestinal tracts while HongJam made from Golden Silk variety which made yellow cocoons were reported to have effects on Parkinson's disease inhibition, neuronal cell protective, memory enhancement, and Alzheimer's disease prevention. In this study, the nutritional components and functionality of the two HongJams produced from silkworm varieties made yellow cocoons were compared to investigate whether they could be replaced each other (Grant No. PJ0156592022).

Key words: HongJam, Golden Silk, Dae Hwang Jam, nutrients, memory

P302

Health promotion effect of HongJam through boosting immune responses

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Hongjam is a health improvement functional food manufactured by steaming and freeze-drying mature silkworms. However, studies on the immune-enhancing effect of HongJam have not yet been HongJam. In this presentation, we present and discuss the results of research on the immunity-boosting effect of HongJam (Grant No. PJ0170242022).

Key words: HongJam, immune, health promotion, boosting

P303

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

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소리 분류 기술은 딥러닝을 통해 다양한 분야에서 활용되고 있다. 멀티미디어 생물정보 데이터를 활용하기 위해 인공지능 기술을 적용하고 성능을 테스트하였다. 7월~9월간 채집한 한국산 매미 12종의 울음소리와 기존에 채집된 데이터를 활용하여 소리 분류를 위한 전처리를 수행하였다. 매미 종별 소리 데이터는 소리 데이터를 1초 간격으로 분할하여 tensorflow 라이브러리를 활용하여 스펙트로그램 이미지로 변환하였고 합성곱신경망 (CNN) 딥러닝 모델에 적용하여 자동 종 분류 시스템을 개발하였다. 특히 fine Tuning(파인튜닝)을 통해 결과의 정확도를 개선시켰다. 분류의 정확도를 높이기 위하여 librosa를 활용하여 매미소리의 17개 특성값을 추출하여 머신러닝으로 학습하였다. 12종의 매미 울음소리를 딥러닝 모델에 적용하였으며, 95%의 정확도를 확인하였다.

검색어: 소리분류, 딥러닝, 합성곱신경망, 인공지능, 기계학습, 매미, 분류

P304

Screening of Bacteria enzyme activity in *Tenebrionidae* Gut and research on Microbial-added Dog Snack Products

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최근 산업곤충 활용방안에 대한 연구들이 활발히 진행되고 있다. 그중에서도 갈색거저리와 아메리카왕거저리에 대해서 장내 미생물 5종을 분리하여 장내미생물을 활용한 산업화 활용방안에 대한 연구를 수행하였다. 갈색거저리 장내미생물을 선발한 미생물 균집을 비교한 결과 *Lactobacillus rogosae*, *Bfidobacterium adolescentis*, *Bfidobacterium longum*, *weissella confusa* 순으로 0.77%, 0.46%, 0.19%, 0.03%로 나타났으며 아메리카왕거저리 장내미생물은 *weissella confusa*, *Lactobacillus graminis*, *Bfidobacterium adolescentis*, *Bfidobacterium longum* 순으로 4.58%, 0.75%, 0.13%, 0.01%로 나타났다. cellulase, amylase, protease, lipase 효소활성시험을 통해 활성이 우수한 거저리류의 장내미생물 *Weissella cibaria*, *Bacillus paralicheniformis*, *Pediococcus pentosaceus*, *Bacillus velezensis*, *Hafnia alvei* 5종을 선발하였다. 선발된 미생물 중 반려견 치석 제거용 덴탈스틱 개발을 위해 *Streptococcus mutans* 균을 대상으로 구강유해균 억제능을 확인하여 *Weissella cibaria* 균주를 선발하였다. 제품개발을 위해 미생물 첨가비율에 따른 배합비를 통해 *Weissella cibaria* 균주 1×10^6 처리구에서 선호도가 가장 좋았으며 일반성분의 경우 시판제품에 비해 1×10^6 처리구에서 단백질, 지방, 회분, 수분의 함량이 가장 높았으며 색도 또한 가장 높은 수치를 나타내었다.

검색어: 거저리류 장내 미생물, 미생물 분포상, 덴탈스틱,

P305

Investigating variety effects of major summer crops using indoor breeding methods of Lepidoptera pests in Gangwon provinces

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The fast adaptation of moths, especially the Lepidoptera pests are being used as indicators of climate change. We tried to investigate the effects of variety in major summer crops of Chinese cabbage, potato and corn. Using indoor breeding system of Lepidoptera pests, we selected larvae of *Helicoverpa armigera* hatched 6~7 days, *Spodoptera exigua*, hatched 3~5 days ago about 1 cm length. Among 4 commercial variety of Chinese cabbage, 'Odae' gathered many larvae of *Helicoverpa armigera*. Potato variety of 'Suji' and corn variety of 'Mi Baek' gathered many larvae, respectively. Using *Spodoptera exigua*, Chinese cabbage variety of 'Cheong Ok', potato variety of 'Sumi' gathered many larvae. We found that Lepidoptera larvae showed variety preference in Chinese cabbage, potato and corn. However the average number of *Helicoverpa armigera* larvae in each crop was 10, 2.2 and 6.6, respectively. Thus we selected Chinese cabbage for further study of testing pesticides resistance. This result will be used for eco-friendly production of major summer crops in Gangwon provinces.

Key words: Lepidoptera, larva, Chinese cabbage, potato, corn

P306

Rapid Development of Microsatellite markers for *Eumeta variegata* using NGS data

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The bagworm (*Eumeta variegata*) is a well known pest on orchard and street trees. However, a lack of genetic information of this pest results in a series of genetic questions remain largely unknown, including population genetic structure, kinship and biotype abundance. Co-dominant microsatellite markers offer a great resolving power to determine these events. Here, we report rapid microsatellite (MS) isolation from *E. variegata* via high-throughput sequencing data on NCBI. Using genomic sequencing data (PRJDB7096), 850 MS loci were detected and a suit of 332 primer pair sequences were designed. Using *in silico* PCR analysis, 24 out of 205 candidate MS markers were selected and used to analyze the genetic diversity of 44 bagworms collected from two species of trees. The results showed the twenty four MS loci were polymorphic between populations. These novel markers are valuable for future genetic mapping, trait association, genetic structure and kinship among *E. variegata*.

Key words: *Eumeta variegata*, Genetic diversity, Microsatellite marker

P307

Study of the decomposition of agricultural by-product and frass using Black Soldier Fly (BSF)

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Agricultural by-products occur at all processes of agricultural production including production, processing, manufacturing, and distribution of agricultural products. There is a need for an eco-friendly way to treat and reduce agricultural by-products. Black Soldier Fly (BSF) could be one of the method which treat agricultural by-products. This study investigated the decomposition of apple pomace and frass using BSF larvae. The larvae fed with apple pomace took 26 days to become pupae compared to the larvae which fed with cattle feed (12 days) as a control. The weight of larvae fed with apple pomace was smaller than the weight of larvae fed with cattle feed. The frass of the larvae fed apple pomace met the fertilizer process standard. It will be possible to resource agricultural by-product at the same time as eco-friendly treatment by using larvae in BSF.

Key words: Black soldier fly, fruit by-products, frass

P308

Investigation on host plant preference of *Bemisia tabaci* and its managerial application

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국내 시설재배에서 대표적인 문제해충인 담배가루이 성충에 대하여 4-choise test를 활용하여 기주선호성 조사를 실시하였다. 담배를 기주로 수년간 사육한 성충은 가지과 작물 8종(담배, 까마중, 구기자, 고추, 피망, 독말풀, 가지, 페튜니아) 가운데 담배(40%), 가지(32%), 까마중(17%), 피망(11%) 순으로 선호성을 보였다. 이들 4종 가운데 가지를 기주로 1세대이상 사육한 성충은 가지(36%), 까마중(33%)의 선호성이 높았으며, 토마토를 기주로 사육 했을 때는 담배(43%)의 선호성이 월등히 높아 사육 기주에 따라 선호성이 달라짐을 알 수 있었다. 토마토 기주에서 사육한 담배가루이에 대하여 2-choice test에서도 담배(65%)에 대한 선호성이 토마토(35%)보다 높았다. 또한 디노테퓨란 입제(2%)를 주당 3g처리한 담배에서 침투이행에 의한 담배가루이 성충의 약효는 처리 후 4일차(97.4%)와 21일차(방사 2일후 100%)에도 높게 유지됨을 확인할 수 있었다. 따라서 선호성이 높은 기주식물을 활용한 침투이행성 약제처리가 포장내 담배가루이 밀도 감소에 영향을 줄 수 있음을 시사한다.

검색어: 담배가루이, 기주선호성, 침투성 약제, 방제효과

P309

Microinsect pests on imported cut flowers in Korea during 2011-2020

Hyemi Park, Sangmok Kim and Youngjin Park

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In this study, we focused on microinsects(Thysanoptera and Aleyrodidae) found in imported plant seedlings and cut flowers from 2011 to 2020 using pest information system. A total number of 36 detection records containing thrips in plant seedlings and 6,129 founds in imported cut flowers to Korea. Aleyrodidae was found in Plant seedling and Cut flower account for 57 and 1,015, respectively. *T.tabaci* is the most thrips found in seedlings. *Frankliniella occidentalis*, *T. tabaci* and *F. intonsa* accounted for more than 70% of the total number of thrips detected in cut flowers. They have been shown a lot in chrysanthemums and carnations. *Bemisia tabaci* and *Trialeurodes vaporariorum* of the aleyrodidae were mainly detected in rubber tress seedlings. *B. tabaci*, and *T. vaporariorum* accounted for more than 90% of the cut flowers, and 85% of them were found in chrysanthemums.

Key words: Plant quarantine, Thysanoptera, Aleyrodidae, Cut flower, Seedling

P310

Library of high-resolution images on plant quarantine pests in Korea

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High-resolution images of the specimens are needed to identify for insect through the diagnostic characteristics as a taxonomic key. The images on pest specimens for quarantine purpose is not sufficient due to the low quality of resolution and characterisitcs for identification on insects. Therefore, high quality images are strongly needed. Animal and Plant Quarantine Agency produced about 800 high-resolution images as photographs and plates from 2021 to August 2022. Coleopteran insects are most taken as 372 cases (46.5%), followed by Lepidopteran as 176 cases (22%), Hemipteran insect as 147 cases (8.4%), and Dipteran insects as 87 cases (10.9%). Library of high-resolution images on pests will be used for classification and identification to alien insect speices for plant quarantine inspection.

Key words: High-resolution image, plant quarantine, insect, characteristics, classification

P311

Trend of plant quarantine pests on imported seedlings (41 items) in Korea

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Using the Pest Information System (PIS), we analyzed on 41 items of imported seedlings over the past 20 years. One hundred eighty five genus (250 species) were detected among 41 items of seedlings including *Vitis* spp., *Arecaceae* spp., and *Cattleya* spp. Tylenchida was the most common pest as 35.9%, followed by Hemiptera as 15.4%, Hymenoptera as 14.3%, and Coleoptera as 10.4% in detection rate. Among regulated pests from 41 items, *Radopholus similis* in Tylenchida was only detected species as prohibited pest, meanwhile 72 insects species are detected as managed pests including *Pseudococcus longispinus*, *Dysmicoccus neobrevipes*, and *Dysmicoccus brevipes* in Hemiptera and *Tapinoma melanocephalum*, *Tetramorium simillimum*, and *Paratrechina longicornis* in Hymenoptera.

Key words: plant quarantine, seedlings, quarantine pests, identification manual, PIS

P312

Safety assessment of frame used for honeybee (*Apis mellifera* L.) breeding and production of bee products

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꿀벌은 축산법에서 소·말·돼지 등과 같이 가축으로 정의하고 있으며, 꿀벌로부터 얻어지는 양봉산물은 축산물로 정의하고 있다. 현재 국내의 축산농장 (한우·젖소·돼지 등) 생산단계 HACCP 관련 내용은 축산물 위생관리법에서 규정하고 있는데 꿀벌은 제외된 상황이다. 축산농장 생산단계 HACCP은 가축의 사육단계에서 발생할 수 있는 위해요소 (동물용의약품, 살모넬라균 등)를 분석하여 중점관리 할 수 있는 기준을 정하고 인체에 위해한 물질이 축산물에 오염되거나 혼입되는 것을 방지하는 제도이다. 한편, 전 세계 급변하는 기후변화는 전국적으로 양봉농가에 월동봉군 피해를 안겼고, 근본적인 해결책을 위해서는 다양한 연구가 필요하다. 따라서 본 연구는 양봉농가 생산단계 HACCP 도입에 앞서 꿀벌 육종과 양봉산물 생산에 필수적인 소광대의 식품용 기구로서 안전성을 알아보려 하였다. 시험에 사용된 소광대는 시중에 판매하는 소광대를 구입하여 재료로 사용하였다. 식품용 기구 및 용기·포장 공전의 목재류 항목 분석 (mg/L) 결과 비소는 기준치 이하 및 불검출, 납은 기준치 이하 그리고 이산화황, 오소페닐페놀, 티아벤다졸, 비페닐, 이마잘린은 모두 불검출로 나타났다. 따라서 이러한 결과는 양봉산물 생산에 직·간접적 재료로 사용되는 소광대의 품질 데이터베이스 구축 및 양봉농가 생산단계 HACCP 연구에 기초자료로 활용될 수 있음을 시사한다.

검색어: 서양종꿀벌, 육종, 양봉산물, 소광대, 안전성

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**Biological characteristics and mass rearing of Korean *Luciola lateralis* Motschulsky
(Coleoptera: Lampyridae)**

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본 연구를 통해 애반딧불이의 생태와 대량사육법을 조사하였다. 또한 이들의 실내 대량사육시 효율적인 실내 대량사육을 위한 인공 산란장소의 이용과 자동 물 교환 시스템을 적용하여 유충의 유실을 최소화하고 사육에 소요되는 시간을 크게 단축하는 성과를 도출하였다. 이외에도 유충의 저온 저장 가능성 조사를 통해 애반딧불이의 개체를 연구 상시 확보 할 수 있는 기초자료를 수립하여 제시하였다.

검색어: 애반딧불이, 생태, 대량사육, 유충관리

