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한국곤충학회 한국응용곤충학회 공동

춘계학술발표회

Entomology and Big Data

일시 | 2023년 4월 27일 (목) ~ 28일 (금)

장소 | 그랜드플라자 청주호텔

주최



(사)한국곤충학회
The Entomological Society of Korea



(사)한국응용곤충학회
Korean Society of Applied Entomology

후원

KOFS
한국과학기술단체총연합회





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본 사업은 기획재정부의 복권기금 및 과학기술정보통신부의 과학기술진흥기금으로 추진되어 사회적 가치 실현과 국가과학기술 발전에 기여합니다.

인사말

존경하는 한국응용곤충학회 및 한국곤충학회 회원 여러분

만물이 소생하는 4월의 화창한 봄날에, 곤충학을 연구하는 국내 양대 학회의 회원 여러분들과 20여 년만의 공동학술대회를 개최함에 만감이 교차합니다.

한국곤충학회와 한국응용곤충학회는 상호 교류를 통해 지속적으로 한국곤충학 발전에 크게 기여하고 있으며, 그동안 공동학술대회 개최, 2012 ICE대구 공동개최 및 한국곤충명집 공동발간 등을 통해 다양한 협력을 하여 왔습니다.

2010년대부터 양 학회의 학술지인 Entomological Research 및 Journal of Asia-Pacific Entomology가 SCIE에 선정되는 쾌거를 이루었으며, 국제 곤충학 연구 분야에서도 주도적인 위치에 올라서게 되었습니다.

21세기 들어서 변화하는 기후환경에 따라 곤충학은 더욱 중요성을 인정받고 있으며 산업곤충학과 같은 새로운 곤충 분과학이 두각을 나타내고 있습니다. 이에 이번에 양 학회의 공동개최를 재개함으로써 시너지 효과를 높이고 국내 곤충학 연구를 한 단계 더 높일 수 있는 기회가 되었으면 합니다.

제 기억으로는 양 학회의 마지막 공동학술대회가 2001년에 있었던 것으로 알고 있습니다. 20여 년만의 공동학술대회를 개최함에 있어서 박종균 한국응용곤충학회장님 및 한국응용곤충학회 회장단 임원 분들의 협조와 양해에 감사를 드립니다. 특히 짧은 준비 기간 중에 서로 다른 양학회의 학술대회 방식을 조율하고 준비해 주신 한국곤충학회 이용석 학술위원장님과 한국응용곤충학회 임언택 학술위원장님 및 준비위원 분들에게도 깊은 감사를 드립니다.

오늘의 공동학술대회를 시작으로 양 학회 회원분들의 교류와 협력이 더욱 활발해지고, 소통과 화합을 통해 대한민국 곤충학의 새로운 시대가 열렸으면 합니다. 이제 세계 속의 한국 곤충학이 우뚝 설 수 있도록 다 같이 하나 되어 전진합시다.

코로나 사태의 길고 어두운 터널을 나와 처음 맞이하는 2023년 춘계 공동학술대회에 참석하신 모든 곤충학 동료들께 감사드리며, 양 학회 회원 여러분들 모두 행복과 기쁨이 충만하시길 기원합니다. 감사합니다.

2023년 4월 27일

사단법인 한국곤충학회

회장 권 오 석

인사말

존경하는 한국곤충학회와 한국응용곤충학회 회원 여러분

오늘 이렇게 대한민국의 곤충학을 이끌어가는 두 학회의 회원 여러분을 모시고 역사적인 공동학술대회를 개최함에 설레는 마음을 어떻게 표현할 수 없을 정도로 벅차고 기쁩니다.

과거 20여 년 전에 두 학회의 공동학술대회가 개최된 이후 실로 오랜만에 본 공동학술대회가 이루어져 더욱 뜻깊게 생각하고 있습니다. 최근 두 학회가 3년여간의 노력의 결실로 한국곤충명집을 성공리에 발간한 것과 같이 상호 협력하고 노력하면 더 나은 미래로의 상생이 가능함을 확신하였습니다.

우리는 자라나는 미래의 젊은 곤충학자들을 위하여 더 다양한 분야를 접하게 하고, 더 다양한 경험을 할 수 있는 기회를 주어야 하며, 두 학회는 더 협력하고 발전해야 한다고 생각합니다. 이것이 우리 기성세대의 역할이고, 사명입니다. 오늘 역사적인 이 자리에서 여러분과 함께 공동학술대회를 통하여 단독 학술대회에서 경험하지 못한 새로운 미래를 볼 수 있으리라 생각합니다.

오랜 시간 단독 학술대회에 익숙했던 탓에 공동학술대회를 준비하는 과정에 많은 어려움도 있었으나 권오석 학회장님을 중심으로 한국곤충학회 임원진의 적극적인 협력, 그리고 임언택 학술위원장님을 비롯한 한국응용곤충학회 임원진의 수고로 이렇게 공동학술대회가 개최되었습니다. 두 학회 임원진 여러분께 고개 숙여 감사 인사를 올립니다.

한 걸음 더 나아가 대한민국의 곤충학의 지평을 넓히기 위하여 지속적인 두 학회의 공동학술대회 개최는 물론 양봉, 양잠, 산업곤충 관련 학외와의 공동 개최를 통해 더 곤충학의 양적, 질적 성장을 기대해 봅니다.

오늘 공동학술대회는 두 학회가 단순히 시간과 공간을 공유하는 자리가 아닌 두 학회 회원 여러분의 마음과 미래를 공유할 수 있는 소통과 화합의 자리가 되길 간절히 소망하며, 두 학회가 손을 잡고 더 나은 미래로 걸어가는 새로운 출발점이 되길 빌어봅니다. 다시 한번 본 행사를 위하여 수고해주신 여러분께 깊은 감사를 드리며, 두 학회 회원 여러분 모두 건강하시고, 가정의 행복과 행운이 가득하시길 기원합니다.

2023년 4월 27일

사단법인 한국응용곤충학회

회장 박종균



2023년 한국곤충학회 • 한국응용곤충학회 공동 춘계학술발표회

Entomology and Big Data

일시: 2023년 4월 27일(목) 11:00 ~ 28일(금) 12:00 / 장소: 그랜드플라자 청주호텔 3층

Program

27 April (Thursday)

Time	Contents		Room	
11:00~12:00	Registration		Desk	
12:00~12:20	Opening Ceremony		Grand Ballroom-A+B 3F	
Keynote Address				
12:20~12:50	Insect Diversity to the New Value of Future Science Bong-Kyu Byun (Hannam University)		Grand Ballroom-A+B 3F	
12:50~13:20	생명연구자원의 확보·관리·활용을 위한 과학기술정책 김영혜 (과학기술정보통신부 첨단바이오기술과장)			
17:20~17:50	Development of Improved Biological Pesticides using Synthetic Biological Application of <i>Bacillus thuringiensis</i> Min Gu Park (Seoul National University)		Grand Ballroom-A+B+C 3F	
Oral Presentation (Competition / Non-Competition)				
13:20~16:00	Generals	All Subjects	Grand Ballroom-A+B 3F	
	Graduates	Ecology / Pest Control / Medical Entomology I		Grand Ballroom-C 3F
		Ecology / Pest Control / Medical Entomology II		Uam Hall 3F
		Physiology / Molecular Biology / Industrial Entomology / ETC		Jikji Hall-A 3F
		Taxonomy / Phylogeny / Morphology	Physiology / Molecular Biology / Industrial Entomology / ETC	Jikji Hall-B 3F
16:00~16:10	Coffee Break			
Poster Presentation (Competition / Non-Competition)				
16:10~17:10	In-person Presentation		Jusung Hall 3F	
17:10~17:20	Coffee Break			



Time	Contents	Room
KSAE/ESK Meeting		
17:20~18:00	Grand Ballroom-A+B+C	Uam Hall
	General Meeting & Special Lectures of the Winner for Songjeong Award (Bong-Kyu Byun) and Young Entomologist Award (Min Gu Park) (KSAE)	한국곤충학회 공로상시상식 및 임시총회 (ESK)
18:00~18:20	Coffee Break	
18:20~20:00	Banquet	Grand Ballroom
Small Group Meeting		
20:00~21:00	Academic Committee Meeting (KSAE) Un Taek Lim (Andong National University) Donghun Kim (Kyungpook National University)	Mars 2F
	Editorial Board Meeting (KSAE) Kijong Cho (Korea University) Jung-Joon Park (Gyeongsang National University)	Hwarang Room 2F
	Graduate Program for the Undiscovered Taxa of Korea (KSAE) Sunghoon Jung (Chungnam National University)	Jikji Hall-A 3F
	Biological Control in Practice (KSAE) Kyeong-Yeoll Lee (Kyungpook National University)	Uam Hall 3F
	ESK Meeting (ESK)	Jikji Hall-B 3F

28 April (Friday)

Time	Contents	Room
Symposia		
09:00~11:30	Entomology and Big Data (by both KSAE and ESK) Yong Seok Lee (Soonchunhyang University) Jae Su Kim (Jeonbuk National University)	Grand Ballroom-A+B 3F
	Trends in Applied Insect Genome Research (KSAE) Juil Kim (Kangwon National University)	Grand Ballroom-C 3F
	Recent Trends in Hymenoptera Research in Korea (ESK) Moon Bo Choi (Kyungpook National University)	Uam Hall 3F
	Forest Entomology: Present and Future (KSAE) Jong-Kook Jung (Kangwon National University)	Jikji Hall-A 3F
	Current Status of Vector Biology in Korea (ESK) Yeon Soo Han (Chonnam National University)	Jikji Hall-B 3F
11:30~11:40	Coffee Break	
11:40~	Closing Ceremony Awards of Competition and Raffle Tickets, Presidential Address, Gwanjung Bok-Sung Cho Quiz	Grand Ballroom-A+B 3F



Contents

Keynote Address

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Symposia

S1. Entomology and Big Data

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S1-3 10:00~10:30	Transcriptome Analysis to Reveal Interactions between Entomopathogenic Fungi and Insects..... 10 Jong-Cheol Kim, Jung Eun Yang, Ho Myeong Kim and Hae Woong Park	
S1-4 10:30~11:00	Data Drive Biological Science!..... 10 Byeong-Chul Kang	
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S2-2 09:30~10:00	Phylogenomics Yields New Insight into the Evolution of Plant Feeding Beetles..... 12 Seunggwan Shin	
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S5. Current Status of Vector Biology in Korea

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Oral Presentation

1. General - All Subject

4. 27. Thu

Grand Ballroom-A+B 3F

Moderator: Dong-soon Kim (Jeju National University)
Soo Dong Woo (Chungbuk National University)

Competition

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Young Su Lee (Gyeonggi Agricultural Research and Extension Services)

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Jun-Ran Kim (Animal and Plant Quarantine Agency)

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5. Graduate_Taxonomy, Phylogeny, Morphology

4. 27. Thu

Jikji Hall-B 3F

Moderator: Jongho Lee (Animal and Plant Quarantine Agency)
June-Yeol Chol (National Institute of Crop Science)

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3. Biological Control in Practice

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Keynote Address



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Insect Diversity to the New Value of Future Science

Bong-Kyu Byun

Department of Biological Science and Biotechnology, Hannam University, Korea

곤충은 지구 생물다양성 중 가장 높은 다양성을 보이며 이로 인해 다양한 연구소재로는 물론 각종 산업화 소재로 그 가치가 재조명되고 있다. 금번 발표에서는 발표자가 그동안 연구해 온 곤충다양성 및 그와 관련된 확대 연구분야를 소개하고 보다 높은 단계로의 발전 방향에 대해 알아보고자 한다.

현재까지 연구해 온 분야는 곤충분류학 및 활용 분야를 우선적으로 들 수 있는데, 특히 산림 곤충의 주요 분류군별 DNA 바코드 정보사업(2012~현재)을 통해 곤충분자동정 기반구축, 곤충자원화 및 산업화 연구(2016~2018), 기후변화와 산림 곤충 분포역 변화(2012~2015), 잠재외래 산림해충의 ICT 연계 진단시스템 개발(2017~2019), 외래 무척추동물(곤충)의 확산 및 변화예측 기술개발(2017~2023) 등과 같이 현실적으로 적용 가능한 연구과제를 발굴·수행하여 곤충학의 새로운 영역을 열어가는 활동도 활발히 추진해 왔다.

또한, 그동안 연구가 미진했던 분류군을 대상으로 집중적인 계통분류학적 연구를 추진했다. 특히, 한국산 잎말이나방과의 계통분류(2011~2014), 가는나방과의 계통분류(2017~2019), 한국산 잠엽성 곤충의 계통분류 (2021~2024), 생물지 발간사업(2022~현재), 등을 꾸준히 수행하여 다양한 응용곤충 분야에 활용할 자료를 제공하고 있다.

이외에도, 자연사 연구소재의 확충을 위해 과학관 전시물 보존 및 전시물 정보공유 플랫폼 구축 (2018~2021)을 통해 국내 중소 과학관의 콘텐츠 확충에 일조하였다. 또한, 곤충학 연구 저변확대 및 학제연구 활성화를 위해 친환경 벌채와 곤충다양성(2012~2021) 및 화분매개원조성 기초연구(2021)를 통해 곤충과 타 학문과 접목을 통한 시너지 제고에 기여하였다. 또한, 일찍이 생물정보의 중요성을 인식하여 산림청에 국가생물종 지식정보구축사업(곤충정보 40여 만 건)을 주도하여 우리나라가 곤충 정보화 방면에서 국제적 상위권에 진입하는 데 일조하였다.

이와 같은 배경을 바탕으로 앞으로 접근성이 용이한 곤충분류학과 그 활용성을 제고하여 학제간 연구가 가능한 분야를 발굴하여 연구를 추진할 계획이다.

검색어: 곤충다양성, 곤충의 자원가치, 분자동정, 신분류학, 학제간 연구

생명연구자원의 확보·관리·활용을 위한 과학기술정책

김영혜

과학기술정보통신부 첨단바이오기술과

생명연구자원은 생명공학 연구 또는 산업적으로 실질적, 잠재적 가치가 있는 인체유래물, 동물, 식물, 미생물 등 다양한 생물체 실험체와 이로부터 산출된 생명 정보로 정의된다. 생명연구자원은 감염병, 기후변화, 식량부족 등 인류가 직면한 난제의 해결뿐만 아니라 의약품 등 산업에서 고부가가치를 창출할 수 있는 잠재적 가치를 가지고 있어 전 세계적으로 확보와 활용의 중요성이 증대되고 있다. 과학기술정보통신부는 2009년에 제정된 ‘생명연구자원의 확보·관리·활용에 관한 법률’에 따라 관계부처와 함께 생명연구자원의 효율적인 확보와 체계적인 관리를 통해 활용을 촉진하는 정책을 추진하고 있으며, 특히 ‘제3차 기본계획(‘20~’25)’ 수립을 통해 바이오 연구데이터의 수집·공유 기반을 구축하여 데이터의 활용으로 연구의 효율성을 제고하고, 바이오 연구 소재의 실험체와 정보를 신속하게 확보할 수 있는 인프라 조성을 추진하고 있다. 이의 일환으로, 바이오 연구데이터 자원의 경우에는 범부처 데이터의 공유 허브 플랫폼으로 국가 바이오 데이터 스테이션(K-BDS)을 구축을 지원하고 있으며, K-BDS를 중심으로 데이터기반 바이오 연구 환경을 조성할 계획이다. 바이오 연구소재 자원의 경우, 기존에 부처별로 관리하던 소재자원은행을 배양세포, 모델동물, 합성화합물 등 14개 클러스터로 재편하고 클러스터별 중앙은행 중심의 협력네트워크를 수요맞춤형으로 육성하며, 수요자의 접근성과 편의성 제고를 위해 소재 정보의 통합 검색부터 분양신청 과정이 원스톱으로 이뤄지는 ‘소재정보 통합 포털시스템’ 구축을 추진 중이다.

Development of Improved Biological Pesticides using Synthetic Biological Application of *Bacillus thuringiensis*

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Bacillus thuringiensis (Bt) produces insecticidal crystal protein which have been used as a major ingredient of most bio-insecticides. The use of Bt in synthetic biology is highly desirable to take advantage of the unique metabolic pathways in this organism for enhanced toxicity, and delay of resistance development. This study aimed to develop a biological pesticide targeting a wider range of pests by isolating and characterizing Bt strains. To enhance the insecticidal activity of Bt strains, novel Bt IMBL-B9 strain were isolated and genetically modified. Additionally, alternative methods using spore-deficient gene engineering and polymer nanoparticle (PNP) technology were developed to improve the transformation efficiency of Bt strains. Finally, a Bt-based dsRNA production system was established to demonstrating the technical potential to control both honeybee Sacbrood viruses (SBV) and *Galleria mellonella*, wax moths simultaneously.

Key words: *Bacillus thuringiensis*, synthetic biology, *Apis cerana*, sacbrood virus, *Galleria mellonella*



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S1-1

Research Status on Big Data for Entomology

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디지털+바이오 융합으로, 2030 글로벌 바이오 강국으로 도약하겠다는 「디지털바이오 혁신전략」이 2022년 12월 과기정통부에 의해 발표되었다. 인공지능·빅데이터를 활용하여 생명현장에 대한 분석·예측을 고도로 가능하도록 하기 위해 5대 인프라 12대 핵심기술을 육성하겠다는 내용을 골자로 하고 있다. 곤충학 분야는 5대 인프라 중 바이오 소재 플랫폼의 14대 소재 정보에 포함되어 있으며, 데이터 기반 바이오연구 확산을 위해 구축하는 국가바이오데이터스테이션에 전 분야 연구데이터에 곤충 관련 데이터도 포함되어 있으며, 12대 핵심기술 중 일부 기술과 연관성이 있다. 본 발제에서는 최근 5년간 국가 R&D 사업, 과제를 대상으로 곤충을 대상으로 한 빅데이터 과제현황조사 결과를 공유하고자 하며, 미래지향적으로 곤충학 분야에 있어서 빅데이터 분석을 위한 기반구축의 방향을 정책적으로 제시해 보고자 한다.

Key words: Digital Bio, Bigdata, Entomology

S1-2

The trivia: What to and how to analyze and generate big data from next-generation sequencing technology

Woo-Jin Kim and Minlee Kim

R&D Center, Genolution Inc.

DNA sequencing has been the essential tool for biological sciences. With the Sanger sequencing technology, the 3 Gbp of human genome had been sequenced which took a decade to complete by 2003, and cost three billion dollars. As the technology keep evolving, the new sequencing platforms which utilize sequencing-by-synthesis, so called NGS, can sequence 3 Tbp of DNA/cDNA in three days under \$75,000 today. Because of the high throughput of current NGS technology, the traditional wet-lab experiments for gene expression studies can be substituted with NGS, and construction of custom database became a feasible project; therefore, the experimental design, NGS platforms, and spectra of the applications became indispensable elements for functional genomics study today.

Key words: Next-generation sequencing, NGS, transcriptome, functional genomics

S1-3

Transcriptome analysis to reveal interactions between entomopathogenic fungi and insects

Jong-Cheol Kim, Jung Eun Yang, Ho Myeong Kim and Hae Woong Park

Fermentation Regulation Technology Research Group, World Institute of Kimchi

Entomopathogenic fungi are being developed as eco-friendly microbial resources for pest control to replace synthetic chemical insecticides. However, the slow insecticidal activity and the lack of information on the mechanism of action of the fungi must be overcome in the development of excellent insecticides. In order for entomopathogenic fungi to develop into improved insecticides, it is necessary to clarify the mode of action, and transcriptome analysis is proposed as one of the ways to solve this problem. Transcriptome analysis can predict changes and secreted metabolites of fungi in pests, and explain the immune response in insects against the fungi. The interaction analysis between entomopathogenic fungi and pests by transcriptome analysis can clearly suggest the mode of action of the fungi that was lacking, and it will be possible to approach pest control in various ways by investigating the response of pests caused by the fungi.

Key words: *Beauveria bassiana*, Entomopathogenic fungi, Interaction, Pest management, Transcriptome analysis

S1-4

Data drive Biological Science!

Byeong-Chul Kang

D.iF, Inc., Suwon, Republic of Korea

Data-driven biology combines interdisciplinary expertise to analyze large-scale biological datasets using computational tools and algorithms. Key aspects include high-throughput technologies, bioinformatics, systems biology, machine learning, artificial intelligence, and data integration and visualization. This approach helps researchers understand complex biological systems, identify potential drug targets, predict disease outcomes, and uncover gene functions. As biological data volume and complexity grow, data-driven biology will play a crucial role in advancing our understanding of life processes.

Key words: Data-driven biology, High-throughput technologies, Bioinformatics, Systems biology Machine learning

S1-5

Research on AI/ML Based Automatic Species Identification Program (Focus on Cicada Image and Sound Recognition)

Kyung-Su Kim¹, Jisu Lee¹, Dong-seok Jang², Kyung-min Park² and Taewoo Kim²

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인공지능(AI) 기술을 활용하여 일반인의 생물 종 동정 수요를 충족시키기 위한 종 동정 프로그램이 필요해지고 있다. 본 연구에서는 상대적으로 쉽게 획득할 수 있고 선택에 대한 효능이 많이 연구되는 매미 13종의 선택(탈피각) 이미지와 소리를 통한 매미 종 동정을 연구하였다. 학습에 필요한 데이터는 2021년부터 2022년 7월부터 9월까지 채집한 선택 이미지(5,000장)와 소리(1,800건, 65,455샘플)에 대해 데이터 라벨링 및 전처리를 진행하였다. 본 연구에서는 이미지 및 소리파형을 학습하는 딥러닝과 선택 형질정보 및 소리 특성에 대한 머신러닝을 병행하여 연구하였다. 이미지는 인셉션-레즈넷-V2(InceptionResNetV2)를 이용하였고 소리 데이터는 1초 간격으로 분할한 후 TensorFlow 라이브러리를 사용하여 스펙트로그램 이미지로 변환하여 합성곱 순환 신경망(CRNN) 모델을 적용하여 자동 종 분류 시스템을 개발하였다. 결과의 정확도는 파인 튜닝을 통해 개선되었다.

머신러닝에서 매미의 11개 형질을 측정하고 랜덤 포레스트(Random forest)를 통해 몸체 길이 및 머리 넓이가 종 구분에 높은 영향을 미치는 결과가 도출되었다. 소리의 경우, librosa 라이브러리를 사용하여 매미 소리에서 17개의 특성 값을 추출하고 XGBoost 분류기(XGB Classifier) 모델로 학습하였다.

이미지 딥러닝은 98.6%, 특성 정보는 95.6%, 소리 딥러닝은 99.1%, 특성 정보 머신러닝은 98.9%의 정확도가 도출되었다. 본 연구는 매미 이미지 및 소리 인식에 초점을 둔 딥러닝 및 기계 학습 기반 방법을 사용한 자동 종 동정에 대한 가능성을 보여준다. 이를 통해 생물학자와 일반인 모두가 종 동정에 대한 정보를 쉽게 얻을 수 있게 되어, 생물 다양성 관리와 보전에 기여할 것으로 기대된다.

앞으로의 연구에서는 매미 종 외에도 다양한 생물 종에 대한 자동 종 동정 프로그램을 개발하고, 정확도를 더욱 높일 수 있는 방법을 연구하고 결괄물에 대한 인공지능과 기계 학습 기반의 자동 종 동정 알고리즘을 공유함으로써, 타 분류군에서의 종 동정 기술에 활용될 수 있도록 할 예정이다. 이러한 연구를 통해 전문가뿐만 아니라 일반인들도 쉽게 생물 종 정보를 얻을 수 있게 될 것으로 기대된다.

검색어: 소리 분류, 딥러닝, 합성곱 신경망, 인공지능, 기계 학습, 매미 소리, 종 동정

S2-1

Introduction of recent genome sequencing technologies and applications

Sang-Choon Lee

PHYZEN Co. (www.phyzen.com)

Sequencing technology has made remarkable progress from the release of next-generation sequencing (NGS) technology in the early 2000s to the current 3rd-generation sequencing technology. In addition, bioinformatics has also been developed rapidly in order to efficiently analyze the big data produced by sequencing technologies and obtain scientifically meaningful results. Therefore, thanks to the development of the two fields, it is now possible to produce and analyze large-scale and high-efficient genome sequence data for almost all organisms, including insects, existing on earth. In this presentation, I would like to look at the development trend of genome sequencing technologies so far and introduce how this technology is being used in research, along with actual analysis results.

Key words: genome, next-generation sequencing, bioinformatics, insect

S2-2

Phylogenomics yields new insight into the evolution of plant feeding beetles

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Recent advances in bioinformatics and data provide new opportunities to resolve longstanding questions in insect evolution. Beetles (Coleoptera) arguably comprise the most diverse order of insects. Because of their varied trophic habits, including specialized forms of plant-feeding, they are well-suited for studying the evolution of trophic habits and life histories. However, relatively little remains known about the evolution and genomic basis of plant-feeding in beetles. We inferred the phylogeny of beetles (order Coleoptera) from nearly 5000 nuclear genes and traced the evolution of beetle genes promoting herbivory using 154 transcriptomes or genomes. Phylogenomic analyses resolved previously controversial beetle relationships, dated the origin of beetles to the Carboniferous, and supported the co-diversification of beetles and angiosperms. Moreover, we reconstructed the diversification of plant-feeding beetles, which account for nearly half of all beetle species, following convergent horizontal transfers of bacterial and fungal genes enabling the digestion of plant cell walls. Our findings clarify beetle phylogenetic relationships and reveal new insights into the evolution of plant-feeding and beetle diversity. Furthermore, this study shows how analyses of large-scale genomic data are revealing the evolution and genomic basis of insect biodiversity.

Key words: phylogenomics, next-generation sequencing, bioinformatics, evolution, insect biodiversity

S2-3

Genome analysis of *Trypoxylus dichotomus* Nudivirus

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The *Oryctes rhinoceros* nudivirus (OrNV) has long been used to control coconut rhinoceros beetle populations in many countries, especially in Southeast Asia. However, the OrNV invaded Korea in 2015 and decimated the farms that rear *Trypoxylus dichotoma* (*Allomyrina dichotoma*): cross-species infection were found. At that time, a complete genome sequence of *Trypoxylus dichotoma* was revealed although no genomic analysis of the virus was done. Here, we investigated the factors implicated in cross-species transmission of this virus other than *Oryctes rhinoceros*. Our findings provide a valuable resource for those seeking a greater understanding of cross-species nudivirus transmission.

Key words: Nudivirus, OrNV, Genome, *Trypoxylus dichotoma*

S2-4

Utilization of medical arthropod genomes to study vector competence

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Medical arthropods, such as mosquitoes, ticks, mites and hemimetabolous vectors, have been the focus of numerous genome sequencing projects. Currently, there are over 300 publicly available genome assemblies of vector arthropods in the NCBI Genome database, and this number is steadily growing due to advancements in genome sequencing technologies. In addition to providing fundamental genetic resources, the abundance of genomic data allows a more comprehensive understanding of the interactions between humans, arthropods, and pathogens. Comparative genomic analysis can also offer valuable insights into mechanism of disease transmission and parasitism. This talk will provide an overview of genome research on *Leptotrombidium pallidum* and *Pediculus humanus humanus* as vectors of human pathogenic bacteria, *Pediculus humanus capitis* as an oligate parasitic non-vector, and two *Anopheles* spp. as vectors of vivax malaria.

Key words: medical arthropods, genome, chigger mite, human louse, mosquito

S2-5

Trends in lepidopteran genomic research, focusing on the genera *Spodoptera* and *Helicoverpa*, and their applications to pest management

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The genera *Spodoptera* and *Helicoverpa* contain many agricultural pests, including *S. exigua*, and *H. armigera*. With the development of next-generation sequencing (NGS) technologies, a variety of studies on their genomes and transcriptomes have been actively conducted, leading to the discovery of previously unknown mechanisms of pesticide resistance and the development of resistance diagnostic markers and field application technologies. In particular, the reference genomes of the three major pests, *S. exigua* (ASM1567961v1), *H. armigera* (ASM2626255v1), and *H. assulta* (JAQOZT000000000), have recently completed using Korean populations. It is expected to enable more effective research on integrated pest management for the domestic populations in Korea. The presentation will focus on the case studies of diamide resistance in *S. exigua* and pyrethroid resistance in *H. armigera* using genomic research. In addition, other important aspects such as host-plant interactions and chemical communications of the two genera, *Spodoptera* and *Helicoverpa*, and their evolutionary relationship will be discussed based on the comparative genome analysis.

Key words: lepidoptera, next-generation sequencing, bioinformatics, evolution, integrated pest management

S3-1

Application and expansion of host analysis using DNA of gut contents from Ichneumonid wasps

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Family Ichneumonidae are the most diverse group within the order Hymenoptera, with about 25,000 cosmopolitan species. The members of family Ichneumonidae usually attack other insects or spiders. The ecology and host record of Ichneumonidae have been clearly identified for only about 11% of species. Classification and ecological studies are still very much needed. Many of the host records recorded so far have been revealed through breeding, which incurs a lot of time and space costs. Therefore, many scientists are trying various methods, and one of them is to use the gut DNA of adult parasitoids to apply it to the family Ichneumonidae and expand the range. Through a screen test, the DNA of the host, *Ivela disparis* was identified in the adults of *Pimla disparis* and *Theronia atalantae gestator* (Ichneumonidae: Pimplinae). In order to expand this study, I tried to identify the host by extracting the DNA of parasitoid wasps that have emerged from other hosts (mainly Lepidoptera).

Key words: Taxonomy, parasitic wasps, host, Hymenoptera

* This work was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (2021R1A6A3A01086474).

S3-2

Impact of the invasive Argentine ant, *Linepithema humile* on the native ants of Busan, South Korea

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The invasive Argentine ant, *Linepithema humile* is one of the world's most invasive species and was first reported at Busan on 13 August, 2019. The invasive ant may have originated from the United States or Japan based on haplotype analysis using COI, COII, and Cytb sequence of their mitochondrial DNA. This study assessed the effects of the *L. humile*, an invasive species, on the indigenous ant fauna using pitfall traps. Overall, we identified 14 ant species belonging to 12 genera and four subfamilies. I found that the species richness of the native ant community was significantly lower in areas invaded by *L. humile*, and most epigeic ants from the study area were not found co-existing with the Argentine ant. *Linepithema humile* continues to spread around the infestation point despite early detection and the implementation of control measure. As *L. humile* has settled in the main transport hub in South Korea, it has the potential to spread throughout the country through human-mediated transport if it is not effectively controlled. Therefore, more aggressive management controls are required to prevent nationwide dispersal. I propose that the logical time to act to improve the management of *L. humile* is now, while there is still an opportunity to limit spread.

Key words: Busan, invasive, *L. humile*, epigeic, control

S3-3

Comparison of microbial communities of *Vespa mandarinia* according to sequencing platforms (Illumina MiSeq and PacBio HiFi)

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장내 미생물군은 소화, 면역체계, 행동 및 질병 등 숙주의 여러 측면에 영향을 미치며, 지배적인 장내 미생물군은 숙주의 생리학적 측면에서 중요한 역할을 할 것으로 예측되고 있다. 최근 곤충의 장내 미생물군에 대한 연구가 활발하게 진행되고 있으며, 특히 장내 미생물군집과 기생충, 병원체의 관계, 특정 종내의 신호전달 체계, 먹이 소화 등에 대한 연구가 진행되고 있다. 이러한 곤충의 장내 미생물군집 연구는 지금까지 16s rRNA의 V1 영역부터 V9 영역 중 특정 영역을 선택하여 짧은 서열을 확보할 수 있는 Illumina MiSeq을 통해 진행하였다. 하지만 최근 PacBio HiFi 플랫폼이 개발되어 16s rRNA 전장서열을 해독할 수 있게 되었다. 본 연구에서는 장수말벌(*Vespa mandarinia*)을 해부하여 gut과 carcass로 나눠 각각 Illumina MiSeq과 PacBio HiFi 플랫폼을 이용하여 sequencing 하였을 때, 미생물군집의 차이를 확인하고자 수행되었다.

Key words: *Vespa mandarinia*, Illumina MiSeq, PacBio HiFi, microbiome

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S3-4

Current status of Hymenoptera research at the Korea National Arboretum

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국립수목원은 1999년 5월 24일 신설된 산림청 산하의 국내 최고 산림생물종 연구기관으로 산림 생물종과 생태계에 대한 다양한 역할을 담당하고 있다. 국내외 50만 점 이상의 곤충표본이 소장된 산림생물표본관, 최근 구축된 분자생물실험실의 우수한 연구시설을 바탕으로 활발한 곤충분류, 생태, 증식 및 복원연구를 추진 중에 있다. 특히, 국립수목원은 다양한 벌목분류군의 학자들이 각자 연구를 수행하고 있으며, 개원초기의 단순 생물상조사, 표본수집연구에서 발전하여 산림서식 해충의 생물학적 방제 기초연구로서 미소기생벌의 분류 및 생태연구, 각종 식물의 화분매개를 담당하는 화분매개 곤충(벌목중심)의 연구, 높은 종다양성을 가지는 벌류의 종 수준의 바코드 및 유전체 염기서열 추적, 산림 및 도심지에 자주 출몰하는 말벌류의 분류, 생태 및 독성분석 연구에 이르기까지 활발한 연구를 수행중에 있다. 앞으로 국립수목원에서 수행중인 많은 국가연구개발사업(R&D)과 연계하여 국내외 학자들과의 활발한 연구교류 및 공동연구, 신규 연구과제 발굴 등에 힘을 예정이다.

검색어: 국립수목원, 벌류, 산림생물표본관, 분류, 생태

S3-5

A review of predators of social wasps in South Korea

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사회성 말벌은 곤충계의 최상위 포식자이지만 말벌을 포식하는 천적에 대한 연구는 극히 드문 상황이다. 특히나 사회성 말벌은 그들의 강력한 독침을 사용하여 천적에 대한 집단 방어행동이 잘 발달되어 있어 그 방어 대상이 사람이 될 경우 매우 심각한 피해를 야기하기도 한다. 지금까지 한국에서 발견된 사회성말벌의 포식자는 대륙목도리담비, 반달가슴곰, 오소리과 같은 포유류가 대표적이며 그 외 벌매와 같은 조류도 포함된다. 그리고 같은 말벌류 중에서도 장수말벌과 꼬마장수말벌은 다른 말벌류의 벌집을 침략하여 성충을 죽이고 애벌레들을 사냥하기도 한다. 본 연구에서는 말벌 포식자들의 사냥 습성 및 대상종에 대한 종합적 검토를 실시하였다.

검색어: 말벌과, 포식자, 천적

S3-6

Review of endoparasites and parasitoids of social wasps in South Korea

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2010~2023년까지 사회성 말벌류에 기생하는 내부기생자(endoparasite) 및 기생포식자(parasitoid) 탐색을 한 결과 총 9과 13종으로 분석되었다. 내부기생자는 Stylopidae (*Xenos* spp.) 2종, Mermithidae (*Pheromermis* sp.) 1종이 나타났으며 기생포식자는 Ichneumonidae (*Latibulus* sp.) 1종, Trigonalidae (*Bareogonalos* sp.) 1종, Eulophidae (*Elasmus* spp.) 2종, Syrphidae (*Volucella* spp.) 2종, Pyralidae (*Pyralis* sp. and *Hypsopygia* sp.) 2종, Cosmopterigidae (*Anatrachyntis* sp.) 1종, Staphylinidae (*Velleius* sp.) 1종으로 나타났다. 따라서 본 연구에서는 분류학적 검토를 통한 종의 동정과 더불어 사회성 말벌에 대한 기생자의 역할을 종합적으로 검토하였다.

검색어: 말벌과, 내부기생자, 기생포식자, 천적

S4-1

Major issues and research status of forest insect pest management in forest and urban ecosystems

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In recent, the Korea Forest Service (KFS) and forest entomologists were faced with turning point in change of forest pest management regime. Because massive honeybee colony collapse was occurred in the last year, criticisms about the KFS's policy of pine wilt disease management, especially aerial application of pesticides have been arisen. The KFS was announced as aerial application of pesticides to prevent PWD spread will not be application in 2023, although other options, such as using tree injection methods, drones and vehicles, may increase in use expected. However, most management methods considered are based on synthetic chemicals that also have a negative impact potential on biodiversity. Thus, this study was aimed to review trends in the occurrence of forest insect pests and management regime in forest and urban ecosystems in Korea.

Key words: forest insect pests, outbreak, pesticide, environmental risk assessment, biodiversity

S4-2

Long-term effects of variable retention harvest on invertebrate biodiversity recovery

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Variable retention harvest has been introduced as an alternative to conventional clearcut, hoping to provide ecological benefits for original biodiversity. We studied recovery trends of three groups of ground-dwelling invertebrates (i.e., carabid beetles, staphylinid beetles, and spiders) using long-term data from the Ecosystem Management Emulating Natural Disturbance (EMEND) experiment, located in northern Alberta, Canada. We used a wide range of dispersed retention treatments from 2% to 100% retention at 1, 2, 6, 11, and 16 years post-harvest in four different forest stand types. We found that only staphylinid beetles showed rapid recovery in an early successional stand, while carabids and spiders did not recover even in high levels of retention 16 years post-harvest, regardless of the forest stand type.

Key words: biodiversity recovery, variable retention harvest, ground beetles, rove beetles, spiders, boreal forest

S4-3

Current status of chemical ecology research of forest insect pest and field application

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Semiochemicals including pheromone are chemicals used in chemical communication of insect. Semiochemicals have been widely used for population monitoring, mass trapping, and mating disruption of insect pest. In this presentation, the current status of pheromone research of major forest insect pest in Korea such as *Monochamus alternatus*, *M. saltuarius*, *Matsucoccus thunbergianae*, *Glyphodes perspectalis*, *Dioryctria abietella*, *Lymantria dispar*, *Synanthedon bicingulata*, and *Naxa seriaria* was introduced, and the results were compared with those reported in other countries. Based on the analysis of current pheromone research of forest insect pests, future studies and development direction was suggested.

Key words: pheromone, semiochemicals, forest insect pest, monitoring, mating disruption, mass trapping

Future of researches on forest insects in the border of South and North Korea

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Insects have wide host ranges and sometimes they can be regarded as important factors of serious economic or ecological damages to agriculture and forestry ecosystem. On the other hand, they can have potentials that can be used for insect industry. A lot of insect species distributes in forest but we especially do not know the insect fauna, especially in the border of South and North Korea. In this presentation, we introduce some cases of recent studies and research trends on forest insects in the border and discuss what we have to do to develop our knowledge on them.

Key words: Border, case, forest insect, insect pests

S4-5

Current research status on biological control agent of the Pine Wilt Disease vectors

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The field surveys were made in Pohang, Gyeongsangbuk-do, South Korea from 2018 to 2020 in order to elucidate ecological and biological characteristics of *Cyanopterus flavator* (Fabricius) and *Spathius verustus* Chao, larval ectoparasitoids on two cerambycid vectors of PWN, namely *Monochamus alternatus* Hope and *M. saltuarius* Gebler. The average parasitism rate of *C. flavator* was $6.33 \pm 6.21\%$ on the larvae of *M. alternatus* and $1.04 \pm 8.91\%$ on *M. saltuarius*. The average parasitism rate of *S. verustus* was $0.69 \pm 3.91\%$ on *M. alternatus* larvae and $0.55 \pm 3.93\%$ on *M. saltuarius*. Both parasitoids appeared to prefer *M. altanatus* over *M. saltuarius* as a host, but *C. flavator* just showed statistical significance. The peak season, mostly with the highest parasitism rate, of *C. flavator* appeared to coincide almost with the larval period of *M. alternatus*. As the parasitism rate of *C. flavator* increased along the tree height, it reached to the peak rate at the height where the larval density of *M. alternatus* was reported the highest. Indoor rearing experiments of both parasitoids were also conducted to study their biology such as fecundity, longevity, sex ratio and in-door parasitism rate, etc in prior to developing a mass-rearing method. *C. flavator* appeared more promising than *S. verustus* as it displayed higher parasitism rate, lived longer and produced more progeny, particularly at 30°C .

Key words: *Cyanopterus flavator*, *Spathius verustus*, *Monochamus*, biological control agent, pine wilt disease, pinewood nematode

S4-6

Preliminary assessment of invasion risk of forest pest: Climatic suitability for established non-native insects in Korea

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국제 무역의 증가와 기후변화는 전 세계적으로 많은 외래곤충들이 새로운 지역에 도입되어 정착할 기회를 제공하였다. 현재 해충으로 여겨지는 곤충 중 중 많은 수가 침입해충이며, 따라서 새로이 정착할 가능성이 큰 외래곤충을 탐색하고 유입을 차단하는 것이 중요하다. 본 연구에서는 외래곤충의 침습성을 결정하는 요소 중의 하나로 기후 적합성이 잠재적 침입해충의 예측변수로 이용될 수 있을지 탐색하고자 하였다. 국내에 정착한 외래곤충 74종의 국외 분포자료를 GBIF 데이터베이스를 이용하여 구축하였다. 분포자료와 함께 임의로 생성한 의사 부재 자료를 이용하여 WorldClim의 생물기후변수로 국내 기후 적합성을 추정하였다. 기후 적합성은 Classification tree analysis, Boosted regression tree, Random forest 알고리즘들을 이용한 모형들을 통합하여 앙상블 기법으로 최종 예측하였다. 각 종에 대한 모든 최종 모델은 우수한 예측 성능을 보였으며, 파리목, 나비목, 바퀴목의 기후 적합성이 높았으나 분류군 내에서도 큰 변이를 보였다. 주요 침입해충으로 분류되는 10종과 나머지 종간의 기후 적합성은 큰 차이를 보였다. 침입해충의 국내 적합성이 높았고, 따라서 외래곤충의 침습성을 평가하는 데 이용될 수 있을 것으로 판단된다. 국내 외래곤충의 기후 적합성은 해안가와 제주 지역에서 상대적으로 높은 것으로 예측되어 최초 유입 후 국지적 정착을 예방하기 위한 노력이 필요할 것으로 보인다.

검색어: 침입곤충, 산림해충, 기후 적합성, 침습성, 앙상블 모형

S5-1

Climate change vector surveillance centers in Korea: Now and Future

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The rise in temperature due to climate change leads to an increase in vectors, an expansion of distribution areas, and an increase in vector-borne diseases. There is also a possibility that diseases transmitted by vectors introduced from abroad may occur in Korea. Since 2010, we have established a nationwide vector monitoring network (VectorNet), and since 2017, we have operated vector surveillance centers in 16 regions. The vector surveillance center monitors the density and distribution of vectors and checks pathogen infections (Japanese encephalitis, West Nile fever, Dengue fever, Yellow fever, Zika virus infection, Scrub typhus, SFTS). We share surveillance data with the public and contribute to the establishment of vector surveillance infrastructure. We will continue to promote standardization work to produce data based on scientific evidence.

Key words: vector surveillance center, climate change, vector monitoring

S5-2

Developing an affordable nucleic acid extraction and RT-PCR kit for large-scale surveillance of vector-borne viruses: challenges and solutions

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Mosquitoes and ticks are major vectors of viral diseases, and detecting viruses in these arthropod populations is crucial for understanding disease transmission and outbreaks. Despite the emergence of newer methods, RT-PCR remains the gold standard for detecting vector-borne viral RNA due to its sensitivity, specificity, and versatility as a molecular technique. This presentation focuses on the nucleic acid extraction kit and RT-PCR kit that we developed for pan-flavivirus and SFTSV, as well as the challenges of scaling up surveillance efforts. We will discuss the protocol we developed and used, which is also utilized by the Korea Centers for Disease Control and Prevention Agency. We will explore the need for affordable and efficient analysis, and highlight the importance of standardizing protocols to scale up surveillance efforts. In this presentation, we will also discuss a case study of a cost-effective and time-efficient diagnostic solution for a large-scale viral surveillance network. Our approach involves integrating RT-PCR with a sample pooling and nucleic acid extraction strategy to detect multiple or single viral targets. This method is optimized for large-scale surveillance field application and provides an efficient way to monitor emerging viruses and gain a better understanding of domestic vector-borne virus ecology.

Key words: Flavivirus, SFTSV, RT-PCR, Nucleic acid extraction, Vector-borne viruses, Viral surveillance

S5-3

Understanding of overwintering ecology of *Haemaphysalis longicornis*, an important vector of severe fever with thrombocytopenia syndrome (SFTS) virus

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It is fundamental to understand overwintering ecology of medically-important vectors to develop long-term and effective management strategies. However, winter ecology of the most disease vectors remains unknown, and this is no exception for *Haemaphysalis longicornis*, an important vector of severe fever with thrombocytopenia syndrome (SFTS) virus. Thus, we conducted a field survey from eight provinces in South Korea to characterize overwintering sites of *H. longicornis* and investigate their SFTS virus infection rates. A total of 679 samples were inspected, consisting of three different structures: ground (leaf litter, soil surface, and topsoil layer), rocks, and dead trees. From the survey, 85 overwintering ixodid ticks were found from ground samples, especially topsoil layer in herbaceous landscapes. *Haemaphysalis longicornis* was the dominant species (88%), mostly in nymphal stage (94%). In addition, SFTS virus was found from 3 out of 38 pools of *H. longicornis* nymphs.

Key words: vector biology, longhorned tick, hard tick, tick-borne disease

S5-4

The relationships between microbiome diversity and epidemiology in domestic species of malaria-mediated mosquitoes of Korea

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Microbiome in the mosquito plays an important role in their behavior and vector competence. The composition of their microbiome is strongly influenced by the environment, especially their habitat. Using 16s rRNA Illumina sequencing, we here compared the microbiome profiles in the adult female of *Anopheles sinensis* from malaria hyperendemic and hypoendemic areas in Korea. In different epidemiology group, the alpha and beta diversity analysis were significant. The major bacterial phylum was Proteobacteria. Most abundant species in microbiome of hyperendemic mosquito was the genera *Staphylococcus*, *Erwinia*, *Serratia*, and *Pantoea*. We found distinct microbiome profile dominated by *Pseudomonas synxantha* in the hypoendemic area, indicating that there would be a correlation between the microbiome profiles and the incidence of malaria cases.

Key words: vector biology, mosquito, *Anopheles sinensis*, mosquito-borne disease, microbiome

S5-5

Research about DENV transmission possibility by the Korean *Aedes albopictus* infected with DENV and exploration of immune related genes in response to mimic DENV ssRNA-like molecule

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흰줄숲모기는 dengue virus (DENV), zika virus (ZIKV), chikungunya virus (CHIKV)를 매개하는 것으로 알려져 있는 주요 매개체로 이집트숲모기와 함께 가장 많이 주목받는 *Aedes* 속의 모기이다. 선행된 연구 결과에 따르면 흰줄숲모기는 22개 이상의 arbovirus를 전파시킬 수 있는 것으로 알려져 있으며 이집트숲모기가 적응하지 못하는 온대 기후에서도 토착화가 가능한 것으로 확인되어 그 중요성이 더 부각되고 있다. 온대 기후에 해당하는 한반도의 모기 매개 질병의 제어를 위해서는 흰줄숲모기의 질병 감수성 확인 및 관련 유전인자에 대한 이해가 매우 중요할 것으로 사료된다.

본 연구는 DENV의 잠재적 매개체인 한국산 흰줄숲모기에 면역 유도제인 DENV like mimic ssRNA를 주사한 후 비교 전사체 분석을 수행하였다. 또한 한국산 흰줄숲모기의 DENV에 대한 감수성을 확인하고 면역, 생리 관련 유전자의 발현을 확인하였다. 이러한 시도는 한국산 흰줄숲모기에 대해서는 최초로 수행된 것으로 본 연구 결과는 향후 국내 DENV의 유입 및 전파에 대한 예측 자료 작성 및 역학조사 등에 기초자료로 사용될 수 있을 것으로 기대된다.

검색어: *Aedes albopictus*, 매개체 매개 질병, 전사체, DENV, 질병매개능, 질병감수성

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S5-6

SFTS in the soldiers with military dogs

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The purpose of this study was to estimate the prevalence of Severe fever with thrombocytopenia syndrome (SFTS) in the military working dogs (MWDs) and their handlers. Serum was collected from 163 MWDs and 29 handlers. Real time reverse transcriptase polymerase chain reaction (qRT-PCR) test and IgG/M antibody tests by ELISA/IFA for SFTS were performed on serum samples. Basic physical examination and complete blood count (CBC) were also performed each MWD to investigate clinical correlation. Also PCR tests were performed on ticks collected from environment where soldiers and MWDs trained. In this study, 9 MWDs (5.5%) and 2 handlers (6.8%) showed positive PCR results. Among handlers, 11 (37.9%) IgG-, and 1 (3.4%) IgM-reactive cases were found. Among overall MWDs, 37 cases (22.7%) showed thrombocytopenia, while among PCR-positive group, 5 cases (55.6%) were thrombocytopenia. No clinical signs or symptoms associated with SFTS were observed both in MWDs or handlers. Through three cases confirmed by data from MWDs and handlers, it was confirmed that there is a risk of infection between handlers, MWDs and Ticks in the military. This study suggests that some MWDs showed asymptomatic infection. and there is a potential risk of transmission between soldiers and MWDs. To monitor the risk of transmission of SFTS in the military, surveillance system should be established including MWDs, handlers and ticks.

Key words: Severe fever with thrombocytopenia syndrome (SFTS), Military working dogs, Handlers

S5-7

Development of lentivirus-based RNA reference material for molecular detection of SFTS virus

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Severe Fever with Thrombocytopenia Syndrome (SFTS) is a tick-borne hemorrhagic fever caused by *Dabie bandavirus*, also known as SFTS virus. Since its first description in 2009, SFTS has spread rapidly among East Asian countries with reported mortality rates ranging from 4.8 to 27 percents. Molecular techniques, including nucleic acid amplification technique (NAAT)-based assays, are the preferred choice by diagnostic laboratories for detection of SFTS virus. Reference materials are required for calibration and performance assessment of NAAT-based assays. Here, we describe the development of RNA reference material for SFTS virus. SFTS virus RNA is packaged into a virus-like particle using lentivirus-based system, which allows evaluation for efficiency of the extraction procedure. Therefore, this virus particle-encapsulated RNA reference material can be used to standardize and control every step of diagnostic procedures, from extraction to final quantitative results. Moreover, since this virus-like particle RNA reference material is non-infectious and non-replicative, researchers and clinicians can perform calibration and performance assessment of their NAAT-based assays without biological safety concern raised by handling live or inactivated virus.

Key words: Severe fever with thrombocytopenia syndrome (SFTS), *Dabie bandavirus*, reference material, virus-like particle, vector biology



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01

Optimizing ethyl formate fumigation for greenhouse pest control: Assessing efficacy, Residue evaluation, and phytotoxicity in three major cucurbit crops

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This study aims to evaluate the optimized ethyl formate (EF) fumigation method for controlling two major insect pests, *Myzus persicae* and *Trips palmi*, in greenhouse-grown cucurbit crops including watermelon, zucchini, and melon. We investigated (1) EF residue levels and their potential environmental impact using headspace-gas chromatography-mass spectrometry (HS-GC-MS), (2) phytotoxicity in three crops at different developmental stages under both laboratory and field conditions, and (3) strategies to mitigate phytotoxicity, thus broadening the range of target pests at more higher concentration. Our findings indicate that optimized EF fumigation can effectively control greenhouse pests while enhancing environmental sustainability and minimizing phytotoxic effects on cucurbit crops. This research provides valuable insights into the development of environmentally responsible pest control strategies for greenhouse cultivation.

Key words: Residue-free, Phytotoxic mechanism, Environmental sustainability, Aphids, Trips

02

Effects of drone spray on the development of honey bees by neonicotinoid insecticide

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네오니코티노이드계 살충제는 유럽 등 사용이 금지된 살충제이다. 그러나 국내에서는 아직 벼, 사과 등 대부분의 작물에서 쉽게 사용되고 있다. 그래서 본 연구에서는 벼 농가에서 관용적으로 사용되는 네오니코티노이드계 살충제인 이미다클로프리드를 드론 방제했을 때 꿀벌 봉군 발육에 미치는 영향을 조사하였다. 살포지는 개활지이고, 살포 대상지로부터 10m, 20m, 50m에 꿀벌 봉군을 설치하였다. 총 2번에 걸쳐 약제를 살포하였으며, 살포일로부터 일주일간 매일 봉군 소문앞 사봉수를 측정하였다. 봉군 발육조사는 성충수, 유충수, 봉관의 수를 기준으로 하였고, 살포일로부터 1주일에 한 번씩 한 달간 조사하였다. 그 결과 거리에 따른 사봉수는 차이를 나타내지 않았으나, 누적 사봉수에서 살포 바로 다음날에 급격히 증가하는 경향을 보였다. 특히 유충의 수는 살충제 살포일로부터 급격하게 감소하는 경향을 보였다. 본 연구의 결과를 바탕으로 네오니코티노이드계 살충제 연구의 기초자료로 사용될 수 있을 것으로 사료된다.

검색어: 드론방제, 만성독성, 꿀벌독성, 농약피해실태, 살충제

Evaluation of acaricide resistance of *Tetranychus urticae* at the strawberry fields

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Tetranychus urticae Koch is known to have a high tendency to develop resistance to acaricides among the mite species. In the present study, we evaluated the susceptibility baseline and resistance status of field populations of *T. urticae* to eight different acaricides that were collected in 2022 from six different locations over the Korea. The susceptibility baselines and resistance status of these populations to the tested acaricides were assessed in the lab via direct spray application. The findings revealed that *T. urticae* field populations from all the collected locations were highly susceptible to acequinocyl, abamectin, and chlorfenapyr. However, populations of *T. urticae* showed higher tolerance and eventually developed resistance to fenpropathrin and pyridaben. The findings of our study will help future efforts to monitor *T. urticae* resistance to acaricides.

Key words: spider mite, resistance monitoring, resistance management, susceptibility

04

Effects of land cover and insecticides around apiaries on overwintering activity of honey bee colonies

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최근 꿀벌의 월동 폐사율이 높아지고 있다. 이상기온, 농약, 병해충 등이 원인으로 추측되며, 그 중 농약의 사용이 꿀벌에 매우 치명적일 것이라고 언급되고 있다. 본 연구는 실제 양봉농가에서 발생하는 농약 피해 실태를 파악하고, 주변 토지 피복도와 꿀벌 봉군 월동에 어떠한 관계가 있는지 분석하고자 하였다. 이를 수행하기 위해 전국 272개 양봉농가를 대상으로 농약 피해에 대한 설문을 수행하였다. 이들 중 80여 개의 양봉농가를 기준으로 반경 100m 이내 토지 피복도를 조사하였다. 각 농가의 월동 폐사율을 조사하고, 상관성을 분석하였다. 설문 결과 전체의 약 51%는 농약의 피해 심각도가 높을 것이라고 대답하였다. 농약 살포 형태로는 지상 방제가 43%로 가장 많았으며, 드론 방제 34%가 그 다음을 차지하였다. 또한, 드론 목격 시기와 꿀벌의 농약 피해시기가 일치하는 것으로 나타났다. 월동 폐사율과 양봉장 주변 토지 피복도 사이의 관계를 조사한 결과 논, 밭, 혼효림, 침엽수림에 의한 토지 피복도가 높을수록 월동 폐사율이 높아지는 경향을 보였다. 본 연구의 결과를 통해 꿀벌 농약 독성 연구를 위한 기본 근거 자료의 바탕이 될 것으로 사료된다.

검색어: 드론방제, 경관분석, 꿀벌독성, 농약피해실태, 살충제

05

Taxonomic study of the family Nolidae (Lepidoptera: Noctuoidea) in Korea

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Based on the results of this study, 78 species from 28 genera, and five subfamilies are recognized from Korea, including totally nine new species and six newly recorded species. In addition, one new synonymy is identified, five tentative synonymies that need more investigation are highlighted, two reinstated species are proposed, and two species eliminated from Korean fauna. Based on these results, all the names of the Korean nolid moths were suggested renamed or newly named.

Key words: new species, new record species, synonym, reinstated, Korean name

06

Characterization of Bomb m 4, a major silkworm allergen, and its cryptic epitopes

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Silkworm pupa is a frequent cause of food anaphylaxis in Asia. However, false-positive reactions by skin prick and serum IgE tests to the extract complicate diagnosis, requiring identification of clinically relevant allergens. In this study, we characterized a novel allergen, Bomb m 4, a 30 kDa lipoprotein by a proteomic analysis. Its recombinant protein was overexpressed in *E. coli*, and the IgE reactivity was compared with other reported allergenic proteins using the serum samples from 17 allergic patients and 11 asymptotically sensitized subjects. Recombinant Bomb m 4 was recognized by IgE from all 17 patients. ROC analysis showed the highest diagnostic value of Bomb m 4 followed by Bomb m 1, 27 kDa glycoprotein, and Bomb m 3. ELISA IgE reactivity increased significantly, when 4 M urea was added in the serum samples. However, only 16% inhibition of IgE reactivity to the extract was exhibited by recombinant Bomb m 4, whereas more than 93% of self-inhibition was obtained possibly due to its low abundance in the extract. Three linear epitopes (81-95, 191-205, and 224-238 residues) of Bomb m 4 were identified. These epitopes are shown to be released by pepsin digestion. Recombinant Bomb m 4 permits exact diagnosis of exact diagnosis of silkworm pupa allergy.

Key words: food allergy, major allergen, silkworm pupa

Taxonomy and phylogeny of Korean Aphodiinae (Coleoptera: Scarabaeidae)

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Aphodiinae Leach comprises over 300 genera with approximately 3,500 species worldwide. Members of the group specialize in feeding on a wide variety of detritus, especially animal dung, and therefore could be a model taxon to elucidate the evolution of coprophagous beetles. In this study, taxonomy of Korean Aphodiinae and molecular phylogeny of Aphodiinae group were conducted. A new species, *Koreoxyomus jirisanensis* sp. nov., is described from South Korea, along with three species that are new to Korean Peninsula: *Agrilinus hasegawai* (Nomura & Nakane), *Rhyssemus inscitus* (Walker) and *Rhyparus helophoroides* Fairmaire. Two misrecorded species, *Teuchestes analis* (Fabricius) and *Gillentianus nigrovirgatus* (A. Schmidt) were removed from the Korean fauna. These results increase the number of Known Korean Aphodiinae to 39 genera with 60 species. Molecular phylogeny using multi-genes (COI, 16S, 28S and 18S) supported (i) monophyly of Aphodiinae group and Aegialiinae, (ii) tribal status of Aegialiinae and (iii) polyphyly of Aphodiini and Euparini, as well as paraphyly of Psammodiini. Ancestral state reconstruction of coprophagous tribe Aphodiini indicated that the stem group of Aphodiini were largely non-nesters with transitions to other nesting behavior types independently derived in generic or specific level. These findings improve to our understanding of the taxonomy and phylogeny of Aphodiinae.

Key words: Aphodiinae, dung beetle, phylogeny, taxonomy

Bioinformatics Analysis of Genome and Transcriptome in the Korean *Aedes albopictus*

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흰줄숲모기는 성장과 번식을 위해 인간이나 동물의 혈액을 필요로 하는 흡혈 곤충으로 뎅기열, 지카바이러스감염증, 치쿤구니아열, 웨스트나일열의 원인 바이러스를 매개하는 것으로 알려져있다. 아시아지역에서 주로 발견되던 흰줄숲모기는 미국, 유럽 등으로 전파되어 각 지역에 토착화 되고 있는 것으로 보고되고 있어 그 중요성이 점차 커지고 있다. 그러나 국내에서는 모기의 분포, 매개 병원체에 대한 조사, 백신의 개발 및 효과적인 방제 방법 등에 대한 연구에 초점이 맞추어져 있어 주요 매개체인 모기 종의 유전자원 확보가 미비한 실정이다.

본 연구는 국내에 서식하고 있는 흰줄숲모기(*Aedes albopictus*)를 대상으로 하여 외부 환경에 노출된 개체와 안정된 실험실 환경에서 사육된 개체의 유전체 및 전사체의 비교 분석을 수행하였다. 또한 공공 데이터베이스에 등록된 데이터와의 비교 분석을 통해 확보한 유전정보의 유용성 및 향후 발전 방향에 대해 분석하였다. 이번 연구를 통해 확보한 연구 결과는 향후 흰줄숲모기에 대한 후속 연구 수행에 있어 주요한 기초 자료로써 활용될 수 있을 것으로 생각된다.

검색어: *Aedes albopictus*, 매개체 매개 질병, 유전체, 전사체, 비교전사체

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09

Trehalose biosynthesis gene *otsA* protects against stress in the initial infection stage of the *Burkholderia*-bean bug symbiosis

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Here, we investigated the role of trehalose biosynthesis in the *Burkholderia*-bean bug symbiosis. Expression level of trehalose biosynthesis gene, *otsA*, was elevated in symbiotic *Burkholderia insecticola* cells. An *in vivo* competition assay revealed that fewer Δ *otsA* cells colonized the host symbiotic organ, the M4 midgut, than wild-type cells. The Δ *otsA* strain was susceptible to osmotic pressure generated by high salt or sucrose concentrations, suggesting that the reduced symbiotic competitiveness of the Δ *otsA* strain was due to the loss of stress resistance.

Key words: symbiosis, *otsA*, trehalose, *Riptortus pedestris*, *Burkholderia insecticola*

010

Early monitoring system on TSWV infection to prevent the viral disease in hot peppers

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고추(*Capsicum annuum*)에 피해를 주는 일명 칼라병은 토마토반점위조바이러스(TSWV)에 의해 유발된다. 이 바이러스의 전파는 총채벌레의 흡즙 활동에 의해 이뤄진다. 바이러스 감염 이후 칼라병 발생까지는 상당한 시간이 소요되어 고추에서 병이 확인되는 시점에는 벌써 여러 기주에 감염되어 효과적 방제 시기를 놓치게 된다. 따라서 고추에서 바이러스 병이 확인되기 전에 이 바이러스의 전파력을 감지할 수 있다면 칼라병 발생을 효과적으로 억제하게 된다. 본 연구는 이를 구현하기 위해 고추 주산지인 영양지역을 대상으로 월동 초기에 총채벌레의 발생을 모니터링하면서 이 바이러스 보독율을 multiplex PCR로 분석하였다. 육묘장 시설재배지에서 월동한 총채벌레는 꽃노랑총채벌레, 대만총채벌레, 파총채벌레 그리고 미동정 총채벌레로 구성되었다. 월동초기에 꽃노랑총채벌레가 발생하였으며 이후 대만총채벌레와 파총채벌레가 포획되었다. 보독된 총채벌레는 대부분 꽃노랑총채벌레이지만, 대만총채벌레와 파총채벌레에서도 TSWV를 보독하였다. 흥미로운 사실은 일부 지역에서는 비교적 총채벌레의 밀도가 높아도 바이러스 보독율이 낮아 총채벌레의 밀도에 따라 칼라병 발생 추정은 정확하지 않을 수 있다는 결과를 얻었다. 따라서 칼라병 발생 억제를 위해서는 보독 총채벌레의 조기진단이 필수적이다.

검색어: 총채벌레, 토마토반점위조바이러스, 진단, 처방

011

Immune responses of the allium leafminer, *Acrolepiopsis sapporensis*, and their genetic factors from transcriptome analysis

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과즙나방(*Acrolepiopsis sapporensis*)은 대파의 주요 해충이다. 그러나 이 비모델 곤충에 대한 생리적 연구가 부재하였다. 본 연구는 이 곤충의 면역반응을 분석하고, 관련 발현유전체를 RNA-Seq 기술로 분석하였다. 이 곤충의 종령 유충 혈림프에 존재하는 총 혈구수는 2.33×10^6 cells/mL이며 대부분(73%) 과립혈구 및 부정형혈구로 구성되었다. 세포성 및 체액성면역 반응을 확인하였다. RNA-Seq 기술로 평균 반복당 약 12Gb 이상의 염기서열 분석을 진행하였으며, 이를 통해 218,116 contig를 모았다. 이를 통해 적어도 100개의 아미노산 길이를 가진 유전자가 총 45,560개로 추정되었다. 이어 진행된 면역처리 개체와 무처리 사이에 차등발현유전체 분석을 통해 약 21.3% (= 9,722개)의 유전자가 면역 처리에 따라 발현량의 변화를 보였다. 이렇게 분석된 발현유전체에서 Toll, IMD 및 JAK-STAT 면역신호전달 과정, 펠라닌형성에 관여하는 페놀옥시데이즈 활성화 과정, 그리고 이들 면역반응을 중개하는 다양한 아이코사노이드 생합성 과정에 관여하는 효소들도 전사체에서 발견되었다.

검색어: 과즙나방, 면역, 전사체, 아이코사노이드

012

Spodoptera frugiperda (Lepidoptera: Noctuidae) life table comparisons and gut microbiome analysis feeding on corn varieties

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The preference of an insect host plant for food affects its life cycle. The dietary needs and unique qualities of plants that act as hosts have an impact on insect pest population. Although *Spodoptera frugiperda* prefers maize (*Zea mays*), alternative crops can serve as appropriate hosts if maize crops are not easily available. Considering the six *Z. mays* cultivars in three different categories, “B: Heukjeom 2-ho” was found to be significantly preferred [F (5,174)=19.817; $p=0.0001$] during larval rearing stage. Metagenomic analysis of biological triplicate samples (6×3=18, 5th instar larvae feeding on six corn cultivars) revealed that Firmicutes was the most prevalent bacterial community, and Proteobacteria was the second leading bacterial phylum. In terms of the bacterial genera, Enterococcus was the most prevalent, followed by Ureibacillus. To prevent the spread of this invasive pest, it is vital to gain a comprehensive understanding of *S. frugiperda*'s feeding preferences and gut microbial community composition.

Key words: *Spodoptera frugiperda*, FAW, Maize, Enterococcus, Cultivars, Microbiome

013

What is the main player of the diamide resistance mechanism in the beet armyworm, *Spodoptera exigua* (Lepidoptera: Noctuidae)?

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In Korea, diamide insecticides have been used extensively for more than fifteen years to control *S. exigua*. Since 2017, a high level of diamide resistance has been documented. Bioassay-based diamide resistance tested 18 localities of field populations of *S. exigua* for nearly a decade. Diamide resistance levels varied depending on the test years and locations. I4790M, G4946E, and Y4701C are three points in the Ryanodine receptors (RyR) target site that had been surveyed so far for known mutations. In earlier studies, these three point mutations conferred various levels of diamide resistance. Nevertheless, only one of them, the I4790M mutation, was detected in significant field populations in Korea. It's interesting to note that we found the I4790M in some older samples prior to the entry of diamide insecticide marketing. Further research is needed to confirm whether the factors i.e. mutation is the only factors or others factors contributing to insecticide resistance. This molecular study on insecticide resistance would help establish an integrated resistant management (IRM) strategy to deal with the diamide-resistant *S. exigua* population.

Key words: Ryanodine receptors, genome, *Spodoptera exigua*, diamide, I4790 mutation, InDel

014

Validation and utilization of the polynomial models for insecticidal synergy in the thyme oils against *Musca domestica* L.

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This study explores the potential of polynomial model-based approaches to investigate the insecticidal synergy of essential oils, using thyme oil and *Musca domestica* as the subject of interest. Chemical composition of twelve commercially available thyme oils were analyzed using GC-MS, and the major constituents were identified as α -pinene, p-cymene, γ -terpinene, linalool, thymol, and undecanoic acid methyl ester. To investigate the active ingredients in the oil, we compared the model-based component effect analyses to the conventional compound elimination assays. The component effect analyses effectively screened out the active ingredients, p-cymene, γ -terpinene, and thymol, with much less effort than conventional approaches. Once the active ingredients were identified, we constructed the response surface of mortality (%) in terms of the composition of p-cymene, γ -terpinene, and thymol at a given dosage. The quadratic model, rather than the linear model, was found to be a better fit for the data. The model indicated the synergistic interactions between p-cymene $\times$ γ -terpinene, p-cymene $\times$ thymol, and γ -terpinene $\times$ thymol. Finally, we investigated the prescriptions for maximizing the insecticidal activity of thyme oil at a given dosage or at the lowest cost, using quadratic programming algorithms. The algorithm suggested that an optimal content ratio of 32:23:45 results in the highest mortality of 87.5%, which can be achieved through various blending prescriptions. Intriguingly, mixing up the three least toxic oils (mortality of 36.7, 40.0, and 3.3%) or blending the two least expensive oils also presents viable solutions. This study demonstrates the potential of model-based approaches for utilizing botanical insecticides, offering the efficient and accurate ways to identify the active ingredients and their synergistic interactions. This unexplored approach could provide an opportunity for boosting commercialization of botanical insecticides by maximizing and ensuring their efficacy and cost-effectiveness.

Key words: botanical insecticide, thyme oil, response surface, synergy

015

Plant paraziting nematode-pathogenic *Beauveria bassiana* JEF-503 with envitonmental safety

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Root-knot nematode (RKN), *Meloidogyne incognita* infects roots of many crops in greenhouse farming and more than 40% of economic losses have been reported and considered as a terribly serious pest. The RKN generates giant cells and producing galls with reduction of plant growth. Unfortunately, currently used chemical nematicides causes serious residual issues in soil and plant crops. Ten *Beauveria bassiana* isolates were used for the assays of nematicidal activity, under *in vivo* and *in vitro* conditions. For the *in vivo* experiments, RKN eggs were harvested from the damaged tomato roots, and a total of 5,000 eggs were infested per plant. An aliquot of 20 ml conidial suspension was drenched in each pot. Two months after treatment, of the ten *B. bssiana* isolates, JEF-503 significantly reduced the number of RKN eggs. *In vitro* assay, RKN was grown in the medium, and nematicidal activity was investigated by dropping the *B. bassiana* JEF-503 conidial suspension. As a result, *B. bassiana* JEF-503 treatment showed nematicidal activity against juveniles and adults of RKN. *B. bassiana* JEF-503 could be an environmentally sound materials to control root-knot nematode. Now, semi-field studies under pot conditions are under progress to confirm this lab-based experimental performance.

Key words: Root-knot nematodes, entomopathogenic fungi, *Beauveria bassiana*, biological control

Nationwide precision monitoring of *Matsucoccus matsumurae* Kuwana (Hemiptera: Matsucoccidae) in Korea using pheromone-based trap and deep learning object detectors

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The Japanese pine bast scale, *Matsucoccus matsumurae* (= *M. thunbergianae*), is a serious insect pest to *Pinus thunbergii* and *P. densiflora* in Korea. Despite its severe damages, nationwide monitoring of this species has not been conducted yet in Korea. Herein, we report the results of the nationwide monitoring of *M. matsucoccus* using its diastereomeric pheromone, (2*E*,4*E*,6*R*,10*R*/*S*)-4,6,10,12-tetramethyl-2,4-tridecadien-7-one, and a CNN-based automatic counting model, covering 164 local administrative districts in 2022. The occurrence of adults was first observed at the southeast coastal regions in early February and subsequently spread to the Southeast and Midwest coastal regions. The capital area showed the peak occurrence from late April to May, and Northeast regions showed the peak in early June. In total, 666,098 of adults were captured, occurring throughout the country. However, further investigation is required on the locational difference in degree-days and the genetic makeup for a better understanding of this pest.

Key words: Japanese pine bast scale, Sex pheromone, Pheromone trap, Deep learning, Monitoring

017

Assessment of nematicidal and plant growth-promoting effects of *Burkholderia* sp. JB-2 in root-knot nematode-infested soil

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Root-knot nematodes (RKNs) are plant-parasitic nematodes that cause considerable economic losses worldwide, because of the damage they cause to numerous plant species and the limited biological agents available to combat them. Therefore, developing novel and eco-friendly nematicides is necessary. In the present study, *Burkholderia* sp. JB-2, isolated from RKN-infested rhizosphere soil in South Korea, efficiently controlled the nematode population in soil and egg mass formations of *M. incognita* in tomato. An improvement in the host plant growth was observed, in which the shoot length and fresh weights of shoots and roots both increased. Therefore, JB-2 could be a promising candidate for the sustainable management of RKNs. 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, *Burkholderia* sp., plant growth

018

Biological control of cotton aphid using phyllosphere-colonized *Beauveria bassiana* JEF-232 and JEF-544

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Cotton aphid, *Aphis gossypii* is a serious pest that causes serious damage by sucking plant sap as well as transmitting plant viruses. Entomopathogenic fungi can control aphids as an alternative to resistance-inducing chemical insecticides. In this study, it was investigated whether *B. bassiana* isolates with insecticidal activity against cotton aphids could colonize on the phyllosphere and infect newly born aphid generations. Cotton aphid-pathogenic fungal isolates were individually treated on cucumber leaves and incubated for two weeks and the incubated cucumber leaves were infested with cotton aphids. The aphids on the two-weeks incubated leaves were killed much faster than the aphids on the non-incubated leaves as a control. In addition, fungal colonization on phyllosphere was observed using egfp-tagging fungal isolates generated by *Agrobacterium tumefaciens* mediated transformation. This work suggests that the *B. bassiana* isolates colonize on the cucumber leaves and it be used to control cotton aphids for a long-term management strategy through constantly contacting generated aphids.

Key words: *Beauveria bassiana*, cotton aphid, colonization, phyllosphere

019

Changes in microbiome of *Tetranychus urticae* against entomopathogenic fungal infection

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Two-spotted spider mite (*Tetranychus urticae* Koch; TSSM) is a polyphagous pest that has acquired acaricide resistance because of its short life cycle and continuous exposure to acaricides. TSSM has symbiotic microorganisms which could be involved in the physiology and ecological adaptation to biotic and abiotic stresses. In this study, entomopathogenic fungi were used to control the TSSM adults and microbiome change of the TSSM infected with entomopathogenic fungus was analyzed. The acaricidal activity of 77 fungal isolates was tested, and the isolate with the highest acaricidal activity was determined. For the analysis of microbiome from TSSM infected with the highly isolate, 16S rRNA and ITS1 were sequenced using Illumina Miseq. As a result of raw data analysis, insect symbiotic microorganisms, the abundance of *Wolbachia* and *Rickettsia* were changed in the infected TSSM. This study will provide an understanding of TSSM symbiotic system against entomopathogenic fungal infection.

Key words: Entomopathogenic fungus, illumina Miseq, microbiome, microorganism, *Tetranychus urticae*

020

Cuticle layer modification in phosphine-resistant Red flour beetle (*Tribolium castaneum*) verified by micro-CT approach

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Phosphine (PH₃) fumigant has been reported to result in the continuous emergence of resistant grain beetles. One of the ways in which insects acquire resistance to insecticides is through the modification of the cuticle layer. To verify it, x-ray micro-computed tomography (micro-CT), which can quantify the 3D data of smaller animal samples, was used to capture images of the PH₃-susceptible *T. castaneum* strain and the PH₃-resistant strain. The 3D data of the cuticle layer of both strains were compared using 3D data analysis software, and the mRNA expression levels of the genes related to the chitin biosynthesis were also assessed to understand the role of differently expressed genes between the two strains using RT-qPCR. Differences were significantly observed in the morphology of the cuticle layer and in the mRNA expression of genes related to chitin synthesis when comparing two strains.

Key words: phosphine resistance, cuticle layer, microCT, RT-qPCR, *tribolium castaneum*

021

Seasonal and geographical variations in the community structure of environmentally-transmitted symbiotic bacteria in *Riptortus pedestris*

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Riptortus pedestris (Hemiptera: Alydidae) newly acquires symbiotic bacteria at every generation from soil where the insect is exposed to diverse microbes. Thus, the heterogeneity of environmental conditions would affect bacteria community of the insect. To address ecological associations between the two organisms, this study characterized the symbiont compositions of field-collected adults using 16S rRNA sequencing across different seasons and regions in South Korea. Among 29 bacterial genera detected, *Caballeronia* was commonly detected across all generations, but in the first generation, *Yokenella* was detected that the comparably high rate as *Caballeronia*. Geographically, *Caballeronia* was frequently found in all sampling sites, whereas *Ralstonia* and *Agrobacterium* were detected only from Jeju Island.

Key words: Bean bug, Insect-microbe interaction, Symbiosis

022

Estimating forest cover effects on hornets' abundance in South Korea

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In South Korea, there are two native and non-native bee species that are reared to produce honey and pollinate pollination-related crops. One of the challenges of beekeeping in South Korea in the presence of hornet species of the genus *Vespa*, which are known as important enemies of these species. The effects of forest cover on the abundance of hornets in South Korea have not been examined, and estimating these effects can also be useful to beekeepers for placing their hives near or far from forest patches. To estimate the effects of forest cover, ten landscapes were selected in different regions of Korea. The forest cover percentage of these landscapes was between 4 and 99%. We quantified forest cover patterns using landscape metrics and estimated their relationship with the abundance of hornets at multiple scales. We found that forest cover has a significant effect on the abundance of hornets as increasing the amount of forest cover increases the abundance of these species. Our results indicated that hornets have a positive and significant relationship with the edge density of forest patches in the surrounding landscape up to a radius of 500 meters. Therefore, our suggestions to beekeepers are to avoid beekeeping in the southern regions of Korea and consider a distance of at least 2 km from the edge of the forest to place their hives in the vicinity of forest patches.

Key words: Honeybees, hornets' abundance, landscape metrics, forest cover

023

Comparison of biology and nutritional indices of two subgroups of the fall armyworm *Spodoptera frugiperda* in the corn plants

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The fall armyworm (FAW), *Spodoptera frugiperda*, is an invasive pest species in Africa and Asia, which is native to the Western Hemisphere. The genetic variation of 13 different population of Korea were compared by analyzing the nucleotide sequence of the nuclear *triose phosphate isomerase* (*Tpi*) gene. The results shows that all samples were corn strain and further fourth exon and intron sequences identified at least three subgroup *Tpi*-Ca1 (81.8%), *Tpi*-Ca2a (7.7%), and *Tpi*-Ca2b (7.7%). The biological parameters were compared between two subgroup *Tpi*-Ca1 and *Tpi*-Ca2 by rearing in corn plant. The pre-adult survival rated of Ca1 and Ca2 are 86% and 72% respectively. This result suggests that the Ca1 subgroup is more biologically active than Ca2, and could be the major genetic group for the economic damage of the corn fields.

Key words: *Spodoptera frugiperda*, *Tpi* gene, sex ratio, subgroup, food intake

024

Comparison of the occurrence models of *Ricania shantungensis* first instars in persimmons and chestnuts

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갈색날개매미충은 처음 대발생 이후 점차 발생지역이 확대되어 국내 단감 최대 생산지인 경상남도 진영 인근까지 발생이 보고되고 있고, 단감 역시 갈색날개매미충의 주요한 기주로 알려져 있다. 현재, 갈색날개매미충 방제 적기는 밤에서 개발된 모델을 사용하고 있으나, 단감에 대한 발생 예측 모델은 없다. 이에 이번 연구에서는 단감에서 갈색날개매미충 방제 적기를 제안하기 위해 12.4, 16.4, 20.4, 24.8, 28.3, 32.4, 36.9°C에서 온도 발육 실험을 진행하였고 야외 발생을 모니터링하여 개발된 모델을 검증하였다. 감에서 갈색날개매미충의 알의 발육영점온도는 12.0°C, 1령 발육까지 필요한 누적온열량은 159.9 온일도로 추정되었다. 이는 밤에서 갈색날개매미충의 방제 적기보다 감에서 방제 적기가 약 1주일 정도 빠르며, 갈색날개매미충 1령의 생태를 고려할 때 감에서 방제적기 예측은 밤과 다른 모델이 사용되어야 함을 의미한다. 이러한 이번 연구 결과는 갈색날개매미충 다른 기주들에서 방제 적기 추정을 위해 활용될 수 있을 것으로 생각된다.

검색어: 갈색날개매미충, 온도발육실험, 방제적기, 밤, 감

025

On the life cycle of the endangered *Callipogon relictus* (Coleoptera: Cerambycidae) in nature

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The true life cycle of the endangered *Callipogon relictus* in nature was hitherto unknown to us. In order to release artificially grown *Callipogon* beetles into the wild in the future for the purpose of conservation, the exact ecological information about its larval growth periods in the field must be understood in advance. For this, in 2017, we made a large steel cage and installed a timber of *Populus deltoides* and let a pair of *Callipogon* beetles mate. We then confirmed that the female lays eggs on the host tree by itself. In 2022, the result shows that 1) the minimum larval period of *C. relictus* in nature is three years, 2) the average larval development seems to be four years, and then, 3) some individuals may spend their larval hood inside the trunk for more than five years.

Key words: *Callipogon relictus*, life cycle, conservation, larval development, emergence

026

Relationship the density of insect pest and damage of host plant: case study of *Bemisia tabaci* in tomato greenhouse

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The importance of integrated pest management to minimize damage to the environment and humans and to maximize the effectiveness of control is emerging. In order to implement IPM, it is necessary to set the economic injury level to determine the control method by identifying pests and weeds that damage the quantity and quality of crops in the field, investigating the occurrence level, and calculating the ratio of cost and effectiveness. Damage of host plants caused to increased density of insect pests appears changes in plant's health that key factor for managing crops. Therefore, understand the relationship between the density of pests and the damage to the host plants is necessary. This study aims to analysis of causal relationship between the density of insect pest and damage of host plant and then, estimate economic injury level of insect pest on host plant.

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

027

Seasonal/environmental surveillance of hard tick population for four years (2019-2022) in Andong, Gyeongbuk province

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We monitored the hard tick population for four years (2019-2022) in Andong, Gyeongbuk. The ticks were collected monthly from April to November using traps placed in grassland, mountain path, grave, and copse. In general, the population peaks were sequentially investigated for each developmental stages: nymph, adult, and larva. *Haemaphysalis longicornis* predominantly found from spring to early summer, while *H. flava* was mainly collected in spring and autumn. Among three tick species collected for four years, *H. longicornis* was the dominant species throughout the investigation. *Haemaphysalis* larvae were molecularly identified using a ddPCR with species-specific probe. For SFTSV detection, virus was detected in 1, 16, 1, and 0 of pools among 68, 96, 76, and 47 pools, respectively, tested for four years.

Key words: Gyeongsangbuk-do, Hard ticks, Season, Environment, SFTSV, ddPCR, Molecular identification

028

Corn as a companion plant in soybean fields

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The use of companion plants in crop systems can be a potential pest control strategy by increasing the densities of beneficial arthropods such as natural enemies. As a series of evaluation of companion plants in soybean pest management, we investigated the effects of planting corn on the population dynamics of arthropods in soybean fields. At intervals of 9–10 days during the cropping season, the numbers of major pests and natural enemies were recorded from 20 soybean plants. The Simpson index of diversity was 0.88 and 0.89 for the treatment and control fields, respectively, without statistical significance. The Shannon biodiversity index also showed no significant difference between the two fields. The dominant pests were *Halyomorpha halys* and *Riptortus pedestris*, while the dominant natural enemies were *Yemma exilis* and *Harmonia axyridis*. The densities of *R. pedestris* were significantly lower in fields with corn; however, there was no significant difference in densities of other species. Potentials of corn as a companion plant for soybean pest management was discussed.

Key words: Farmscaping, *Glycine max*, Conservation biological control, *Riptortus pedestris*

Monitoring insecticide efficacy in *Bemisia tabaci* in the Republic of Korea

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주요 농업 해충 중 하나인 담배가루이(*Bemisia tabaci*)는 고추와 토마토, 오이 등 시설재배 작물을 흡즙하여 식물 생장 방해 및 감로 배설을 통한 그을음병을 유발한다. 담배가루이로 인한 작물의 상품성 하락과 방제를 위한 지속적인 살충제 사용은 농가에 다양한 경제적 피해를 야기한다. 지속적인 화학적 방제는 담배가루이의 살충제 저항성 발달로 이어지며, 이는 효율적인 방제를 방해하는 주요 원인이 된다. 본 연구는 전국 고추 시설재배지에서 발생하는 담배가루이의 약제별 살충률 조사를 통해 효과적인 약제 선정 및 제시 등 농가에서 활용 가능한 해충 관리법을 제시하고자 한다. 사용량이 많은 살충제 중 작물기작별 1종씩 총 8종의 살충제를 선정하였다. 선정된 약제들은 예천과 구미, 사천, 나주, 천안, 횡성을 포함한 총 6개 지역의 시설재배 고추에서 발생한 담배가루이를 대상으로 살충률을 조사하였다. 곤충생장조절제(insect growth regulators, IGR)인 피리프록시펜을 제외한 7종의 약제는 2령 약충을 대상으로 살충률을 조사하였으며, 피리프록시펜 살충제는 알을 대상으로 조사하였다. 모든 약제는 잎에 붙은 담배가루이를 대상으로 엽침지법을 이용하여 살충률을 조사하였다. 아버멕틴, 밀베마이신계 살충제는 6개 지역(예천, 구미, 사천, 나주, 천안, 횡성)에서 10ppm 처리 시 각각 100%, 100%, 87.7%, 93.9%, 76.3%, 85.2%의 높은 살충률을 보였다. 네오니코티노이드계 살충제는 6개 지역에서 50ppm 처리 시 각각 16.2%, 20.5%, 23.7%, 15.3%, 29.7%, 19%의 낮은 살충률을 보였다. 설폰시민계 살충제 또한 6개 지역에서 35ppm 처리 시 각각 31%, 26.9%, 19.2%, 20%, 28.4%, 43.6%의 낮은 살충률을 보였다. 특이적으로 아버멕틴, 밀베마이신계 살충제 10ppm 처리 시, 5개 지역(예천, 구미, 사천, 나주, 횡성)에서 85.2% 이상의 살충률을 보였으나 천안에서는 76.3%의 상대적으로 낮은 살충률을 보였다. 또한 스피노신계 살충제 25ppm 처리시 천안과 나주, 횡성 제외한 3지역에서 80.9% 이상의 살충률을 보였으나 천안과 나주, 횡성에서는 각각 60.5%, 67.4%, 67.4%의 낮은 살충률을 보였다. 실험 결과를 통해 지역별 그리고 살충제별 담배가루이 생존율이 다를 수 있었다. 본 연구결과는 고추 재배 지역에 따라 효과적인 담배가루이 살충제 제시를 가능케 하여 농가의 방제 비용 감소에 도움이 될 것으로 예상된다.

검색어: 담배가루이, 생물검정, 살충제, 고추, 약제저항성

030

Comparative analysis of chemical preference between *Drosophila melanogaster* and *Drosophila suzukii*

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Two taxonomically close flies, *Drosophila melanogaster* and *Drosophila suzukii*, have different habitats. *D. melanogaster* is mostly found in decaying and fermenting fruits where large amounts of chemicals are produced, whereas habitat of *D. suzukii* is fresh fruit. Considering their distinct habitats, two flies have hypothesized to have different chemical preferences. In this study, we compare preference for chemicals associated with fruit fermentation, including, 2-phenylethanol, ethanol and acetic acid, between *D. melanogaster* and *D. suzukii* through Y-tube olfactometer assay and electroantennogram analysis. *D. melanogaster* exhibited higher preference for three chemicals than *D. suzukii*. In the comparison between mated and virgin *D. melanogaster*, mated female exhibited higher chemical preference than virgin. These results suggest that high concentration of chemicals is important attraction factor for *D. melanogaster* to seek appropriate site for oviposition.

Key words: *Drosophila melanogaster*, *Drosophila suzukii*, Chemical preference, Electroantennogram

031

Geostatistical analysis of *Bemisia tabaci* in commercial tomato greenhouse

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Integrated pest management strategy requires accurate estimation of pest density, which can be achieved through spatial statistical analysis methods. Since traditional methods ignore the correlation between sampling locations and data, geostatistics, such as variogram and kriging, are employed to estimate pest density. Variogram is used to characterize the spatial dependence of data and provides information about the distance at which data points are correlated. Kriging is a spatial interpolation technique that uses variogram parameters to estimate the values of a variable at an unsampled location. Cross-validation is a method used to evaluate the fitness of the model by comparing predicted values with actual values. This method helps to assess the accuracy and reliability of the model. This study focuses on applying geostatistical analysis to *Bemisia tabaci* in commercial tomato greenhouse and making control decisions.

Key words: IPM, *Bemisia tabaci*, tomato, geostatistics, variogram, kriging

032

Investigation of bacterial community and population genetics between bisexual and parthenogenesis Asian longhorned tick, *Haemaphysalis longicornis*, in the Republic of Korea

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The Asian longhorned tick, *Haemaphysalis longicornis*, is the predominant hard tick species in Korea and is widely distributed throughout Korea. *H. longicornis* is known as the three-host tick, which requires three different blood meals for a successful life cycle. There are two reproductive strategies for *H. longicornis*, bisexual and parthenogenesis, which determine population maintenance and vector capacity. There are not only morphological differences, such as body size and genital apron, but also genetic characteristics between bisexual and parthenogenesis individuals. Parthenogenesis *H. longicornis* had insertion of two thymine 'T' in 16s rDNA. In this study, we analyzed the proportion of bisexual and parthenogenesis *H. longicornis* collected from thirteen cities in Rep. of Korea: Goseong[GS], Sokcho[SC], Ganghwa[GH], Samcheok[SCH], Sangju[SJ], Boryeong[BR], Ulsan[US], Iksan[IS], Gochang[GC], Jinju[JNJ], Jindo[JD], Jeju[JJ], and Seogwipo[SG]. Parthenogenesis individuals predominated in seven cities of northeastern populations, including Goseong, Sokcho, Ganghwa, Samcheok, Sangju, Ulsan, and Jinju. Whereas in five cities of southwestern populations, including Boryeong, Iksan, Jindo, Jeju, and Seogwipo, bisexual individuals were dominant except Gochang. In addition, the analysis of haplotype diversity using the partial sequences of mitochondrial cytochrome B (CytB) revealed that *H. longicornis* individuals in Korea were grouped into one of two major haplotypes (Hap_1 and Hap_3) and are divided into two clades. Based on analysis of the bacterial community between bisexual and parthenogenesis, genus *Coxiella* predominated in both reproductive systems of *H. longicornis*. Whereas genus *Rickettsia* mainly existed in bisexual compared with parthenogenesis individuals. Both bisexual and parthenogenesis *H. longicornis* have coexisted in Rep. of Korea. Bacterial communities such as the genus *Coxiella* and *Rickettsia* were similar or different depending on the reproductive system. The current study might provide us with an understanding of the reproductive strategy and vectorial capacity of *H. longicornis*.

Key words: *Haemaphysalis longicornis*, reproductive system, population genetics, microbiome analysis

033

Effect of fluorescent brighteners on the insecticidal activity of LdMNPV and *Bacillus thuringiensis* var. *kurstaki* on *Lymantria dispar asiatica* in Korea

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Stilbene-based fluorescent brighteners (FB) have been shown to enhance pathogen insecticidal activity, such as in viral formulations. We investigated the effect of two FBs (Calcofluor M2R and Blankophor BHH) on the insecticidal activity of *B. thuringiensis* var. *kurstaki* (Btk) and nucleopolyhedrovirus (LdMNPV) in *Lymantria dispar asiatica* instars. The FB Blankophor BHH presented a significantly enhancing effect on mixtures of LdMNPV, presenting higher mortality in medium and high concentrations (3×10^4 and 3×10^6 POBs/ml). Calcofluor M2R, presented more prominent results in treatments in combination with Btk, presenting a significant increase in mortality in the low concentration (1.6×10^4 IU/ml) when compared to Btk treatments alone. Our findings suggest that the pathogenic enhancing effects of FBs differ not only by larval stage but also by pathogen and FB combination, as well as host physiology of *L. dispar asiatica*.

Key words: fluorescent brighteners, insecticidal enhancement, entomopathogenic organisms, spongy moth

034

Evaluation of eco-friendly chemical to control of honeybee mites

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꿀벌 건강에 미치는 생물적 요인으로는 질병, 해충이 있다. 이중 국내 발생하는 꿀벌 외부 기생성 응애는 꿀벌응애와 중국가시응애가 있다. 이들 기생성 응애 피해는 1차로 꿀벌의 수명, 무게, 활동력 감소를 일으켜 봉군을 폐사시키며, 2차는 바이러스를 매개하여 날개불구바이러스가 발현된다. 이들 방제는 화학적 방제, 생태적 방제가 있으나 주로 화학적 방제를 통해 방제가 이루어진다. 화학적 방제는 fluvalinate, coumaphos, amitraz를 이용한다. 최근 fluvalinate에 대한 꿀벌응애 저장성이 보고되었으며 이에 따른 대체 약제 개발이 필요한 시점이다. 꿀벌응애 방제에서 친환경 약제는 개미산, 옥살사 등 유기산을 이용한 방제가 관행적으로 이루어졌으나 이에 대한 꿀벌안전성, 방제 효율은 전무한 실정이다. 이에 개미산과 옥살산을 이용한 꿀벌응애류의 방제 효율과 안전성을 평가하였다. 개미산 농도별 처리시 꿀벌응애류의 방제 효율은 차이가 있으나 높은 방제 효율을 보였으며, 꿀벌 번데기에 기생하는 응애류도 방제하는 것을 확인하였다. 옥살산은 훈증 처리에서는 꿀벌 안전성이 높았다. 따라서 이를 이용한 표준 사용법을 제시하고자 한다.

검색어: 꿀벌응애, 중국가시응애, 친환경 약제, 방제

Attraction behaviour preference of *Solenopsis invicta* Buren (Hymenoptera: Formicidae)

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The Red Imported Fire Ant (RIFA), *Solenopsis invicta* Buren is native to South America and has been expanding its habitat in the United States, Asia, and Oceania through abiotic and international trade routes. Subsequent intensive surveillance is essential to eradicate this invasive species. Understanding the RIFA response to attractants help effectiveness on surveillance. This study assessed the attraction rate performance and behavior of RIFA to the five pheromones (farnesene mixture, 4-Methylpyrrole-2-carboxylic acid, geranylgeraniol, allofarnesene, and 2,5-dimethyl-3-pyrazine) and 13 commercial poisoning baits. The attraction sensitivity of RIFA to the five pheromones and poisoning baits indicated that allofarnesene was a potential attractant. The attraction rate of allofarnesene showed an attraction rate of 50% at lower concentration towards RIFA comparative to other pheromones. Among the poisoning baits, the InTice gel bait (Rockwell Labs Ltd, USA) showed the most efficient attraction. The behavioral preferences of pheromones and baits towards RIFA showed higher attraction to pheromones than commercial baits. Based on these results, allofarnesene may be used as attractant to support extensive surveillance and prevent RIFA infestation.

Key words: RIFA, surveillance, pheromone, attractant

Exploring DNA Metabarcoding as a Tool for Analyzing Floral Composition in Paper Wasp Nests

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Nest construction is one of the most interesting behavior in paper wasps however, little information is available on the plants which are being used by wasps. We evaluated the possibility of using DNA metabarcoding approach using *rbcL* and *trnL* molecular markers in qualitative and quantitative detection of plants in mixed origin woody samples with seven artificially mixtures of nine bark samples. We found that sequencing the *trnL* gene resulted in a significantly higher number of reads and a higher proportion of taxonomy-assigned reads compared to the *rbcL* gene. In addition, the taxa richness and taxa diversity was significantly higher while using *trnL* marker. A threshold of 0.01 proportion of reads were applied for both molecular markers based on a presence of false positives due to possible contamination of bark samples by airborne pollen, however, this threshold for median calculation was only 0.0025. All plant taxa included in this research were detectable through metabarcoding of bark mixtures using both *trnL* and *rbcL* molecular markers, however, after elimination of taxa which were present lower than the assigned threshold, the median proportion showed better performance while considering the taxa richness. Despite some missing taxa using *rbcL* marker, LMEM analysis showed it is more reliable than *trnL* and the median proportion in quantitative studies. Overall, this study highlights the possibility of using molecular methods for plant identification in nest construction studies and provides insights into the diverse range of plant taxa used by these wasp species.

Kew words: Eusocial wasps, DNA metabarcoding, Environmental DNA, bioinformatics

037

Additive toxicity and behavioral effect of formulation of acetamiprid alone and in binary mixture with emamectin benzoate on honey bee, *Apis mellifera*

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Acetamiprid (ACE) is the most common neonicotinoid that exhibits the lowest toxicity to honeybees. This study examined the risk assessment of formulation of a binary mixture (MIX) of ACE and emamectin benzoate (EB) on *A. mellifera*. The MIX had the highest toxicity to adult honeybees with a lethal dose, LD₅₀ 0.001 µg/bee (oral), 0.00004 µg/bee (contact) and 72-h lethal concentration, LC₅₀ 0.2 µg/ml for larvae. Additionally, the MIX had high spray hazard potential (HQc = 5000). In addition, the estimated additive indices (AI) indicated that ACE and EB interact additively with the calculated AI values of 0.047, 0.01 and 0.02 in oral contact and larvae respectively. Our results also indicate repeated sublethal exposure to MIX showed a significant decrease in survival relative to larvae exposed to solvent and negative controls. It was also revealed that the proboscis extension response (PER) scores to a sub-lethal dose of MIX (1, 10 ng/bee) was significantly reduced in acquisition and memory retention than the control and ACE treated groups. Our findings indicated MIX has adverse effects by reducing the bees' survival, appetitive olfactory learning, memory and odor discrimination than individual pesticide exposures on honeybee suggesting further study in the field to reduce effects that harm honeybees by the mixture of pesticides.

Key words: Spray toxicity, Oral toxicity, Acute exposure, Repeated exposure, Additive effect, Proboscis extension response

The Edible Insect Industry in Asia: An Overview of Present State and Recent Developments

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Despite a long-standing tradition of entomophagy in many communities worldwide, including Asia, it is only the 1980s when it began to receive significant attention. In addition to its cultural significance, edible insects offer a sustainable and nutrient-dense food resource. In recent years, the edible insect industry in Asia has witnessed a surge in interest, following a trend similar to that of Europe and North America, driven by growing demand and increasing awareness. Currently around 50 start-ups and companies are exploring the commercial potential of this industry in Asia, while hundreds of small to medium-scale insect production facilities have emerged, augmenting income for smallholder farmers. The insect farming industry primarily focuses on producing animal feed, utilizing insects as ingredients in human food, exploring the potential of extracting bioactive compounds like chitin and insect oil, and producing fertilizer. The industry is centered around the domestication of certain species, including black soldier flies, mealworms, and crickets while other species like wasps, palm weevils, weaver ants etc. are semi-domesticated. This article delves into the diverse landscape of the edible insect industry across various Asia countries.

Key words: Entomophagy, Nutrition security, Sustainability, Insect farming, Agri-business

Vespa velutina reactivity about sex pheromone

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등검은말벌은 국내에 침입해 정착한 이후 사회성 곤충 특유의 적응력, 꿀벌에 대한 먹이 선호성 등으로 양봉농가에 심각한 경제적 피해를 야기하고 있다. 이를 막기 위해 유인 트랩, 착농약송환법, 포충망을 이용한 직접방제 등 여러 방제법을 사용하고 있지만, 선택성이 없고 효과가 떨어지는 단점이 있다. 이에 2017년 중국에서 규명 및 합성한 등검은말벌 성페로몬 물질(4-OOA, 4-ODA)을 이용한 페로몬 트랩을 개발해, 보다 효과적인 방제책을 제시하고자 한다. 본 연구에서는 해당 물질의 반응성 및 유인력을 실내조건에서 검증하고자 하였다. 성페로몬에 대한 암수 반응의 차이를 비교하기 위해 수원 국립식량과학원 풍동실험실(25℃)에서 EAG 실험을 진행하였다. 양 끝을 자른 더듬이에 페로몬이 섞인 공기를 분사해 전기적 반응을 기록하였다. 암수 간의 성페로몬에 대한 반응 차이를 비교한 후 수벌의 생존 기간별로 실험하였다. 실험 결과를 토대로 Y-tube 실험을 통해 실내에서 유인력을 실험하였다. 암실 조건(25℃)에서 성페로몬 물질과 용매(Dichloromethane)를 챔버에 두고 분당 125 ml 속도로 방출하였다. EAG 실험 결과 수벌만이 성페로몬 물질에 대한 반응을 보였다. 우화 1~7일간 생존기간이 늘수록 반응이 컸으며 우화 15일차에서 가장 큰 반응을 보였다. Y-tube 실험의 경우 우화 5일차부터 성페로몬 물질에 대한 유의미한 선택성을 보였으며, 13일차에서 가장 높은 선택률을 보였다. 이를 현장에 적용하여 야외 검증에 성공한다면 등검은말벌 방제에 있어 선택적이고 효과적인 방제책이 될 수 있을 것으로 기대한다.

검색어: 등검은말벌, 꿀벌, 성페로몬, EAG

O40

Diet-mediated Transgenerational Plasticity for Locomotor Activity in the Bean Bug (*Riptortus pedestris*)

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Environments experienced by parents can exert significant influences over offspring phenotype, a phenomenon widely known as transgenerational plasticity (TGP). In rodents and humans, the parental consumption of suboptimal diet has been associated with hyperactive offspring phenotype, which is generally viewed as maladaptive or behavioral disorder. To our knowledge, we are unaware of any experimental studies investigating the diet-mediated TGP for offspring activity in insects. Here, we examined whether the quality of diet consumed by parents could affect offspring locomotor activity and fitness-related traits in a highly mobile hemipeteran insect, *Riptortus pedestris*. Various parameters of pedestrian locomotor capabilities (e.g., speed, distance moved) were compared between the offspring of parents fed on soybean (high-quality diet) and of those fed on peanut (low-quality diet). The offspring of peanut-fed parents exhibited significantly improved locomotor activity, moving not only faster but also farther than the offspring of soybean-fed parents. Interestingly, the offspring with suboptimal parental diet history grew faster and had better body conditions compared to those with favorable parental diet history, suggesting that this diet-induced TGP can be adaptive. This study reports the first evidence for TGP for locomotor activity in insects and demonstrates how broadly such parentally-induced offspring hyperactivity is preserved across the tree of life.

Key words: Transgenerational effect, Hyperactivity, Diet quality, *Riptortus pedestris*

O41

Hydrolysis and pH adjustment for utilization of *Hermetia illucens* larvae protein in residue fraction and their effect on protein structure and functionality

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Proteins are abundantly present in edible insects and are extracted for use as ingredients in food and feed. However, residual proteins remain in the insoluble fraction after protein extraction. To utilize these, we investigated the effect of hydrolysis and pH adjustment during on protein structure and functionality of insoluble protein. The enzymatic hydrolyze when extracted from the residue fraction, led to decreasing pH and protein molecular weight and increased protein unfolding of protein obtained from *Hermetia illucens* larvae. These structural changes in protein improved its solubility, foaming, and emulsifying properties. Furthermore, adjusting the pH of the extraction buffer to an alkaline or acidic level also enhanced the foam stability and emulsifying capacity of the hydrolyzed protein. Therefore, the hydrolysis and pH adjustment of *Hermetia illucens* larvae protein can be a effective way in utilizing the insoluble fraction in water.

Key words: *Hermetia illucens*, protein extraction, hydrolysis, pH adjustment

O42

Biochemical properties of a structural protein, TSWV-N, encoded in tomato spotted wilt virus

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A structural N protein of tomato spotted wilt tospovirus (TSWV) represents the nucleocapsid protein by binding to the viral RNA genome. However, it remains unknown how the RNA-binding protein specifically interacts with the viral RNA from host RNAs in the target cells. To study the molecular basis of N function, we produced a recombinant protein in *Escherichia coli* and investigated protein-RNA interactions of N protein. The recombinant N protein migrated on agarose gel to anode in the electric field due to its high basic isoelectric point (pI = 9.055). N protein specifically interacted with RNA, but not with DNA. It preferred single stranded RNA rather than double-stranded RNA. However, they did not discriminate positive or negative strand. To investigate the viral RNA specificity, N protein was incubated with RNA extracts from TSWV-infected plants or thrips and subsequently subject to a pull-down assay. The resulting pull-down RNAs were different to those of healthy plants or insects. Furthermore, a quantitative RT-PCR analysis showed that the pull-down RNAs using N protein were rich in TSWV RNAs. These results suggest that N protein prefers TSWV RNA in plant and insect cells.

Key words: N protein, TSWV, viral RNA

O43

Chitosan-based nanoparticle as an optimal dsRNA formulation to control the western flower thrips infesting hot pepper

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The western flower thrips, *Frankliniella occidentalis*, is a serious insect pest that causes serious damages on various crops. It is a vector of a plant pathogen of tomato spotted wilt virus. To control this pest, chemical insecticides have been used but become unsatisfactory in the control efficacy due to the rapid resistance development of *F. occidentalis*. A novel insecticidal agent was derived from dsRNAs specific to vATPase-A/B of the thrips. These RNAi treatments gave > 85% mortalities in 7 days in laboratory. However, its spray in greenhouse resulted in only 53.53~55.88% control efficacies in 7 days. To enhance this insecticidal activity in field conditions, chitosan-based nanoparticle (NP) formulation was applied to the dsRNA insecticides. The chitosan NP prevented the dsRNA degradation by the gut juice treatment of the thrips. Under desiccation, chitosan NP stabilized the dsRNA. These protective role of chitosan NP much enhanced the control efficacy against *F. occidentalis*.

Key words: Chitosan, dsRNA, nanoparticle, vATPase, *Frankliniella occidentalis*

O44

Trehalose transporter influencing cold tolerance in the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae)

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The fall armyworm (FAW), *Spodoptera frugiperda* is considered as one of the most destructive pests because of its diverse host range as polyphagous pest. Generally, overwintering is carried out by rapid cold hardening (RCH) and supercooling capabilities in insects. This study demonstrates that the trehalose transporter in FAW (Sf-Tret) is involved in RCH under cold condition. Since, Sf-Tret carries trehalose from the source of production in the fatbody to the hemolymph, Sf-Tret suppression by dsRNA decreases the concentration of trehalose in the hemolymph. In addition, Sf-Tret-suppressed FAW had a reduced survival rate under cold circumstances, and other alterations in carbohydrate and polyol levels were observed in FAW larvae. Based on our result, Sf-Tret is essential for maintaining hemolymph trehalose concentration and is a positive mediator for survival during RCH. Therefore, Sf-Tret may be crucial in responding to cold temperatures and altering physiological states in FAW.

Key words: Rapid cold hardening, trehalose, cryoprotectant

O45

Double-stranded RNA mycoviruses isolated from entomopathogenic fungi

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Mycoviruses are a special group of viruses that infect filamentous fungi. Most mycoviruses have cryptic infections, but some affect various phenotypes. Studies on the effect of mycoviruses on the phenotype of entomopathogenic fungi are being actively conducted overseas, but there has been no report in Korea. Therefore, in this study, mycovirus-infected strains *Metarhizium pinghaense* 4-2 and *Beauveria bassiana* 255 were prepared by physicochemical methods to remove mycoviruses, and the biological characteristics of the isogenic dsRNA-free strains and dsRNA-infected strains were compared. As a result, it was confirmed that there was a difference in pathogenicity and spore productivity between the virus-infected strain and the treated strain.

Key words: entomopathogenic fungi, mycovirus, phenotypic change

O46

Development of molecular diagnosis method for the Korea endemic silkworm strains of *Bombyx mori* (Lepidoptera: Bombycidae) based on 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 and genetic similarity. 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. 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 sequencing, Single nucleotide polymorphism, Decision tree, Molecular diagnosis

O47

Expression profiles of antimicrobial peptides in honeybee, *Apis mellifera*, treated with five pesticides

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The honeybee, *Apis mellifera*, also has an innate immune system to defend against pathogens and parasites. However, some pesticides have been reported to reduce the expression levels of immune genes, including antimicrobial peptides (AMPs) in honeybee. In this study, to investigate the effects of pesticides on the immune system of honeybee, we determined the expression levels of five AMPs (*Abaecin*, *Apidaecin 1*, *Defensin 1*, *2*, and *Hymenoptaecin*) in honeybee treated with five pesticides (imidacloprid, flupyradifurone, fenitrothion, carbaryl, and bifenthrin) for 72 hours using quantitative real-time PCR. Although expression patterns of AMPs was varied depending on the type of pesticides, chemicals targeting nervous system generally reduced expression levels of AMPs, suggesting that pesticides disrupt the immune system of honeybee and might make honeybee susceptible to diseases.

Key words: honeybee, pesticide, CCD, antimicrobial peptide, expression level

O48

Gene expression profiles in dead honeybee, *Apis mellifera*, after miticide exposure

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Recently, the population of honeybee has been declining due to various reasons, including climate changes, parasites, and chemical exposure. In addition, damage caused by exposure to pesticides and miticides has been reported in apiary. The molecular diagnostics is an appropriate approach for determining the reason of honeybee colony damage, but dead honeybees are usually provided as samples after damage. Therefore, in this study, we investigated expression stabilities of ten candidate reference genes in head and abdomen of honeybee for 7 days after death and exposed three miticides (oxalic acid, formic acid, and tau-fluvalinate) using four programs (NormFinder, BestKeeper, geNorm, and RefFinder). Among ten genes, *RAB1a* was the most stable reference gene in head for 4 days after death. Subsequently, we generated heatmap profiles based on the expressions of eight genes (*AChE2*, *CAT*, *SOD2*, *CYP9Q1*, *CYP9Q2*, *CYP9Q3*, *GST-D1*, and *GST-S1*) in head of surviving and dead honeybees exposed to three miticides using qRT-PCR normalized by *RAB1a*. The heatmap will be used to identify the reason of colony damage.

Key words: *Apis mellifera*, carcass, miticides, reference gene, gene expression, heatmap

O49

The characterization of physiological function of neuropeptide F (NPF) in the Asian tiger mosquito, *Aedes albopictus*

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The blood-meal is a primary nutrient for female mosquitoes' ovarian development and survival. Host-seeking and feeding behavior of female mosquitoes are significantly reduced after successful blood meals, but those are restored after oviposition. Multiple signaling pathways regulate mosquito feeding behavior. Neuropeptide F (NPF) is involved in regulating the feeding, appetite, and olfaction of invertebrates. The open reading frame (ORF) of *Aedes albopictus* NPF (Aedal-NPF) was cloned and sequenced based on the BLAST search against the SRA database. The transcripts of NPF, 423 nucleotides (141 amino acids) in length, were temporally and spatially profiled. The expression patterns of Aedal-NPF were different depending on blood feeding. The success rate of blood feeding was significantly reduced by RNA interference of Aedal-NPF, while there was no significant difference in the fitness of mosquitoes. Understanding the physiological function of Aedal-NPF may provide insight into developing a novel method to control mosquito-borne diseases.

Key words: *Aedes albopictus*, Neuropeptide F, appetite, RNA interference

O50

Molecular identification of SIFamide receptor in the Asian longhorned tick, *Haemaphysalis longicornis*

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Tick salivation is crucial to complete tick bloodmeal by suppressing the host's defenses, such as hemostasis and coagulation. Salivary glands are thought to be controlled by synganglion through the peptidergic innervation, such as SIFamide, myoinhibitory peptide, and elevenin. The physiological function of SIFamide in tick salivation is currently unclear, although it has been described molecular characteristics of SIFamide and SIFamide receptor (SIFa-R) included localization and expression profile from salivary glands and synganglion of *Ixodes scapularis*. To investigate the physiological function of SIFa-R in tick salivary secretion, the open reading frame (ORF) of SIFa-R was cloned and sequenced from the synganglion of partially engorged *Haemaphysalis longicornis*, which has been shown to work RNA interference (RNAi) in the previous studies. SIFa-R was 1275 nucleotides (425 amino acids) in length and featured in the seven transmembrane domains. In the future study, the physiological function of SIFa-R in *H. longicornis* should be characterized by profiling the expression of SIFa-R in different tissues and developmental stages and interfering the expression of SIFa-R.

Key words: tick, salivation, neuropeptide, GPCRs, SIFamide receptor

051

***Tribolium castaneum* CPAP1-C cuticular protein is required for movement of legs, locomotion and mobility**

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Structural cuticular proteins (CPs) and the polysaccharide chitin are the primary components of insect cuticle/exoskeleton. A large number of *CP* genes have been identified in insect genomes and classified into several distinct families defined by the presence of specific amino acid sequence motifs. Cuticular Protein Analogous to Peritrophins (CPAPs) composed of one (CPAP1s) or three (CPAP3s) chitin-binding domain comprise one of CP families. In this study, we report a novel role for *TcCPAP1-C* from the red flour beetle, *Tribolium castaneum*, in movement of legs and locomotion. RNAi for *TcCPAP1-C* had no effect on any type of molt or development. However, the resulting adults exhibited a defect in movement of legs in which the internal tendon cuticle was ruptured near the femur-tibia joint. Femur muscles were developed normally and connected to the internal and external tendon cells at opposite ends. However, the muscle were rounded because loss of tension when the internal tendon cuticles were broken. There was no obvious difference in morphology of leg exoskeletal cuticle between *TcCPAP1-C*-deficient insects and controls. All of these results indicate functional specialization of *TcCPAP1-C* in the structural integrity of the internal tendon cuticle, and loss of function of *TcCPAP1-C* caused internal tendon cuticle breakage, resulting in impaired leg movement and defective locomotion.

Research on the First Transcriptome Analysis and Genetic Resource Conservation of the Endangered Species *Polyphylla laticollis manchurica* in Korea

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수염풍뎅이(*Polyphylla laticollis manchurica*)는 과거 국내에 서식하는 개체수가 많았지만, 1970년대 이후 급격하게 개체수가 감소하여 현재는 환경부 지정 멸종위기 I급 및 적색분류 위급(CR)으로 분류되고 있다. 그러나 이 종은 NCBI와 같은 공개된 데이터베이스에서 사용할 수 있는 서열정보가 거의 없어 분자 수준에서의 특성분석이 어려운 실정이다. 이에 본 연구진은 이러한 한계를 극복하고 새로운 유전자의 발견과 특성분석을 위하여 해당 생물자원을 확보하고 생물정보학적 기술을 활용하여 유전체 데이터를 분석하였다. 본 연구는 Illumina HiSeq 2500 NGS sequencing platform을 이용하여 수염풍뎅이의 RNA reads를 53,433,048개 확보하였으며, 이를 이용하여 Trinity 및 TGICL clustering을 이용한 *De novo* 분석을 통해 생물종 고유의 unigene을 확보하였다. 이후 확보된 unigenes는 PANM DB를 기반으로 한 BLASTX 분석 및 GO, KOG, KEGG 분석을 통한 기능 분석을 진행하였다. 이번 연구는 국내 멸종위기 종인 수염풍뎅이에 대한 최초의 전사체 분석으로 국내 멸종위기종인 수염풍뎅이의 고유한 유전적 특성을 발굴 및 확보함으로써 국내외 전반적인 유전자원 확보에 기여하고 멸종위기 생물의 보전 및 복원 시스템 구축 기반으로써 활용될 수 있을 것으로 사료된다.

검색어: 수염풍뎅이, transcriptome analysis

053

Functional importance of tyrosine hydroxylase and DOPA decarboxylase in pigmentation and morphology of adult cuticle and setae from the Japanese pine sawyer, *Monochamus alternatus*

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Tanning is a complex and vital physiological process in insect 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 produce 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, *Monochamus alternatus*. This wood-boring beetle is a major vector of the pinewood nematode, *Bursaphelenchus xylophilus*, which is a causal agent in the most destructive forest disease, pine wilt disease. We identified, cloned and characterized the *MaTH* and *MaDDC* cDNAs. Loss of function of *MaTH* and *MaDDC* by RNAi resulted in pale/white and light yellow-brown adult body coloration, respectively. In addition, black and orange setae on cuticle became transparent and malformed in ds*MaTH*-treated adults, while became white and light yellow-orange in ds*MaDDC*-treated adults. These results indicate that MaTH and MaDDC play critical roles in normal coloration and/or morphology of the adult body cuticle and setae of *M. alternatus*.

054

Sex classification of tick nymphs using vitellogenin

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참진드기는 중증열성혈소판감소증후군(SFTS), 라임병, 쯤쯤가무시증 등을 매개하며, 국내에는 *Haemaphysalis longicornis*가 주요 매개종이며, 최근까지 SFTS를 매개하는 참진드기 종은 *H. flava*, *Amblyomma testudinarium*, *Ixodes nipponensis*가 있다고 알려져 있다. 선행된 연구에서 수컷보다 암컷이 매개하는 질병의 감염률이 더 높은 것으로 확인된다. 참진드기의 약충은 형태적으로 성충과 비슷하지만 생식공이 발달되어 있지 않아 형태적인 성별 구분은 어려운 현실이다. Vitellogenin은 성장 중인 배아에 아미노산 공급을 위한 난황의 주요 저장 단백질의 전구체이다. Vitellogenin이 암컷에서 주로 발생하기 때문에 물고기의 성별을 식별하는데 사용되어져 왔다. 본 연구진은 채집된 *H. longicornis*와 *H. flava*를 sequencing을 진행하였으며, PANM DB와 BLAST 프로그램을 사용하여 vitellogenin 서열을 annotation하였다. 확인된 *H. longicornis*와 *H. flava* vitellogenin 서열을 polydot 프로그램을 이용하여 비교하였다. *H. longicornis*와 *H. flava*의 vitellogenin을 포함하여 NCBI에 등록된 다른 유기체들의 vitellogenin 서열을 Maximum Likelihood (ML), Neighbor Joining (NJ) 방법으로 계통발생학적 분석을 진행함으로써, vitellogenin을 이용한 참진드기 약충의 성별 구분과 종 동정 가능 여부를 확인하였다.

검색어: 참진드기, Vitellogenin

055

Taxonomy of *Rondibilis* Thomson (Coleoptera: Cerambycidae) with a new record in Korea

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The genus *Rondibilis* (Coleoptera: Cerambycidae) belongs to the fauna of Eastern Asia (Cherepanov, 1991). A total of 65 species have been recorded from the world of which 33 species are recorded from the Palearctic region and just three species of subgenus *Rondibilis*, *R. (R.) coreana* (Breung, 1974), *R. (R.) schabliovskiyi* (Tsherepanov, 1982), *R. (R.) undulata* (Pic, 1922), have been recorded from Korea. As result of investigation on insect fauna of islands in Korea, *R. (R.) amanoi* Hayashi (1961) was newly discovered from Is. Heuksan, Jeollanam Province, Korea in 2022. In this presentation, we provide a taxonomic note on the genus and diagnostic characteristics of *R. (R.) amanoi* Hayashi.

Key words: Cerambycidae, Coleoptera, Korea, new record, *Rondibilis*

056

Taxonomy of the *Ibalia* Latreille (Hymenoptera: Cynipoidea) with a new record in Korea

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The family Ibalidae is one of the small family in Cynipoidea (Hymenoptera: Apocrita) with less than 20 known species from the Northern Hemisphere and these are known as parasitoids against for wood-boring insect larvae and some are used for biological control agents for siricid woodwasps. In Korea, a total of four species two subgenera of *Ibalia* have been recorded and only one species of subgenus *Ibalia* (*Ibalia*), *I. (I.) leucospoides leucospoides* (Hochenwarth) has been recorded. As a result of taxonomic study on Korean Ibalidae, *I. (I.) aprilina* Kerrich was discovered in Korea. In this presentation, we provide a taxonomic note of the genus and diagnostic characteristics of (*I.*) (*I.*) *aprilina* Kerrich.

Key words: *Ibalia aprilina*, Ibalidae, new record, South Korea, taxonomy

057

Species diversity of the aphid genus *Stomaphis* Walker (Hemiptera: Aphididae) in Korean Peninsula

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The aphid genus *Stomaphis* Walker, 1870 is native of palaearctic region belonging to subfamily Lachninae, with 31 valid species. To date, Six species of *Stomaphis* have been reported in the Korean Peninsula: *Stomaphis asiphon* Szelegiewicz, 1975; *S. blackmani* Lee, Kanturski & Lee, 2022; *S. japonica* Takahashi, 1960; *S. matsumotoi* Sorin, 1995; *S. sinisalicis* Zhang & Zhong, 1982 and *S. yanonis* Takahashi, 1918. In this study, we provided taxonomic studies about *Stomaphis* in Korean Peninsula.

The results of this study additionally include as followings: 1) Species identification, 2) redescription of the poorly known and sexual morphs, 3) DNA barcoding, 4) population genetic analyses.

Key words: Aphids, Lachninae, DNA barcoding, Population

058

Genetic diversity of the invasive fall armyworm (*Spodoptera frugiperda*) (J.E. Smith) (Lepidoptera, Noctuidae) in the Democratic Republic of the Congo

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The genetic diversity of fall armyworm populations in the Democratic Republic of the Congo (DRC) was studied by using samples collected from 8 provinces. Based on both the partial mitochondrial *cytochrome oxidase subunit I (COI)* and the nuclear *triosephosphate isomerase (Tpi)* polymorphism, we analyzed the COI haplotypes and the *Tpi* SNPs. The COI haplotype diversity was 0.324 including the presence of both the rice and corn strains. Our results showed that 84% of specimens were the heterogeneous hybrid (*COI*-rice strain/*Tpi*-corn strain), and the remaining 16% were from the homogenous corn strain (*COI*-corn strain/*Tpi*-corn strain). This study improved our understanding of the genetic diversity of the fall armyworm in the DRC, which is important for pest surveillance.

Key words: Fall armyworm, haplotype, *COI* gene, *Tpi* gene, invasive pest, corn/rice strain

O59

Application of AI in Microlepidopteran pest

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The genus *Stathmopoda* is considered as a forestry and agricultural pest. However, due to their tiny size and similarity between them in appearance, experts in morphology and molecular information are lacking. Among them, *S. auriferella* Walker, 1864 is considered a worldwide pest because it feeds on a wide range of fruit trees, such as peach, apple, avocado, etc. In this study, we detected and identified *S. auriferella* using the YOLO algorithm, which is widely used in agriculture due to its fast processing and real-time detection capabilities. This algorithm learns by segmenting a given image into multiple grids and predicting one object in each grid, and we tried to see how well YOLO could detect *S. auriferella* using 100 photos when training.

Key words: *Stathmopoda*, agriculture, pest, YOLO

O60

A historical review of the classification of Acronictinae (Lepidoptera: Noctuidae) in Korea

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Acronictinae established by Harris, 1841 based on the type species, *Acronicta leporina*, has often been externally misidentified at the genus-level. As their ambiguous morphologic keys and variable features. In this study, we review the history of Acronictinae in Korea including the features of Acronictinae, genitalia, and biological information. Additionally, further study direction is proposed for deeper understanding on Acronictinae.

Key words: history, morphology, ecology, genitalia

O61

Taxonomic review of the subfamily Typhlocybae (Hemiptera: Auchenorrhyncha: Cicadellidae) from Korea

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Leafhopper subfamily, Typhlocybae (Hemiptera: Auchenorrhyncha: Cicadellidae), caused direct damage by sap-sucking or indirect damage by transmission of viruses or diseases on the host plants, so typhlocybae is one of the important pest groups in the world. In this study, we provide a taxonomic review and list subfamily Typhlocybae from Korea, including previously incorrectly described species, new records species, and new species candidates. We also reported new species that have potential pests.

Key words: leafhopper, revision, new species, list

O62

Taxonomic study of the Family Cynipidae (Hymenoptera: Cynipoidea) in South Korea

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Gall wasps (Hymenoptera: Cynipoidea: Cynipidae), with approximately 1,400 species mainly distributed throughout the Holarctic region, are some of the most diverse gall-inducing insects after gall midges. Gall wasps are divided into two main trophic groups: the gall inducers, which encompasses most described species, and the inquilines. Herein we illustrated each species, and give some biological information.

Key words: Hymenoptera, Cynipidae, Cynipoidea, South Korea

063

DNA barcode analysis of Korean limoniid crane flies (Diptera: Limoniidae)

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Crane fly belonging to Limoniidae is one of the largest groups in Diptera comprising 10,700 species. However, taxonomical identification on the species level have not been fully resolved due to individual morphological variations, sexual dimorphism, and high cryptic species diversity. Therefore, DNA barcodes have recently been used to support the species delimitation. Here, we performed DNA barcode analyses using a segment of the mitochondrial cytochrome c oxydase subunit I (COI) gene to delimit species of limoniid crane flies in South Korea. A total of 162 COI sequences from 37 genera and 100 species including 11 unrecorded species were obtained. The establishment of a Limoniidae DNA barcode library for South Korea will improve the taxonomy and biodiversity of this family as well as ones of crane flies.

Key words: Chioneinae, Dactylolabinae, Limnophilinae, Limoniinae, species delimitaion

O64

Identifying the Optimal Nutrition in the Yellow Mealworm, *Tenebrio molitor* L. (Coleoptera: Tenebrionidae)

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In recent years, there has been a growing interest to use insects as alternative protein sources for animal feed and human food because they are cost-effective to produce, environmentally sustainable, and highly nutritious. The yellow mealworm, *Tenebrio molitor* L. (Coleoptera: Tenebrionidae), is one of the few edible insect species mass-produced around the world to meet this increasing demand. While numerous studies have attempted to establish the optimal diet for rearing *T. molitor* larvae, the exact amount and balance of nutrients ideally required by *T. molitor* larvae remain largely elusive. The goal of this study is to quantify the optimal intake of protein and carbohydrate in *T. molitor* larvae by leveraging a powerful “nutritional performance landscape” approach. We recorded key life-history traits from *T. molitor* larvae reared on one of 42 synthetic foods that differed in the ratio of protein-to-carbohydrate (P:C) and in the protein plus carbohydrate (P+C) concentration. Survivorship was maintained high as long as protein was ingested in high amounts. Growth rate was maximized at a moderately protein-biased P:C ratio (~2:1) and at high P+C intakes (>150 mg), but fell as the P:C ratio deviated from this optimal ratio and also as the P+C intake declined. Unlike growth rate, lipid content increased linearly with carbohydrate intake, peaking at a carbohydrate-biased P:C ratio (~1:4 – 1:3). When offered a food choice, *T. molitor* larvae preferentially selected a P:C ratio (1:1.2) that was near the midpoint between the ratios that maximized growth and lipid content. Our results have implications for designing the optimal dietary regimen that will help us improve the industrial production of this economically important insect.

065

Tritrophic communication among PGPR, hot pepper, and thrips via methyl jasmonic acid

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토양세균, 식물 그리고 곤충 사이에 화학고신에 의한 상호작용이 알려져 있다. PGPR (plant growth-promoting rhizobacterium: PGPR)은 식물 생육은 물론이고 유도저항성을 통한 병해충에 대한 면역력 증진에 기여한다. 이 가운데 자스모닉산(jasmonic acid: JA)은 흡즙성 해충에 대한 식물면역 유발 인자로 잘 알려져 있다. 본 연구는 꽃노랑총채벌레(*Frankliniella occidentalis*)를 대상으로 고추(*Capsicum annuum*)의 내충성 기작에 미치는 PGPR과 JA의 기능을 분석하였다. 고추 잎에 메틸자스모닉산(MeJA) 처리는 총채벌레에게 뚜렷한 기피효과를 유발하였다. 온실에서 MeJA를 처리한 고추에 낮은 총채벌레 서식 밀도를 확인하였다. 5종의 PGPR 가운데 *Bacillus velezensis* Ak-0 균주가 상대적으로 높은 기피 효과를 유발하였다.

Key words: *Frankliniella occidentalis*, hot pepper, PGPR, jasmonic acid

066

Enzyme kinetics of a recombinant Phospholipase A₂ encoded in the Asian onion moth, *Acrolepiopsis sapporensis*

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The Asian onion moth, *Acrolepiopsis sapporensis*, is an insect pest infesting the Welsh onion by the larvae. Manipulating insect immunity provides diverse novel control strategies. Phospholipase A₂ (PLA₂) catalyzes phospholipid (PL) to release arachidonic acid, which is used for biosynthesis of various eicosanoids. Eicosanoids mediate cellular and immune responses in insects. Any compounds inhibiting PLA₂ would be used to develop novel insecticidal agents. *A. sapporensis* encodes at least four different PLA₂s, in which *As-PLA₂A* is the most highly expressed and supposed to be a major PLA₂ associated with this insect immunity. Its recombinant protein (rAs-sPLA₂A) was produced using a bacterial expression system. The purified rAs-sPLA₂A protein was active to catalyze PL substrate and followed a typical Michaelis-Menten enzyme kinetics. The activity was highly susceptible to sPLA₂-specific inhibitor, but not to other types of PLA₂ inhibitors. rAs-sPLA₂B catalyzed PL, but did not neutral lipids or glycolipids. Furthermore, rAs-sPLA₂B was recognized by a polyclonal serum raised against other lepidopteran sPLA₂. Using this antibody, the cellular localization of As-sPLA₂ was determined. Interestingly, the immune challenge stimulated the intracellular migration of As-sPLA₂B near to nuclear or cellular membranes. A bacterial metabolite, benzylideneacetone (BZA), competitively inhibited the enzyme activity of rAs-sPLA₂B. BZA treatment inhibited the immune responses of *A. sapporensis*. These results suggest As-sPLA₂A mediate immune responses of *A. sapporensis*.

Key words: *Acrolepiopsis sapporensis*, specific enzyme activity, Michaelis-Menten, phospholipase A₂

067

Phenotypic variation of orientation aggressiveness among bred lines of honey bee colonies (*Apis mellifera* L.)

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Honeybees (*Apis mellifera* L.) are social organisms that express complex behavioral patterns to exhibit defensive mechanisms for their survival. Chemical cues, accompanied with physical and visual stimuli were used to evaluate aggressiveness and orientation among five bred lines of honey bee colonies. Both chemical assays recruited honeybees but the time of recruitment was significantly lower for alarm pheromone ($t=1.965$, $P=0.0004$). Honeybees response to both assays culminated to stings which differed among bred lines for alarm pheromone ($K=25.185$, $df=4$, $P<0.0001$) and paraffin ($K=14.551$, $df=4$, $P=0.006$). Honeybees performed orientation aggressiveness which varied among bred lines. It is crucial to repeatedly evaluate orientation aggressiveness among bred lines when selecting defensive and less-defensive honeybee colonies.

Key words: Honeybee bred lines, *Apis mellifera* L., Controlled breeding, Defensive behavior, Chemical pheromone

068

Surveillance of SFTSV infection rate and the evidence of transovarial transmission of this virus from field collected chigger mites in Korea

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Sever fever with thrombocytopenia syndrome (SFTS) is a viral infectious disease transmitted by ticks. In 2017, SFTSV and scrub typhus pathogens (*Orientia tsutsugamusi*) were simultaneously detected in one SFTS patients, raising the possibility of SFTSV transmission by chigger mites. Therefore, this study aimed to investigate the nationwide SFTSV infection of chigger mite by collecting them from wild rodents, known as the main host animals of the mites. SFTSV was confirmed in 6 (25.0%) larvae hatched from eggs laid by 24 infected mites which is rearing in laboratory after collected field, confirming the possibility of transovarial transmission of SFTSV from mites. The SFTSV infection rate in wild rodents was 3.6% out of 56 collected from 17 regions, and in chigger mite, it was found in 3 pools (2.3%) out of 132 pools (3,402).

Key words: Chigger mite, SFTSV, transovarial transmission



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Korean Society of Applied Entomology

A1

Taxonomy of the genus *Colpotrochia* Holmgren, 1856 (Hymenoptera, Ichneumonidae, Metopiinae) from South Korea

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The subfamily Metopiinae is the moderately large group of the family Ichneumonidae which is known as endoparasitoids of lepidopteran larvae and pupae. Their oviposition is into the larvae of hosts, apparently a considerable time prior to pupation and then emergence is almost from pupae. *Colpotrochia* is the moderately sized genus in this subfamily, comprising 62 species from worldwide. 21 species have been reported from the Eastern Palaearctic and nine species from South Korea. In this study, three species are newly recorded from South Korea. We provide diagnoses with photographs and an identification key to South Korean species.

Key words: new records, parasitoids, wasps

* This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (NRF-2021R1F1A1052395).

A2

Two new species of the genus *Anisobas* Wesmael, 1845 (Hymenoptera, Ichneumonidae, Ichneumoninae) from South Korea

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The subfamily Ichneumoninae is the second largest subfamily of the family Ichneumonidae which is known as endoparasitoids of Lepidoptera larvae or pupae. Many species of Ichneumoninae are sexually dichromatic and dimorphic. In the Ichneumoninae sexual differences can be extraordinarily great in morphology as well as in coloration (Heinrich, 1977). *Anisobas* Wesmael (1845) is the small genus in this subfamily, comprising 26 species from worldwide, 11 from the Eastern Palaearctic and only one species from South Korea. In this study, two new species, *A. sp. nov.* 1 and *A. sp. nov.* 2 are described. Diagnoses of two new species with photographs and key to South Korean species are provided.

Key words: Listrodromini, new species, parasitoids, wasps

A3

First record of the genus *Notopygus* Holmgren, 1857 (Hymenoptera, Ichneumonidae, Ctenopelmatinae) from South Korea

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The genus *Notopygus* is a small group of the subfamily Ctenopelmatinae, comprising 17 species from worldwide, seven species from the Eastern Palaearctic. This species and genus are report for the first time from South Korea. This genus have the following morphological characters: Posterior margin of last tergite rather strongly projecting upwards. Female hypopygium stronly enlarged. In this study, *Notopygus emarginatus* Holmgren, 1857 is described and provide characteristic photographs of this species.

Key words: Ctenopelmatini, new record, parasitoids, wasps

* This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (NRF-2021R1F1A1052395).

A4

Update of Dokdo insect fauna list from 2021 to 2022

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Dokdo is an island located in the middle of the East Sea of Korea and is of great military, geographical, and economic importance. Although it is difficult to access by climate and terrain conditions, it is important to establish an insect fauna clearly through continuous update. In 2020, a total of 10 orders, 82 families, and 190 species (excluding unidentified species) were reported. This survey newly updated 192 in 10 orders and 39 families including unrecorded one family (Drinidae family of Hymenoptera) and two species (*Haplogonatopus oratorius* and *Nabis capsiformis*). The results of this survey will be updated on the Global Biodiversity Information Facility (GBIF).

Key words: Dokdo, Insect fauna, Drinidae, *Haplogonatopus oratorius*, *Nabis capsiformis*

A5

A new species of the genus *Phaenolobus* (Hymenoptera: Ichneumonidae) from South Korea

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The subfamily Acaenitinae are one of the family Ichneumonidae, currently 280 species in 28 genera worldwide. Among them 16 species are from South Korea. This group are mainly koinobiont, endoparasitoids of wood-boring Coleoptera or Lepidoptera. One of the genera, genus *Phaenolobus*, are moderately large group comprising 26 species. In South Korea, only three species have been recorded. This genus are easily distinguished from other genera with very stout body, incomplete occipital carina, intercepted nervellus near its upper part and propodeum with sharp wrinkling and carinae. They are known as parasitoids of longhorn beetles (Cerambycidae) or clearwing moths (Sesiidae). In this study, we report three species of genus *Phaenolobus* from South Korea. Which of them, a species is described as new. Photographs of habitus and diagnoses of newly recorded species and new species are provided.

Key words: Taxonomy, parasitic wasps, Hymenoptera, eastern palaearctic region

A6

New faunistic record of the subfamily Dactylolabinae from South Korea (Diptera: Limoniidae) with molecular data

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Crane flies belonging to the subfamily Dactylolabinae Alexander, 1920 have hitherto been unknown in Korean peninsula. We report two new species of short-palped “Rock Crane fly”, *Dactylolabis* (*Dactylolabis*) *heungwola* sp. nov. and *Dactylolabis* (*Dactylolabis*) *whangjeongsana* sp. nov. from South Korea for the first time. Details on finding in the field and description based on the male and female adults with original photographs of the main diagnostic features are given. DNA barcodes of the two new and other *Dactylolabis* (*Dactylolabis*) Osten Sacken, 1860 species are presented.

Key words: *Dactylolabis*, DNA barcode, new species, Korean peninsula, rock crane fly

A7

Four intertidal *Bryothinusa* Casey (Coleoptera: Staphylinidae: Aleocharinae) species new to Korea

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The intertidal myllaenine genus *Bryothinusa* Casey contains 40 species worldwide. In Korea, four species have been recorded [*Bryothinusa gangjinensis* Ahn and Jeon, *B. koreana* Ahn and Jeon, *B. minuta* (Sawada), and *B. nakanei* (Sawada)]. They occur under stones along the coasts of gravel/pebble beach, sandy beach, or mud flat in the intertidal zone. During repeated collecting trips on the coasts of Korea, we found four species new to the Korean fauna (*Bryothinusa algarum* Sawada, *B. hokkaidensis* Liu, Ono and Maruyama, *B. itsuroi* Liu, Ono and Maruyama, and *B. japonica* Liu, Ono and Maruyama). They were compared with the related species and a key to species of Korean *Bryothinusa* is presented.

Key words: *Bryothinusa*, intertidal, Staphylinidae, Coleoptera, Korea, new record

A8

Taxonomic revision of the genus *Fannia* Robineau-Desvoidy (Diptera: Fanniidae) from Korea

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So far, six *Fannia* species have been discovered in Korea. During a taxonomic survey of this genus, the author found two newly recorded species for the first time in Korea: *F. barbata* (Stein, 1892) and *F. japonica* Nishida, 1974. Diagnoses, illustrations, and keys to the Korean species are provided.

Key words: *Fannia*, Fanniidae, morphology, new record, Korea

A9

Characterization of two complete mitochondrial genomes of argid species (Hymenoptera, Argidae) from Korea

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Two complete mitochondrial genomes of argid species, *Spinarge fulvicornis* (Mocsáry, 1909) and *Sterictiphora koreana* Lee & Wei, 2017, from Korea are determined and characterized in the present study. The circular genome is 15,368 bp and 17,873 bp long in order, which consists of 13 protein-coding genes (PCGs), two ribosomal RNA genes, 22 transfer RNA genes, and an A+T-rich region. The four A+T-biased codons are mainly used in all PCGs: TTA, ATT, TTT, and ATA. The mitochondrial gene order of five argid species including four Arginae and one Sterictiphorinae is identical to that of an ancestral insect form, exception of two tRNA gene translocations. The A+T content of members of Arginae is apparently higher than that of Sterictiphorinae. A maximum likelihood (ML) tree reconstructed with the nucleotide and amino acid sequences of 13 PCGs showing familial relationships within superfamily Tenthredinoidea.

Key words: Arginae, molecular phylogeny, Sterictiphorinae, Symphyta, Tenthredinoidea

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A10

An updated checklist of millipedes (Myriapoda: Diplopoda) of the Korean Peninsula

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The Korean Peninsula is geographically located in the centre of Far Eastern Asia and has complex and various climate conditions following longitudinal topology, which would expect to be result in high diversity and endemism of millipede. In this study, the millipede fauna of the Korean Peninsula consists of 69 species plus 5 subspecies from 29 genera, 15 families and 7 orders. Of these species/subspecies, 29 and 12 are endemic in South Korea and North Korea, respectively; nine are recorded in both South Korea and North Korea. Each species has been provided comprehensive information including an original report, taxonomic changes, distribution, and remarks if necessary. Moreover, unsolved taxonomic uncertainty of some species included in this checklist should be investigated through further study.

Key words: Millipede, checklist, taxonomy, fauna, Korean Peninsula

A11

First record of the genus *Lorostema* Motschulsky (Coleoptera: Carabidae: Platynini) from Korea

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The genus *Lorostema* Motschulsky, 1864 is a small genus of the tribe Platynini, which is only comprised of six species worldwide. This genus usually occurs in Oriental and Australian regions, and in the case of Palearctic region, it was only known to occur in Japan and the Northern part of India. As a result of our study, this genus is recorded for the first time in Korea, based on *Lorostema ogurae* (Bates, 1883) collected from Jeju Island. *L. ogurae* has been only recorded in Japan, but now it is also recorded in Korea. A diagnosis of an unrecorded species and key to the world species of the genus *Lorostema* are provided here.

Key words: Korea, morphology, taxonomy, unrecorded genus, unrecorded species

A12

Complete mitochondrial genome of *Chorthippus fallax* (Zuboxsky) (Orthoptera: Acrididae) from Mongolia

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In this study, the complete mitochondrial genome (mitogenome) of *Chorthippus fallax* was completely sequenced and characterized. It was 15,864 bp length being composed of 13 protein-coding genes (PCGs), 22 transfer RNA genes, two ribosomal RNA genes, and one control region. Detailed parameters such as gene arrangement patterns, gene compositions, A+T contents, and codon usage patterns were studied. Also, maximum likelihood analyses based on amino acid sequences of the PCGs were performed for resolving *Chorthippus* phylogenetic relationships. The most common start codon for 13 PCGs is ATG and the most common termination codon is TAA. The overall A+T content was 75.02%.

Key words: *Chorthippus fallax*, Complete mitochondrial genome, Acrididae, molecular phylogeny

A13

Taxonomy of the Shore fly Genus *Setacera* Cresson (Diptera: Ephydriidae) from Korea

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The genus *Setacera* Cresson, belonging to the Ephydriidae, had been described 15 species in all zoogeographical regions except Antarctica. Among them, only one species has been found in Korea. In this study, we added one unrecorded species to the Korean fauna. The taxonomic information, external photographs, and Korean species key are provided herein.

Key words: Shore fly, *Setacera*, Ephydriidae, Diptera, new record, Korea

* 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 (NIBR20233201).

A14

A newly recorded species of the jewel beetle genus *Trachys* Fabricius (Coleoptera: Buprestidae) from Korea, with the first descriptions of pupa and male genitalia

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The jewel beetle, *Trachys pseudoscrobiculatus* Obenberger, 1940 is known as a leaf-miner of *Viola mandshurica* and has been recorded in Japan and China. In this study, we report *T. pseudoscrobiculatus* for the first time from Korea, with the first descriptions of pupa and male genitalia. Also, their brief biological notes are presented.

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

A15

A new genus of long-legged fly (Diptera: Dolichopodidae) from Korea, with two new species

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In the course of taxonomic survey on the long-legged flies in Korean peninsula, the authors have found a genus new to science, *Magniunguis* gen. nov. with two new species: *M. flavicrus* sp. nov. and *M. koreanus* sp. nov. This new genus is similar to the genus *Hydrophorus* Fallén, 1823 with thickened and ventrally spined fore femur, but is clearly distinguished by the distinct large claws. The new species are mainly found on sandy coast but also occasionally on abandoned saltern. Diagnoses and morphological characteristics of the new genus and species are provided here.

Key words: Hydrophorinae, new species, new genus, 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 (NIBR20233201).

A16

Taxonomy of the genus *Aulagromyza* Enderlein (Diptera: Agromyzidae) from Korea

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Up to now, only one species in the genus *Aulagromyza* Enderlein, 1936 has been known to be occurred in Korean fauna. In the course of the taxonomic survey on the Korean Agromyzidae, the authors found one newly recorded species from Korea, *Aulagromyza anteposita* (Strobl, 1898). Therefore, a total of two species under this genus are listed in the Korean Agromyzidae. The key to the Korean species and description for newly recorded species are provided herein.

Key words: Agromyzidae, Phytomyzinae, new record, Korea

A17

Occurrence of the Pyralid moth *Hypsopygia mauritalis* (Lepidoptera, Pyralidae), reared from nests of social wasp in South Korea

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최근 전국적으로 말벌의 피해가 증가하면서 이에 대한 다양한 방제법이 연구되고 있다. 그 중 생물학적 방제를 위한 천적 탐색 연구가 진행되는 가운데 최근 일부 말벌집에서 기생포식을 하는 나방류가 발견되고 있다. 지금까지는 명나방과의 은무늬줄명나방과 창날개빨나방과의 세모창날개 빨나방 2종이 쌍살벌류인 왕바다리 벌집에서 기생하는 것으로 알려져 있으나 2021~2022년 진주, 구례, 전주, 성주 일대에서 명나방과 *Hypsopygia* 속의 새로운 나방이 사회성 말벌 둥지에서 발견되었다. 이를 동정하기 위해 나방 생식기의 형태적 분석 및 DNA 바코드 분석법을 통해 분석하였고, 그 결과 *Hypsopygia mauritalis*라는 종으로 동정되었으며 숙주로는 왕바다리, 외래종 등검은말벌로 나타나 추후 이들에 대한 방제효과를 검증할 필요가 있다.

검색어: 말벌과, 명나방과, 포식기생, DNA 바코드, *Hypsopygia*

A18

Valid specific status of *Dolichovespula kuami* Kim & Yoon (Hymenoptera: Vespidae) through molecular and morphological evidence

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Dolichovespula kuami and *D. flora* have been subject to conspecific debate for a long time. Therefore, we further analyzed the evidence through morphology such as pronotal rugae and male genitalia and DNA barcodes and presented a valid specific status for *Dolichovespula kuami*. As a result, as these evidences clearly indicate that these two species are distinct, further debate must be ended.

Key words: *D. flora*, male, description, taxonomy

A19

Donacia coreana Kim & Lee (Coleoptera: Chrysomelidae: Donaciinae), a new species from Korea

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The subfamily Donaciinae have a very unique life history. All Donaciinae members live in freshwater wetlands, such as ponds, marshes, bogs, lakes, and streams, and their larvae feed on roots or subterranean stems of aquatic plants and are therefore considered aquatic beetles.

There are 70 species of the genus *Donacia* Fabricius recorded worldwide. In Korea, the genus is represented by seven species: *D. aquatica*, *D. bicolorcornis*, *D. clavareaui*, *D. flemola*, *D. lenzi*, *D. provostii* and *D. thalassina*. In this study, a total of 8 species are recognized including a new species, *D. coreana* sp. nov. from Korea. A dorsal habitus image and illustration of the male genitalia are provided.

Key words: Donaciinae, *Donacia*, new species, leaf beetles, Chrysomelidae

A20

Korean stoneflies (Plecoptera) with four new species and three new Korean records

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Plecoptera is a small order of hemimetabolous insects, with more than 4,300 species, 436 genera, and 31 families in the world. Within the Korean Peninsula, 97 species, 39 genera and 11 families of Plecoptera have been catalogued by Hwang and Murányi (2020, 2021, 2023) including the following three species recorded only from North Korea: *Pictetiella asiatica* Zwick & Levanidova, *Claassenia radiata* (Klapálek), and *Xanthoneuria unimaculata* (Zhiltzova). In this study four new species are described from South Korea and three new species from the Korean peninsula: *Kogotus* n. sp., *Skwala* n. sp., *Utaperla* n. sp. 1, *Utaperla* n. sp. 2, *Pictetiella zwicki* Zhiltzova, 1976, *Haploperla maritima* Zhiltzova & Levanidova, 1978, and *Alloperla tiunovae* Teslenko, 2009. Materials and distribution data, descriptions for new species, and diagnostics for newly recorded species with photos are provided.

Key words: Plecoptera, stoneflies, new species, new Korean records, Republic of Korea

A21

A taxonomic study on the genus *Stichillus* (Diptera: Phoridae) from South Korea

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The South Korean species of the genus *Stichillus* Enderlein, 1924 are revised and five species are newly recognized. The genus *Stichillus* is a group of blackish, robust scuttle flies (Diptera: Phoridae) comprising more than 30 species worldwide, characterized by synapomorphic demarcated ocellar region forming a three-looped line. Two species are described as new to science and three species, *S. cylindratus* Nakayama and Shima, 2004, *S. japonicus* (Matsumura, 1915) and *S. spinosus* Liu and Chou, 1996, are described for the first time in South Korea. The species from South Korea are seemed to be distributed mostly in mountainous regions of relatively high altitude, about range of 700~1,900 m above sea level, except one species from forests of lower altitude and inside of cave. Photographs and a key to all *Stichillus* species in South Korea are provided.

Key words: new species, Phoridae, South Korea, *Stichillus*, taxonomy

A22

Malaise trap surveys of scuttle flies (Diptera: Phoridae) from Kangwon National University Experimental Forest

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한국산 벼룩파리과의 분류학적 연구를 위한 기반 조사를 목적으로, 강원도 춘천시 동산면 강원대학교 학술림 내 2개 지점에 2년간 말레이즈 트랩을 설치하여 벼룩파리과를 채집, 분류하였다. 채집된 개체들을 속별 형태종 수준으로 분류하였으며, 지점 간 형태종의 다양성과 우점종, 종별 출현 시기, 종 구성의 차이를 비교하였다. 채집된 16속 2,518개체의 분류 결과 형태종 195종이 확인되었으며, *Megaselia*속이 전체 채집량의 96%를 차지하였다. 계곡부 지점과 산지 능선 지점 간 벼룩파리 종 구성의 차이가 분명하였으며, 계곡부에서 1~2종의 우점 현상이 두드러졌다. 월별 출현 양상은 대부분의 벼룩파리 종이 7~9월에 집중적으로 발생하였으나, 봄 또는 가을에 특정 종들의 급격한 발생 및 소멸이 확인되었다. 구체적인 종 동정 결과 국내 기록종은 2속 4종이 확인되었으며, 이를 제외한 14속 191종의 신규 분류군에 대한 심도 깊은 연구가 필요하다.

검색어: 말레이즈 트랩, 벼룩파리과, 우점종, 종 다양성, 춘천, 출현 시기, 학술림

A23

Badumna longinqua, an invasive spider species new to Korea (Araneae: Desidae)

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The invasive grey house spider, *Badumna longinqua* (Araneae: Desidae), is newly discovered in urban habitats from Tongyeong, South Korea. Specimens and their webs were found in public parks and around houses near ports. This species is native to Australia and has been introduced widespread into New Zealand, countries in the Americas, Germany, Japan, and South Africa, and currently listed as invasive species in many countries. Moreover, the family Desidae is recorded again in Korea, after the exclusion from Korean spider fauna as a result of transfer of the genus *Paratheuma* from Desidae to Dictynidae. Since this species can be established in new habitats as an invasive species, extensive investigation is more than warranted to monitor and confirm its distribution range in Korea.

Key words: Araneae, *Badumna longinqua*, invasive species, synanthropy, taxonomy

A24

Two new species of the genus *Pholcus* (Araneae: Pholcidae) from Korea

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Currently 37 species of the *Pholcus phungiformes*-group (Araneae: Pholcidae) have been known from Korea, and undoubtedly many species still await discovery. In this study, two new species belonging to this species group were found in mountainous regions from Danyang, Yeongju and Jecheon, Korea. These new species have common characteristics with *Pholcus sokkrisanensis*, such as claw-like large sclerotized projection on the edge of membranous prolateral process of procurus and half-heart-shaped uncus in male palp and strongly elongated anterolateral portion of female internal genitalia pointing anteriorly. Brief descriptions, photographs and a distribution map of the new species and *P. sokkrisanensis* are provided.

Key words: Araneae, cellar spider, new species, *Pholcus phungiformes*-group, taxonomy

A25

Taxonomic review of the genera *Philhelius* and *Doros* (Diptera: Syrphidae: Syrphini) in Korea and Japan

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As a result of our taxonomic study of the syrphid genera *Philhelius* and *Doros* in Korea and Japan, we recognized the following two species new to Korea: *P. eoa*, and *P. sichotana*. We found that the previous Korean species, *P. sapporensis*, was due to the misidentification of *P. eoa*. We also conducted a DNA barcoding analysis of *Philhelius* (12 species, 94 samples) and *Doros* (3 species, 15 samples). The resulting DNA phylogram clearly indicated their monophyly when compared with other genera, but did not showed whether the genus *Doros* is a member or a sister group of the genus *Philhelius*. Our analysis also showed that the previously synonymized *P. eoa* and *P. laetum* actually are different species.

Key words: Syrphidae, Syrphini, *Philhelius*, *Doros*, DNA barcoding

A26

Quantification of color patterns in *Stenaptinus occipitalis jessoensis* (Coleoptera: Carabidae: Brachininae) using R-based analysis

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Species identification of the genus *Stenaptinus* is primarily based on color patterns, but it is incomplete due to intraspecific variation and subjective interpretation. To overcome these limitations, the Patternize and Recolorize R packages were used to quantify the color patterns of *Stenaptinus occipitalis jessoensis*, which is distributed in Korea. Then, principal component analysis (PCA) was used to classify differences in color patterns and identify new patterns that are localized to specific regions within this species. The present study is one of the objective and reliable methods when the difference in color pattern becomes an important identification key.

Key words: Brachininae, *Stenaptinus*, variation, R package, PCA

A27

Hidden diversity of fungus gnats (Diptera: Mycetophilidae) from headwater stream forest in South Korea

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Riparian headwater areas are possess unique insect fauna associated with wet microhabitats such as mosses and high mountain vegetation. This unquity of insect fauna is also caused by geological isolation from the nearby water systems and high valleys. Mycetophilidae is one of the most divers family groups in Diptera, the larva eats fungi and moss and the adult acts as a pollinator. They are described more than 4,500 species in the world but only 11 species are recorded in South Korea. In this study, we showed the habitat information and the species list of Mycetophilidae, with six newly recorded genera and 13 species: one *Azana*, one *Boletina*, four *Dziedzickia*, two *Ectrepesthoneura*, four *Palaeodocosia*, and one *Saigusaia* species.

Key words: South Korea, Riparian headwater area, Mycetophilidae, species list

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A28

A new species of *Tortopsis* (Ephemeroptera: Polymitaarcyidae) from Mexico

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The study on Mexican Ephemeroptera has been poor in terms of taxonomy. Therefore, it is expected that there is still a huge diversity of Ephemeroptera unknown. The genus *Tortopsis* Molineri is a Neotropical genus (Polymitaarcyidae), with little more than 10 species described from South America. In Mexico, the North American *Tortopsis primus* (McDunnough) is the only species officially reported. The type locality of the new species is the Reserve of the Biosphere “Montes Azules” located at the Southern part of Mexico, Chiapas State. *Tortopsis mexicana* sp. nov. is described based on male and female adults. *T. mexicana* is close to the Colombian *T. unguiculatus* (Ulmer), but *T. mexicana* is different by the following characters: abdominal terga with remarkable dark pigmentation present only at terga VIII-X; apex of penes has a wide V-shaped notch at the middle; apex tip hooked and curved downward interiorly similar to a bird's beak; parastyli pale, long and curved at the apex; tip of apex sharp and dark-pigmented; forceps pale, straight, thin, and larger than penes and parastyli; apex rounded but flat at the exterior-lateral margin.

Key words: Ephemeroptera, burrowing mayfly, Polymitaarcyidae, Tortopsis, Mexico

A29

Unraveling existence of a cryptic species in Korean mayfly genus *Baetis* Leach (Ephemeroptera: Baetidae)

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The family Baetidae is believed to be a basal lineage of living mayflies and is the most diverse family in the order Ephemeroptera. Its genus *Baetis* Leach includes over 150 species and can be found in various lotic habitats. While 40 or more *Baetis* species are recorded in the nearby countries including Japan, Mongolia and Russian Far East, only four species in the genus have been discovered in Korea so far. In this study we obtained DNA barcodes of all four Korean *Baetis* species based on the mitochondrial cytochrome c oxidase subunit I gene and examined genetic differences within morphologically indistinguishable species groups. DNA sequences are acquired from larval specimens collected from different locations in the Namhan River upstream region. Large intraspecific p-distance is shown inside the *Baetis silvaticus* and the *Baetis fuscatus* group and this may indicate the presence of potential cryptic species, which is also supported by our previous research of DNA barcode analysis on Korean mayflies.

Key words: Baetis, DNA barcoding, cryptic species, Korea, taxonomy

A30

New records of Ceratopogonidae (Diptera: Culicomorpha) in Korea with emphasis on cryptic diversity of *Culicoides circumscriptus* group

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The family Ceratopogonidae comprises small- to medium-sized Diptera, some of which are known as blood-feeding vectors. This family is diverse and broadly distributed worldwide with more than 6000 species. Currently, 37 species from seven genera have been recorded in Korea. However, only seven species from six genera of non-blood-feeding group have been recorded. Moreover, multiple isomorphic species groups from the blood-feeding genus *Culicoides* Latreille has been reported worldwide. In the study, we present the first report of three genera, *Atrichopogon*, *Forcipomyia*, and *Serromyia* in Korea, and three new species, *Culicoides dokdoensis* sp. nov., *Serromyia jiriensis* sp. nov. and *Serromyia jejuensis* sp. nov.

Key words: *Atrichopogon*, biting midge, *Culicoides*, *Forcipomyia*, new species, *Serromyia*

A31

Classification of the leafhopper tribe Drabescini Ishihara from Korea (Homoptera: Cicadellidae)

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Until now, a total of 18 species with 8 genera under 2 subtribes of the tribe Drabescini Ishihara are listed in the Korean fauna. During the continuous taxonomic survey on the leafhoppers in Korean peninsula, the authors have found further 2 unknown species new to science, and discovered 2 newly recorded species. Thus, a total of 22 species and 9 genera of the present tribe are known to be occurred in Korea. Descriptions with illustrations of these newly added taxa, and keys to the Korean species are provided respectively.

Key words: Hemiptera, Auchenorrhyncha, Eurymelinae, taxonomy, identification, new species

A32

New discovery of the leafhopper tribe Megipocerini Isaev from Korea (Homoptera: Cicadellidae)

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The leafhopper tribe Megipocerini Isaev, 1988, consisting of 26 genera to be known world-widely so far. In the course of taxonomic survey on the leafhoppers in Korean peninsula, the authors have found this tribe firstly based on the discovery of the constituent monotypic taxon in Central Korea: *Megipocerus mordvilko* Zachvatkin, 1945. Description and illustration of morphological features of the present nominate species are provided respectively.

Key words: Hemiptera, Auchenorrhyncha, Eurymelinae, taxonomy, identification

A33

Taxonomic revision of the leafhopper tribe Idiocerini Baker from Korea (Homoptera: Cicadellidae)

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Since both the early revision by Kwon (1985) and the recent report by us (2022), a total of 18 species with 11 genera of the leafhopper tribe Idiocerini Baker, 1915 have been known to Korean fauna, hitherto. In the course of taxonomic survey on the leafhoppers in Korean peninsula, the authors have found further 5 new species and 2 new genera with the nominate new species respectively. Thus, all together 23 species with 13 genera are enumerated to be occurring in Korean peninsula, through the present investigation.

Key words: Hemiptera, Auchenorrhyncha, Eurymelinae, taxonomy, identification

A34

Classification of the microleafhopper genus *Empoa* Fitch from Korea –2 (Homoptera: Cicadellidae: Typhlocybinae)

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In the first part of this article, the authors reported 8 species belonging to the leafhopper genus *Empoa* Fitch, including one new species. During the continuous taxonomic survey on the microleafhoppers from Korea, the authors have found a further species new to science: *E. (Empoides) gasana* sp. nov. Thus, a total of 9 species of the present genus are recognized to be occurred in Korean fauna. A key to discriminate the subgenera and species from Korea are provided here.

Key words: Auchenorrhyncha, Typhlocybini, morphology, identification, new species

A35

Is this new jumping plant-louse should be an invasive species in Korea ? (Homoptera: Psyllidae)

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As a continuous taxonomic survey on the jumping plant-lice in Korean peninsula since the recent completion of the monograph on the Korean Psylloidea (Kwon & Kwon, 2020), the authors have found a further new species belonging to the genus *Cacopsylla* Ossiannilsson, 1970, at a village garden in South Korea. The populations of this psyllid have observed during the adult overwintering period, dwelling on *Cotoneaster dammeri*, an ornamental bearberry introduced possibly from China. Description with illustrations of morphological features are provided respectively.

Key words: Sternorrhyncha, Psylloidea, taxonomy, morphology, identification, new species

A36

**Contributions to the knowledge of the jumping plant-lice from Korea:
on the 3 new species of the genus *Cacopsylla* Ossiannilsson (Homoptera: Psyllidae)**

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As a continuous taxonomic survey on the jumping plant-lice in Korean peninsula since the recent completion of the monograph on the Korean Psylloidea (Kwon & Kwon, 2020), the authors have found further 3 unknown species new to science belonging to the genus *Cacopsylla* Ossiannilsson, 1970. Descriptions with illustrations of morphological features of these new taxa are provided respectively.

Key words: Sternorrhyncha, Psylloidea, taxonomy, morphology, identification, new species

A37

**Classification of the dancefly genus *Heleodromia* Haliday belonging to
the subfamily Brachystomatinae from Korea (Diptera: Empididae)**

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Previously, 3 species belonging to the dancefly genus *Heleodromia* Haliday, 1833 were listed to Korean fauna since Kwon *et al.* (2021). In the course of taxonomic survey on the danceflies in Korean peninsula, the authors have found further 2 unknown species new to science, which have consisted of totally 5 species in the present genus. Descriptions, illustrations and key to the Korean species are provided respectively.

Key words: Diptera, Empidoidea, Empididae, Brachystomatinae, taxonomy, new species

A38

Two new species of the dancefly genus *Rhamphomyia* Meigen from Korea (Diptera: Empididae)

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A total of 14 species belonging to the dancefly genus *Rhamphomyia* Meigen, 1822 were listed to Korean fauna since Kwon *et al.* (2021), previously. In the course of taxonomic survey on the danceflies in Korean peninsula, the authors have found further 2 unknown species new to science, which have consisted of altogether 16 species in the present genus. Descriptions, illustrations and key to the Korean species are provided respectively.

Key words: Diptera, Empidoidea, Empididae, Empidinae, taxonomy, new species

B1

Hard tick surveillance in southern part of Gyeongsangbuk-do, Korea in 2021 and 2022

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SFTS (Severe Fever with Thrombocytopenia Syndrome)는 중증 열성 바이러스 질환으로 바이러스를 보유한 참진드기가 숙주를 흡혈할 때 전파된다고 알려져 있다. 국내에서는 2013년에 첫 감염사례가 확인되었고 이후 지속적으로 보고되고 있다. 이처럼 인간에게 피해를 주는 참진드기의 종별 분포와 병원체 유무를 조사하기 위해 2021년부터 2022년까지 경상북도 김천시에서 4가지 환경(무덤, 산길, 잡목림, 초지)에서 Dry ice trap을 설치해 채집하였다. 2021년에 총 4,687마리가 채집되었으며, 초지에서 2,115마리(45.1%)로 가장 많이 채집되었다. 2022년에는 3,510마리가 채집되었으며 무덤에서 1,558마리(44.4%)로 가장 많이 채집되었다. 2022년은 2021년보다 채집량이 약 25% 감소율을 보였으며, 환경별 채집량도 다르게 나타났다. 참진드기의 종별 분포를 조사한 결과, 2021년에는 총 3종이 채집되었으며, 외형 동정이 어려운 유충을 제외하고 *Haemaphysalis longicornis*가 1,920마리(99.0%)로 가장 많이 채집되었다. 2022년에는 총 4종이 채집되었으며, 유충을 제외하고 *Haemaphysalis longicornis*가 1,866마리(98.4%)로 역시 가장 많이 채집되었다. 2022년의 전체적인 채집량은 전년 대비 감소하였으나, 2021년에 채집되지 않았던 *Amblyomma testidunarium*이 추가로 채집되었다. 채집된 참진드기의 SFTS 감염 여부를 확인하기 위해 성충은 최대 5마리, 약충은 최대 30마리, 유충은 최대 50마리씩 pooling하여 Nested PCR을 실시한 결과, 2021년과 2022년 샘플 모두 음성으로 확인되었다. 본 조사에서는 양성 발견되지 않았지만, SFTS는 치사율이 높은 편이며 백신과 치료제가 없기 때문에 참진드기에 대한 지속적인 감시가 필요할 것으로 판단된다.

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

B2

**Estimation of the development temperature of the blowfly
(*Calliphora vicina*, Calliphoridae) using phenotypic plasticity of
wing morphology and growth rates in the larval stage**

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Forensic entomology uses necrophagous insects and arthropods for legal investigations. Estimating the minimum post-mortem interval (PMI_{min}) is a major component in forensic entomology. Temperature significantly affects the development and succession of necrophagous insects, particularly by modifying the morphological shape of an organ in an adult fly. Therefore, we estimated the temperature during the growth period of a necrophagous insect (*Calliphora vicina*), using quantitative analysis of phenotypic plasticity and estimated the wing morphology of the collected blowflies. Growth rate differed significantly at each development stage depending on the temperature. Furthermore, body length was longer at lower than at higher temperatures across all stages. Body length and centroid size were significantly positively correlated. The blowfly wing shape change with temperature and sex. Although the wild population is closely related to the 18°C and 22°C groups in the natural environment, the ambient temperature fluctuated for 24 h. Further, large variations in body length and wing size were observed in the wild population, indicating that various factors affect phenotypic plasticity. However, the temperature experienced by the blowfly, could compensate for the accuracy of ambient temperature obtained from weather stations, thus, indicating the application of the measured morphological plasticity in accurately estimating PMI_{min}.

Key words: development temperature, geometric morphometric analysis, minimum post-mortem interval, sexual dimorphism, wing morphology

B3

Forensic entomological analysis of development rate of *Chrysomya pinguis* (Diptera: Calliphoridae) for estimation of postmortem interval (PMI)

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Estimation of PMI using insects possible highly accurate predictions. Diptera is a first colonizer when a corpse occurs, thus this study was conducted to secure basic data through the development rate experiment of *Chrysomya pinguis*. Eggs of F2 generation were acquired from wild individuals collected in Yangpyeong, Gyeonggi-do. The 7 of temperature conditions are 16°C, 19°C, 22°C, 25°C, 28°C, 31°C, 34°C. During the study, humidity 65±5% and photoperiod 12:12 (L:D)h maintained in chamber, and pig liver provided as feed. Image data, development stage and body length were obtained at 12h intervals. As a result, the average of development duration are 734.5h at 16°C, 445.5h at 19°C, 299h at 22°C, 242.5h at 25°C, 192.5h 28°C, 181h at 31°C, 166h at 34°C. Conclusive, this study aim to contribute to securing legal evidence through the development of scientific criminal investigation technology that reflects objectivity and certainty.

Key words: Calliphoridae, *Chrysomya pinguis*, Development rate, Forensic entomology, PMI

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B4

Forensic entomological analysis of insect fauna succession according to decay stage of hanging rat carrion

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Insects approaching carcasses are different by decay stage, this study aimed to estimating postmortem interval (PMI) by analyzing the insect fauna succession. The decomposition proceeds in five stages: 1st (fresh stage), 2nd (bloated stage), 3rd (active decay stage), 4th (advanced decay stage), 5th (remains stage). The 9 rat carrion of 6 week old ICR female were hung from trees located on Buram mountain (Nowon-gu, Seoul). The period of the study was from July 13th to September 25th in 2022, insects collected every day for the first 10 days, once every 2 days for the next 10 days, and once every 4 days thereafter, and the experiment was terminated when all carrion reached the 5th stage. The total of 4,728 individuals, 10 orders (Insecta: Diptera, Hymenoptera, Coleoptera, Orthoptera, Lepidoptera, Dermaptera, Hemiptera, Dictyoptera, Arachnida: Araneae, Acari) were collected. The number of order (population ratio) are 2 orders (0.3%) for 1st stage, 6 orders (22.1%) for 2nd stage, 10 orders (69.9%) for 3rd stage, 6 orders (7.1%) for 4th stage, 5 orders (0.6%) for 5th stage.

Key words: Decay stage, Forensic entomology, Insect fauna, PMI, Succession

B5

Flight-Mill: A DIY tool for measuring flight availability of insects using Arduino's hall magnetic sensor

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We developed a flight-mill using an Arduino hall magnetic sensor to measure insect flight speed, distance, and maximum speed. The sensor detects changes in the magnetic field generated by the rotating body, and we calculate flight parameters using an Excel sheet. This low-cost system is easy-to-use and adaptable for different insects and research applications, providing a valuable tool for studying insect behavior.

Key words: flight-mill, arduino hall sensor, insect flight, flight speed, flight distance

B6

Community structure and Similarity analysis of Benthic Macroinvertebrates in Gucheon Stream (Deogyusan National Park)

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In the Gucheon stream of Deogyusan National Park, a survey was conducted at three sites (six sites in total) in 2018 and 2021. A total of benthic macroinvertebrates of 107 taxa 46 families 13 orders in 6 classes of 5 phyla were found. According to the analysis of the appearance by year, a total of 87 species were surveyed in 2018, and a total of 89 species were surveyed in 2021. As a result of ben diagram analysis, a total of 69 common species appeared. As a result of the average annual community indices analysis, DI 0.38, H' 3.48, R' 3.23, and J' 0.85 in 2018, and DI 0.55, H' 2.98, R' 2.91, and J' 0.70 in 2021. As a result of the similarity analysis between all sites, St.4 is the least similar to other sites with 61.3% similarity, while its neighbors St.5 and St.6 are the most similar with 82.2% similarity.

Key words: Deogyusan National Park, Benthic Macroinvertebrates, Community indices analysis, Similarity analysis

B7

Functional Feeding Groups (FFGs) of Benthic Macroinvertebrates in Wonhyo and Yongchu Valley Streams of Mudeungsan National Park

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In 2022, a total of two surveys (May and September) were conducted at Wonhyo and Yongchu Valley in Mudeungsan National Park. During the survey, A total of benthic macroinvertebrates belonging to 102 taxa, 50 families, 14 orders, 7 classes and 5 phyla were found. According to the functional feeding group analysis, Gathering-Collector(GC) accounted for a high species share (Wonhyo: 27.7%, Yongchu: 29.9%). In the functional habitat group analysis, Clinger(CL) accounted for a high species share (Wonhyo: 47.1%, Yongchu: 56.4%). As a result of community indices analysis, the average DI is 0.59, H' is 2.77, R1 is 3.08, and J' is 0.62 in Wonhyo. In Yongchu, the average DI is 0.54, H' is 3.20, R1 is 3.35, and J' is 0.71 respectively. The results of the community stability analysis showed that species belonging to Group I were highly abundant at all sites, ranging from 49.1 to 58.8%.

Key words: Mudeungsan National Park, Benthic Macroinvertebrates, Community stability, Community indices analysis

B8

Assessment of Effects of GM Rice Bt-T on the Diversity of Non-target Insects

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Transgenic rice Bt-T, expressing toxin from *Bacillus thuringiensis*, is resistant to the rice callus moth and tolerant to the herbicide glufosinate. This study was evaluated under field conditions in Gunwi and Jeonju in 2021 and 2022 to detect possible effects of Bt-T events on the above-ground insects and spiders. In the scores of PROXSCAL multidimensional scaling using the combined data, insect and arachnid communities were clearly distinguished by cultivation areas and years, but there was no difference in rice cultivars. Overall, the results showed that GM rice Bt-T did not negatively affect the community of plant-dwelling non-target insects and arachnids in rice.

Key words: insect-resistant transgenic rice (Bt-T), biosafety, insect diversity

* This work was supported by the Cooperative Research Program for Agriculture Science and Technology Development (Project no. RS-2023-00217915) of the Rural Development Administration.

B9

Seasonal Prevalence of Mosquitoes Collected with Mosquito Traps in Gyeongsangnam-do Province, Republic of Korea, 2022

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The vector mosquito surveillance is important when recommending prevention and control measures. The surveillance of the vectors were conducted at a total of 7 locations with light emitting diode (LED traps) and BG-Sentinel traps from March to November, 2022 in Gyeongnam province. In the surveillance, a total of 14 species belonging to seven genera were collected in a total of 10,085 females and 76.4/trap/night (Trap Index; TI) in 2022. Among the collection sites, Gangseo-gu at the pigsty in Busan with a LED trap recorded the highest TI 88.9 (Species Ratio 48.8%) for *Culex tritaeniorhynchus* females in 2022. Each one of *Cx. tritaeniorhynchus* female was firstly collected for 2022 at Eulsukdo in Busan at 7th April. In the results of isolation of viral RNA, *Flavivirus* were negative in 383 pools (5,493 individuals) of 13 mosquito species including *Cx. tritaeniorhynchus*, *Cx. pipiens*, *Aedes vexans*, *Ae. albopictus*, and *Ochlerotatus togai* in 2022.

B10

Surveillance of Hard Ticks (Acarina: Ixodidae), the Vector of Severe Fever with Thrombocytopenia Syndrome (SFTS) in Gyeongsangnam-do, Republic of Korea, 2022

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A tick survey was conducted to monitor ticks using tick traps attached dry ice method at each four sites in Ulju county, Gyeongsangnam-do from April to November, 2022. Four species belonging to three genera were collected with tick traps. A total of 3,156 ticks were collected as *Haemaphysalis longicornis* (Trap Index; TI 31.4), *Haemaphysalis flava* (TI 1.1), *Amblyomma testudinarium* (TI 0.3) and *Ixodes nipponensis* (TI <0.1) in 2022. *Haemaphysalis longicornis* was the most frequently collected, representing 95.6% in Ulju. In the collection environments, a total number of 2,192, 823, 104, and 37 ticks were collected from a glassland, a copse, a mountain path, and a grave, respectively. In the results of the isolation of Severe Fever with Thrombocytopenia Syndrome (SFTS) from the ticks, no pathogens were detected from RNA of 128 pools of the ticks using a Polymerase Chain Reaction method in 2022.

B11

Seasonal Prevalence of Chigger Mites from Wild Rodents in Gyeongsangnam-do Province, Republic of Korea, 2022

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A seasonal chigger-borne disease surveillance program was established at Geoje in March, April, October, and November, 2022. 3 species of 25 wild rodents were collected by using Sherman traps, including *Apodemus agrarius* (Species Ratio; SR 52.0%), *Crocidura* spp. (SR 40.0%), *A. peninsulae* (SR 8.0%) in Geoje, 2022. A total of 2,231 chiggers were collected from 3 species of the rodents in Geoje. The chigger mites were collected from *A. agrarius* (Chigger Index; CI 156.5) *C. spp.* (CI 0.2), *A. peninsulae* (CI 52.0) for Geoje. In the collection environments, a total number of 339, 1,108, 663, 0, and 121 chiggers were collected from a reservoir, a ditch, a rice paddy, a field, and a hill, respectively. In the results of the isolation of *Orientia tsutsugamushi* from the chigger mites, no pathogens were detected from the DNA of the 45 pools of the mites using a Polymerase Chain Reaction method in 2022.

B12

Comparative population genetic analyses of the burrowing mayfly, *Ephoron shigae* (Ephemeroptera: Polymitarcyidae), in South Korea and Japan: Implications for mayfly mass emergence

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Ephoron shigae, a burrowing mayfly, is renowned for its extremely short adult lifespan of only 1-2 hours and population-specific asexual reproduction. It is also considered a nuisance insect due to its frequently reported mass emergence patterns across Japan. Here, we investigated the genetic variations and population genetic structures of populations from Korea and Japan with newly developed microsatellite markers and mitochondrial *COI* gene to understand its present and past microevolutionary processes. The star-like haplotype network patterns with high levels of genetic variations and the existence of gene flow among populations were identified in Korean populations while the populations from Japan showed lower levels of genetic diversity and less gene flow among populations. These differences may reflect the characteristics of mass emerging populations (e.g., parthenogenetic populations) in Japan. Furthermore, the population genetic analyses using nuclear and mitochondrial markers revealed two distinct genetic clusters between Korean and Japanese populations, suggesting that the validity of this species based on its morphological, genetic, and ecological characteristics needs to carefully be examined.

Key words: Ephemeroptera, mass emergence, microsatellite, *COI*, phylogeography, population genetics

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B13

Records of new social wasp hosts of parasitoid moths in South Korea

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말벌류는 양봉장의 꿀벌을 대량으로 사냥하는 대표적인 천적으로 매년 심각한 경제적 피해를 야기하고 있으며 또한 도시, 농촌, 산림 지역에서 사람들을 독침으로 쏘며 심각한 공중보건적 피해도 일으킨다. 이러한 말벌류의 감소를 위한 방제법 개발 중 최근 말벌의 천적을 활용한 생물학적 방제에 대한 연구가 일부 진행되면서 기생자에 대한 탐색이 본격화되고 있다. 본 연구에서는 2014~2023까지 전국에서 채집된 말벌집에서 발생한 포식기생자 나방류의 종류를 파악하였다. 그 결과 국내의 말벌집에서 발생한 포식기생자 나방은 총 2과 3속 3종으로 분류되었고 숙주가 된 말벌은 총 3속 11종으로 나타났다. 특히 국내 기생 기록이 없던 말벌속의 종들은 대부분 나방이 기생하는 것으로 나타나 추후 이들에 대한 방제효과 연구가 필요할 것으로 보인다.

검색어: 말벌과, 명나방과, 창날개뿔나방과, 포식기생

B14

Vespa velutina nigrithorax have already adapted to new environment in South Korea: Comparison of gut bacteria communities and their diet sources of the queen of five *Vespa* species

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The gut bacterial community of all queen hornet of five species was primarily composed of members of the Firmicutes and Proteobacteria phylum, with notable differences at the phylum, class and genus level. *V. velutina* had a higher number of unique gut bacterial OTUs and a higher relative abundance of Bacilli at class level and *Leuconostoc* at genus level compared to the other species, which may have contributed to its successful adaptation to the new environment. The stable isotope analysis showed no significant differences in food sources among the five *Vespa* species, but a significant correlation was found between the diversity of food sources and the diversity of gut bacterial communities.

Key words: gut microbiota, *Vespa*, adaptation, stable isotopes, invasive species management

B15

Identification of endoparasites and parasitoids in colonies of asian giant hornet, *Vespa mandarinia* (Hymenoptera: Vespidae) in South Korea

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All endoparasites and parasitoids appeared in the colonies of *Vespa mandarinia* were identified using morphology and DNA barcodes. *Xenos moutoni* du Buysson (Stylopidae: Strepsiptera) and *Pheromermis vesparum* Kaiser (Mermithidae: Nematoda) were identified as endoparasites. In parasitoids, *Volucella suzukii* Matsumura and *V. coreana* Shiraki (Syrphidae: Diptera), *Pyralis regalis* Denis and Schifferrmüller (Pyralidae: Lepidoptera), and *Quedius pectinatus* Sharp (Staphylinidae: Coleoptera) were found.

Key words: Northern giant hornet, endoparasite, parasitoid, DNA barcode

B16

Genetic and morphological variation of *Vespa velutina nigrithorax* which is an invasive species in a mountainous area

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We hypothesized that a high-altitude would be negatively correlated with the genetic diversity of the hornet population, and hornet wing morphology would change with an increase in altitude. Our results showed that the genetic diversity of *Vespa velutina* did not decrease as altitude increased. Regardless of the altitude, the inbreeding coefficient was high at the newly colonized sites. A single genetic population occurred in the mountainous areas examined and gradually expanded its range. Wing morphology, especially shape, did not change with an increase in altitude or decrease in temperature. Although cool temperatures at high altitudes could limit nest-building activities, they did not prevent the extension of the range of the species.

Key words: genetic variation, geographic barrier, morphological variation, temperature, wing shape

B17

Effects of urbanization on carabid beetles in an urban riparian area

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We used carabid beetles to assess the impact of urbanization on a river and its riparian areas. Carabid beetle diversity sharply decreased with increasing urbanization. Flight capacity and feeding type varied along the urbanization gradient. Environmental variables associated with urbanization such as riparian quality and disturbance level significantly influenced carabid diversity. Land use type in increasingly urbanized areas was correlated with decreased carabid diversity and increased carabid dominance. Patch density, patch size, and interspersed metrics revealed that fragmentation and isolation influenced carabid diversity. Mitigation of disturbances and conservation of riparian microhabitats are required to improve biodiversity in riparian areas.

Key words: habitat connectivity; carabid; isolation; patchy disturbance; riparian; urbanization

B18

Social wasps fauna (Vespidae) of Ulleung Island, Korea

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울릉도는 내륙으로부터 약 130km 떨어져 있는 동해의 화산섬으로 칼데라 분지인 나리분지와 성인봉 원시림이 형성되어 있어 그 생물군이 매우 독특한 곳이다. 이미 섬의 다양한 생물상이 조사되고 있으나 말벌상에 대한 공식적인 조사는 없었다. 최근 국내 내륙뿐만 아니라 섬 지역에서도 말벌에 의한 피해가 지속적으로 발생함에 따라 이에 대한 피해 대책을 세우기 위해 말벌 중 조사는 필수적이다. 조사는 기존의 2012년 이후 조사된 표본과 더불어 2022년 4-10월까지 울릉도 12개 지점에 말벌 트랩을 설치하여 말벌 표본을 확보하였다. 결과적으로 총 2아과 3속 3종이 동정되었고 말벌속의 털보말벌과 땅벌속의 땅벌이 채집된 표본 중의 99.9%를 차지하였으며 쌍살벌속의 별쌍살벌이 극소 개체가 채집되었다. 이번 연구를 통해 울릉도산 말벌 중 목록을 확정하였고 내륙으로부터 종의 침입이나 특정종의 분포 확장 등을 추후 연구하는 데 있어 기초자료로 활용될 수 있을 것이다.

검색어: 울릉도, 말벌과, 털보말벌, 땅벌

B19

Pollen metabarcoding reveals the floral resources and niche overlap of honeybees in forest areas

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We investigated the floral resources of the honeybee (*Apis mellifera*) by pollen DNA metabarcoding as the first step in honeybee conservation. *Quercus* and *Actinidia* were the most frequently detected taxa of pollen resources in both forests and national parks by pollen metabarcoding. According to the niche overlap analysis result, the honeybee preferred the pollen resources in both forests and national parks, and the co-occurrence pattern analysis of pollen resource taxa in both forests and national parks showed a simple network. Altogether, our findings suggested that DNA metabarcoding of pollen collected by the honeybee can provide useful information on the flowering plants in a given area.

Key words: *Apis mellifera*, pollen, DNA metabarcoding, niche

B20

Community analysis of Benthic Macroinvertebrate in Bangujeong-wetland

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전라남도 곡성군 및 순천시에 위치한 하천습지인 반구정습지의 저서성대형무척추동물상을 파악하기 위하여 2022년 4월부터 9월까지 총 3회에 걸쳐 5개 지점에 대해 조사를 실시하였다.

조사 결과, 총 4문 6강 20목 68과 132종 8,588.6개체/m²가 조사되었다. 분류군별 출현 현황으로는, 편형동물문 1종(0.8%), 연체동물문 13종(9.8%), 환형동물문 5종(3.8%), 연갑강 4종(3.0%)으로 확인되었으며, 절지동물문중 곤충강의 경우 수서곤충류가 109종(82.6%)으로 높은 출현율을 나타냈다. 우점종 및 아우점종으로는 깔따구류와 흰점줄날도래 확인되었다. 군집분석 결과, 우점도지수(DI)는 평균 0.6111(±0.184), 다양도지수(H')는 평균 2.576(±0.0808), 종풍부도지수(R1)는 평균 2.521(±1.101), 종균등도지수(J')는 평균 0.717(±0.125)로 산출되었다. 수환경 평가 결과, 총생태점수(TESB)는 42~155로 '보통~매우양호'한 상태로 보호수역~최우선보호수역으로 지역구분 되었으며, 수질등급은 'II ~ I'으로 분석되었다.

검색어: 반구정습지, 하천습지, 저서성대형무척추동물, 군집분석, TESB

B21

Occurrences of *Orientia tsutsugamushi* infection rates of wild rodents and chigger mites captured in Chungnam Yesan (2018-2022)

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쯔쯔가무시병(Scrub Typhus)은 *Orientia tsutsugamushi*에 의해 발생하는 인수공통감염병이다. 국내에서 털진드기는 15속 63종이 보고되어 있으며, 그중 4속 8종이 병원체를 매개하는 것으로 알려져 있다. 본 연구에서는 야생 설치류에 기생하는 털진드기의 증감 추이 및 쯔쯔가무시병 매개 털진드기 조사를 위해 수행되었다. 2018~2022년 중 3~4월과 10~12월에 충청남도 예산지역에서 Sherman trap을 사용하여 논, 밭, 저수지, 수로, 야산에서 설치류를 포획하였다. 각 지점에 20개씩 5m 간격을 두고 총 100개를 설치하였고 24시간 뒤 수거하였다. 트랩으로 채집된 설치류는 2018년 28마리, 2019년 21마리, 2020년 26마리, 2021년 16마리, 2022년 23마리로 총 142마리가 채집되었으며, 전체적으로 등줄쥐(*Apodemus agrarius*)가 수로에서 가장 많이 채집되었다. Hanging method를 통해 쥐에서 분리된 털진드기는 2018년 5,232마리(Chigger Index (C.I.) 186.9), 2019년 2,272마리(C.I. 108.2), 2020년 3,458마리(C.I. 133), 2021년 2,253마리(C.I. 140.8), 2022년 1,832마리(C.I. 79.7)였다. 털진드기 샘플의 절반을 이용하여 *O. tsutsugamushi* 양성도를 확인한 결과 2018년 5건, 2019년 2건, 2020년 0건, 2021년 9건, 2022년 0건으로 확인되었다. 기후 변화에 맞추어 공중보건학적 측면에서 매개체는 잠재적인 위협이 될 수 있으며, 이러한 상황을 대비하여 감염병 예방 및 매개 질환의 발생을 예측하기 위해 지속적인 모니터링이 필요할 것으로 보인다.

검색어: 쯔쯔가무시병, 털진드기, 설치류, 감염병

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B22

The Population Trend and Management for Conservation in *Polyphylla laticollis manchurica* on Miho River, Cheongju

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수염풍뎡이는 환경부 멸종위기 야생생물 1급으로 지정되어 관리되고 있다. 서식지 내 높은 개발 압력으로 인해 보호가 시급한 실정으로 개체군 모니터링을 통한 서식지 위협요인 해소가 우선적으로 요구된다. 본 연구는 2020년부터 3년간 수염풍뎡이 서식이 새롭게 확인된 청주 미호강을 중심으로 육안조사, 유아등 조사를 통해 서식현황을 확인하였다. 아울러 주변지역을 모니터링하며 조명에 유인되어 로드킬된 개체를 조사하였다. 조사기간 발견된 수염풍뎡이는 총 33개체로 강변을 따라 산발적으로 관찰되었고, 야간 유아등 조사시 20시 30분부터 21시 30분 사이 가장 많은 개체가 출현하였다. 조명에 유인되어 로드킬된 개체는 28개체로 가로등 등 서식지 주변 광원은 이들 개체군 유지에 큰 위협요인임을 시사하였다. 본 연구 결과는 향후 이루어질 수염풍뎡이 서식지 보호 및 관리방안을 수립하는데 중요한 기초자료가 될 수 있을 것으로 판단된다.

Key words: *Polyphylla laticollis manchurica*, Endangered species, Conservation, Miho River

B23

Similarity analysis of benthic macroinvertebrates in Janggumegi wetland and three Abandoned paddy wetlands

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This study was conducted in three abandoned paddy wetlands (Simgok-dong: S, Goeran-dong: G, and Pyeongdume: P), which are similar in environment to the central part of the Janggumegi wetland. A total of 24 species and 1,565.1 individuals/m² of benthic macroinvertebrates were collected in the central part of the Janggumegi wetland. As a result of similarity analysis, the sites were categorized into two similar groups, with the highest similarity of 67% between the S and P sites. In addition, the P site showed the lowest similarity with 37.7% to other sites. As a result of common species analysis, the highest number of common species were found at the P site with 10 species, and the least number of species were found at the G site with 8 common species. As a result of community structure analysis, O.H.C. taxa (55.7±4.4%) and GOLD taxa (24.0±7.1%) were highly represented at all sites.

Key words: Janggumegi wetland, Paddy Wetlands, Benthic macroinvertebrates, Community stability, Similarity analysis

B24

Benthic macroinvertebrate community structure and correlation analysis of sewage treatment plant

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This investigation was conducted three times from 2021 and 2022 at five surveyed sites (st. A, st. D, st. M, st. S, st. Y). A total of benthic macroinvertebrates belonging to 140 taxa, 68 families, 19 orders, 7 classes and 4 phyla were collected. FFGs analysis showed that the share of species tends to decrease in the treatment stream sites of SH and FC. FHGs analysis showed that the share of individuals decreased in the treatment stream sites in all regions of BU. The community indices tended to increase as the diversity and abundance decreased treatment stream sites of processing and then went downstream sites. As a result of Pearson's correlation analysis, TOC and population showed a negative correlation.

Key words: Sewage treatment plant, Benthic macroinvertebrates, Community structure, Correlation analysis

B25

The invasion report of a Alert Alien Species, *Paratrechina longicornis* (Latreille, 1802) in natural ecosystem from South Korea

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최근 국내 자연생태계에서 서식이 확인된 열대긴수염개미(*Paratrechina longicornis*)는 유입주의 생물로 국내에 유입될 경우 생태계 안전성에 위협을 미치거나 사회적 피해 등을 야기할 우려가 있는 생물을 말하며 환경부에서 지정 고시하고 있다. 2019년부터 2022년까지 전국 주요 항만 및 내륙컨테이너기지 주변에서 함정트랩과 육안조사를 병행하여 예찰한 결과, 2019~2022년 부산 감만부두 및 부산역~부산진역 컨테이너터미널 일대에서 산발적으로 확인되었으며, 2022년 부산 신선대부두, 양산 내륙컨테이너기지, 울산 온산항, 광양항 일대에서 서식이 확인되었다. 따라서 본 연구에서는 지역별로 채집된 개체의 형태와 COI 정보를 파악하여 조기발견 및 선제적 대응 등 향후 관리를 위한 기초자료로 활용하고자 한다.

검색어: 유입주의 생물, 열대긴수염개미, *Paratrechina longicornis*, longhorn crazy ant, 개미류 예찰

C1

Fine Structural Analysis of Plastic Biodegradation in the Digestive Tract of the Mealworm, *Tenebrio molitor*

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Globally, plastics are a commodity in many fields because they are easy to manufacture and deform easily. However, plastic is a factor in environmental pollution caused by people's reckless dumping. Plastics are broken down into microplastics in the environment, and biological accumulation affects the health of living things from invertebrates to vertebrates. In this study, polystyrene, polyethylene, and polyurethane were ingested into mealworm larvae, and the biodegradation process in the digestive tract of mealworms was visualized through light and scanning electron microscopy. Histological damage was observed in the digestive tract of the plastic intake group. Plastics are thought to inhibit the growth and proliferation of enterocytes either by direct impact through the digestive tract or by lack of nutrients of plastics. We observed plastic weakening and loss of shape within the digestive tract of mealworms, suggesting that plastics may be biodegradable. Further research is needed to apply the biodegradation of plastics through the digestive tract of mealworms in a sustainable way.

Key words: mealworm, plastic, biodegradation, environmental pollution, microstructure

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C2

Fine structure of Silk Sphere Scaffolds in the Golden Orb Web Spider, *Trichonephila clavata*

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In terms of high-toughness biomaterials that can be applied *in vivo*, spheres made of silk are proposed as potential biomaterials for biomedical applications. The silk of the golden orb-web spider, *Trichonephila clavata* is known to be stronger and more flexible than the commonly used silkworm silk. In this study, dragline and tubuliform gland silks of *T. clavata*, as well as cocoon silk of *Bombyx mori*, were collected and used as experimental materials. Two types of silk solutions containing spider and silkworm silk clusters were transformed into silk spheres using salt leaching and hexafluoroisopropanol (HFIP) methods. The designed silk spheres were analyzed with an Field emission scanning electron microscope (FESEM) to observe their fine structures. Silk spheres with a diameter of 800nm were observed using the salt leaching method. Various concentrations of silk-HFIP solution were examined to selectively obtain intended sized spheres.

Key words: FESEM, fine structure, *Trichonephila clavata*, spider silk, scaffold

* This research was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (No. 2019R1I1A3A01062105).

C3

Fine Structure of the Antennal Sensory Organs in the Bark Beetle, *Ips subelongatus*

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The bark beetle is a common beetles group that infests tree trunks and lays eggs along the phloem of pine and spruce trees. The beetle's antennae are sensory organs that gather information about touch, sound, taste, smell, temperature, and humidity in the beetle's environment. As part of our research on controlling this pest insect, we conducted microstructural analysis using field emission scanning electron microscopy (FESEM) on the antenna of *Ips subelongatus* (Coleoptera: Curculionidae: Scolytinae). The antennae are short and clubbed, with many sensory hairs compactly arranged on the surface of the last antennal segment. Each antenna has three parts: the basal segment (scape), the second segment (pedicel), and the flagellum with many subsegments. Male beetles have a broader surface area of antennae (average: $7.21 \times 10^{-3} \mu\text{m}^2$) compared to females (average: $6.36 \times 10^{-3} \mu\text{m}^2$). Although the form of antennae varies greatly within Coleopteran beetles, they are similar within the same family and no fine structural differences can be detected.

Key words: antenna, sensilla, bark beetle, fine structure, *Ips subelongatus*

C4

Nanoscale Structure of the Cribellar Silk Spigots for Non-sticky Capture Threads in the Spider *Nurscia albofasciata*

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Cribellar silk is a unique form of spider silk that has dry-adhesive properties due to the way it is spun. Recent studies have shown that the silk is spun through electrically charged nano-scale fibers, in contrast to other silk threads that are spun using wet glue. In this research, we examine the nanoscopic structure of the cribellar spigots responsible for spinning non-sticky capture threads in the spider *Nurscia albofasciata*. The surface of the cribellum is covered with thousands of tiny spigots that are evenly distributed. Each spigot has five distinct segments, and the spaces between them create the pearling effect that supports the silk fibrils during the hackling process. The cribellar surface also has a unique 3D pattern of etched cuticular protrusions that protect the delicate spinning tubes from physical damage while providing a surface to hold the spigots. These fine structural features are consistent with an electrostatic charging interaction that occurs during the nano-scale spinning process.

Key words: Cribellum, silk, spider, spigot, *Nurscia albofasciata*

* This research was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (No. 2019R1I1A3A01062105).

C5

Comparative Analysis of Silk Scaffolds of *Araneus* and *Trichonephila* Spiders

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It has been reported that natural spider silk is an effective scaffold material, and a female araneid spider can produce up to seven kinds of silks with different functions. Therefore, we investigated the fine structure of the nature scaffold materials produced by two independent group of araneid spiders, the garden spider *Araneus ventricosus* and the golden orb web spider *Trichonephila clavata* through FESEM analysis. The dragline silk spun by both *T. clavata* and *A. ventricosus* spiders consists of two strands of silk fibers. The diameter of the former is about 1.5 times that of the latter. Although the surface of the spider's cocoon appears smooth, both spiders had fine scale-like patterns on the surface of the silk fibrils. In particular, the silk produced by *A. ventricosus* was more prominent than that of *T. clavate*. In addition, the cocoon silks of both spiders are composed of separated monofilament fibers, and in common, the cross-sections of the two cocoon filaments are superimposed with a multi-layered sheet structure. However, the diameter of the cocoon silk of *A. ventricosus* spider is about 20 microns, twice that of *T. clavata* spider.

Key words: scaffold, silk, spider, *Araneus ventricosus*, *Trichonephila clavata*

C6

Fine Structure of Spider's Film Scaffolds Derived from *Araneus* and *Trichonephila* Spiders

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Although spider silk is well known for its excellent mechanical properties, there are restricted studies on spider silk-based biomaterials. This is because spiders are evolutionarily adapted to solitary life, which makes artificial breeding difficult. Here, we fabricated various film scaffolds by dissolving individual cocoons and dragline silks from two genera of web-building spiders, *Araneus* and *Trichonephila*, and observed their microstructural properties using FESEM. The upper free surfaces of the film scaffolds made of dragline silk and cocoon silk of the two spiders are relatively smooth, but cracks can be observed on the surface of the films made of *A. ventricosus* dragline silk under low magnification. The lower surface of the film made of cocoon silk of *A. ventricosus* can be observed at low magnifications that the small spheres are aggregated together. The lower surfaces of the film scaffolds fabricated from spider silks are relatively smooth, but the scale-like patterns can be seen under high magnification.

Key words: film scaffold, natural spider silk, *Araneus*, *Trichonephila*

C7

Fine Structural Difference of the Silk Scaffolds from Various Silk Glands from the Orb-Web Spider *Trichonephila* Spiders

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Among seven types of silk glands in an orb web spider, the dragline silk produced in the major ampullate gland and the cocoon silk from the tubuliform glands are the most prominent. Here we demonstrate the microstructural differences in silk scaffolds fabricated from various silk glands in the orb-web spider, *Trichonephila clavata* with aid of FESEM for future applications of spider silk scaffolds. The surface of the film derived from the dragline silk glands is very smooth, and surface depressions and some large pores are seen through the cross section. At a high magnification, it can be seen that some short fibers are evenly distributed on the surface of the film. On the other hand, the tubuliform silk glands film surface is not smooth but is more widely distributed. At a high magnification, some circular vesicles of uneven size are raised on the surface, which is similar to that can be seen on the surface of the fibroin film. In addition, small depressions and relatively small pores can be seen in the cross section of the film.

Key words: scaffold, silk, spider, hydrogel, film

D1

Investigating the immunological roles of *TmTAK1* in *Tenebrio molitor*

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The immune deficiency (IMD) pathway is one of the nuclear factor-kappa B (NF-κB) signaling pathways that regulates the production of antimicrobial peptides (AMPs) in insects. Transforming growth factor-β (TGF-β) activated kinase (*TAK1*), which acts as a kinase, is an important component of the IMD signaling pathway. Here, we investigated the immune function of *TmTAK1*, followed by systemic infection using *E. coli*, *S. aureus*, and *C. albicans*. The result showed a survival rate of about 25% lower in *E. coli* group and about 20% lower in the *S. aureus*-injected group compared to the control group. The expression levels of AMPs were measured at 24 hours after systemic infection with *E. coli*. The AMP expression levels in the gut, Malpighian tube, and hemocytes, were generally lower than that of the control group during *E. coli* infection. Therefore, *TmTAK1* is an important gene involved in the immunity of *T. molitor*.

Key words: *Tenebrio molitor*, *TmTAK1*, IMD pathway, AMP, gene silencing

D2

Immunological roles of *TmToll-2* in response to *Escherichia coli* systemic infection in *Tenebrio molitor*

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The antimicrobial roles of Toll-like receptors have been mainly identified in mammalian models and *Drosophila*. However, its immunological function in other insects has yet to be fully clarified. Here, we determined the innate immune response involvement of *TmToll-2* encountering Gram-negative, Gram-positive bacteria, and fungal infection. Our data revealed that *TmToll-2* expression could be induced by *Escherichia coli*, *Staphylococcus aureus*, and *Candida albicans* infections in the fat bodies, gut, Malpighian tubules, and hemolymph of *Tenebrio molitor* larvae.

Key words: Toll-2, *Tenebrio molitor*, microbial infection, antimicrobial peptides, RNAi technology

D3

Innate immune response of *TmToll-3* following systemic microbial infection in *Tenebrio molitor*

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Although Toll-like receptors have been widely identified and functionally characterized in mammalian models and *Drosophila*, the immunological function of these receptors in other insects remains unclear. Here, we explored the relevant innate immune response of *TmToll-3* against Gram-negative bacteria, Gram-positive bacteria, and fungal infections. Our findings indicated that *TmToll-3* expression was mainly induced by *Candida albicans* infections in the fat bodies, gut, Malpighian tubules, and hemolymph of *Tenebrio molitor* larvae.

Key words: *Toll-3*, *Tenebrio molitor*, microbial infection, RNAi, antimicrobial peptides, AMP assay

D4

Investigating Gut Immunity of *Tenebrio molitor* (Mealworm) through Oral Infection with *Escherichia coli* and *Listeria monocytogenes*

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Understanding the insect gut immunity through natural feeding methods is an essential aspect of entomology and insect biology. This study aimed to investigate the gut immunity of *Tenebrio molitor* through oral infection using *Escherichia coli*, a Gram-negative bacterium, and *Listeria monocytogenes*, an intracellular bacterium. In this study, we analyzed tissue-specific expression patterns of certain genes after oral infection using qRT-PCR, with *TmAtg8* as a marker for autophagy, *TmDorax1* and *TmDorax2* as a marker for Toll signaling pathway, and *TmRelish* as a marker for Imd signaling pathway. The results showed that the expression of four selected marker genes were induced by oral infection within 24 h, and particularly, *L. monocytogenes* infection showed higher expression patterns of four marker genes.

Key words: *Tenebrio molitor*, gut immunity, microorganisms

D5

The Role of Fas-Associated Death Domain Protein in the Immune Response of *Tenebrio Molitor* to Microbial Infection

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This study aimed to characterize the newly identified *TmFADD* in *Tenebrio molitor*. Here, we investigate the immunological roles of *TmFADD* in response to microbial infection using RNA interference technology. The results showed that the larval survival rate against *E. coli* but not *S. aureus* or *C. albicans* was decreased by *TmFADD* RNAi. Additionally, the study showed that *TmFADD* may play a role in immune responses against Gram-negative bacteria independently from IMD pathway, unlike in other arthropods.

Key words: *Tenebrio molitor*, IMD pathway, *TmFADD*, RNAi

E1

Diagnostic PCR assay for five species of chigger mites in the Republic of Korea

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쯔쯔가무시증(Tsutsugamushi)의 매개체로 알려진 털진드기(chigger mite)는 알려진 종에 비하여 이용 가능한 분자 데이터는 많지 않기에 현재는 형태학적으로만 동정 되고 있다. 하지만 털진드기는 개체 크기가 작아 손상이 쉬우며, 자연적 변이와 성충의 유사성 등 여러 원인으로 인하여 정확한 분류 동정에 어려움이 있다. 이에 본 연구에서는 한국의 야생 설치류로부터 채집된 털진드기 5종 (*Leptotrombidium pallidum*, *L. scutellare*, *L. palpale*, *L. orientale*, *Euschoengastia koreaensis*)의 internal transcribed spacer(ITS) 영역을 활용한 다중 PCR 방법을 제시하고자 한다. 국내에 분포하는 털진드기의 분자적 종 동정에 대한 최초의 보고로서 매개체 감시에 유용할 것으로 기대된다.

검색어: 털진드기, ITS, 다중 PCR, 쯔쯔가무시증

E2

Diagnostic method development of mosquito insecticide resistance using Droplet digital PCR

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Droplet digital PCR is a system that divides a 20ul PCR reaction into around 20,000 tiny droplets and counts amplified products. This technique is known to be roughly 1,000 times more sensitive than real-time PCR. It was adopted to detect low mutation rates of the insecticide resistance for *Aedes albopictus*, *Aedes vexans*, and *Culex pipiens* complex samples collected from all over Korea. Regarding to the *AChE1* (G119S) and *VSSC* (F1534C) mutation sites of *Ae. albopictus* and *Ae. vexans*, no resistant pools were found. However, there were five resistant pools in *AChE1* (G119S) and 20 in *VSSC* (L1014F) from *Cx. pipiens* complex. This was approximately 4% differences between the results of droplet digital PCR and the Quantitative Sequence (QS) which could perform the large scale of insecticide resistance detection. Thus, this diagnostic assay would be useful for precisely detecting insecticide resistance from mosquito vectors.

Key words: Droplet digital PCR, *Aedes albopictus*, *Aedes vexans*, *Culex pipiens* complex

E3

SFTS virus sequence secured through transcriptome analysis of *Heamaphysalis longicornis*

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Heamaphysalis longicornis as a vector can carry many kinds of pathogens, like severe fever with thrombocytopenia syndrome (SFTS), lyme disease, *Rickettsia* and etc. Among these, SFTS is a disease with a high mortality rate throughout East Asia. SFTS, known to be primarily mediated by *H. longicornis*, is a zoonotic infectious disease caused by the SFTS virus (SFTSV). We investigated the transcriptome of *H. longicornis* in the hope of discovering SFTSV transmission mechanism. We processed the raw data (73,270,436) using cutadapter, sickle to removal adapter sequence and low quality sequence, using trinity to obtain 15,039 unigene, and performed a functional analysis of the unigene compared to the KOG, PANM, Swissport, and Unigene databases. We also comparison of the unigene and SFTS databases identified the SFTS virus in unigene. This experiment extends the transcriptome data of *H. longicornis* and provides a resource for further research on effective prevention and control of bloodsucking and pathogen transmission. And it can contribute to the prevention and control of human disease.

Key words: *Heamaphysalis longicornis*, SFTS, SFTSV, transcriptome

E4

Transcriptome analysis of *Culex pipiens pallens* using Next-Generation Sequencing (NGS)

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빨간집모기(*Culex pipiens pallens*)는 West Nile virus (WNV)의 주요 매개체로 알려져 있다. 또한, 빨간집모기의 아종은 일부 기후경계지역에서 종간의 교잡종 출현으로 인해 형태학적 분류가 어려워지고 있다. 이로 인해 매개체 감시를 효율적으로 하기 위해 유전자원 확보 및 정확한 유전정보의 생물정보학적 분석이 선행되어야 할 필요성이 있다. 본 연구는 채집된 빨간집모기에서 mRNA를 추출한 후 RNA sequencing 분석을 수행하였다. 분석결과 75,639,854개의 raw data를 Trimming 과정을 통해 clean data를 확보하였다. Trinity를 사용한 *de novo* assembly를 진행하여 contigs를 확보하였으며, TransDecoder로 coding region을 확보하였다. TGICL을 사용한 clustering으로 Unigenes를 확보하였으며, 본 연구실에 구축된 PANM DB를 활용하여 BLAST를 수행하여 annotation 결과를 확보하였다. GO, KOG, KEGG, InterProScan 분석을 실시하여 기초적인 데이터를 확보하였다. 본 연구 결과를 통해 Transcriptome data를 통해 추후 계통분류학적 연구 및 생물정보학적 연구 등의 후속 연구에 활용될 수 있을 것으로 사료된다.

검색어: 빨간집모기, Transcriptome analysis

E5

Microbiome Profile of South Korean Vector Mosquito

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Vector-borne diseases are one of the paramount contributors to human death and ill health in the tropics and subtropics. The mosquito species – *Anopheles sinensis*, *Aedes aegyptii* and *Culex quinquefasciatus*, are a public health concern due to their ability as vectors of pathogens and arboviruses that manifest in diseases such as malaria, dengue, yellow fever, lymphatic filariasis etc. These mosquito species have a thriving microbiome that is involved in regulating the development, physiology and vectoral capacity of mosquitoes. The manipulation of this microbiota is thus emerging as a promising method for the development of novel vector control strategies. This study is the first attempt to identify, evaluate, quantify (relative abundance) and analyze the microbiome profile, similarities, and unique species of the mosquito species in South Korea to provide potential targets for developing mosquito/arbovirus control strategies.

Key words: Mosquito, vector, microbiome, South Korea

E6

Function of epidermal groups I and II chitinases in cuticle turnover during molting in a wood-boring beetle, *Monochamus alternatus*

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Insect cuticle is an extracellular matrix formed primarily from two different biopolymers, chitin and protein. During each molt cycle, a new cuticle is deposited simultaneously with degradation of the old one by molting fluid cuticle degrading-enzymes, including epidermal chitinases (CHTs). Insect CHTs, belonging to family 18 glycosylhydrolase (GH18), have been classified into at least eleven subgroups based on phylogenetic analysis. Group I (CHT5s) and II (CHT10s) CHTs present in molting fluid are produced by epidermal cells. In this study we report the physiological function of MaCHT5 and MaCHT10 in the Japanese pine sawyer, *Monochamus alternatus*. RNAi for either *MaCHT5* or *MaCHT10* resulted in larval-pupal and pupal-adult molting defects, in which the insects were unable to shed completely their old cuticle and died. In addition, TEM analysis revealed a failure of degradation of the old cuticle in MaCHT5- and MaCHT10-deficient insects. These results indicate that both CHTs are required for turnover of the chitinous old cuticle, which is critical for completion of insect molting. We also discuss the possible function of two spliced variants of MaCHT10, MaCHT10a and MaCHT10b.

E7

Functional genomics of PhTH and PhDDC involved in tyrosine-mediated cuticle pigmentation in the yellow-spotted longicorn beetle

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The yellow-spotted longicorn beetle, *Psacotha hilaris*, is an economically important xylophagous pest, which infests and bores into host Moraceae such as mulberry (*Morus* spp.) and fig trees (*Ficus* spp.). *P. hilaris* adults have fascinating body color that is black covered with green-greyish pubescences and yellow spots. Melanins and quinoid pigments derived from catechols produced by tyrosine-mediated cuticle tanning metabolism are major pigments and important for the cuticle coloration in insects. In this study, we investigated physiological functions of tyrosine hydroxylase (PhTH) and DOPA decarboxylase (PhDDC) in *P. hilaris*, which catalyze hydroxylation of tyrosine to 3,4-dihydroxyphenylalanine (DOPA) and decarboxylation of DOPA to dopamine, respectively, in the tyrosine metabolism. Loss of function of PhTH and PhDDC by RNAi resulted in pale and reddish-brown adult cuticle coloration, respectively. All major catechols analyzed were drastically decreased in PhTH-deficient insects, while more than a 10-fold increase in levels of DOPA was evident in PhDDC-deficient insects when compared with controls. These results indicate that both PhTH and PhDDC play a role in tyrosine metabolism, which is critical for normal cuticle coloration of *P. hilaris* adults.

E8

Molecular Characterization of JNK Pathway Transcript Factor, *TmKayak*, on Innate Immune Responses against Microbial Infection in *Tenebrio molitor*

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Jun N-terminal kinase (JNK) is one of the mitogen-activated protein kinases and the related pathway regulates several cellular processes including proliferation, apoptosis, embryonic development, autophagy, and inflammation. We characterized immunological function of *TmKayak*, which is known as a transcription factor for JNK pathway, through systemic infection and RNA interference in *Tenebrio molitor*. The expression levels of *TmKayak* were examined at 3, 6, 9, 12, and 24 h after injection of *E. coli*, *S. aureus* and *C. albicans*. The effects of *TmKayak* RNAi on larval survivability and induction patterns of AMP genes against microbial challenges were screened. These results suggested that the *TmKayak* plays a critical role in regulation of AMPs production to protect host itself against pathogenic infection in *T. molitor*.

Key words: *T. molitor*, JNK pathway, kayak, transcription factor, RNAi

E9

Preliminary Study of Intracellular Kinase of Toll Signaling Pathway, *Tmpelle*, in *Tenebrio molitor*

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Toll pathway is an important to regulate AMP production for host defense against pathogenic infection. In *Tenebrio molitor*, it was well studied the immunological function of extracellular components, whereas intracellular function of Toll pathway is poorly characterized. Pelle, serine/threonine kinase, is well known intracellular component of Toll pathway. Here, we identified the *pelle* (*Tmpelle*) from *T. molitor* nucleotide database, and a phylogenetic analysis of *Tmpelle* with its orthologs were conducted. The temporal and spatial expression patterns of the *Tmpelle* were investigated by qRT-PCR. In addition, to investigate the immunological function of *Tmpelle*, the induction patterns of *Tmpelle* were screened at 3, 6, 9, 12, and 24 h-post injection of pathogens. These results support basic information to understand the immunological function of *Tmpelle* in *T. molitor*.

Key words: *T. molitor*, Toll pathway, *Tmpelle*, pathogen infection, qRT-PCR

E10

Preliminary Study of JNK Kinase of JNK Signaling Pathway, *Tmhhep*, in *Tenebrio molitor*

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The antimicrobial peptides (AMPs) production mainly regulated by Toll and Imd pathways is one of the most important immune pathway in both vertebrate and invertebrate organisms. JNK pathway also plays a critical role in innate immune responses including AMP production, apoptosis, proliferation, embryonic development and autophagy. Prior to identifying the immunological function of the *hep* gene, a preliminary experiment was conducted. In this study, we identified the open reading frame (ORF) sequence of *hep* from *Tenebrio molitor* (*Tmhhep*) and a phylogenetic analysis of *Tmhhep* with its orthologs was performed. RNA was extracted from each developmental stage and each specific organ, and the expression pattern of the *Tmhhep* was investigated by qRT-PCR. In addition, to characterize the immunological function of the *Tmhhep* in advance, the expression patterns of *Tmhhep* were investigated at 3, 6, 9, 12, and 24 hours after microbial injection. This study provides important basic data for further investigation of immunological function of the *Tmhhep*.

Key words: *T. molitor*, JNK pathway, *Tmhhep*, expression patterns, qRT-PCR

E11

Preliminary Study of Intracellular Protein of Toll Signaling Pathway, *Tmpellino*, in *Tenebrio molitor*

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Antimicrobial peptides (AMPs) production through toll pathway is one of the important innate immune responses in invertebrate organisms. It was studied that the intracellular protein, pellino is interacting with the serine/threonine kinase, pelle, to regulate AMPs production, however, it has not yet been studied the interaction between Pellino and Pelle in *Tenebrio molitor*. In this study, the full-length ORF sequence of *Tmpellino* was indentified from *T. molitor* nucleotide database and a phylogenetic analysis of *Tmpellino* with its othologs was conducted. To understand the basic role of *Tmpellino*, developmental and tissue-specific expression patterns of *Tmpellino* were investigated. Additionally, to know how to response the *Tmpellino* against microbial infection, pathogens were injected into *T. molitor* larvae and the expression patterns of *Tmpellino* were time-dependently investigated (at 3, 6, 9, 12, and 24 h). This study may provides an basic information to understand how *Tmpellino* regulate AMPs production in *T. molitor*.

Key words: *T. molitor*, Toll pathway, *Tmpellino*, pathogenic infection, qRT-PCR

F1

Mosquito (Diptera: Culicidae) surveillance in southern part of Gyeongsangbuk-do in Korea, 2021-2022

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모기(Diptera: Culicidae)에 의해 발생하는 감염병은 Flavivirus에 의한 것으로, 암컷 모기가 산란을 하기 위해 숙주를 흡혈하는 과정에서 일어난다고 알려져 있다. 모기에 의해 매개되는 대표적인 질병은 말라리아, 일본뇌염, 뎅기열, 지카바이러스감염증이 있다. 이처럼 인류에 중대한 위협을 가하는 곤충인 모기의 종별 분포 양상 및 바이러스 보유 여부를 조사하기 위해 2021년부터 2022년까지 대구(도심)와 경상북도 군위(철새도래지)의 다양한 환경에서 채집을 진행하였다. 2021년 도심에서는 총 6,788마리의 모기가 채집되었으며, 그중 *Culex pipiens* complex가 66.1% (4,484마리)로 가장 많이 채집되었다. 2022년에는 2,346마리가 채집되었으며 2021년과 동일하게 *Culex pipiens* complex (76.5%, 1,795마리)가 역시 가장 많이 채집되었다. 철새도래지에서는 2021년 총 352마리가 채집되었고, 그중 *Aedes albopictus* 39.2%(138마리)로 가장 많았다. 2022년에는 총 135마리의 모기가 채집되었으며, *Armigeres subalbatus*가 44.4%(60마리)로 가장 많이 확인되었다. 도심에서의 모기 개체 수는 2021년 대비 2022년에 약 66.5%가 감소하였다. 철새도래지에서는 2021년 대비 2022년 채집량에서 약 61.6% 감소율을 보였다. 채집된 모기의 Flavivirus 보유 여부를 확인하기 위하여 Real-time PCR을 이용해 분석한 결과 Flavivirus를 보유한 모기는 발견되지 않았다. 본 조사 결과는 대구를 포함한 경상북도 지역의 모기 방제를 위한 기초 자료로 활용될 수 있으리라 기대된다.

검색어: Mosquito, Flavivirus, *Culex pipiens* complex, *Aedes albopictus*, *Armigeres subalbatus*

F2

Seasonal fluctuation and insecticide resistance of aphids around highland potato fields

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진딧물은 감자에 다양한 바이러스병을 옮기는 대표적인 매개충이므로 건전 씨감자의 안정적 생산을 위해서 진딧물 방제는 필수적이다. 강원도 고랭지 지역은 진딧물 발생량이 비교적 적어 씨감자 생산에 적합하나, 최근 농업 환경이 변화에 따라 발생 양상이 바뀌고 있다. 최근 3년간 고랭지 포장에 비래하는 진딧물의 발생소장을 조사하고 시기별 변동을 확인한 결과 초발생은 4월 하순경이었으며 연간 2회의 발생 최성기가 확인되었다. 또한 2022년 발생한 지역 집단을 대상으로 등록 방제 약제를 이용한 생물검정을 수행한 결과, Deltamethrin과 Spirotetramat에 저항성이 있음을 확인하였다. 이러한 진딧물 개체군의 예찰 및 선제적 관리를 통해 무병 씨감자의 생산 및 보급 증대에 기여할 수 있다.

검색어: 진딧물, 예찰, 고랭지, 감자

G1

Analysis of Nutrient in *Protaetia brevitarsis* larvae reared with different diets

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This study took the experiment on a feed model for breeding *Protaetia brevitarsis* larvae (PBL) with high-level nutritional value by setting 4 different diet combinations. Analysis of PBL nutritional components has been done by Proximate analysis, Fatty acid analysis and Constituent amino acid analysis. Data shows that the changes in the amount of unsaturated fatty acids are directly related to the different composition of feed material combinations.

Key words: *Protaetia brevitarsis* larvae, nutritional component, Proximate analysis, amino acid

H1

A study on the Efficiency of Insect Trapping Method_Light trap (bucket type)

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제5차 전국자연환경조사 육상곤충분야 야행성 곤충류 조사방법 중 LED를 활용한 버킷라이트 트랩 포획 효율성을 확인하기 위해 Black light (BL)와 신규 LED 3종(LED_UV, LED_Green, LED_Blue)의 광원을 선별하여 총 6회 현장조사를 실시하였다. 분석 결과, 광원유형에 따른 종수의 평균값은 BL 80.33, LED_UV 77로 높은 수치를 보인 반면 LED_Blue와 LED_Green은 각각 12와 14.17의 평균값을 보여 상대적으로 낮은 수치를 나타냈다. 개체수의 평균값 또한 BL (158.5) 및 LED_UV (141.33)에 비해 LED_Blue (18.67)와 LED_Green (20.83)의 수치가 낮게 나타났다. 분산분석결과, 종수($F=123.08$, $p<.001$) 및 개체수($F=33.70$, $p<.001$) 모두에서 유의한 차이가 있는 것으로 나타났으며, Post Hoc Tests Multiple Comparisons Scheffe (사후검증) 결과 BL은 LED_Blue 및 LED_Green과는 종수 및 개체수 모두에서 유의한 차이를 보였지만($p<.001$), LED_UV와는 유의수준 $p<.001$ 수준에서 유의한 차이를 보이지 않았다. 즉, BL과 LED_UV는 LED_Blue와 LED_Green과 차이가 나는 것을 확인할 수 있었다.

검색어: 전국자연환경조사, 버킷라이트 트랩, LED, 효율성, 분산분석

H2

Selection of insects to decompose organic waste resources

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최근 곤충에 대한 연구의 초점은 대두박 또는 어분을 대체할 단백질 공급원으로 반려동물 및 경제동물의 사료로 개발하는 것에 주안점을 주고 있다. 이는 사료비 절감을 위해 유용 곤충의 산업화를 위해 나아갈 방향을 제시한다. 그 밖에 곤충의 장점은 경제동물에서 발생하는 유기성 폐자원을 분해하여 비료로서의 가치와 환경 오염원을 줄여 축사 환경을 개선하는 효과이다. 그러나 이에 대한 곤충의 수는 제한되어 있어 충분한 연구가 필요한 시점이다. 본 연구에서는 동애등애와 비교하여 환경 오염을 감소시킬 수 있는 대표 곤충을 선별하는 것이 목적이다. 그 결과는 굼벵이가 그 역할을 할 수 있는 것으로 나타나 향후 다양한 유기성 폐자원인 축분에 적용하여 새로운 정보를 얻을 수 있을 것으로 기대한다.

검색어: 동애등애, 굼벵이, 유기성 폐자원, 곤충 산업화

H3

Biodiversity of forensically relevant blowflies (Diptera: Calliphoridae) in Gyeongsangnam-do, Republic of Korea

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Understanding the biodiversity and distribution of forensically relevant blowflies (Diptera, Calliphoridae) in an area can aid in legal investigation when insects are associated with remains. For this purpose, we conducted nine-month blowfly survey at the urban and forest habitats in four areas (Busan, Changwon, Gimhae and Tongyeong) of Gyeongsangnam-do, Korea. Fly traps baited with mouse cadavers were deployed for three days twice a month throughout the study. A total of 2,450 adult blowflies were collected, comprising 16 species from 4 genera. *Lucilia porphyrina* and *Chrysomya pinguis* were predominant species collected from this survey, with collections representing 36.49% and 36.41% of total flies captured, respectively. In addition to relative abundance, we investigated blowfly community composition, species abundance, richness, and diversity by season and habitat types. Overall, the mean number of blowflies collected among the eight study sites had no statistically significant difference, but it differed according to the season and habitat types. These findings demonstrate the relative abundance of blowflies differed markedly in the season and habitat types.

Key words: calliphoridae, season, habitat, legal investigation, fly trap

H4

The compilation of Inventory of National Biological Resources with 111 Alert Alien Species in Korea

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국립생물자원관은 2022년 12월 기준으로 총 58,050종(동물계 32,936종, 식물계 8,193종, 유색조식물계 3,211종, 균계 6,116종, 원생동물계 2,888종, 세균계 4,682종, 고세균계 24종)의 국가생물종목록을 구축하였다. 전년 대비 총 1,802종이 추가되었고, 각각 동물계 663종, 식물계 37종, 유색조식물계 55종, 균계 300종, 원생동물계 43종, 세균계 703종, 고세균계 1종이 증가하였다. 특히 곤충은 소백털털이맷시벌, 한국털털이맷시벌 등의 신종을 포함하여 465종이 추가되었다. 이렇게 구축된 국가생물종목록은 야생생물 보호 및 관리에 관한 법률, 생물다양성 보전 및 이용에 관한 법률 등 다양한 법률 제·개정 시 기초자료로 활용되고 있다(한반도의 생물다양성 <https://species.nibr.go.kr>). 그러나 과거 국명 없이 학명만 보고된 경우가 빈번하여, 국립생물자원관에서는 2013년에 국가 생물종 국명 부여 지침 초안을 마련하였고, 2017년부터 본격적으로 국가생물종 국명 부여사업을 추진하여 왔다. 2022년에는 국가생물종목록 대상(2021.12.31.기준)으로 유입주의 대상 생물 후보종 111종(포유류 8종, 조류 5종, 어류 6종, 양서류 2종, 파충류 4종, 식물 84종, 곤충 2종)에 대하여 국명을 부여하였다.

검색어: 국가생물종목록, 유입주의생물

H5

Application of IUCN Red List categories and criteria of unevaluated endangered insect species

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IUCN은 전 세계 생물종의 멸종 위험성을 평가한 적색목록(Red List)을 발표하고 있으며, 한국은 IUCN 지역적색목록 기준(지역 내/외 조정)을 적용하여 국내 생물종을 평가하고 있다. 환경부가 지정한 멸종위기 곤충 중에서 지역적색목록 기준에 의해 평가된 종은 25종이 있고, 평가되지 않은 종은 4종이 있다. 본 연구에서는 미평가종 중 하나인 뚝보주름메뚜기(*Haplotropis brunneriana* Saussure, 1888)의 발생 현황, 개체군 밀도 등을 이용하여 적색목록 범주 기준에서 확인하고자 하였다. 조사는 2022년 3개 지역에서 3월부터 6월까지 월 3회씩 총 12회 조사를 수행하였다. 개체군 밀도는 지역별로 영월: 19개체/3840 m², 제천: 24개체/3840 m², 의성: 28개체/3840 m²로 나타났으며, 지역 간 유의한 차이는 확인되지 않았다(p -value > 0.05). 조사된 자료로 시기별 개체군 차이는 확인했으나(p -value < 0.05), 장기적 변화를 확인하기 위해서는 추가적인 연구가 필요할 것으로 생각된다. 뚝보주름메뚜기의 개체군 밀도는 멸종위기 범주(위급, 위기, 취약)에 근접한 것으로 나타났다.

검색어: IUCN, 적색목록, 멸종위기종, 개체군 밀도, 뚝보주름메뚜기

H6

Seasonal occurrence patterns of blowfly species (Diptera: Calliphoridae) in Yeongdo-gu, Busan, Republic of Korea

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Blowflies (Diptera: Calliphoridae) are insects of forensic interest as they may indicate characteristics of the environment where a body has been laying prior to the discovery. Therefore, their biological aspects have been studied increasingly worldwide. In this study, we analyzed seasonal occurrence patterns of blowfly species based on samples collected from 111 animal cadaver cases from the year 2015 to 2023 in residential and mountainous area of Yeongdo-gu, Busan, Republic of Korea. Identification of adult blowflies exhibited 6,760 specimens, comprising of 3 subfamilies, 6 genera and 17 species. Of these, *Chrysomya pinguis* (Walker, 1858), and *Lucilia porphyryna* (Walker, 1856) were abundant in spring, summer, and autumn, but the abundance of *Calliphora nigribarbis* Snellen van Vollenhoven, 1863 was very low or not observed in summer. *Calliphora vicina* Robineau-Desvoidy, 1830 was collected only during the spring. The data from this study may be used to identify the potential of forensically important fly species within Yeongdo-gu and fulfill the information blowfly fauna in Republic of Korea.

Key words: blowflies, cadaver, occurrence, *Chrysomya pinguis*, *Lucilia porphyryna*

H7

Do different local communities of cadaver insects produce different rates of decomposition process?

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This study aims to illustrate the cadaver insects, their succession patterns and decomposition stages of pig cadavers in ecologically different sites. Three domestic pig cadavers (33.8kg, 22.0kg and 24.5kg) were employed as human models for application to future homicide investigations in each study sites. Research was conducted Yeongdo island, Namyangju in July and August in 2017 and Haenam in August in 2018. A total of 50 species belonging to 18 families of four orders was sampled. Among them, 21 insect species were observed in the Yeongdo island, 16 species in the Namyangju, and 30 species in the Haenam. The cluster analysis with SIMPROF test classified the samples into two cluster groups based on the similarities between species composition between different localities. The result suggested that the geographical ecology could be significantly different in decomposition process at least by cadaver insects known as one of important decomposers. It is likely to produce any difference in estimating the post-mortem intervals for medicolegal entomology.

Key words: geographic difference, cadaver insects, decomposition rates, post-mortem interval, medicolegal entomology



Poster Presentation

Competition

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Korean Society of Applied Entomology

P1

**An Impartial and Effective Method of Describing Lepidopteran New Species:
In the case from New Species of *Endoclita* C & R Felder, 1874 (Hepialidae)**

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A stem-boring ghost moth species, *Endoclita gageodoensis* sp. nov. (Lepidoptera: Hepialidae), is newly described from Gageo-do Island, the Southwesternmost island of Korean territory. The description is based on the observation of the male and female imagoes' habitus, 3D models of holotype genitalia which were obtained from CLSM (confocal laser scanning microscope), and DNA barcoding (COX1, 658bp). From the result, impartial and effective methods of describing new lepidopteran species are discussed.

Key words: Hepialidae, *Endoclita*, new species, Gageo-do, CLSM, 3D model

P2

**Confirmation on the presence of *Cybister tripunctatus lateralis* (Fabricius, 1798)
(Coleoptera: Dytiscidae: Cybistrinae) in Korea**

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The genus *Cybister* Curtis contains 98 species worldwide. Previous studies had reported that only three species of the genus *Cybister* occur in the Korean Peninsula. However, recent investigations have recognized the presence of *C. tripunctatus lateralis* (Fabricius), which had been removed from the Korean species list. In this study, we report the presence of this species in Korea and provide a diagnosis with illustrations of diagnostic characters. Habitus photographs and a pictorial key of Korean *Cybister* species are also provided to facilitate identification.

Key words: *Cybister tripunctatus lateralis*, Dytiscidae, *Cybister*, pictorial key, Korea

P3

Insecticidal and attraction-inhibitory activity of mosquito coils against *Culex pipiens* and *Aedes albopictus*

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The indoor use of mosquito coils are limited due to the distinctive odor and smoke generation, and they are usually burnt outside during outdoor activity such as camping. Traditional test guidelines including WHO instruct to test the insecticidal efficacy of mosquito coils in a Peet-Grady chamber. However, considering the recent trend, we need to understand their efficacy in outdoor conditions. In the present study, indoor insecticidal activity and outdoor attraction-inhibitory activity were compared. *Aedes albopictus* and *Culex pipiens* exhibited 90.2±0.7% and 93.7±2.9% of 24h mortality in a Peet-Grady chamber, while it showed 34.3±6.7% reduction when BG-sentinel traps were employed during the overnight testings (22~24°C, RH 58~95%).

Key words: Biocides, Mosquito coils, Asian tiger mosquito, Common house mosquito, Insecticide

P4

Comparison of insecticidal efficacy of electric vaporizers in different testing scales against the Asian tiger mosquito, *Aedes albopictus*

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Mat and liquid type electric vaporizer insecticides are the second frequently selected household insecticide formulations followed by aerosols in Summer for indoor mosquito control. Since the efficacy can be affected by the volume of the space while the insecticidal substances are vaporized and accumulated in the treated room, we must understand the efficacy of those products at certain test conditions. The objectives of the present study were to examine the lab-scale test conditions for mimicking the real-use situation (usually 30m³) against the Asian tiger mosquito. Insecticidal activity at two testing volume (0.5 and 5.8m³), air circulation, and pre-heating were examined.

Key words: biocide, electric vaporizer insecticide, insecticide, Asian tiger mosquito

P5

One new record of genus *Daphnusa* walker, 1856 (Lepidoptera: Bombycoidea: Sphingidae: Smerinthinae) from Korea

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Sphingidae is the one of the macrolepidopteran family (Lepidoptera) including almost 1,400 species belonging to 202 genera in worldwide. So far, 58 species of 30 genera have been recorded in Korea. Among the family, we found *Daphnusa ocellaris* Walker, 1856 from Wando which located the southern part of the Korea. Illustrations of its adult and genitalia are also provided.

Key words: *Daphnusa*, New record, Sphingidae, Taxonomy, Wando

P6

The first record of *Thyas coronata* (Fabricius, 1775) (Lepidoptera: Noctuoidea: Erebiidae) in Korea Peninsula

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The family Erebiidae (Leach, [1815]), one of the largest families of the superfamily Noctuoidea. The Erebiidae is found on all continents except Antarctica. The wingspan of the Macrolepidopteran group, Erebiidae, range from 6.0 mm to 120.0 mm, and the coloration of the adults is also diverse from the full range of dull, dark, and camouflaged to contrasting and colorful. So far, 514 species belonging to 209 genera of the Erebiidae have been recorded in Korea.

In this study, *Thyas coronata* is reported for the first time from Korea. Distributional information, illustration of adult and a taxonomic key to Korean *Thyas* species are also provided.

Key words: Erebiidae, Lepidoptera, new species, taxonomy, *Thyas*

P7

Isolation and identification of gut bacteria in insect

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곤충의 장내미생물은 기주 곤충의 성장, 발달, 그리고 면역 등 다양한 생리적 현상에 기여하는 것으로 보고되고 있다. 그러나 현재까지, 다양한 곤충을 대상으로 한 곤충 장내 미생물에 대한 연구는 거의 없는 실정이다. 과거 본 분야의 연구적 한계는 미생물들을 분리, 배양, 동정하는 작업이 필요한데 이러한 분야는 곤충학자들에 의하여 외면 받아왔으며, 초파리와 누에 등 모델 곤충만을 대상으로 연구되었던 한계가 있다. 따라서 본 연구는 모델 곤충 외에도 우리나라에 서식하는 다양한 곤충들을 대상으로 장내 미생물을 분리/배양/동정하였으며, 추후 미생물 연구자들과 협동 연구를 통하여 산업적으로 활용할 수 있는 다양한 미생물들을 보고하는데 연구 목적이 있다.

검색어: 장내미생물, 미생물 분리, 미생물 동정, 미생물 산업, 산업

P8

A preliminary list of insect resources for the forensic entomology

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사후경과시간(Post Mortem Interval, PMI)은 사건을 해결하기 위한 중요한 단서 중 하나로, 이를 추정하는 방법 중에는 법곤충학이 있다. 법곤충학은 동물의 사체를 먹이 및 산란 장소로 이용하는 곤충들을 분류 및 생태 지식을 종합하여 응용되는데, 사체의 부패 단계에 따라 출현하는 곤충집단이 각기 다름을 활용하여 사망추정시간을 확인할 수 있다. 그러나 우리나라에서는 법곤충학 관련 자료가 부족한 실정으로 이를 위한 곤충소재 파악이 요구되는 시점이다. 이를 위해 법곤충학과 관련된 연구 자료를 조사하여 활용 가능 곤충 목록 작성, 실험 방법 및 결과 해석 등을 중심으로 문헌 조사를 실시하였다. 조사 결과를 바탕으로 곤충 종류별 섭식 특성 및 분류군 특성을 정리하여 법곤충학 연구 자료로 제공하고자 한다.

검색어: 법곤충학, 분류학, 사후경과시간, 파리목, 딱정벌레

P9

A recombinant secretory phospholipase A₂ (As-sPLA₂B) of the allium leafminer, *Acrolepiopsis sapporensis*, and its enzyme catalytic activity

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파좀나방(*Acrolepiopsis sapporensis*)은 대파의 엽육을 가해하여 경제적 피해를 주는 해충이다. 이러한 파좀나방의 생리적 특성을 이해하는 것은 효과적 방제 기술 개발에 필수적이다. Phospholipase A₂ (PLA₂)는 인지질을 가수분해하여 아라키도닉산을 생성하는 효소로서 다양한 곤충 생리작용에 영향을 준다. 비모델 곤충의 유전체를 이해하기 위해 RNA-Seq 분석을 이용하였다. 이를 통해 4종류의 PLA₂ 유전자를 추정하였다. 이들 4가지 PLA₂ 유전자 가운데 본 연구는 As-sPLA₂B에 대한 효소학적 특성을 분석하였다. 생물정보학 기술을 통한 기능 영역을 분석한 결과 이 단백질은 칼슘결합 부위는 물론이고, PLA₂ 촉매부위로 알려진 His-Asp dyad 서열을 확인하였다. 이를 통해 His의 R기에서 유래된 전자 전달 반응이 궁극적으로 인지질의 sn-2 부위 에스테르 결합을 가수분해하는 것으로 추정되었다. 특히 면역반응에 의해 이 유전자의 발현량이 급격히 증가된다. 즉, 세균을 이 곤충의 혈강에 주입할 경우 이 PLA₂ 유전자의 발현량(FPKM)이 약 3배 증가하였다. 이 효소의 촉매기능을 분석하고자 세균발현시스템을 이용하여 과발현시킨 후 Ni-NTA affinity chromatography로 재조합 단백질을 정제하였다. 정제된 재조합단백질은 PLA₂ 촉매 기능을 보였다.

검색어: 파좀나방, PLA₂, 재조합단백질, 정제, 효소활성

P10

Mechanism study of phosphine-resistant *Tribolium castaneum* using deltamethrin contact toxicity

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Deltamethrin is a synthetic pyrethroid insecticide for pest control. This insecticide exhibits contact toxicity by binding to the ion channels of neurons, reducing the membrane potential difference and inhibiting their functions such as movement, finally leading to their mortality. Deltamethrin-resistant strain of red flour beetle (*Tribolium castaneum*) are known to have increased expression of the brain-specific cytochrome P450 detoxification enzyme gene compared to susceptible strains. In this study, we confirmed 34-fold higher cytochrome P450 expression in phosphine (PH₃)-resistant *T. castaneum* strain than in susceptible strain like deltamethrin-resistance. Subsequently, we evaluated the deltamethrin contact toxicity against PH₃-resistant *T. castaneum* and obtained results showing that PH₃ resistance is not significantly to deltamethrin resistance, although the gene expression of cytochrome P450 gene was up-regulated in PH₃ resistant *T. castaneum*.

Key words: Deltamethrin resistance, phosphine resistance, *Tribolium castaneum*

P11

The management of phosphine and imidacloprid-resistant pests through the ethyl formate fumigation

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The potent fumigant phosphine (PH₃) and effective insecticide imidacloprid (ID) have problems with the emergence of resistant pests. The alternative fumigant, ethyl formate (EF), is a chemical with almost no residue and has not been reported to have resistant problems. In this study, it was confirmed that PH₃-resistant *Tribolium castaneum* and ID-resistant *Myzus persicae* exhibited similar mortality rates to their each susceptible strains when fumigated with EF. The LCT₉₀ values for EF against PH₃-resistant *T. castaneum* and susceptible strains were 99.67 and 101.88 mg·h/L, respectively, while the LCT₇₀ values for EF against ID-resistant *M. persicae* and susceptible strains were 3.39 and 3.24 mg·h/L, respectively. EF do not affect any significant differences in mortality rate between resistant and susceptible strains of both. Therefore, EF has the potential to control PH₃-resistant grain beetles and ID-resistant agricultural pests at the same concentration as susceptible strains.

Key words: ethyl formate, phosphine resistance, imidacloprid resistance, *tribolium castaneum*, *mysus persicae*

P12

A list on insect pests occurring from Korean pear

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한국 배(*Pyrus pyrifolia*, Korean pear)재배면적은 9,680ha로 품목별로 배 생산량은 전년대비 19%증가 하였으며 국내육성 품종 보급 사업(유목-신화.창조)으로 재배면적이 늘어 향후 반입량이 꾸준히 증가할 것으로 예측된다. 본 연구는 배에서 발생하는 해충에 대한 현장조사 계획 수립을 위해서 현재까지 보고된 문헌 자료를 바탕으로 배에서 발생하는 해충목록을 작성하였다. 문헌조사에 따르면, 꼬마배나무이(*Psylla pyricola*), 조팝나무진딧물(*Aphis spiraeicola*), 배나무면충(*Prociphilus kuwanai*), 가루각지벌레(*Pseudococcus comstocki*), 점박이응애(*Tetranychus urticae*) 등이 우점해충으로 기록되어 있다. 그러나, 최근에는 갈색날개매미충(*Ricania* sp.), 미국선녀벌레(*Metcalfa pruinosa*), 꽃매미(*Lycorma delicatula*), 주경배나무이(*Cacopsylla jukyungi*)등의 출현도 잦고, 그 발생 빈도가 점차 증가하고 있어 앞으로의 예찰의 중요성이 더 커질 것으로 판단된다.

검색어: 배나무, 해충, 문헌조사, 예찰

P13

A new record of *Chaoborus* Lichtenstein, 1800 (Diptera: Chaoboridae) species in South Korea

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The family Chaoboridae Edwards, 1932 (Diptera: Culicoidea), commonly known as phantom midges, is one of lower dipteran families and known as sister group of Culicidae. Chaoboridae is divided into two subfamilies and comprises six extant genera globally. Two species in the genus *Chaoborus* Lichtenstein, 1800 – *C. flavicans* (Meigen, 1830) and *C. crystallinus* (De Geer, 1776) are known to be distributed in Korean peninsula. In this study, several chaoborids were collected using a sweep net in a fishless pond. Morphological and molecular identification were performed for each stage, from larva to adults. As a result, a new record species of the *C. flavicans* complex is reported with the short description in this study.

Key words: Chaoboridae, *Chaoborus*, Culicoidea, phantom midge

P14

***Asphalmus izawai* Morimoto (Coleoptera: Curculionidae: Entiminae) new to Korea**

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The family Curculionidae is one of the largest families along with the family Staphylinidae. Curculionidae includes over 70,000 species, and Entiminae is the largest subfamily in Curculionidae. Subfamily Entiminae comprises over 15,000 species. And species of the Entiminae have short and broad rostrums. The genus *Asphalmus* Sharp, 1896 includes 47 species recorded in Japan. But, only one species *Asphalmus japonicus* Sharp, 1896 is recorded in the Korean peninsula. This genus can be distinguished from other genera by its oval and rounded pronotum, and antennal scape shorter than the funicle, reaching the anterior margin of the pronotum. In this study, we report the unrecorded species *Asphalmus izawai* from Korea for the first time.

Key words: *Asphalmus*; Entiminae; new records; broad-nosed weevil; taxonomy

P15

A new species of the genus *Delina* Robineau-Desvoidy, 1830 (Diptera: Scathophagidae) from South Korea

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Family Scathophagidae Robineau-Desvoidy, 1830, commonly referred to as dung flies, is a small family of Muscoidea and known as a sister group of Anthomyiidae. Despite the fact that only ~500 described species in ~60 genera are in this family, the larval biology of this family is greatly diverse, drawing curiosity from biologists. Yet our current taxonomic knowledge of scathophagids from the Eastern Palearctic region excluding the Russian Far East and Japan remains poorly studied. Herein, the genus *Delina* Robineau-Desvoidy, 1830 (Scathophagidae: Scathophaginae) is identified for the first time in South Korea, as reporting of its new species. In this paper, we provide descriptions with photographs of diagnostic characters. An identification key to the Korean scathophagids is provided. In addition, molecular approaches corroborate the phylogenetic position of *Delina* based on 7 mitochondrial genes.

Key words: *Acanthocnema*, Scathophagidae, new species, South Korea, Taxonomy

P16

Development of diagnostic technology using insect image information from fruit trees

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최근 남부 지방에서부터 시작된 기후변화와 외래해충의 유입으로 농가들의 피해가 증가하고 있다. 따라서 기후변화에 따른 잠재해충의 진단이나 외래해충의 정확한 동정이 필수적이다. 하지만 일반 농가에서는 해충에 대한 정확한 진단을 내리기가 쉽지 않다. 이러한 문제를 병해충 진단기술을 이용하여 해결하고자 해충의 생활사를 바탕으로 한 외부형태, 작물의 피해 등의 이미지 정보를 확보하고자 한다. 2021년부터 2022년도까지 감, 감귤, 매실, 배, 복숭아, 사과, 자두, 포도 등 8개의 작물에서 발생하는 주요 해충 24종의 발육단계별, 피해기주 등에 대한 영상진단 이미지 34,661매를 생성하였다. 이 자료들은 AI 기반 영상학습을 통하여 해충 진단 시스템에 활용될 것이다.

검색어: 과수류, 해충, 진단 시스템, AI

P17

Taxonomic review of the genus *Hexacentrus* Serville, 1838 (Orthoptera: Tettigoniidae) in Korea

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The genus *Hexacentrus* (Orthoptera: Tettigoniidae), commonly known as fierce predatory katydids, comprises two species in Korea: *Hexacentrus japonicus* Karny, 1907, and *H. hareyamai* Furukawa, 1941. While *H. japonicus* is well-known in Korea, *H. hareyamai* was previously confirmed through a DNA barcoding study without taxonomic investigation. And the sequence of Korean *H. hareyamai* was initially reported as *H. unicolor* Serville, 1831 by only DNA barcoding. In this research, we reviewed the Korean *Hexacentrus* using morphological and bioacoustic characters, and conducted a phylogenetic analysis using cytochrome oxidase I (COI) for molecular identification. We redescribed *H. hareyamai* in Korea, which was known only as DNA sequence. We confirmed that there are no specimens identified as *H. unicolor* in Korea. Based on our results, the existence of *H. unicolor* in Korea should be excluded. However, although *H. unicolor* and *H. hareyamai* are distinguished by morphological and bioacoustic characters, they are not distinguished by DNA barcoding using COI. For this systematic comparison, further studies are required to conduct including *H. hareyamai* and *H. unicolor*, in Southeast Asia.

Key words: Orthoptera, *Hexacentrus hareyamai*, Phylogeny, DNA barcoding, Bioacoustics

P18

A new record the genus *Froggattiella* Leonardi, 1900 (Hemiptera: Diaspididae: Aspidiotinae) from South Korea

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The genus *Froggattiella* Leonardi, 1900 (Hemiptera: Diaspididae: Aspidiotinae) has been known to damage bamboo and includes five species in the world. Among five species, *Froggattiella penicillata* is distributed in Korea, China, and Japan, Sri Lanka. *F. penicillata* is occurring under the sheathing bases of the leaves, and the species observed being attached to the stem and not to the leaf. In this study, photographs and information on the distribution and hosts of this species, are provided.

Key words: Diaspididae, new record, *Froggattiella penicillata*, Korea

P19

The first record of the genus *Tagosodes* Asche and Wilson, 1990 (Hemiptera: Auchenorrhyncha: Delphacidae) in South Korea

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The genus *Tagosodes* Asche and Wilson, 1990 comprised 12 species in the world. Most of species in this genus feed on plants belonging to the family Poaceae including rice. Several species are economically important because it well recognized vectors of hoja blanca virus of rice in South and Central America.

In this study, we report the genus *Tagosodes* for the first time from Korea with *Tagosodes pusanus* Distant, 1912. We provided diagnosis and photographs of male habitus and genitalia.

Key words: Delphacidae, *Tagosodes*, new record, South Korea

P20

The first record of *Pachyllothrips zelkoveae* Okajima, 2006 (Thysanoptera: Phlaeothripidae) in Korea

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Pachyllothrips zelkoveae Okajima, 2006 (Thysanoptera: Phlaeothripidae) has been only recorded in Japan and it is known to overwinter under the bark of *Zelkova serrata* Makino, 1903 and feed leaves of *Z. serrata*. We collected *P. zelkoveae* from *Z. serrata* in Boeun-gun and Jinju-si in 2023. In this study, we report a new record of *P. zelkoveae* with morphological characteristics and biological information.

Key words: Thysanoptera, Phlaeothripidae, New record, *Pachyllothrips zelkoveae*, Korea

P21

A checklist of the genus *Anarsia* with a newly reported species from Korea

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The family Gelechiidae (Lepidoptera: Gelechioidea) is known as one of the largest families in microlepidoptera, comprising about 600 genera and more than 5,000 described species worldwide. Among the genera of the family, the genus *Anarsia* Zeller, 1839 is poorly known in Korea, with only 10 species. In this study, we provide a newly recorded species in Korea, *Anarsia isogona* Meyrick, 1913, with a brief description and diagnostic characteristics, and images of adults and genitalia of both sexes. A checklist of Korean *Anarsia* is also provided.

Key words: gelechiid moths, Anarsini, new record, Korean peninsula

P22

A new record of *Dolichozepe* (*Nesopeza*) *albitibia* (Alexander, 1922) (Diptera: Tipulidae: Dolichozepeinae) in Korea

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The subgenus *Dolichozepe* (*Nesopeza*) Alexander, 1914 (Diptera: Tipulidae: Dolichozepeinae) is a relatively large subgenus within the genus *Dolichozepe* Curtis, 1825, with 131 species described worldwide. Especially, 127 species of this subgenus have been recorded from Oriental and Eastpalearctic regions. In Korea, however, only one species, *Dolichozepe* (*Nesopeza*) *geniculata* (Alexander, 1918), had been recorded in this subgenus despite the diversity of the taxon, even at the subfamily level. In this study, we report a new record of *Dolichozepe* (*Nesopeza*) *albitibia* (Alexander, 1922) from Jeju island, Korea, which is not only the second report of the subgenus *Dolichozepe* (*Nesopeza*), but also the second report of the subfamily Dolichozepeinae Podenas and Poinar, 2001. In addition, we redescribe the morphological characters of both sexes.

Key words: Diptera, Tipulidae, Dolichozepeinae, *Dolichozepe* (*Nesopeza*) *albitibia*, Jeju island, Korea

P23

Review of the genus *Lecithocera* (Lepidoptera, Lecithoceridae) in DR Congo, with description of four new species

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A taxonomical review for the genus *Lecithocera* Herrich-Schäffer, 1853 (Lepidoptera, Lecithoceridae) in DR Congo, Africa is provided. The genus is the most diverse genus in the family Lecithoceridae, comprising more than 310 species. In Africa, less than 27 species are known in the family, of which four species of *Lecithocera* (*L. chloroscia* Meyrick, 1938, *L. lucernata* Meyrick, 1913, *L. triferca* Meyrick, 1938, and *L. xanthochalca* Meyrick, 1914) have been reported in the DR Congo. In this study, four new species (*Lecithocera katangaica* Park, sp. nov., *Lecithocera seydeli* Park, sp. nov., *Lecithocera cornutispina* Park, sp. nov., and *Lecithocera lusingaensis* Park, sp. nov.) are described as new to science from DR Congo. In addition, *L. ideologa* Meyrick, 1937 is recorded for the first time from DR. Congo.

Key words: Microlepidoptera, new species, Africa, *Lecithocera*, DR Congo

P24

Three species in Phycitinae (Lepidoptera, Pyralidae) new to Korea

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Addyme Walker, 1863 and *Dioryctria* Zeller, 1846 are genera of Phycitinae. Among them, three species, *A. obscuriella* (Inoue, 1959), *D. yiai* Mutuura & Munroe, 1972, and *D. rubella* Hampson, 1901, are newly reported in Korea and the genus *Addyme* is new to Korea. *A. obscuriella* is similar to *A. confusalis* Yamanaka 2006 and it was even misplaced in a different genus (as in *Calguia* Walker, 1863, specifically *C. defiguralis* Walker, 1863) in Korea. However, this species can be easily distinguished by color of forewing and genital characteristics. *D. yiai*, is very similar to *D. pryeri* Ragonot, 1893, but can be distinguished by genital characteristics. Between *D. rubella* and *D. sylvestrella* Ratzeburg, 1840, there are no differences except for a few male genital features as well as mitochondrial COI and COII (Du *et al.* 2005). Here we provide diagnoses, brief descriptions, images of adults and their genitalia, and sequences of COI mtDNA.

Key words: snot moths, Phycitini, new record, Korean fauna, Korean peninsula

P25

Preliminary result of a taxonomic study on *Amiota* (Diptera: Drosophilidae) in South Korea with DNA barcoding, genitalic examination and wing interference patterns

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In general, it can be challenging task to identify drosophilid species, including lachryphagous flies such as *Amiota*, on species level by using only external morphological characters. Thus, for accurate species identification, examination of genitalic structures is essential and molecular analyses, using COI and NADH2 sequences, are also needed to be performed. In this study, we conducted an integrated analysis of the genitalic characters and COI barcodes of *Amiota* species in conjunction with Wing Interference Patterns (WIP) in order to determine whether the latter could serve as a reliable diagnostic character for species identification. As the result of these analyses, we successfully identified three of the seven species previously recorded in South Korea, and we discovered four species that would be new to Korean insect fauna or to science.

Key words: Diptera, Drosophilidae, *Amiota*, DNA barcoding, Wing Interference Patterns

P26

Taxonomic review of genus *Hololepta* Paykull, 1811 (Coleoptera, Histeridae) from Korea

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The genus *Hololepta* Paykull, 1811 is one of morphologically characteristic groups of Histeridae, consisting more than 100 described species worldwide. Among them, 14 species are known to Palearctic region and four species are reported from Korea. Herein, we describe a new species, *Holelepta Koreana* sp. nov., from Korea. Also, we review the genus *Hololepta* from Korea with five species. A key to species, diagnoses, and images of adult are provided.

Key words: Taxonomy, Histeridae, *Holelepta*, first record, Korea

P27

New record of *Abies* feeding *Cinara* Curtis (Hemiptera: Aphididae) in South Korea

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The genus *Cinara* Curtis, 1835 (Hemiptera: Aphididae: Lachninae) is a large aphid genus comprising 256 known species worldwide. All species of this genus are associated with coniferous trees (Cupressaceae and Pinaceae families). In this study, We report *Cinara* (*Cinara*) *todocola* (Inouye, 1936) on *Abies* spp. for the first time in South Korea.

The results of this study additionally include as followings: 1) redescrptions of the poorly known apterous viviparous female and alate viviparous female and descriptions of the hitherto unknown fundatrix, oviparous female, and male of *C. todocola* for the first time in detail, 2) notes on life cycle, 3) Modeling the potential distribution to preserve eventual gradations.

Key words: Aphids, Lachninae, Pest, Distribution

P28

Investigation of insect pests in strawberry (*Fragaria x ananassa*) in Iksan

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국내 시설딸기의 재배면적은 5,634 ha로 국내 시설 과채류 재배면적 중 두 번째로 많은 면적을 차지하고 있다. 그 중, 전북은 국내에서 4번째로 많은 면적인 593 ha를 차지하고 있으며 매년 그 재배면적이 증가하고 있는 지역이다(KOSOS, 2021). 본 연구는 익산 지역에서 재배되는 시설딸기재배농가에 발생하는 곤충상을 조사하여, 해충군과 익충군의 구분을 통해 향후, 방제와 익충군의 보호에 기여 하고자 수행되었다. 2022년 6월 하순을 시작으로 익산 왕궁면과 금마면의 시설딸기재배농가에서 2주 간격으로 조사하였으며, 미소곤충의 경우, COI 유전자를 이용한 DNA barcoding 방법을 통해 종을 동정하였다. 조사결과, 총 곤충 종은 9목 19종으로, 주요 해충군은 5목 8종, 익충군 3목 3종으로 확인되었다. 가장 피해가 큰 해충은 점박이응애(*Tetranychus urticae*), 애뿔털진딧물(*Chaetosiphon minus*), 꽃노랑총채벌레(*Frankliniella occidentalis*)로 확인되었으며, 그 외에도 배추좀나방(*Plutella xylostella*), 어리노랑초파리류(*Drosophila simulans*), 애긴노린재(*Nysius plebeius*) 등이 관찰되었으며, 익충군은 일본풀잠자리(*Chrysoperla nipponensis*), 애꽃노린재(*Orius sauteri*)와 꽃등애류(*Eristalis sp.*) 등으로 확인되었다. 추가적으로 잎과 과실 부위의 피해양상을 포함한 해충의 피해사진 또한 제공하였다.

검색어: 익산, 시설딸기, 곤충상, 해충, 피해특징

P29

New distributional records of the mesostigmatic mites in Laos

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The mesostigmatic mites in Laos were very poorly studied despite of the country belongs to the Indo-Burma biodiversity hotspot. From our recent expedition, we discovered the seven species in four families of mites which is a new record in Laos: *Asca garmani* Hurlbutt; *Cosmolaelaps brevipedestra* (Karg); *Cosmolaelaps chianensis* (GU); *Gaeolaelaps queenslandicus* (Womersley); *Gamasolaelaps ctenisetiger* (Ishikawa); *Holaspululus tenuipes* Berlese; *Veigaia uenoi* Ishikawa. In this study, digital images of each species and a brief diagnosis will be provided.

Key words: Acari, Mesostigmata, Laos, New record, Taxonomy

P30

DNA barcoding of the 62 species of subfamily Tortricinae (Lepidoptera: Tortricidae) in Korea

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The subfamily Tortricinae, so called as leaf-rollers, have been known as a difficult group in identification due to their small size and similar wing patterns among the allied species. Some species are well known as pests to the agricultural and ornamental plants that occur massively enough to cause injuries to plants of economic importance. Therefore, this study was carried out to provide the DNA barcode and related information for distinguishing the complex species on Tortricinae.

In this study, we obtained and analyzed the DNA barcodes from 191 specimens of 62 species in the family Tortricidae. Among them, we obtained 177 specimens of 57 species in the subfamily Tortricinae and 14 specimens of 5 species in the subfamily Olethreutinae, respectively. Based on the result, one species of the genus *Acleris* area reported for the first time from Korea and three cryptic species of the genus *Ptycholomoides*, *Neocalyptis* and *Acleris*. Detected unrecorded species groups will be determine by further study including intensive taxonomic review in near future.

Key words: Lepidoptera, Tortricinae, Olethreutinae, DNA barcode, identification

P31

The preliminary checklist of the subfamily Herminiinae (Lepidoptera: Erebidae) in Korea

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The subfamily Herminiinae, comprising more than 1,000 species worldwide, is a relatively small group, belonging to the family Erebidae (Poole, 1989; Han et al., 2006). In Korea, totally 63 species under 19 genera of the subfamily have been known to date (KSAE & ESK, 2021). Some species of this group are known as a fruit sucking pest. But, it has been poorly conducted in detail until now in Korea. The aim of this study was to enumerate the known species for future research on taxonomic and biological study of this group. All the available information and the checklist of the subfamily Herminiinae from Korea is provided.

Key words: Noctuoidea, Erebidae, Herminiinae, Taxonomy, Checklist, Korea

P32

**Review of the subfamily Parornichinae Kawahara & Ohshima, 2016
(Lepidoptera: Gracillariidae) from Korea**

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The subfamily Parornichinae, is a relatively large group with more than 100 described species under 4 genera worldwide (Prins & Prins, 2006-2022). Recently, Kawahara & Ohshima (2017) established this group as new subfamily with the well supported clade of *Callisto* and *Parornix*. In this study, genus *Parornix* Spuler, 1910 in Korea was reviewed. A total of 4 species of *Parornix* was recognized from Korea with all available information, including checklist, host plant, adult and genitalia.

Key words: Parornichinae, *Parornix*, leafminer, taxonomy, Korea

P33

Genus *Conopomorpha* (Lepidoptera, Gracillariidae, Ornixolinae) new to Korea

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The subfamily Ornixolinae is a relatively large group with more than 300 described species under 30 genera worldwide (Prins & Prins, 2006-2022). Recently, Kawahara & Ohshima (2017) established this group. In this study, genus *Conopomorpha* Meyrick, 1885 is recorded as new to Korea. Also, one species, *C. flueggella* Li, 2011, is reported for the first time from Korea. All available information, including checklist, host plants and images of adults and genitalia for species is provided.

Key words: Ornixolinae, newly recorded species, leafminer, taxonomy, Korea

P34

Review of the genus *Liocrobyla* Meyrick, 1916 (Lepidoptera: Gracillariidae: Ornixolinae) from Korea

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The genus *Liocrobyla* was established by Meyrick in 1916, including 9 described species worldwide (Prins & Prins 2006-2022). This study was conducted to review of the genus *Liocrobyla* Meyrick, 1916, belonging to the subfamily Ornixolinae from Korea. In this study, two species of the genus were recognized from Korea. Among them, one species, *Liocrobyla* sp. nov., is described as new to science. Also, one species, *L. indigofera* Liu, Wang & Wang, 2018 is reported for the first time from Korea. All available information, including check list, host plants and images of adults and genitalia for species is provided.

Key words: Ornixolinae, newly recorded species, leafminer, taxonomy, Korea

P35

Review of the genus *Eumetriochroa* Kumata, 1998 (Lepidoptera: Gracillariidae: Oecophyllembiinae) from Korea

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The genus *Eumetriochroa* Kumata & Kuroko, 1988 has been known as a small genus with twelve described species worldwide. This study was aimed to review the Korean species of the genus *Eumetriochroa* of the subfamily Oecophyllembiinae, belonging to the family Gracillariidae. In this study, three species of this genus was recognized from Korea. Among them, two species, *Eumetriochroa araliella* Kobayashi, Huang & Hirowatari, 2013 and *E. hiranoi* Kumata, 1998 are reported for the first time from Korea. All the known species were enumerated with their available information and briefly redescribed. The adults and genitalia of the species are redescribed and illustrated.

Key words: Oecophyllembiinae, newly recorded species, leafminer, taxonomy, Korea

P36

Three species of the genus *Cryptophagus* Herbst (Coleoptera: Cucujoidea: Cryptophagidae) new to Korea

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The genus *Cryptophagus* Herbst is one of the largest groups of the family Cryptophagidae Kirby, and found in soil litter, under bark, nests of small animals, social insects, and stored products. Approximately 200 species of this genus have been described in the world and seven species have been recorded in the Korean Peninsula. During taxonomic study of this genus, we identified three additional species, *C. nitidulus* Miller, *C. obsoletus* Reitter, and *C. rufomaculus* Lyubarsky, from the Korean Peninsula. Illustrations of habitus, diagnostic characters, and collection localities for each species are provided.

Key words: biodiversity, new record, Palearctic, silken fungus beetle, taxonomy

P37

Systematic revision of the genus *Chejuanomala* Kim, 1998 with a first female description of the type species (Coleoptera: Scarabaeidae: Rutelinae)

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Anomala quelparta Okamoto, 1924, an endemic species of Jeju Island in Korea, is a unique scarab beetle that no female has been discovered for nearly 100 years after its original description. In a previous taxonomic review of Korean Rutelinae, the genus *Chejuanomala* Kim, 1998 was established for this peculiar species only, based on body shape, luster, and genitalia. However, it was later considered as a junior synonym of the genus *Anomala* Leach, 1819 due to the broad concept of the senior synonym. Recent investigations on Jeju Island have confirmed the presence of numerous females of *A. quelparta*. In this study, we present a gender-specific description and photographs of this species. Furthermore, we reconstructed a multi-gene phylogeny with Korean Rutelinae to confirm the phylogenetic relationship between *A. quelparta* and other rutelines and to systematic position.

Key words: *Chejuanomala*, *Anomala quelparta*, systematic revision, Korean Peninsula, Jeju Island

Distribution of *Bemisia tabaci* MED cryptic species in Korea

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Bemisia tabaci is agricultural pest, consisting of at least 44 cryptic species complex, distributed worldwide. In Korea was detected the distribution of JpL, MEAM1 and MED cryptic species. MED is divided into Q1, Q2, Q3 and ASL strains, which have different level of tolerance to neonicotinoid insecticides, and various secondary endosymbionts profiles. We collected *B. tabaci* in 41 sites in all provinces of Korea, and individual analysis of mtCOI gene sequences showed the distribution of only MED cryptic species. Among 82 studied samples, most were identified as Q1, and belonging to Q2 strain were found two samples, collected in Miryang and Dangjin, which are geographically close to Changyeong and Anseong respectively, where Q2 samples were found in 2018 by Guo et al. Whiteflies *B. tabaci* Q2 strain are keeping in the same geographical locations overtime, coexisting with Q1 strain.

Key words: cryptic species, MED, strains, whitefly

P39

Complete mitochondrial genome of the blue-tailed damselfly, *Ischnura elegans* (Odonata: Coenagrionidae), which is a climate-sensitive indicator species in South Korea

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Ischnura elegans is one of the climate-sensitive indicator species in South Korea. In this study, we sequenced the complete mitogenome of *I. elegans* for subsequent trace of population movement in response to climate change. The 15,963 bp-long complete mitogenome of *I. elegans* has typical sets of genes and one A+T-rich region, containing two subunits, each of which are tandemly triplicated. Comparison of the sequence divergence among two available and the current mitogenomes revealed 7 genes to have variation. Phylogenetic reconstruction based on all available sequences of Coenagrionidae showed the sister relation between *I. elegans* and *I. senegalensis*.

Key words: *Ischnura elegans*, Mitochondrial genome, Coenagrionidae

P40

Complete mitochondrial genome of *Ceriagrion nipponicum* (Odonata: Coenagrionidae) and comparison to Zygoptera groups

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우리나라 기후변화지표종인 연분홍실잠자리(*Ceriagrion nipponicum* Asahina, 1967)는 잠자리목 실잠자리과에 속하는 종으로 복상하고 있다. 본 연구에서 연분홍실잠자리의 완전 원형 미토콘드리아 유전체(mitogenome; 16,874bp)의 염기서열을 NGS 일종인 BT seq 방법으로 완성하였다. 연분홍실잠자리의 미토지놈은 13개의 protein-coding genes (PCGs), 2개의 ribosomal RNA (rRNA) genes, 22개의 transfer RNA (tRNA) genes 그리고 1개의 non-coding A+T-rich region으로 전형적인 구성을 가지고 있었다. 다만, 현재까지 구해진 실잠자리아목의 미토지놈 중 연분홍실잠자리의 A+T-rich region은 2,125 bp로 실잠자리아목 중 가장 길었다. 실잠자리아목 미토지놈의 13개 PCGs와 2개의 rRNA genes를 Bayesian inference method와 Maximum-likelihood methods를 사용하여 계통 분석을 수행하였다. 본 연구는 처음으로 연분홍실잠자리 완전 미토지놈 서열을 확보한 연구로 향후 미토지놈의 특성과 실잠자리과 내 계통분류학적 위치를 분석하는 데 도움이 될 것이다.

검색어: 미토지놈, *Ceriagrion nipponicum*, Zygoptera, 기후변화지표종

P41

Morphology and distribution of antennal sensory structures in *Eriborus* sp. (Hymenoptera: Ichneumonidae), parasitoid wasp of *Cydalima perspectalis* Walker (Lepidoptera: Crambidae)

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Box tree moth (*Cydalima perspectalis*) is a major pest that attacks boxwood (*Buxus mucrophylla*) in Korea. *Eriborus* sp. is a parasitoid wasp commonly found in Korea as a natural enemy of the box tree moth. In this study, we examined the morphological structure of the antennae of *Eriborus* sp. to investigate the mechanisms how the parasitoid wasp detect box tree moth larvae. The flagellum of the antennae was composed of a total of 33 segments. The sensilla were classified into sensilla chaetica, sensilla trichodea (2 types), sensilla basiconica, sensilla coeloconica (2 types), sensilla placodea (2 types), and Böhm's bristles based on their morphology and distribution. This study could be helpful for chemical ecology research on how parasitoid wasps detect their hosts.

Key words: parasitoid wasp, antenna morphology, sensilla, *Cydalima perspectalis*, *Eriborus* sp.

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Ultrastructural observation of antennal sensilla in *Pryeria sinica* Moore (Lepidoptera: Zygaenidae)

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The defoliating pest *Pryeria sinica* Moore (Lepidoptera: Zygaenidae) frequently causes considerable damage to *Euonymus alatus* and *Euonymus japonica*. The structure, morphology, and distribution of the antennal sensilla of *P. sinica* were investigated using scanning electron microscopy (SEM). Five types and ten subtypes of sensilla, including trichodea (subtypes 1, 2, 3, and 4), basiconica (subtypes 1, 2, 3, and 4), chaetica (subtype 1 and 2), squamiformia, and böhm bristles, were identified on the antennae of both sexes. The most numerous sensilla were the trichodea on the antennae of both sexes. Sexual dimorphism was observed, with the male antennae having more sensilla trichodea than the female antennae. This information is essential for understanding the electrophysiological and behavioral aspects of chemical communication in *P. sinica*.

Key words: *Pryeria sinica*, antennal sensilla, ultrastructure, scanning electron microscopy (SEM)

P43

Weighing similarity against functionality to evaluate dung beetle species candidates for taxon substitution using an individual-based model

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Scarabaeus typhon (Coleoptera: Scarabaeidae), the native dung beetle species in the Taean Sinduri Coastal Dune, is now locally extinct in South Korea. As an effort to restore the unique ecosystem of coastal dune, two dung beetle species, *Gymnopleurus mopsus* (Coleoptera: Scarabaeidae) and *Copris ochus* (Coleoptera: Scarabaeidae) are currently being considered as an alternative for *S. typhon*. *Gymnopleurus mopsus*, a telecoprid like *S. typhon*, rolls dung balls away from dung pads when nesting, exhibiting behavioral similarity to the locally extinct species. Unlike *S. typhon*, *C. ochus*, a paracoprid, burrows under dung pads for nesting, but is known to be more efficient in dung removal, which is a principal ecological function of dung beetle. Thus, in our study, we aim to determine optimal restoration strategy for the two candidate species and to evaluate and compare their viability for taxon substitution using an individual-based model.

Key words: conservation biology, ecological model, simulation, species recovery

P44

Development of *Spodoptera frugiperda* population model modified by flight activity with its field validation

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열대거세미나방, *Spodoptera frugiperda* (J.E. Smith(Lepidoptera: Noctuidae)는 열대 및 아열대 아메리카 대륙에 서식하는 위협적인 농업 해충이다. 이 해충은 이동 능력이 뛰어나기 때문에 수백 킬로미터를 날아서 이동할 수 있으며, 봄에서 가을까지 미국 텍사스와 플로리다주에서 캐나다 퀘벡주와 온타리오주까지 1700 km 이동이 가능한 것으로 알려져 있다. 열대거세미나방이 제주에 비래 후 실제 발생양상을 추정하기 위해서는 기초 모형을 기반하여 제작한 개체군 모형을 실제 유살 수와 비교해 볼 필요가 있다. 본 연구에서는 야행성인 열대거세미나방의 비행활동에 있어 비행을 제한하는 저온 경계를 규명하고자 저온 비행 실험을 진행하였다. 이 자료를 바탕으로 미리 제작한 개체군 모형에 적용하여 열대거세미나방의 간단한 개체군 모델을 새로 구성하였다. 또한 야외 페로몬 트랩에서 유살된 열대거세미나방과 제작한 모델을 시뮬레이션하여 적합성을 평가하였다.

검색어: 열대거세미나방, 비래 해충, 개체군 모형, 모델 시뮬레이션

P45

A study of density dependent fecundity and mortality of *Ramulus mikado*

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Ramulus mikado is known to parthenogenetic species and a female can lays approximately 100 eggs. This study was conducted to investigated the relationship between density groups (1, 5, and 10 nymphs in a cage) and their fecundities (number of eggs laid per one individual). In addition, we compared mortality among density groups. In 2022, 1st nymphs on host leaves in Mt. Cheonggye were collected and moved to laboratory in Kangwon National University. From June to August, a branch with leaves of *Quercus mongolica* was supplied as a food item. After adult emergences, laid eggs on ground of each cage was checked and collected every day. As a result, no significant differences were found in fecundity, i.e., number of eggs per a female by considering mortality in each cage, among density groups in general. However, *R. mikado* adults in high- and middle-density cages showed rapid increases of mortality since middle of oviposition periods.

Key words: Stick insect; Walking stick; Crowding effect; Intraspecific competition

P46

Changes in the flying period of two common butterflies in the agricultural landscape across Korea

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최근 지구적으로 일어나는 기온상승은 생물의 생식, 산란, 출현 시기 등 생물계절(phenology)에 변화를 일으킨다고 알려져 있다. 본 연구는 2020년부터 2022년까지 농업생태계 기후변화 지표종인 배추흰나비(*Pieris rapae*)와 노랑나비(*Colias erate*) 2종을 대상으로 동북부(단양, 평창, 양구 3지점), 서북부(안성, 남양주, 파주, 음성 4지점), 남부(사천, 무안, 해남, 영광 4지점)에서 출현양상을 조사하였다. 나비 조사는 선조사법을 실시하였으며, 선조사법은 각 조사지에서 약 1.5km 내외로 설정하고 경로를 따라 좌우 그리고 위로 5m 반경 안에 출현하는 나비를 육안으로 확인 기록하였다. 조사는 매년 4월부터 10월까지 2주 간격으로 실시하였다. 각 조사지에서 얻어진 자료는 비선형회귀를 이용한 단봉(Unimodal) 발생현상을 시간적(기간)으로 나타내는 모델을 통해 분석하였으며 R 패키지 'nlstimedist'를 이용하였다. 지난 3년간 남부지방에서 배추흰나비는 최대출현일(50%)은 5.30일 노랑나비는 3.06일 빨라지고 있는 것으로 확인되었다. 서북부지방에서 배추흰나비는 평균 24.82일 늦어져 남부지방과는 차이가 있었지만, 노랑나비는 2.03일 빨라졌다. 동북부 배추흰나비는 최대출현일이 24.06일 늦어졌으나 노랑나비는 최대출현일이 31.31일 늦어져 동북부 나비 출현은 점차 늦어지는 것으로 확인되었다. 추후 이 연구를 기반으로 기후변화에 따른 남방계 나비의 북상 범위 분포 예측 및 기후변화 지표종 선정에 대한 기초자료로 사용이 가능할 것으로 예상된다.

검색어: 배추흰나비, 노랑나비, 출현시기, 생물계절, 농업생태계

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P47

Application of noninvasive sonic tomography for detecting internal status of *Quercus palustris* injured by wood boring insect pests

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Recently, some wood boring insect pests were frequently observed in pin oaks, *Quercus palustris* that planted as roadside trees in urban areas. The present study assessed injury characteristics in the woody part of injured trees caused by *Neocerambyx raddei* and *Synanthedon* spp. using a noninvasive sonic tomography in Wonju-si, Gangwon-do. A total of 35 pin oaks were investigated and the number of holes on the external part of trees. In addition, we taken sonic tomograph images showing proportion of injured and decayed areas in the woody part. As a result, *N. raddei* larvae caused more damage to the woody part, especially in xylem areas with borings compared to *Synanthedon* spp. larvae. In larvae of *Synanthedon* spp. that generally feeds on cambium areas under barks, internal damaged appeared only in some injured trees.

Key words: Pin oak, Roadside tree, Wood boring insects, PiCUS, Insect pest management

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Lepidopterous insect fauna in Upo-Wetland (Changnyeong) from Korea

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우포늪은 창녕군 유어면, 이방면, 대합면, 대지면 등 4개의 면에 걸쳐있는 국내 최대 자연내륙 습지로 경상남도 창녕군에 위치해 있다. 우포늪의 중요성은 국내뿐만 아니라 국제적으로도 랍사르협약(1998) 등 널리 알려진 바 있다(창녕군, 2015). 최근 변화되어가는 기후와 다양한 요인들로 인해 멸종되어 가는 종의 보호 및 관리는 중요한 실정이며, 이와 관련하여 우포늪에는 멸종위기 동·식물이 서식하고 있어 보존가치는 더욱 중요시되고 있다.

금번 연구는 창녕군 농업기술센터의 지원으로 우포늪 내 서식하는 나비목 곤충상을 파악하고 보존, 관리하고자 수행되었다. 조사 방법은 2022년 5~6월에 걸쳐 채집 조사하였으며, 채집된 곤충은 건조표본으로 제작하여 종 수준까지 분류 및 동정하였다. 조사 결과 나비목 곤충류 28과 278종 1,072개체가 조사되어 목록으로 작성되었다.

검색어: 우포늪, 곤충상, 생물다양성, 나비목

P49

Patterns of termite damage in wooden cultural heritage in Korea

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흰개미는 생태계 내에서는 고목을 섭식하여 분해하는 분해자 역할을 하지만 인간세계에서는 목조 건축물을 가해하여 구조적인 문제를 초래하는 해충으로 알려져 있다. 우리나라에 서식 중인 흰개미는 지중 흰개미로 외부에 노출하지 않고 땅속에 서식처를 만들어 서식하기 때문에 쉽게 발견하기 어렵다. 이 때문에 흰개미는 외부로 노출하지 않은 채 목재 내부로 침투해 속을 비우는 공동화 현상을 일으켜 겉으로 보기엔 멀쩡해 보이는 기둥도 속이 비어 피해가 심각한 경우에는 건물이 무너질 수도 있어 목조건축물에서는 매우 위험한 해충으로 보고되어 있다. 우리나라에 분포하는 사찰들은 대부분 산속 지형에 있기 때문에 흰개미가 주로 서식하는 산림지대와 매우 가깝게 있어 흰개미 가해 영역에 포함되어 있다. 이러한 목조건축물은 국보, 보물로 지정된 문화유산으로 보존 및 관리가 필요하다.

국립문화재연구원에서는 2011년부터 전국의 국가 지정 목조문화재에 대한 생물 피해 조사를 정기적으로 실시하여 흰개미 및 다른 가해 해충에 의한 피해 여부를 조사하고 있다. 조사 방법으로는 흰개미 탐지견의 후각을 이용하여 흰개미를 탐지하거나 육안으로 보이는 피해 여부를 기록하였다. 조사 결과는 매년 정리하여 보고서를 발간하였으며 국내 연구자들이 공동으로 활용할 수 있도록 배포하였다.

검색어: 흰개미, 목조문화재, 목조건축물, 생물피해

Lepidopterous insect fauna of the Jin-do and Anmyeon-do in Korea

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본 연구는 호남권 등 섬 지역 조사를 통해 다양한 자생생물(동물분야)의 분포 정보를 확보하고 그 동안 발굴되지 못한 생물 종 및 점차 변화될 생물종 다양성을 확인하는 연구를 위한 기초자료를 확보하기 위해 수행되었다. 2022년의 조사 지역은 전남 진도 및 충남 안면도 일대이다. 현지 조사는 주요 곤충류가 활발히 활동하는 시기인 6~8월까지 총 4회에 걸쳐 조사 지역 당 2회씩 채집조사를 수행하였다. 세부적인 조사 지점은 해당 지역을 순회하면서 식생이 양호하고 채집이 용이한 지역을 고려하였다. 주간에는 포충망을 이용한 쓸어잡기, 채어잡기 및 현장 확인 등을 통해 기본 조사를 수행하였다. 또한, 화상 자료를 확보하기 위해 주간에 확인되는 나비목, 메뚜기목 등 생태사진을 촬영하였다. 야간에는 유아등을 이용한 등화유인채집과 버킷식 유아등 트랩을 이용하였다. 현지 조사를 통하여 채집된 곤충은 건조표본으로 제작하여 종 수준까지 분류 및 동정 작업을 수행하여 총 60과 298종 1,553개체의 나방류, 딱정벌레류 및 노린재류가 채집 조사되었다. 금번 연구를 통해 밝혀진 진도 및 안면도 일대의 곤충다양성 조사 결과는 향후 섬지역 생물다양성 및 생물지리학적 연구를 위한 기초 자료로 활용될 것으로 기대된다.

검색어: 진도, 안면도, 채집조사, 분포, 육상곤충류, 버킷라이트트랩

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Impact of high temperature on development of the bumblebee *Bombus terrestris*

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고온이 서양뒤영벌(*Bombus terrestris*)의 산란 행동에 미치는 영향을 조사하였다. 고온(35°C)에서 산란한 여왕벌의 난괴는 적온(27°C)보다 단경(1.3배)과 장경(1.3배)이 다소 긴 반면 높이는 1.9배 낮았다. 특히 35°C에서 난괴 두께는 27°C에서 보다 2.0배 두꺼웠다. 알의 크기는 35°C가 27°C보다 단경(1.3배)과 장경(1.1배)이 다소 짧았으며, 알 수도 평균 5.0±1.6개로 27°C보다 1.9배 적었다. 여왕벌의 산란율은 35°C와 27°C 모두 100%였으며, 첫산란 소요일 수도 각각 8.5일로 유사하였다. 그러나 산란 횟수(40일 동안)는 35°C가 평균 5.6회로 27°C(2.8회)보다 1.9배 많았다. 첫산란 이후 산란기간을 조사한 결과, 35°C는 첫산란 이후 2~4차 산란기간이 2~3일 간격인 반면에 27°C는 2차 산란까지는 산란기간이 길어지다가 일벌이 출현한 3차부터 점차 줄어드는 경향을 보였다. 이와 같이 잦은 산란과 짧은 산란기간을 보인 35°C는 난괴 속에서 알이 부화하지 못하였으나 27°C에서는 100% 일벌이 출현하여 봉군을 형성하였다. 그러나 35°C에서 32°C로 이동 사육 시 26일 후 일벌이 출현하였다. 또한, 수벌의 경우, 우화 후 15일째까지의 생존율이 27°C는 100%인 반면 35°C에서는 75%로 낮았다. 이러한 결과들은 고온이 여왕벌의 산란 행동과 수벌의 수명에 심각한 영향을 미치는 것으로 보인다. 한편, 고온 처리 시 여왕벌과 일벌의 vitellogenin 유전자 발현은 27°C에 비해 35°C에서 높게 나타나 고온 영향에 따른 차별적인 발현 양상을 보였다.

검색어: 고온, 서양뒤영벌, 산란, 발육, vitellogenin 유전자

P52

Seasonal and compositional variations of saproxylic beetle compositions in oak dead wood

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Saproxylic beetles are a group of insects associated with dead or dying trees. They are taxonomically and functionally diverse, and play significant roles in nutrient cycling, and maintaining healthy forest ecosystems. Despite the importance of saproxylic insects, there has been limited knowledge and interest in Korea. To understand the species composition and diversity of saproxylic beetles, we conducted a study in saproxylic ecosystems in Mt. Bumosan, Cheongju-si, Chungcheongbuk-do, Korea. We sampled a total of 60 oak dead wood that represent three different decay stages during both summer and winter. Then, we moved them into emergence chambers, and collected beetles. We collected a total of 1,793 saproxylic beetles from oak dead wood, representing 75 species. We found a significantly distinct species composition between summer and winter. Furthermore, saproxylic beetles revealed a different composition between early and well-decay dead wood, suggesting that the maintenance of dead wood in various decay classes is critical for ensuring high biodiversity.

Key words: saproxylic beetle, dead wood, decay class, seasonality, biodiversity conservation

P53

Distribution of aphids and its pesticide efficacy evaluation in hairy vetch, rye, and spearmint during off-season under plastic house

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겨울철 휴한기 동안 시설 토경 재배지 내 친환경 재배를 위해 파종한 헤어리베치와 호밀, 그리고 가루이 유인 식물로 활용되는 스피아민트에 발생한 진딧물류를 조사하였다. 헤어리베치에서 채집한 2,174마리 중 아카시아진딧물과 보리수염진딧물이 각각 $98.3 \pm 4.6\%$ 와 $1.7 \pm 4.6\%$ 분포하였다. 호밀에서는 아카시아진딧물 $21.2 \pm 17.5\%$, 기장테두리진딧물 $76.0 \pm 18.4\%$, 보리수염진딧물 $2.8 \pm 8.1\%$ 로 분포하였고, 스피아민트에서는 목화진딧물만 관찰되었다. 휴한기 재배 작물에서 발생한 진딧물류가 정식한 작물로 이동하는 것을 최소화하기 위해 유기농업자재 8종, 화학농약 22종에 대해 약효 평가를 수행하였다. 기장테두리진딧물에서 약제 3종, 아카시아진딧물에서 약제 5종을 제외한 약제에서 70% 이상의 사충율이 나타나, 휴한기 진딧물류는 전반적으로 약제에 대한 감수성이 높은 것으로 나타났다.

검색어: 진딧물류, 헤어리베치, 호밀, 스피아민트, 휴한기

P54

Effect of water depth and volume for testing efficacy of mosquito larvicides against the Asian tiger mosquito, *Aedes albopictus*

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In the present study, lab-scale larvicidal activity in different water depth was accessed. Larvicidal activity of temephos and diflubenzuron on the third instar larvae of Asian tiger mosquito, *Aedes albopictus*, was examined in two different water depth (3.3 and 26.2cm). Additionally, the insecticidal activity in deep condition (26.2cm) with the limited space (3.3cm) was compared to the other conditions. Based on ANOVA analyses, no floatability of the substances was observed, and the larvicidal activity was positively related to the water depth.

Key words: biocide, Asian tiger mosquito, larvicide, temephos, diflubenzuron, insecticidal effect

P55

Insecticidal activity and teratogenicity of spirotetramat against *Aphis gossypii* (Hemiptera: Aphididae)

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This study investigated the susceptibility of spirotetramat to *Aphis gossypii* collected from six regions and its effect on teratogenicity. *A. gossypii* nymphs showed 100% mortality in all areas, but adults showed less than 80% mortality except MK (81.5%) and HS (92.8%). *A. gossypii* treated with spirotetramat at recommended concentrations (110 ppm) in all areas were observed to give birth to malformed nymphs that did not develop appendages. The malformation rate of F₁ generation of birth nymph and the survival rate to adult stage were researched after exposure to LC₁₀, LC₃₀, LC₅₀, and LC₇₀ values for 1st instar nymphs and adults for 24 h respectively.

Key words: *Aphis gossypii*, spirotetramat, insecticidal activity, teratogenic deformity

P56

Evaluation of susceptibility and synergistic effect of three insecticides against *Aphis gossypii* (Hemiptera: Aphididae)

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This study researched the susceptibility of three insecticides (afidopyropen, chlorfenapyr and cyantraniliprole) on *Aphis gossypii* collected in 8 areas. The mortality of each insecticide against *A. gossypii* was significantly different depending on the area. Wanju (WJ) and Chuncheon (CC) were the areas where the resistance ratio (RR) of the median lethal concentration (LC₅₀) value compared to the susceptible strain *A. gossypii* for the 3 insecticides was all over 100. In order to confirm the synergistic effect through the mixing of the insecticides, the mortality was observed by diluting with concentrations of 1 (recommended concentration), 1/2, 1/4, and 1/8 fold, respectively.

Key words: *Aphis gossypii*, resistance monitoring, afidopyropen, chlorfenapyr, cyantraniliprole, synergistic effect, susceptibility

P57

Distribution of three Hemiptera and their control effect using chemical pesticides in soybean fields

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The distribution of three Hemipterans (*Riptortus pedestris*, *Halyomorpha halys*, and *Plautia stali*) and effectiveness of insect pest control strategies in soybean fields in Jeung-pyeong and Gongju were compared. *H. halys* was collected the most, except for *R. pedestris* (55.5%) in the R5-R6 stages of soybeans in the Jeung-pyeong. Five insect pest control programs were suggested for 3 different soybean reproductive stages using 3 pesticides (fenitrothion, bifenthrin, clothianidin). Program 5 had the highest rate of normal seed with 78.4% of Jeung-pyeong and 76.2% of Gongju. Program 5, a total of 3 pesticide applied, was the most effective Hemipteran control strategy, showing a control efficiency of 63.2%.

Key words: *Riptortus pedestris*, *Halyomorpha halys*, *Plautia stali*, insect pest control programs, distribution

P58

Construction of entomopathogenic fungi-derived metabolite library for controlling melon thrips, *Thrips palmi*

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Melon thrips, *Thrips palmi* is a serious agricultural pest and a vector of terrible plant viruses. Chemicals have been mostly used to control *T. palmi* but encounter residual issues with big challenges. To overcome these problems, entomopathogenic fungi can be used as an alternative for control *T. palmi*. In this study, we isolated a total of 100 fungi from soil in four different regions in South Korea and performed virulence assays against *T. palmi* for screening. From the assays, highly virulent 25 isolates were screened out. Culture filtrate of the selected 25 isolates were subjected to assays against *T. palmi*. From the culture filtrate assays, highly virulent seven fungal isolates were screened out. Thermotolerance of seven fungal isolates was investigated by exposing fungal blastospore to 45°C for 120 min. A dose-response assay was performed to figure out the optimal application for *T. palmi* control. One entomopathogenic fungus isolate showed higher insecticidal activity when compared with the other isolates. This study suggests that the derived metabolites from the culture filtrate of entomopathogenic fungi could be used to control *T. palmi*.

Key words: Thrips palmi, entomopathogenic fungi, culture filtrate, virulence assay

P59

Establishment of test methods for effective control of *Eriophyes japonicus* Huang

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밤나무(*Castanea crenata* S.et Z.)는 참나무과에 속하는 교목성 낙엽과수로 아시아, 유럽, 북미, 북아프리카 등의 온대지역에 분포되어 재배되고 있다. 밤의 용도로는 간식용으로 많이 이용되고 있으며, 그 밖에 군밤 · 통조림 · 과자의 원료로 쓰인다. 또한 밤나무의 목재는 가구재 · 건축재 · 철도궤목 · 조선재 및 버섯재배용으로 사용되며, 목재 및 수피에 함유된 탄닌은 화학제품 연료로 이용된다. 밤나무에는 종실을 가해하는 복숭아명나방(*Conogethes punctiferalis*), 밤바구미(*Curculio sikkimensis*), 신초를 가해하는 밤나무혹벌(*Dryocosmus kuriphilus*), 수간을 가해하는 밤나무왕진딧물(*Lachnus tropicalis*), 그리고 잎을 가해하는 밤나무혹응애(*Eriophyes japonicus* Huang)등이 우점 해충으로 알려져있다.

본 연구에서는 잎을 가해, 광합성을 저해하여 생산량에 문제를 발생시키는 밤나무혹응애를 대상으로 하여 방제약제를 선발하였다. 설정되어 있지 않은 밤나무혹응애에 대한 방제방법을 같은 혹응애류인 구기자혹응애(*Aceria kuko*)의 시험방법을 인용하여 실험을 진행하였다. 실험은 국내의 밤 주 생산단지인 충남 청양에서 진행하였으며, PLS 제도의 시행에 따라 등록된 약제가 없는 밤나무에 발생하는 밤나무혹응애 방제약제와 방제방법 설정을 본 실험의 목표로 두었다.

검색어: 밤나무, 밤나무혹응애, 방제, 설정, PLS제도

P60

Mode of action of destruxin from the entomopathogenic fungus *Metarhizium pinghaense* 15R

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Destruxins (DTXs) well known cyclic depsipeptide produced by various pathogenic fungi, especially the genus *Metarhizium*. These secondary metabolites are closely related to biological activities for host pathogenicity. To date, it has been reported that DTX causes ATPase inhibition by depolarizing the Ca^{2+} gradient in the insect muscle plasma membrane. Therefore, in this study, as a basic study to develop a biochemical crop protection agent for DTXs produced by *Metarhizium pinghaense* 15R strain, the mode of action of DTXs against aphids was investigated. As a result, it was confirmed that the amount of ATP and mitochondrial activity decreased after DTXs treatment.

Key words: Destruxin, Entomopathogenic fungi, *Metarhizium pinghaense* 15R, ATPase

P61

Variation of droplets deposition rate by aerial spray under the forest and its honeybee risk

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최근 항공방제에 따른 꿀벌 위해성 우려가 지속적으로 제기되고 있어 산림 환경에서 심도있는 꿀벌 위해성 검토가 필요하다. 산림에서는 살포 방식 및 공간 특성에 따라 살충제의 잔류 및 행적이 달라질 수 있으므로 꿀벌 위해성의 크기가 달라질 수 있다. 본 연구에서는 멀티콥터를 이용하여 산림 공간에 따른 살포액의 도달량을 추정하고, 이를 바탕으로 꿀벌 위해성 평가의 개선점을 제시하고자 하였다. 수관 상부, 중심부, 하부와 지중에서 수관 아래, 수관 주변부, 개방된 지점에 감수지를 설치하고 멀티콥터를 이용하여 물을 살포한 후 살포액 도달량을 정량화하였다. 항공살포액은 수관 상부에서 더 많이 도달하였고, 수관으로 차폐되지 않은 지점은 수관 상부와 유의미한 차이가 없었다. 수관 상부의 살포액 도달량의 중앙값을 기준으로 수관 아래 지중에는 21.2%의 살포액이 도달하였다. 수관 차폐 정도를 고려하여 수관 아래의 꿀벌 위해성을 평가한 결과, 위해지수(HQ)와 잔류시간(RT₂₅)은 농약 등록 당시의 값보다 수관 아래에서 낮을 것으로 추정되었다. 따라서 산림의 공간 특성에 따라서 꿀벌 위해성 역시 달라질 것으로 예상되나, 산림에서 살충제 도달량에 영향을 미칠 수 있는 요인들의 추가적인 검토가 필요할 것으로 보인다.

검색어: 항공방제, 살충제 잔류량, 산림 공간, 위해지수, 꿀벌 영향평가, 잔류시간

P62

Improved insecticidal activity of *Autographa californica* nucleopolyhedrovirus harboring dsRNA genes specific to *Spodoptera exigua*

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Spodoptera exigua, is one of the worldwide distributed agricultural pest insects and has been known to show high resistance to conventional chemical insecticides. Although baculoviruses could be a effective alternative for the control of *S. exigua*, their use as bio-control agents has been limited mainly by their slow speed of action. To improve pathogenicity of baculovirus, in this study, dsRNA genes specific to $\beta 1$ integrin, apolipophorin III and acetylcholinesterase genes of *S. exigua* were introduced into the genome of *Autographa californica* nucleopolyhedrovirus. When these recombinant baculoviruses were applied to *S. exigua* larvae, they showed increased insecticidal activities compared to ApEGFP.

Key words: Baculovirus, *Spodoptera exigua*, RNA interference, recombinant virus, insecticidal activity

P63

Use of UV-LED light and Buckwheat plant to enhance establishment of *Nesidiocoris tenuis* (Reuter) for control of *Bemisia tabaci* (Gennadius) infesting greenhouse *Cucumis melo* L.

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Bemisia tabaci (Gennadius) (Hemiptera: Aleyrodidae) is a major pest of greenhouse *Cucumis melo* L. Previously, we found that the predatory performance of *Nesidiocoris tenuis* (Reuter) (Hemiptera: Miridae) on *B. tabaci* was improved by using 385 nm LED light under laboratory conditions. Here we evaluated the effect of releasing *N. tenuis* with a banker plant and LED light on *B. tabaci* in greenhouses of *C. melo* by direct count. We transplanted seedlings of *C. melo* on June 2022, installed LED lighting and released 50 individuals of *N. tenuis* on buckwheat per plot on September 2022. There was no significant difference in the numbers of whitefly adults and *N. tenuis* between control and treatment plots. However, there was a significant difference in the number of whitefly nymphs between treatment and control plots. The potential of incorporating UV-light and buckwheat was discussed.

Key words: Augmentation, Phototaxis, Predator, Whitefly, Oriental melon

P64

K-SDM (Korean Species Distribution Model), platform design for the forest invasive insect pests

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최근 기후변화로 인한 외래곤충의 침입 가능성이 높아짐에 따라 이들의 확산 및 변화 파악을 통한 조기 방제의 중요성이 강조되고 있다. 침입 외래종은 대부분 심각한 해충으로 돌변할 가능성이 높으며, 빠르게 확산되기 때문에 초기 대응 및 방제를 위해 이들의 분포 및 생태 등의 데이터를 구축하고 분석해야 한다. 본 연구는 이러한 침입외래종의 조사데이터를 구축하고 이를 통해 예상되는 확산 정도를 분석하는 K-SDM (Korean Species Distribution Model) 시스템의 구축 현황을 제시한다. 본 플랫폼은 조사야장을 웹에 업로드하여 현장조사 DB를 구축하고, 이를 분석하여 외래 침입종의 확산 예측 정보를 제공하여 차후 국내 외래 곤충의 현황 파악과 조기 방제 등에 기여할 것으로 기대된다.

검색어: 외래곤충, 외래해충, DB구축, 분포조사

P65

Epiphytic and endophytic activity of *Beauveria bassiana* JEF-503 on tomato roots for the management of root-knot nematode

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Root-knot nematode, *Meloidogyne incognita*, causes substantial yield losses, as parasitic on the roots of many crops. In our previous studies, *Beauveria bassiana* JEF-503 showed high nematicidal activity against *M. incognita* under pot and greenhouse conditions. Based on this result, we investigated epiphytic and endophytic colonization of *B. bassiana* JEF-503 in tomato roots. When roots were dipped into a conidial suspension of JEF-503 expressing egfp signal, fluorescence was observed on the surface of roots suggesting fungal epiphytic colonization around the roots. A fluorescence signal of JEF-503-egfp was also detected in the root-cross section. After grinding the surface-sterilized JEF-503-egfp-treated root and spreading it on the ¼ SDA, followed by incubation for seven days, a significant level of JEF-503-egfp colony was observed. This work possibly suggests that *B. bassiana* JEF-503 colonizes epiphytic and endophytic on tomato roots.

Key words: Root-knot nematode, entomopathogenic fungi, *Beauveria bassiana*, endophytic colonization

P66

Transcriptional response of Japanese pine sawyer beetle fat body against infection of *Beauveria bassiana* ERL836

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Japanese pine sawyer beetle (JPSB), *Monochamus alternatus* is a vector of pine wilt nematode causing pine wilt disease. In this study, the entomopathogenic fungus *Beauveria bassiana* ERL836 that has high virulence against JPSB adults was used to control JPSB. To investigate the response of the fat body to infection, transcriptome analysis was performed. RNA samples were obtained from the fat body two and four days after fungal treatment. In JPSB two days after treatment, genes related to oxidative phosphorylation were up-regulated. In the immune response, most genes involved in the Toll signaling pathway and melanization were down-regulated, whereas the serine protease inhibitor genes that inhibit the immune pathway were up-regulated. These findings suggest that the produced energy did not activate the immune response, and the invading fungus may suppress the immune response in the JPSB fat body by up-regulating the serine protease inhibitor gene.

Key words: *Monochamus alternatus*, Entomopathogenic fungi, Biocontrol, Defense mechanism, Immune response

P67

The value and potential of *Purpureocillium* sp. JB-4 as biological control agents with nematocidal activity

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Root-knot nematodes (RKNs) are widely distributed worldwide and cause significant damage in agriculture and forestry. Chemical control has been overused due to significant control effects and low cost, resulting in restrictions or prohibitions due to multidrug resistance in RKNs, environmental pollution, and biotoxicity. In order to reduce reliance on chemical pesticides and establish sustainable nematode control, it is essential to develop new environmentally friendly biological control agents. Therefore, in this study, microorganisms isolated from soil infected with RKNs were evaluated for their nematocidal potential. Among them, the *Purpureocillium* sp. JB-4 strain exhibited nematocidal potential by producing chitinase and proteinase enzymes and inhibited hatching by parasitizing on nematode eggs. Additionally, the strain showed efficacy in reducing the number of egg masses in a pot experiment. These results suggested that the *Purpureocillium* sp. JB-4 strain could be a valuable resource for developing eco-friendly nematocides.

Key words: Root-knot nematodes, Biological control, *Purpureocillium* sp.

P68

Stability of *super kdr*-mutations in the voltage-sensitive sodium channel gene of a *Cimex lectularius* population

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The common bed bug, *Cimex lectularius*, has been a global health hazard causing physical and mental diseases. Recent reports suggest they have developed resistance to multiple insecticides, particularly pyrethroids. Two *super-kdr* mutations (V419L and L925I) on the voltage-sensitive sodium channel are known to be responsible for the pyrethroid resistance in bed bugs. In this study, stability of the mutations in a bed bug population was evaluated. The resistance alleles remained stable for 20 generations even without pyrethroid exposure. This stable resistance allele was also confirmed by crossing between pyrethroid-resistant and -susceptible strains. Acute contact toxicity assessment revealed that fipronil and imidacloprid are effective alternative insecticides for resistant bed bugs.

Key words: bed bug, *Cimex lectularius*, *kdr*-resistance, voltage-sensitive sodium channel, fitness cost, insecticide resistance

P69

Not Presented

P70

Baculovirus expression system for antimicrobial peptides (AMPs)

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Baculovirus gene expression is a popular method for producing large quantities of recombinant proteins in insect host cells. In most cases, posttranslational processing of eukaryotic proteins expressed in insect cells is similar to protein processing in mammalian cells. As a result, insect cell-processed proteins have comparable biological activities and immunological reactivities to proteins expressed in mammalian cells. Protein yields from baculovirus systems are higher, and costs are significantly lower than in mammalian expression systems. The baculovirus expression system can express genes from bacteria, viruses, plants, and mammals at levels from 1–500 mg/liter. Furthermore, using Baculovirus has a significant advantage in that it can express antimicrobial peptides that cannot be expressed when using *E. coli*

Key words: Baculovirus, insect, cell, recombinant proteins, antimicrobial peptides

P71

Transcriptome analysis of detoxifying enzymes in *Bemisia tabaci* biotype Q

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The tobacco whitefly, *Bemisia tabaci*, is a major pest worldwide and causes economic damage to tomato, eggplant, and pepper crops. Biotype Q, dominant species in Korea among about 40 species of whitefly biotypes, exhibited resistance to various pesticides such as neonicotinoids, pyrethroids and carbamates. However, the detoxifying enzymes and mechanisms for these substances are still not clearly known. Transcriptome analysis of Q biotype of *B. tabaci* and de novo assembly produced 1.8 Gbp and N50 value was 1192bp. The average contig length was 660bp, having maximum contig length was 32,006bp. Detoxification-related genes was identified: 35 cytochrome oxidases, 4 glutathione S-transferases, 5 esterases, and 4 hydrolases.

Key words: *Bemisia tabaci*, detoxifying enzymes, transcriptome, cytochrome oxidase

P72

AA15 lytic polysaccharide monooxygenase is required for chitinous cuticle turnover during insect molting

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Lytic polysaccharide monooxygenases (LPMOs) catalyze the oxidative cleavage of glycosidic bonds in crystalline polysaccharides including chitin and cellulose. The recent discovery of wide distribution of LPMO-like proteins in various insect species suggests that these enzymes could be involved in chitin degradation in the cuticle, tracheae and peritrophic matrix during development. However, the physiological functions of insect LPMO-like proteins (LPMO15s) are still undetermined. A phylogenetic analysis indicates that insect LPMO15s could be divided into at least four subgroups. In this study, we investigated the function of subgroup I LPMO15 (TcLPMO15-1) in the red flour beetle, *Tribolium castaneum*. RNAi for *TcLPMO15-1* resulted in lethal arrest of molting at all developmental stages, in which the insects entrapped inside the old cuticle and died. Furthermore, TEM analyses revealed failure of turnover of the chitinous old cuticle. These results indicate that TcLPMO15-1 plays a critical role in cuticular chitin degradation, which is essential for completion of insect molting.

P73

Detection of deformed wing virus from strawberry plants and honey bees in greenhouse

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Honey bee, *Apis mellifera* L., is one of the most important pollinators. However, honey bee is facing a crisis of population decline, and deformed wing virus (DWV), among various factors, is considered to mainly affect the honey bee colony decline. Possibilities of horizontal transmission of DWV, such as *Varroa destructor* and flowers, have been reported in previous studies. In this study, DWV was detected from strawberry flower, feces, pupa, larva, nurse, and forager bee samples. In particular, we detected DWV from the surface of strawberry flowers and the surface of foragers, suggesting that DWV is horizontally transmitted through flowers and pollen in the greenhouse. Furthermore, DWV-positive pollen samples collected from uninfected foragers imply that shared floral sources can act as a bridge in DWV infection between uninfected and infected colonies in field conditions.

Key words: *Apis mellifera* L., Deformed wing virus (DWV), Flower, Horizontal transmission

P74

Molecular detection and phylogenetic analysis of six honeybee viruses from *Varroa destructor* nationwide of Korea

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RNA viruses, which are horizontally transmitted via *Varroa destructor*, significantly affect honeybee health and contribute to the population decline. In this study, we detected six RNA viruses [deformed wing virus (DWV), chronic bee paralysis virus (CBPV), Kashmir bee virus (KBV), sacbrood virus (SBV), Israel acute paralysis virus (IAPV), and black queen cell virus (BQCV)] in *V. destructor* collected from nationwide of Korea. DWV was detected in all regions of Korea, and other viruses found in several regions: KBV in Chungnam, IAPV in Jeonnam; KBV and IAPV in Gyeongbuk; IAPV and CBPV in Gyeongnam; SBV, IAPV, and CBPV in Jeju; CBPV, SBV, IAPV, and BQCV in Gyeonggi; KBV, SBV, IAPV, and BQCV in Chungbuk and Gangwon, suggesting widespread distribution of honeybee viruses in Korea. In the phylogenetic analysis, we could not find the distinct sequence variations depending on the regions, which might be due to extensive migratory beekeeping in Korea.

Key words: honeybee virus, *Varroa destructor*, virus distribution, phylogenetic analysis

P75

A comparative study on the expression level of cytochrome P450s between *Apis cerana* and *Apis mellifera* (Hymenoptera: Apidae)

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The increased use of synthetic pesticides and the expansion of exposure pathways have raised concern about the toxicity of pesticides to honey bees. In Korea, the Asian honey bee (*Apis cerana*) and the European honey bee (*Apis mellifera*) (Hymenoptera: Apidae) are the two major honey bee species. Despite their close phylogenetic relationship, *A. cerana* is known to be more sensitive to multiple insecticides and miticides, including fipronil, amitraz, fenitrothion, and most neonicotinoids, than *A. mellifera*. The goal of this investigation was to determine the cause of toxicological differences between the two honey bee species. Since cytochrome P450s (P450s), especially CYP9Q family, play a significant role in detoxification of xenobiotics in honey bees, this study focused on comparing the spatial expression levels of key P450s in CYP3 and CYP4 clans of the two honey bee species. This study represents the first attempt to compare the CYPomes and elucidate the molecular basis of the toxicological difference between two closely related honey bee species, *A. cerana* and *A. mellifera*.

Key words: *Apis mellifera*, *Apis cerana*, bioactivation, detoxification, cytochrome P450

P76

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

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Mythimna loreyi Duponchel, 1827 (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 *M. loreyi* 15 populations in South Korea using COI sequences. The 15 populations as a result of analyzing the COI sequences for 161 individuals, a total of 24 haplotypes were identified. The genetic divergence between haplotypes ranged from 0.152% to 0.608%. In the F_{ST} results between populations to compare genetic isolation, it was confirmed that there was a meaningful genetic divergence in Seochon and Six populations (Goseong, Cheongju, Namhae, Goheung, Yeosu, Sinan).

Key words: *Mythimna loreyi*, Population genetic analysis, Mitochondrial DNA, COI

P77

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

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The gypsy moth, *Lymantria dispar* Linnaeus (Lepidoptera: Erebidae) outbreaks occurred in 2020 and 2021 inducing severe damage to forests. So far, we investigated the genetic diversity and the relationships of *L. dispar* 15 populations in South Korea using COI sequences. The 10 populations as a result of analyzing the COI sequences for 359 individuals, a total of 38 haplotypes were identified. The genetic divergence between haplotypes ranged from 0.065% to 0.457%. As a result of haplotype diversity comparison between 18 populations, it was confirmed that Danyang was the largest at 0.8925. In the BAPS analysis results to compare genetic population, it was confirmed that there are a total of 5 haplogroups.

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

P78

Selection of stable reference genes for transcriptional profiling across five individual species in *Anopheles Hyrcanus* Group

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Anopheles Hyrcanus Group is a vector of *Plasmodium vivax* malaria that is prevalent in East Asia and comprises six species found in South Korea. Although these species are morphologically similar, differences in vector competence and insecticide resistance have been reported. One conventional method for investigating these physiological differences in transcriptional levels, it is transcriptional profiling based on appropriate reference genes. In this study, we compared the stability of 11 candidate genes across the five developmental stages (4th larvae, pupae, 24h female, 3d female, and oviposited female) of five individual species in the *Anopheles Hyrcanus* Group (*An. sinensis*, *An. belenrae*, *An. pullus*, *An. kleini*, and *An. sineroides*). For interspecies comparison, ribosomal protein L8 (RPL8) and ribosomal protein L13a were found to be the most stable in larval stages, whereas RPL8 and ribosomal protein 32 were the most stable in adult stages. Ribosomal protein S17 was stable across all five species regardless of developmental stages. The selected reference genes will facilitate a wide range of genetic studies on the *Anopheles Hyrcanus* Group.

Key words: *Anopheles Hyrcanus* Group, reference gene, RT-qPCR, housekeeping gene

Characterization of kinetic and inhibitory properties of two acetylcholinesterases from the western flower thrips, *Frankliniella occidentalis*

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We investigated the kinetic and inhibitory properties of two acetylcholinesterases (FoAChE1 and FoAChE2) from the Western flower thrips, *Frankliniella occidentalis*. Recombinant FoAChE1 showed 1.5-fold higher catalytic efficiency toward acetylthiocholine iodide than FoAChE2 and exhibited a similar sensitivity to FoAChE2 to cholinesterase inhibitors including organophosphorous (OP) and carbamate (CB) insecticides. Both FoAChE1 and FoAChE2 exhibited the highest expression level in the head followed by thorax and abdomen. FoAChE1 was more abundantly expressed compared to FoAChE2 in all tissues examined, suggesting that FoAChE1 may be the main enzyme for synaptic transmission. Considering the membrane-anchored properties and distribution in neuronal tissues, however, both FoAChE1 and FoAChE2 are likely involved in synaptic transmission. Among the mutations conferring OP and CB resistance, some field populations possessed the S197A mutation in FoAChE1. The recombinant S197A variant of FoAChE1 showed decreased sensitivity to most of OP and CB insecticides examined, indicating that S197A mutation is responsible for OP and CB resistance. In case of FoAChE2, the G200 residue was present in all field populations examined, which is different from some other groups of insects having S200 residue. The recombinant G200S variant of FoAChE2 showed significantly decreased sensitivity to OP and CB insecticides, suggesting that the native FoAChE2 has a relatively higher baseline sensitivity to them.

Key words: Acetylcholinesterase, Western flower thrips, *Frankliniella occidentalis*, Baculovirus expression, Kinetics, Inhibition, Mutation

P80

Ingestion of heat-killed pathogens confers transgenerational immunity to the pathogens via the vitellogenin–hypopharyngeal gland axis in honeybees

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Honeybee diseases are a serious threat to beekeeping and pollination. Transgenerational immune priming (TGIP) has been attracting increasing attention as a promising strategy to protect honeybee colonies from infections. This study investigated whether feeding honeybees (*Apis mellifera*) with a heat-killed pathogen cocktail can provide them with transgenerational immunity to these pathogens. We found that *vitellogenin* (*Vg*) and *defensin-1* were highly upregulated in nurse bees upon feeding them with a cocktail of heat-killed *Ascosphaera apis* and *Paenibacillus larvae* (A + P cocktail). Pathogen-pattern-recognition receptor genes in the Toll signaling pathway were upregulated in nurse bees upon ingestion of the A + P cocktail. In the nurse bees of the hives supplied with the A + P cocktail, *Vg* was upregulated in the fat body, and the *defensin-1* expression and *Vg* uptake in the hypopharyngeal glands were induced. Consequently, the major proteins in royal jelly were upregulated. In addition, *defensin-1* was upregulated in the queen larvae and young worker larvae in these hives. In correlation, the young worker larvae showed high pathogen resistance to *P. larvae* infection. Thus, our findings imply that introduction of a heat-killed pathogen cocktail into hives is an efficient strategy for conferring honeybees with social immunity through TGIP.

Key words: *Apis mellifera*, Honeybee, Immune priming, Vitellogenin, Royal jelly

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P81

Transcriptional responses of development-, immune-, and defense-related genes in bumblebees exposed to high temperature

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Climate changes are a serious threat to global biodiversity and agricultural productivity. The loss of pollinating bees is particularly problematic because of economical values these species provide. Elevated temperatures severely impact organism development, behavior, lifespan, immunity, and physiology. In this study, we investigated the expression profiles of development-, immune-, and defense-related genes in bumblebees (*Bombus terrestris*) exposed to high temperature. Queens, workers, and males of *B. terrestris* were exposed to two different temperatures (optimal temperature 27°C or high temperature 35°C) for 1, 3, and 5d in chambers under 65% relative humidity. The expression profiles of 9 genes involved in development, immune, and defense were examined by quantitative real-time polymerase chain reaction (qRT-PCR). Importantly, all 9 genes (*CCHamide-2*, *ILP2*, *SOD*, *defensin-1*, *Dorsal*, *Relish*, *transferrin*, *HSP 83*, and *HSP 90*) used in this study were upregulated in 35°C compared to 27°C group. Our result reveal that elevated gene expression in queens, worker, and males of *B. terrestris* is host response to high temperature. Thus, our results suggest that *B. terrestris* regulates its metabolism via the elevation of gene expression to promote host resistance against thermal stress. These findings help us understand the gene regulation of *B. terrestris* to high temperature and provide a biomarker for the detection of thermal impact.

Key words: *Bombus terrestris*, Bumblebee, Climate change, High temperature, Gene regulation

P82

Antiviral activity of polysaccharides from entomopathogenic fungi against insect killing viruses

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As the insect industry has been increased, the control of entomopathogenic fungi and viruses has emerged. To control insect viruses, various agents have been developed but there is no effective and economical antiviral agent so far. Polysaccharides are widely known to have antitumor, antioxidant, and immunoregulatory activities, and some polysaccharides from plant and mushroom have the antiviral activity against various viruses. Therefore, we investigate the antiviral activity of polysaccharides from entomopathogenic fungi against budded baculovirus. This is first research to understand the activity of polysaccharides extracted from entomopathogenic fungi.

Key words: entomopathogenic fungi, antiviral, polysaccharide

P83

Neutral pH adapted insect cell for quantitative and qualitative enhancement of virus-like particle

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배큘로바이러스 발현계는 연구 및 산업적 측면에서 다양한 진핵생물계 단백질을 발현하는데 사용되며 높은 생산량 및 다중 유전자 발현이 가능한 특성을 활용하여 바이러스 유사 입자 백신 개발 및 연구가 진행되고 있다. 현재 바이러스 유사 입자 백신은 일부 바이러스에 대해서만 상용화되어 있으며 낮은 생산성 및 구조 형성 효율과 같은 문제들로 인해 백신 개발에 어려움을 겪고 있는 상황이다. 배큘로바이러스 발현계에 사용되는 곤충세포의 배양 환경은 약산성으로 이러한 조건에서 특정 바이러스 입자는 낮은 안정성을 가지며 이는 바이러스 유사 입자의 생산성을 감소시킬 수 있다. 이러한 문제를 해결하고자 다양한 pH에 높은 적응성을 갖는 곤충세포를 중성 조건에 배양적응하여 바이러스 유사 입자 생산에 활용하고자 하였다. 본 연구에서는 HFMDV, PPV, CPV와 같은 다양한 바이러스를 선정하여 적응 세포와 일반 세포 간의 항원단백질 생산량 및 바이러스 유사입자 조립 효율을 비교하였다.

검색어: 바이러스 유사입자, 배큘로바이러스 발현계, pH

P84

Production and characterization of hepatitis A virus like particle using insect expression system

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A형 간염(hepatitis A)의 예방을 위한 백신으로는 현재 불활화 백신이 이용되고 있으나, 생산 비용이 높고 효력이 낮아 새로운 형태의 백신 개발이 필요하다. 다양한 백신의 형태 중 바이러스 유사입자(virus-like particle: VLP) 백신은 유전물질을 함유하지 않은 바이러스 형태로 생산비용 및 효력이 매우 높은 장점을 가져 다양한 바이러스 질병에 대해 그 연구개발이 활발히 이루어지고 있다. 곤충 발현계(baculovirus expression system)는 이러한 VLP 생산에 가장 적합한 발현계로 알려져 있다. 본 연구에서는 hepatitis A VLP (HAVLP) 생산을 위하여 HAV의 구조단백질(P1-pX)과 그 특이적인 단백질 분해효소(3CD)의 발현에 가장 효율적인 프로모터를 결정하고 이들을 생산할 수 있는 재조합 바이러스를 제작하였다. 생산된 HAVLP의 효율과 형태적 특성을 분석하였으며, 그를 통해 HAVLP 백신 개발의 가능성을 제시하였다.

검색어: A형 간염, Hepatitis A virus, VLP, 곤충발현계

P85

Insects on Korean postage stamps as a cultural entomological study

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Cultural entomology deals with the relationship with insects that affect various aesthetic activities of humans. Stamp imply nature, history, and culture, and insects are also used as materials for stamp designs. In this research, insect-related postage stamps issued in Korea were organized by taxon and year. Among the 3,624 kinds of stamps issued in Korea, the number of stamps with insect real images was 43, and with insect-related designs, 37. The proportion of stamps using insects as designs was 2.98% of the total. The first Insect stamp was issued in April 1960 as bee-designed stamps in Korea. There were 23 types of stamps containing insects in the crafts or paintings used in the design of the stamps.

Key words: Entomophilately, honey bee, butterfly, cultural entomology

P86

Efficiency increase of baculovirus expression system by removing Ac-ORF72

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The baculovirus expression vector system (BEVS) is widely used as a tool for producing foreign proteins because of its high productivity and safety. BEVS requires the production of recombinant baculoviruses to produce foreign proteins in insect cells. However, baculovirus is limited in expression because protein production and cell death occur simultaneously during host cell infection. Recently, as interest in baculovirus gene functions has increased, virulence genes involved in host cell survival have been reported. In this study, an attenuated virus was prepared by removing Ac-ORF72, which is presumed to be virulence, and the expression efficiency was evaluated. Lack of Ac-ORF72 in baculovirus increased cell survival time of 24 hours and the efficiency of expression increase by 1.4 times. Removal of Ac-ORF72 suggests increased efficiency of the baculovirus expression system.

Key words: Baculovirus, BEVS, Virulence, Ac-ORF72

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Canceled by Author

P88

Monitoring reports about *Bactrocea dorsalis* of South Korea in 2022

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최근 기후변화, 국제교역량, 여행객 및 외국 이주민 증가 등으로 고위험 식물병해충의 유입이 증가하고 있으며, 고위험해충에 대한 국내 유입여부를 상시 조사하여 외래식물해충을 발견하고 발생시 조기 대응하는 전문지식과 경력을 갖춘 민간 전문가를 활용한 예찰시스템 구축의 필요성이 요구되고 있다. 침입우려 고위험 해충인 오리엔탈과실파리(*Bactrocera dorsalis*)는 광식성 해충으로 파프리카, 망고, 바나나, 감귤류 등 약 80종의 과실 농작물에 피해를 입히고 있으며, 해당 종의 국내정착 시 큰 경제적 피해를 입을 것으로 예상된다. 2022년 조기 방제 및 선제적 대응과 국내 확산 정착을 방지하기 위해 4개도(강원, 전북, 전남, 경남) 19개 시군 88개소에 유인트랩(스테이너)을 설치하여 설치장소별 월 1회 정밀조사를 실시하였다. 트랩에 포획된 해충을 수거 후, 동정한 결과 오리엔탈과실파리는 발견되지 않았다.

검색어: 고위험해충, 예찰조사, 오리엔탈과실파리

P89

Complete mitochondrial genome and phylogenetic position of *Acoptolabrus leechi yooni* (Deuve, 1990) (Coleoptera: Carabidae), endangered species in Republic of Korea

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The carabid beetles, one of the largest groups with more than 40,000 recorded species. *Acoptolabrus leechi yooni* Deuve, 1990 has been listed as an endangered species in Republic of Korea. We sequenced the 16,825bp with 13 protein-coding genes, 2 rRNA genes, 22 tRNA genes and 1 control region. The composition is 79.4% of A-T region and 20.6% of G-C region. Phylogenetic position revealed that *A. leechi yooni* is very close relationship to *A. mirabilissimus mirabilissimus* and *A. changeonleei*.

Key words: Carabidae, *Acoptolabrus leechi yooni*, Endangered species, Mitochondrial genome, Phylogeny

P90

Review of subfamily Cryptarchinae Thomson, 1859 (Coleoptera: Nitidulidae) in Korea (Part II: genus *Cryptarcha* Shuckard, 1839)

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The subfamily Cryptarchinae Thomson, 1859 from Korea is partly reviewed. This study is the second part of the revision, treating one genus: *Cryptarcha* Shuckard, 1839. This study reports one new describe species (*Cryptarcha* sp. nov.) and two species for the first time in Korea (*Cryptarcha kapfereri* Reitter, 1913 and *Cryptarcha inhalita* Reitter, 1884). Descriptions, photographs of external morphology and genital structures, biological information and a key to species are provided.

Key words: Korea, New species, new records, Nitidulidae, Cryptarchinae, *Cryptarcha*

P91

An identification and diagnostic tool for fruit flies as quarantine regulated pests (Diptera: Tephritidae)

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The Animal and Plant Quarantine Agency quarantines imported plants in accordance with the Plant Protection Act to prevent the inflow of pests and diseases that harm Korea's agriculture and natural environment. Prohibited pests are pests that are judged to have a high degree of harm to plants when introduced into the country, and thus ban the import of host plants from the country of distribution. There are 64 species of prohibited pests designated by the Animal and Plant Quarantine Agency, among which 46 species of fruit flies in 6 genera are designated. According to the quarantine inspection statistics data of the Animal and Plant Quarantine Agency, a total of 176 fruit flies were detected from 1996 to February 2023, and in detail, 21 species in 11 genera (13 quarantine pests, 6 provisionally regulated pests, 2 regulated non-quarantine pests) were recorded. As climate change and international trade increase, the detection of fruit flies is expected to continue to increase. Therefore, through this study, it is expected that the quarantine safety can be improved by producing a Lucid key for the identification of fruit flies to identify fruit flies more quickly and accurately.

Key words: Quarantine, Fruit fly, Prohibited pests, Quarantine inspection statistics

P92

Classification of the genus *Trogoderma* (Coleoptera: Dermestidae) from Korea

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Skin beetle is a storage grain pest that damages a variety of crops. Among them, the species of the genus *Trogoderma* are easily mistaken for other species because of their similar appearance. In particular, an accurate classification method is required to distinguish them from *Trogoderma granarium*, a worldwide quarantine pest. Therefore, we intend to provide morphological characteristics for adults and larvae that can identify them, including one unrecorded and two recorded species from Korea.

Key words: *Trogoderma*, Skin beetle, Morphological characteristics, New record, Korea

P93

First record and new host for *Podagrion pachymerum* (Hymenoptera: Chalcidoidea: Torymidae) in Korea

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The genus *Podagrion* is distributed worldwide with 96 valid species. They are known as the main parasitoids on the eggs of mantis. *Podagrion pachymerum*, which is distributed from the western and central palearctic to the oriental region (India), is known as the parasitoid of *Empusa egena*, *Iris oratoria* and *Mantis religiosa*.

In this study, we confirmed the distribution of *P. pachymerum* in Korea and discovered its new host record, *Tenoderella angustipennis* saussure (Mantidae), for the first time.

Key words: Chalcidoidea, parasitoid, new record, taxonomy

P94

Checklist of the Tineoidea (Lepidoptera) with two new species from Korea

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In this study, a total of 69 species of the superfamily Tineoidea were recognised from Korea. It includes two new species of the family Psychidae: *Psychinae* sp. nov., and *Oiketinae* sp. nov. Adults and genitalia were described, and DNA barcodes for precise identification of the species are provided.

Key words: ditrysis, bagworms, clothes moths, new species

P95

Phylogenetic placement and redescription of *Aphaenomurus interpositus* Yosii, 1956 (Collembola: Tomoceridae) in Korea

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The genus *Aphaenomurus* Yosii currently contains only one species, *Aphaenomurus interpositus* Yosii, which is widely distributed in the entrance and twilight zone of lava tube caves in the Korean Peninsula. In a previous study, the phylogenetic relationships of seven genera in the family Tomoceridae, excluding *Aphaenomurus*, were investigated and designated four new subgenera. Based on two mitochondrial (COI, 16S rDNA) and three nuclear gene fragments (18S rDNA, 28S rDNA D1-2, 28S rDNA D7-10), we inferred the phylogenetic placement of *A. interpositus* relative to other Tomoceridae genera. Our results strongly support the hypothesis that *Aphaenomurus* is a sister group to the genus *Plutomurus* Yosii, which comprises troglobite or troglophile species. We also provided a redescription of *A. interpositus* in light of the latest trends.

Key words: cave-dwelling Collembola, *Aphaenomurus*, phylogenetic placement, redescription, lava tube

P96

A cosmopolitan storage pest, the genus *Tineola* Harrich-Schäffer (Lepidoptera, Tineidae), first report from Korea

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The genus *Tineola* Harrich-Schäffer is reported for the first time from Korea, with a species *Tineola bisselliella* (Hummel, 1823). The genus common pest found inside building such as home, stores, and museums. The webbing clothes moth *T. bisselliella* is the most important and widespread tineid moth pest throughout the world. These moths can cause the damage of irreplaceable material of aesthetic, historic and scientific importance, as well as damaging everyday items such as clothes, furnishings and other materials prepared from animal fur, wool, feathers and leathers (Cox and Pinniger, 2007). Photograph of adults, and the genitalia of *T. bisselliella* are provided.

Key words: Lepidoptera, Tineidae, *Tineola*, Storage pest, Cosmopolitan

P97

Update on the national species (insect) of Korean islands in Jindo

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진도는 우리나라에서 세 번째로 큰 섬으로 산, 초지, 갯벌, 염전 등 다양한 생태계가 어우러져 있어 생물다양성이 굉장히 높을 것으로 예상된다. 섬 지역 곤충종목록에 따르면 진도에는 총 789종의 곤충이 보고되었고, 나비목이 760종(96.3%)으로 가장 많이 조사된 것으로 확인된다. 본 연구에서는 진도를 대상으로 2021년 6~9월, 2022년 6~8월까지 총 10회의 곤충조사 및 표본확보 연구를 수행하였다. 연구 결과, 진도에 기록되지 않은 곤충 166종을 추가 확인하였고, 이들의 확증표본을 함께 확보하였다. 이 중, 국외반출승인대상종 34종, 고유종 2종이 포함된 것으로 확인되었다. 섬 지역 곤충종목록의 지속적인 최신화를 통해 섬 생물다양성 연구의 필요성 및 인식 제고를 위한 기초자료로 활용될 수 있을 것으로 판단된다.

검색어: 섬, 생물다양성, 곤충상, 진도

P98

A new species of genus *Lissonota* (Hymenoptera: Ichneumonidae: Banchinae) with a new host record

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The genus *Lissonota*, one of the genera of subfamily Banchinae, is the largest genus with approximately 400 cosmopolitan species. Among them, 24 species from South Korea. This genus can be distinguished by following: Apical margin of clypeus without median notch. Areolet present (sometimes areolet absent). First tergite without longitudinal wrinkling or with only weak wrinkling. Ovipositor sheath usually more than 1.4 as long as hind tibia. Most species are koinobiont endoparasitoids of lepidopteran larvae and pupae, especially Noctuidae and Tortricidae. In this study, we report a new species of genus *Lissonota*. This species is easily distinguished from other species following: black body with a few yellow spots, fore wing with areolet, first tergite with striated longitudinally, ovipositor shorter than metasoma. Additionally this species is discovered from *Dichomeris heriguronis* (Matsumura) (Lepidoptera: Gelechiidae). This is new host record of genus *Lissonota*. Description and plates of new ichneumon species and its new host were provided.

Key words: Taxonomy, parasitic wasps, Hymenoptera, eastern palaearctic region

P99

First report of the genus *Mizodorcatoma* Hayashi (Coleoptera, Ptinidae) with two species descriptions from South Korea

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The genus *Mizodorcatoma* Hayashi belonging to the family Ptinidae was described in 1955 based on *M. pinicolae* Hayashi, consisting of 11 species worldwide and 4 species have been reported in Japan. Here, we report the first record of the genus *Mizodorcatoma* in Korea, with two newly recorded species, *M. pulcherrima* Sakai, 1979 and *M. pinicola* (Hayashi, 1951), which are distinguished by habitus and male genitalia. Re-descriptions of the Korean species, images of habitus and male genitalia are provided in the present study. We also provides information on the fungal hosts from which two species were collected.

Key words: Taxonomy, Biogeography, Fungal host, Fungivorous beetle

P100

High-resolution image library for identification of plant quarantine pests in Korea

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In order to identify pests morphologically, images taken with high resolution are required. However, there are not enough high resolution photographs of the pests found at the quarantine site. Also, a lot of the content was shot in poor quality, making it unsuitable for use in quarantine facilities. To compensate for this, Hhigh-resolution images of 1,000 pest species were collected for two years starting in 2021. Based on pests found at the quarantine site or quarantine pests, the object was chosen. Coleoptera insects are most taken as 41.9%, followed by Hemiptera insects as 23.5%, Lepidoptera insects as 17.6%. A total of 326 species of images of them, including 40 prohibited pests, 69 managed pests have been secured. The high-resolution images were taken using Nikon D500 16-80mm VR Kit or Leica M205C, Dhyana400DC. They are provided to the pest information system (PIS) so that they can be used to identify pests found at the quarantine site.

Key words: High-resolution image, plant quarantine insect, identification, PIS

P101

EAD-active compounds present in host and non-host plant extracts for the beet armyworm, *Spodoptera exigua* (Hübner)

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파밤나방(*Spodoptera exigua*)은 주요 피해 작물인 파를 포함하여 많은 농작물과 화훼류를 가해하는 광식성 해충이다. 우리는 파밤나방에 냄새활성을 나타내는 식물 냄새물질들을 동정하기 위해, 파밤나방의 기주를 포함한 7 종의 식물(고추, 배추, 토마토, 옥수수, 벼, 대파, 감자)로부터 휘발성물질들을 포집하여, 파밤나방에 냄새활성을 나타내는 물질들을 GC-EAD를 통해 알아보았다. 그 결과, 7 종의 식물추출물에서 총 18가지의 물질이 파밤나방 암, 수컷에 냄새활성을 나타낸다는 것을 확인하였다. EAD 활성을 보이는 냄새활성물질들의 조성은 식물 종류에 따라 특이적이었으며, 이 중 두 가지 물질은 여러 식물에 공통적으로 존재하였다. 이들 중 대파와 고추에서 탐지된 냄새활성물질들이 파밤나방에 대해 가장 강한 EAD 활성을 나타내었고, 식물에서 동정된 대부분의 냄새활성물질들은 파밤나방 암, 수컷에 대해 비슷한 냄새활성을 보였으나, 대파에서 방출하는 한 가지 물질 등 몇 가지 물질들은 성특이적인 반응을 보였다. 파밤나방에 EAD 활성을 보인 이들 식물냄새물질들의 화학구조는 GC-MS 등의 화학분석을 통해 밝힐 예정이다.

검색어: 파밤나방, 식물추출물, 냄새활성, GC-EAD

P102

Estimation of northern limits of *Agrotis ipsilon* in Korea using CLIMEX model

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검거세미나방은 밤나방과에 속하는 곤충으로써 유충이 고추, 감자, 옥수수 등 밭작물을 가해하여 큰 피해를 입힌다. 그러나 국내에서의 이들 생태는 불분명한 점이 많고 기상자료에 의한 발생예측도 어려운 상태이다. 검거세미나방은 해마다 중국과 같은 주변국으로부터 국내로 비래하여 개체군을 형성하는 것으로 추정되어왔으나, 판단할 수 있는 자료가 많지 않고 최근의 기후 변동으로 인하여 국내에서의 월동 능력에 대해서도 재고가 필요한 상황이다. 이에 파키스탄에서 발표된 CLIMEX 매개변수와 중국에서의 장기간에 걸친 겨울철 발생자료를 토대로 하여 국내 적용에 적합한 매개변수를 추정하고 검거세미나방의 계절초기 발생 예측에 활용하고자 하였다.

검색어: CLIMEX, 비래해충, 기후변동, 월동한계, 채소해충

P103

Incidence of macropterous and brachypterous of *Thrips nigropilosus* in medicinal plant, *Ligusticum officinale*

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활용빈도가 높은 약용작물인 천궁(*Ligusticum officinale*)을 가해하는 총채벌레류 조사과정에서 7종을 확인하였고 포획한 미나리총채벌레(*T. nigropilosus*)에서 두 종류의 날개형을 확인하였다. 천궁을 재배하고 있는 재배지에서 미나리총채벌레 날개형의 재확인을 위해 2020년에는 7월에서 9월까지, 2022년에는 7월과 8월에 각각 천궁 주산지에서 타락법으로 포획하였다. 2020년 조사는 경북 영양 3재배지, 강원 태백 1재배지 등 4재배지에서 진행하였고 2022년에는 전북 진안 2재배지, 경북 영주 2재배지, 경북 영양 2재배지, 강원 영월 1재배지, 태백 1재배지, 정선 3재배지, 평창 1재배지, 충북 제천 1재배지 등 13재배지에서 진행하였다. 2020년 4재배지 모두에서 장시형과 단시형을 포획하였고 2022년 정선 1재배지와 평창 1재배지를 제외한 11재배지에서도 장시형과 단시형을 포획하였다. 하지만, 포획수를 비교했을 때, 장시형의 비율이 훨씬 높음을 확인하였다. 이 결과는 천궁에서 발생하는 총채벌레류 중 미나리총채벌레 장시형이 우점하고 있음을 알려주고 있으며 생태형 분포 연구에 도움이 될 것으로 기대한다.

검색어: 천궁, 미나리총채벌레, 날개형, 장시형, 단시형

P104

Monitoring reports about ants found around major ports in 2021~2022

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국가 간 인적·물적 교역 증가로 수입 컨테이너를 통해 유입되는 개미류가 지속적으로 증가하고 있으며, 새로운 서식 환경에 터를 잡고 생물다양성을 저해하는 요인으로 작용한다. 국립생태원에서는 2021~2022년 중국, 일본과 물류량이 많고 확산 우려가 높은 주요 항만(감만항, 허치슨항, 평택당진항, 광양항, 인천항, 경인항, 군산항, 대산항, 온산항, 울산신항, 영일만항) 일대를 예찰한 결과 개미류는 총 4아과 24속 34종이 확인되었다. 그 중에서 국내종인 주름개미(*Tetramorium tsushimae*)가 우점하였고, 그 다음으로 스미드개미(*Nylanderia flavipes*), 누운털개미(*Lasius alienus*) 등이 확인되었다. 외래개미류는 2022년 부산 감만항에서 열대긴수염개미(*Paratrechina longicornis*), 열대불개미(*Solenopsis geminata*), *Trichomyrmex destructor* (국명미정)가 발견되었고, 광양항과 온산항에서 열대긴수염개미가 발견되었다.

검색어: 외래개미류, 주요 항만, 예찰, 수입 컨테이너

P105

The termite specialist *Isoscelipteron pectinatum* (Neuroptera: Berothidae) in Korea

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Beaded lacewing (Berothidae) is one of the mysterious groups of Neuroptera. The family includes about 22 genera and almost 100 species in worldwide. Nowadays, the genus *Isoscelipteron* recorded about 20 species. Ecological character of this group is a predator of termites. The larva of *Lomamyia* is well known to feed on termites which they subdue with an aggressive allomone. Additionally, the second larvae are known to be without feeding and sleeping in the larval stage. In this study, the ecological characteristics and life history of *Isoscelipteron pectinatum* in Korea have been investigated as well as the life table. We provide life table and photos of the ecological character of *I. pectinatum*.

Key words: Neuroptera, Berothidae, genus *Isoscelipteron*, *Isoscelipteron pectinatum*, termite

P106

Analysis of similarity between national parks in Korea through a comparison of Presence of the common inhabiting Lepidoptera species

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A list of species of Lepidoptera species inhabiting 22 national parks in Korea was compiled. A similarity analysis was performed to compare all national parks and cladograms were constructed. The similarity cladogram showed that Hallasan, Taebaeksan, Taeanhaean, and Bukhansan mountains were each classified independently, and those in the Hallyeohaesang, Dadohaesang, Naejangsna, and Byeonsan-peninsula in the southern and western parts of Korea were classified as a single group. Seoraksan, Odaesan, and Jirisan, which showed the presence of relatively more number of species than other parks, were grouped together forming a group along with Woraksan, Sobaeksan, Gyeryongsan, Deogyusan, Songnisan, and Juwangsang. Finally, Gayasan, Chiaksan, Mudeungsan, Gyeongju, and Wolchulsan formed a group.

Key words: National Park, Similarity, Lepidoptera, distribution map

P107

Seasonal abundance and biological characteristics of fig weevil, *Aclees taiwanensis* (Coleoptera: Curculionidae)

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The fig weevil (*Aclees taiwanensis*) is causing serious damage to fig farms in recent years. Adults attack leaves and fruits, while larvae feed by tunneling into the trunk beneath the surface of soil. There is no known way to properly manage the fig weevil population. To understand the field occurrence and biology of this pest will contribute to establishing control strategies. We investigated the field abundance of this pest in fig farms in Hwawon-myeon, Haenam-gun, Jeonnam province, and conducted laboratory experiments to determine some of its biological characteristics. It was confirmed that the fig weevil has two generations per year, overwintering as older larvae and pupating in the spring season, regardless of whether the fig trees are grown in the open field or in the rain-protected plastic house. In addition, the development period from egg to adult of this weevil took an average of 75 days at 25°C.

Key words: *Aclees taiwanensis*, biology, fig tree, Korea

P108

Impact assessment on sporadic and subtropical insect pests by climate change

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최근 기후변화와 이상기후의 영향으로 농작물 병해충의 발생양상이 다양해지고, 작물의 병해충에 대한 저항성 또한 변화함에 따라 새로운 효과적인 적응 대책이 필요해지고 있다. 특히 돌발해충 및 남방계 해충의 국내 발생 범위, 빈도 및 대규모 출현율이 증가하고 있는 추세인 반면, 이들 해충에 대한 대비책은 발생의 불규칙성 및 이전 자료의 부족으로 인해 상당히 미흡한 실정이다. 따라서 해충 발생 실태조사 방법을 표준화시켜 각 시·군별 장기간의 조사를 통해 실제적 기후변화 경향성 및 영향 평가가 필요하다. 본 연구에서는 2022년 전국 134개 시·군에 트랩을 설치하여 돌발·남방계 해충인 미국선녀벌레(*Metcalfa pruinosa*), 썩덩나무노린재(*Halyomorpha halys*), 담배거세미나방(*Spodoptera litura*)의 전국 단위 발생 실태조사를 실시한 후 각각의 발생량에 대한 영향평가를 진행하였다. 그로 인해 기준연도(2016~2020) 대비 영향평가를 분석한 결과 평가값이 미국선녀벌레 5.0, 썩덩나무노린재 2.7로 크게 나타난 결과를 확인할 수 있었다. 이 결과를 바탕으로 해충방제 및 확산 저지방안을 마련하고 농작물 안전생산 기술개발의 기초자료로 활용되기를 기대한다.

검색어: 기후변화, 실태조사, 미국선녀벌레, 썩덩나무노린재, 담배거세미나방

P109

A comparative study of host plants and oviposition traits of *Ricania* sp. (Hemiptera: Ricaniidae)

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Ricania sp. (Hemiptera: Ricaniidae) is a sporadic pest that can cause significant damage to economic fruit and landscaping trees in agricultural land and mountainous areas. The pest punctures young branches and lays eggs, which leads to branch damage and plant growth interruption. This study analyzes the characteristics of sweet persimmon, jujube, plum, and peach plants to identify the best host plant for *Ricania* sp. The results show that the jujube has the highest hardness of young branches at 7.7N/cm² and the lowest moisture content at 38.7%. In addition, the number of eggs per egg mass was lowest in the jujube, but the average hatching rate was the highest. Overall, these findings can serve as a reference for selecting moisture-resistant host plants to winter with eggs and effectively manage the pest.

Key words: *Ricania* sp., Jujube, Hardness, Moisture content, Oviposition, Egg mass

P110

Investigation on Insecticide response to brown planthopper (*Nilaparvata lugens*)

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벼의 주요 비래해충인 벼멸구(*Nilaparvata lugens*)를 2022년에 남해에서 채집하여 실내에서 증식한 다음 몇 가지 약제에 대한 반응을 조사하였다. 시험에는 8종(에토펜프록스 유제 20%, 티아메톡삼 입상수화제 10%, 플로니카미드 입상수화제 10%, 페노뷰카브 유제 50%, 피메트로진 유제 50%, 이미다클로프리드 액상수화제 8%, 설펍사플로르 입상수화제 20%, 카보선판 액상수화제 20%)의 약제를 추천농도로 희석하여 사용하였다. 시험관(30 mm × 150 mm)에 엽면침지법으로 약제가 처리된 벼 유묘를 넣고 벼멸구 약충을 30마리를 접종하여 각 약제당 3반복으로 생물검정을 수행하였다. 약제 처리 후 3, 4, 7일 동안 관찰하면서, 사충수를 기록하였다. 3일차 조사 결과, 에토펜프록스 유제 등 7가지 약제는 사충률이 91~100%인 반면, 이미다클로프리드 액상수화제는 54%를 보였다.

검색어: 벼멸구, 저항성, 살충제, 에토펜프록스, 이미다클로프리드

P111

Practical application of natural enemies into the smartfarm-type oriental melon greenhouse

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참외 주산지인 성주지역의 참외 재배지에 스마트팜형 환경관리시스템이 보급되면서 천적을 활용한 친환경적 해충관리법의 기술개발이 요구된다. 스마트팜형 참외 재배지의 환경조건을 분석하고 해충 발생시기에 따른 해당 천적의 투여 시기, 양과 빈도에 따른 해충 방제율을 시험하였다. 참외의 주요 해충으로서 가루이류, 진딧물류, 총채벌레류, 응애류 등이 발생한다. 진딧물류 관리를 위하여 2월 중순에 보리 파종 후 기장테두리진딧물을 미리 접종하여 3월 기생성 천적인 콜레마니진디벌이 유지, 정착뿐만 아니라 3~5월에 외부에서 유입되는 천적인 무당벌레류, 꽃등애류 등이 유지될 수 있도록 지속적인 관리가 필요하였다. 총채벌레류 천적으로 자가생산한 토양 포식성응애인 뿌리이리응애를 3월부터 2주 간격으로 처리하였고 온실 주변에 식재된 쇠비름, 돌나물 등을 미끌애꽃노린재 유지식물로 활용하여 5월 초순에 미끌애꽃노린재를 2회 처리하였다. 가루이류는 4월 초순에 온실 안에 담배를 식재하여 담배장님노린재 유지/보호에 활용, 5월 중순에 담배장님노린재를 2회 처리하였다. 응애류 천적으로서 자가생산한 사막이리응애를 5월부터 2주 간격으로 처리하였다. 참외 스마트팜의 천적 농업에 대한 해충방제율 및 경제성 분석을 진행 중이다. 본 연구를 통하여 참외 스마트팜의 효율적인 생태공학적 천적농법에 대한 매뉴얼을 개발할 계획이다.

검색어: 천적 농업, 참외, 생태공학적, 천적유지식물, 자가생산

P112

Impacts of sub-lethal diamide exposures on microRNA and putative target transcript expression in *Spodoptera frugiperda* strain

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Spodoptera frugiperda, commonly known as the fall armyworm (FAW), has evolved resistance to new compounds with different modes of action, such as diamides. Previous studies suggest that miRNAs may play a role in the development of insecticide resistance. To provide a comprehensive insight into the resistance mechanisms of *S. frugiperda* to diamides, microRNA analysis of the resistant and susceptible strain was performed using Illumina sequencing. Of the nine differentially expressed miRNAs, seven miRNAs were significantly down-regulated (-1.28 to -4.90 fold), and only two were significantly up-regulated in the resistant strain (1.32 and 2.54-fold) as compared to those in the susceptible strain. Consistent with the microRNA sequencing results, three miRNAs, namely sfr-miR-novel-11, sfr-miR-novel-60, and sfr-miR-10460-5p exhibited significant downregulation in their expression levels across all the time points after treatment with chlorantraniliprole and flubendiamide. Gene Ontology analysis predicted putative target transcripts of the differentially expressed miRNAs encoding significant genes belonging to detoxification pathways (*P450*, *GST*, *UGT*, *ABC*, *RyR*, and *ChE1*) and other genes associated with specific developmental processes (*EcR-78C*, *KLF6_7*, *JHBP*, and *Br-C*). RT-qPCR validated an inverse correlation between differentially-expressed miRNAs and the putative target transcripts in response to chlorantraniliprole and flubendiamide. Overall, our findings provide insights into the possible regulatory role of miRNAs in detoxification of *S. frugiperda* in response to diamide insecticides.

Key words: miRNAs, *Spodoptera frugiperda*, diamides, insecticide resistance

P113

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

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Phosphine is a pesticide used to control pests in Rice Processing Complex (RPC). However, increasing use of aluminum phosphide caused the occurrence of phosphine resistance pests. In this study, phosphine resistance pests collected in RPC was investigated with FAO No. 16 test, Dihydrolipomaide dehydrogenase (DLD), and amino acid mutation analysis to identify the occurrence of phosphine resistance in Korea. Tested pests were collected in the 8 province 34 region. As a result of the FAO test of 21 regions, all sample were phosphine sensitive. In DLD test, 8 area samples were weak resistance. Accordy to result of amino acid analysis, 5 area samples were weak resistance. 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

P114

Mortality of *Tribolium castaneum* (Coleoptera, Tenebrionidae) by low oxygen condition

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Tribolium castaneum (Coleoptera, Tenebrionidae) is a common stored-grain pest, particularly in rice. *T. castaneum* consumes grain kernels and excretes feces that contaminates and damages the grain. If pest control measures are implemented during the prolonged storage phase of grain, it can be the most cost-effective option. In this study, we investigated CA treatments with 5, 1, and 0.1% O₂ in 20°C environment to determine effective low-oxygen threshold to control *T. castaneum* adults during the storage phase. As a result, 5% O₂ showed 53.59% mortality on the seventh day, while 1% and 0.1% showed 100 % mortality on third day. Treatment with 0.1% O₂ for 8 hours showed 0.64% mortality, but when the treatment time extended to 18 and 24 hours, the mortality increased to 82.69% and 90.73%, respectively. It was confirmed that if oxygen level in the storage can be decreased to 1% or less, the adult stage can be controlled on the third day. This result suggests that CA treatment during the storage phase can effectively control *T. castaneum*, and further researches about combined treatment with fumigants are required to reduce treatment period.

Key words: *Tribolium castaneum*, Controlled atmosphere (CA), low oxygen

P115

Comparative efficacy of single and combined treatment of ethyl formate and low temperature to the red flour beetle, *Tribolium castaneum*

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Because of recent reports about phosphine resistance problem, development of effective fumigation method to control grain pests is very important. Combined treatment of fumigant with physical treatment can increase the efficacy of fumigant with lower phytotoxicity on crops. In this study, we assessed the efficacy of single and combined treatment of ethyl formate, a popular fumigant, mixed with cold treatment to control red flour beetle, *Tribolium castaneum*. Ethyl formate was treated for 4h at 20°C, followed by 1 days cold (1°C) treatment. Combined treatment of ethyl formate and cold treatment showed a slight difference in efficacy against *Tribolium castaneum* compared to single treatment of ethyl formate and cold treatment. The synergistic effect of combined treatment of chemical and physical treatment can be shown different each pest and stage.

Key words: *Tribolium castaneum*, ethyl formate, low temperature treatment, combined treatment

P116

Optimal control for efficient management of *Scotinophara lurida* (Burmeister) in paddy fields

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먹노린재는 벼를 흡즙하여 생육을 저조하게 하거나 고사시키고 출수기에는 이삭을 가해하여 수량에도 직접적인 악영향을 주는 벼의 중요한 해충이다. 인근 야산에서 월동한 먹노린재는 벼가 심겨지는 이앙기 이후에 논으로 유입되며 최근 발생량이 증가추세에 있다. 따라서, 먹노린재의 월동충 활동시기를 예측하여 충남지역 논으로 유입되는 먹노린재의 피해를 최소화하기 위하여 본 연구를 수행하였다. 충남지역에 발생하는 먹노린재의 종류는 먹노린재, 꼬마먹노린재, 갈색큰먹노린재로 3종이 확인되었으며 그중 먹노린재의 채집량이 가장 많았으나 지역 간 차이가 있는 것으로 확인되었다. 2021년과 2022년에 걸쳐 이전 연구에서 설정된 먹노린재 월동충 활동시기에 대한 누적유효적산온도(CDD)를 이용하여 활동초기, 활동최성기, 활동후기를 비교한 결과, 각각 약 15일, 약 10일, 약 6일의 활동시기 차이를 보였다. 최대 활동 최성기인 5월은 논에 벼가 없기 때문에 먹노린재의 논 유입은 없으며 활동후기인 6월은 논으로의 유입이 시작되는 시점으로 5월 월동충 및 6월 본답 방제가 가장 적당한 방제시기이며 약제살포시 물에 떨어지는 먹노린재의 습성상 논에 물을 빼는 시기에 방제를 추진하는 것을 감안했을 때 벼 재배 농사 일정을 고려하면 본답에서의 방제는 6월 하순 1차 중간물 빼기에 처리하는 것이 가장 적당한 것으로 판단된다.

검색어: 먹노린재, 논, 활동시기, 누적유효적산온도, 방제

P117

Damage caused by *Rhizoglyphus robini* Claparede in *Allium wakegi* ARAKI plantations in Chungnam province

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충청남도의 쪽파 재배면적은 1,066ha로, 전국 재배면적의 21%를 차지하고 있으며, 그 중에서도 과반 이상의 면적이 예산과 아산 지역이다. 최근 해당 지역에서 쪽파 지하부 해충에 의한 피해가 증가하고 있으며, 그 중에서도 뿌리응애에 의한 미발아, 생육저조, 갈변 등의 피해가 가장 심한 것으로 조사되었다. 쪽파를 재배하는 기간이 길고 재배면적이 넓은 예산 지역에서 뿌리응애 발생량이 포기당 $1,024.0 \pm 1,925.4$ 마리로 가장 높게 나타났다. 뿌리응애 발생은 화학약제가 사용되지 않는 무농약 재배에서 포기당 $2,076.2 \pm 2,585.6$ 마리로 가장 밀도가 높았으며, 시설 재배에서 포기당 $729.3 \pm 1,672.1$ 마리가 발생하여 55.3 ± 94.2 마리가 발생한 노지 재배보다 밀도가 높게 나타났다. 또한, 쪽파 주재배지인 예산과 아산에서 친환경포장과 일반 관행포장을 구분하여 뿌리응애에 의한 피해구율을 조사한 결과, 관행 포장에서는 평균 14.9%였으며 시간이 지남에 따라 피해구율이 점점 낮아졌고, 무농약 재배에서는 평균 25.7%였으며 시간이 지남에 따라 피해구율이 증가하였다. 유기재배 포장에서는 평균 피해구율이 29.6%로 가장 높았으나 시간에 따라 일정하였다. 따라서, 쪽파 재배지에서 뿌리응애에 의한 피해는 심각한 수준이며 상품성에 영향을 주는 잎 끝마름 증상도 뿌리응애가 원인일 가능성이 높아 관리가 필요한 해충이다.

검색어: 뿌리응애, 쪽파, 밀도, 친환경, 관행

P118

Surveillance of hard ticks (Acarina: Ixodidae) as Severe Fever with Thrombocytopenia Syndrome (SFTS) virus vectors in the Republic of Korea, 2022

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The purpose of this monitoring project was to investigate the geographic distribution of ticks in the Republic of Korea using tick traps with dry ice attachment. The monitoring was conducted for eight months from April to November 2022 at 10 provinces and 1 metropolitan area. A total of 61,259 hard ticks (7,425 females, 2,538 males, 15,145 nymphs, and 36,151 larvae) were collected, representing four species belonging to three genera (*Haemaphysalis longicornis*, *H. flava*, *Ixodes nipponensis*, and *Amblyomma testudinarium*). *H. longicornis* was the most frequently collected species, accounting for 94.8% of all collected ticks, followed by *H. flava* (4.5%), *I. nipponensis* (0.4%), *A. testudinarium* (0.3%), and *H. japonica* (< 0.1%) during the study period. *H. longicornis* was the dominant species observed in all 11 areas studied. No pathogens were detected in the RNA of 2,511 tick pools using the PCR method for Severe Fever with Thrombocytopenia Syndrome (SFTS) in 2022.

Key words: hard tick, monitoring, survey, tick trap, sfts

P119

Monitoring of Japanese encephalitis vector mosquitoes (*Culex tritaeniorhynchus*) in Korea, 2022

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To monitor the vector distribution of Japanese encephalitis (JE), mosquitoes were collected twice a week using black light traps at nine sites nationwide from April to October 2022. The weekly mosquito surveillance data was transformed into the average daily number of individuals caught per trap (trap index; number of mosquitoes per trap per day), which was used for comparative analysis. Based on the surveillance data, *Cx. tritaeniorhynchus*, a known JE vector, was first detected in the Busan area on April 11th, leading to a warning. On July 23rd, a nationwide alarm was issued due to the confirmation of *Cx. tritaeniorhynchus* accounting for more than 50% of the total mosquito collection. The occurrence rate of *Cx. tritaeniorhynchus* was 17.5% (20,340) among the total mosquito population in 2022, which was an 88.2% increase compared to the previous year. Genotype 5 was identified in 2 species and 3 pools through virus infection investigation. Therefore, continuous monitoring and data analysis of vector prevalence, detailed epidemiological surveys of JE patients, and identification of novel JE vectors for genotype 5 are essential for effective prevention and control of JE.

Key words: *Culex tritaeniorhynchus*, Japanese encephalitis virus (JEV)

P120

Seasonal abundance of hard ticks (Acari: Ixodida) and their harboring rates of severe fever with thrombocytopenia syndrome virus in 2021-22 in Gyeonggi-do, South Korea

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Hard ticks are major vectors of severe fever with thrombocytopenia syndrome virus (SFTSV). To monitor their seasonal abundance, hard ticks were collected monthly using CO₂-bait traps from four different landscapes including grassland, shrubs, grave, and mountain trail in Gyeonggi-do, South Korea. From April to November in 2021-2022, we collected a total of 20,035 hard ticks, and all of which belonged to genus *Haemaphysalis*. Excluding the larvae, 98.2% of collected ticks were identified as *H. longicornis*, and the density peak of nymphs and adults was observed in April-May and June-July, respectively. In addition, density peak of *Haemaphysalis* larvae was recorded in August, while no clear occurrence pattern was observed in *H. flava* due to low density. Although number of ticks collected was highest from mountain trail in 2021 and shrubs in 2022, no significant difference was detected between landscapes. Finally, half of the ticks collected were subjected to PCR analysis to estimate SFTSV harboring rates, and no positive pools were observed.

Key words: tick surveillance, tick-borne disease, longhorned tick, ixodid tick, population dynamics

P121

Genetics structure and molecular diversity of *Spodoptera exigua* based on mitochondrial COI gene sequences

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2020년 7월 및 9월에 성페로몬 트랩으로 포획한 과밤나방 8개 지역집단(388개체)의 암컷 성충에 대하여 미토콘드리아 COI 유전자 염기서열을 이용한 집단유전분석을 실시하였다. Pairwise 분석 결과, 28개 haplotype을 확인할 수 있었으며, Nucleotide diversity는 평균 0.001415였으며, 안성-7월 (0.001998)과 김천 7월 집단(0.001898)이 가장 높았다. 주성분 분석을 통해서 크게 8개 지역집단 과밤나방은 김천-9월과 고창-9월, 안성-9월 집단은 나머지 집단과 다른그룹을 형성하는 것으로 확인되었다.

검색어: 과밤나방, MtCOI 유전자, haplotype, genetic structure

P122

Changes in gene expression by maturation stage in 5th instar silkworm larvae

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The advantages of silkworm as a health functional food are known and various products are being developed. In general, silkworms distributed on the market include silkworms with 5 instars 3 days and mature silkworms with 5 instars 7 days or more. In this study, we analyzed genetic changes in the 5th instar of silkworm larvae and tried to determine the possibility of maturity analysis using this. After breeding white jade, samples were collected on the 1st, 3rd, 5th, and 7th days of the 5th instar, and a cNDA library was constructed after RNA extraction. The constructed library was sequenced through NGS and the expression levels of genes for each date were compared. As a result, genetic changes were clearly shown for each date, and a total of 2892 differentially expressed genes were identified. Among them, 10 contigs showing increased or decreased expression were selected on the 5th and 7th day of the 5th instar, and primers for the gene were prepared and analyzed by RT-PCR. As a result, Contig C127159_g1_i1 (NADPH 3) increased rapidly on the 7th day of the 5th instar and contig C72224_g1_i2 (ALP1-like) showed a decrease, so it is judged that the maturity of the 5th instar silkworm can be analyzed using this.

Key words: Silkworm, five instars, gene expression, maturation

P123

A report of provional Lepidopteran pests in the plant quarantine inspection from 2013 to 2022

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For the past decade, a total of 117 species and 6,136 cases of lepidopteran pest are reported in the plant quarantine inspection. Of them, 69 species and 4,023 cases were intercepted as the quarantine pest. The detected quarantine pests consisted of the Noctuidae (2,358 cases 58.6%), the Pyralidae (556 cases 13.8%), and the Lepidoptera (452 cases 11.2%). In addition, the main detected items were confirmed to the vegetables (1,888 cases 46.9%), cut-flowers (1,042 cases 25.9%), industrial crops (417 cases 10.4%), and seedlings (276 cases 6.9%) in order. Especially for most lepidopteran pests were intercepted as larval forms in the plant quarantine inspection. They were bred at room temperature conditions with host items and identified after emerging to adults.

In the present study, we provide characteristics of lepidopteran pests in plant quarantine inspection and report their identifying results using superficial features and COI gene analysis.

Key words: Lepidoptera, plant quarantine, Larvae, COI

P124

Effect on colony strength by thermal insulation of honeybee (*Apis mellifera* L.) hive in strawberry greenhouse

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Bee pollination is imperative for strawberry production during winter in Korea. We examined the effect of thermal insulation of the hive on strawberry pollination. In terms of pollination activity and hive lifespan, the average temperature inside the insulated hive bee box was 4.6 °C higher than ordinary bee box, and the time taken for the bees to completely vanish from the hive was 20 days longer. Therefore, it is thought that thermal insulation of the hive is essential for pollination of strawberries in winter because the heat-insulating hive can improve the internal temperature of the hive, increase the activity of bees and the lifespan of the hive.

Key words: hive insulation, strawberry, pollination, honeybee

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P125

Genetic comparison of *Alcis angulifera* (Lepidoptera: Geometridae) in southern Korea

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털뿔가지나방 (*Alcis angulifera*)은 우리나라 산림 전역에 매우 흔히 볼 수 있는 종으로, 다식성이며 지역 특이적이지 않아 집단유전학 연구에 적합한 분류군이다. 이번 연구에서는 3개 집단 (한라산, 지리산, 승달산)의 유전적 비교를 위해 털뿔가지나방의 mitochondrial *COI* 유전자 염기서열을 이용하여 유전적 다양성, 집단구조 등에 대한 분석을 수행하였다. 그 결과 Haplotype 다양성은 한라산(0.934)에서, Nucleotide 다양성은 지리산(0.00477)에서 가장 높게 관찰되었다. 지역 간 유전적 차이가 나타났으며 제주도와 내륙 간의 다른 유전자 풀을 구성하는 것으로 보이나 지리적 거리와 유전적 거리 간의 상관성은 확인되지 않았다. 더욱 뚜렷한 지역 간 비교를 위해서 남부지역뿐 아니라 우리나라 전역을 대상으로 한 추가적인 연구가 필요하다고 생각한다.

검색어: 털뿔가지나방(*Alcis angulifera*), *COI*, 유전적 다양성

* 본 논문은 정부(환경부)의 재원으로 국립생물자원관의 지원을 받아 작성하였습니다(NIBR202333201).

P126

Increasing of the expression efficiency by over-expression of actin in baculovirus expression system

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Actin is a type of cytoskeleton and is known to be involved in organelle movement, and gene transcription. Recently, it has been reported that actin is an important role in the initiation of gene transcription by *p10* and *polh* promoters used in the baculovirus expression system (BES). In this study, we tried to increase the production of recombinant proteins in BES through over-expression of actin. For this purpose, the expression efficiency of the recombinant protein was evaluated according to the level of actin over-expression. To evaluate the effect of actin over-expression, recombinant viruses expressing fluorescent proteins under the *p10* or *polh* promoter were generated. By comparatively evaluation the fluorescence intensities of these recombinant viruses, the increase in the expression efficiency of BES by actin was confirmed.

Key words: Baculovirus expression system, Actin, *p10* promoter, *polh* promoter

P127

Effect of green tea leaf powder supplemented food sources on the growth of *Protaetia brevitarsis* larvae

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In order to investigate the effect of green tea leaf powder feeding on the development, nutrition, and safety of larvae of *Protaetia brevitarsis* larvae weight, survival rate, nutrients, and harmful substances were comparatively analyzed. When fermented oak sawdust was fed with 5% green tea leaf powder (GT) and 10% brewer's spent grain (BSG), the weight of larvae increased 1.4-4.6 times compared to fermented oak sawdust (control group), and the survival rate of larvae was more than 90% in all groups before cocoon formation. As a result of nutritional analysis, 5% GT and 10% BSG increased protein content by 1.1 times and dietary fiber by 7.9 times compared to the control group. The mineral content increased 3.8-5.1 times in calcium and 13.6-13.9 times in zinc in the 5% GT and 10% BSG. The heavy metal content was in accordance with the heavy metal control standards for edible insects in all groups, and no pathogenic microorganisms were detected. In view of the above results, the food source containing green tea leaf powder contains various nutrients, and safety is also proven, and it has an effect of promoting the development of larvae.

Key words: *Protaetia brevitarsis*, supplemented food source, green tea leaf powder

P128

Thrips on imported cut flowers and seedlings in Korea during 2001-2020

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농림축산검역본부 병해충정보시스템(PIS)을 이용하여 최근 20년간(2001~2020년) 수입된 절화류와 묘목류를 대상으로 검출건수를 기반으로 품목별, 국가별로 총채벌레목 해충의 검출동향을 분석하였다. 수입된 절화류에서 검출된 해충은 총 464종 13,659건이며 그중 총채벌레목은 46종 6,727건이다. 전체 검출건수의 약 50%에 해당하며 2011년 이후 꾸준히 증가하였다. 가장 많이 검출된 총채벌레는 *Frankliniella occidentalis* (2,393건), *F.intonsa* (1,027건), *Thrips tabaci* (1,564건), 가 74% 이상 차지하였으며, 국화와 카네이션 절화에서 가장 많이 검출되었다. 묘목류에서는 675종 7,831건의 해충이 검출되었으며 그중 15종 71건이 총채벌레목으로 *T. tabaci* (9건), *F. occidentalis* (3건), *Gynaikothrips ficorum* (7건)이 고무나무묘목과 동양란묘에서 주로 관찰되었다. 수입 절화류에서 검출된 총채벌레목은 관리해충 19종, 잠정규제 8종, 비검역 19종이었으며 묘목류에서는 관리해충 5종, 잠정규제 3종, 비검역 7종이 검출되었다.

검색어: 식물검역, 병해충정보시스템(PIS), 수입 절화, 수입 묘목, 총채벌레



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Korean Society of Applied Entomology

P129

Taxonomic revision of the Tribe Clivinini Rafinesque, 1815 (Coleoptera, Carabidae) from the Korea

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Tribe Clivinini Rafinesque, 1815 has been recorded with 3 species, 2 subgenera, 1 genus in the Korea. This tribe is very diverse tribe including ground living and fossorial species of which the majority are hydrophile. As a result of comparing and confirming the taxonomic characteristics of the genus *Clivina*, belonging to the tribe Clivinini, t148

he three species showed morphological difference at the species level, and one new recorded species was found. In this study, taxonomic key, photographs of habitus, male genitalia, and redescrptions of each species are provided

Key words: Carabidae, Scaritinae, Clivinini, Taxonomic Key, Korea

P130

Not Presented

P131

Six new records of running crab spiders of the genus *Tibellus* Simon, 1875 with four new species (Araneae: Philodromidae) from Korea

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Hitherto, 49 species of the genus *Tibellus* Simon, 1875 of the Philodromidae Thorell, 1869 in the Araneae Clerck, 1757 have been recorded and only two species, *Tibellus oblongus* (Walckenaer, 1802) and *Tibellus orientis* Efimik, 1999, are distributed in Korea to date. The spider fauna of rice fields and reclaimed lands was intensively explored in 2015–2022 and six *Tibellus* spiders were collected; two of them are new to Korean spider fauna and four of them are indentified as new species. Four new species can be distinguished from the other *Tibellus* members by the structure of the female genitalia and the male palp. Present study taxonomically describes these six *Tibellus* spiders with diagnoses, measurements, morphological illustrations, and distribution map.

Key words: description, Korea, *Tibellus*, Philodromidae, taxonomy

P132

A study on two species of Pteromalidae parasitizing *Neodryinus typhlocybae* (Ashmead, 1893) (Hymenoptera: Dryinidae)

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Neodryinus typhlocybae, the natural enemy of *Metcalfa pruinosa*, which is currently a problem as an alien pest, is emerging as a biological control agent. However, in this study, it was confirmed that two species, *Spaniopus japonicus* and *Acroclisoides sinicus*, were hyperparasitism in *Neodryinus typhlocybae*. In this study, description and diagnostic illustration of *Spaniopus japonicus*, *Acroclisoides sinicus* are provided.

Key words: Pteromalidae, hyperparasitism, new host, *Neodryinus typhlocybae*

P133

A newly recorded species of the genus *Taeniogonalos* Schultz, 1906 (Hymenoptera: Trigonalidae: Trigonalinae) from Korea

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Taeniogonalos is small genus of the subfamily Trigonalidae. This genus comprises 53 recognized species in the world. Among them, the east palaearctic region 9 species have been recorded up to date. Biology of Trigonalid wasps is unusual, they laying eggs directly on the leaves or laying their host (sawfly larvae). Then, trigonalid wasps egg hatches and attacks any other parasitoid larvae: Hymenoptera (Ichneumonidae, Braconidae) or Diptera (Tachinidae). To date, only 4 species have been known from Korea: *T. fasciata*, *T. mongolica*, *T. subtruncata* and *T. tricolor* (Carmean & Kimsey, 1998; Lelej, 2003). In the present study, we report *T. flavoscutellata* (Chen, 1949) for the first time in Korea. We provide its diagnosis and photographs, also a key to the Korean species of genus *Taeniogonalos* is given.

Key words: Trigonalidae, New record, Hyperparasitoid, Braconidae

P134

Update on the National Lepidopteran Species of Korean Islands in Jeju

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거제도(Seogwipo)는 우리나라 남동단에 위치한 섬으로, 우리나라에서 두 번째로 큰 섬이다. 산림, 저수지, 해안지형 등 다양한 생태계가 밀집되어 상호작용하는 지역으로 곤충다양성이 높을 것으로 추측된다. 특히 거제도는 무늬박이제비나비, 남방오색나비와 같은 미접(길잃은 나비)이 관찰되거나 서식이 확인되는 등 외래생물의 유입 연구에 중요한 지역이다. 2017년 전국자연환경조사와 섬지역 곤충종목록에 따르면 거제도에서 확인되는 나비목은 총 227종이며, 이는 섬 크기가 비슷한 진도에서 확인된 나비목 760종에 비하여 나비목의 조사가 미비하였기 때문으로 보인다. 본 연구에서는 2021년 거제도 조사를 통해 총 21종의 나비목 곤충을 추가로 확인하였으며, 그중 미접으로 추정되는 *Euploea eunice* (Godart, 1819)를 확인하였다. 이는 거제도와 같은 섬 지역 곤충상 조사 및 미접과 같은 해외 유입종의 연구에 기초자료로 활용될 것으로 판단된다.

검색어: 섬, 생물다양성, 거제도, 나비목

P135

A New Record of aphid species, *Hyalopterus arundiniformis* (Hemiptera: Aphididae) in South Korea

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The genus *Hyalopterus* is known to have originated in the Mediterranean and generally distributed in Eurasia. Since three species in the genus *Hyalopterus* had been recorded worldwide, one species, *H. pruni*, was only recorded in Korea. Surveying aphid fauna, we recognized *Hyalopterus arundiniformis* for the first time in South Korea. We collected the species from *Prunus mume* in Gunsan. Here we report descriptions and illustrations of this species.

Key words: unrecorded species, aphids, *Hyalopterus*

P136

Taxonomic notes on the family Culicidae (Insecta: Diptera) from Korea

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Mosquitoes have worldwide distribution, comprising about 3,533 described species of 112 genera belonging to family Culicidae (Harbach, 2013). Mosquitoes are a serious pest that affect both wild and domestic animals, including human beings. The first systematic study of Korean mosquito species was provided by Lee (1971), with record of 47 species of nine genera. Up to now, 54 species of 22 genera belonging to three subfamilies of Culicidae are known from Korea.

Key words: Insect, mosquitoes, Korean peninsula, faunistic list

P137

Taxonomic notes of *Spilonota* Stephens (Lepidoptera: Tortricidae: Olethreutinae) in Korea

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The genus *Spilonota* Stephens is belonging to the tribe Eucosmini, subfamily Olethreutinae. *Spilonota* was established by Stephens (1829), based on the type species *Tortrix ocellana* ([Denis & Schiffermüller], 1775), it consist of 41 described species in the worldwide (Brown *et al.*, 2018), mainly distributed in East Asia. In Korea, five species have been recorded until now: *S. albicana* (Motschulsky, 1866), *S. eremitana* Moriuti, 1972, *S. lechriaspis* Meyrick, 1932, *S. ocellana* ([Denis & Schiffermüller], 1775) and *S. semirufana* (Christoph, 1882). In this study, we provide a checklist of Korean *Spilonota*, with information of host plants and distribution for each examined species.

Key words: Lepidoptera, leaf roller moth, distribution, host plant, taxonomy

P138

An updated checklist of *Olethreutes* (Lepidoptera: Tortricoidea: Tortricidae) in South Korea

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The genus *Olethreutes* was established by Hübner (1822), based on the type species *Phalaena arcuella* Clerck, 1759. This genus is largest group of the subfamily Olethreutinae and more than 230 species described in the worldwide.

Up to date, about 21 species have been reported in South Korea. In this study, we provide an updated checklist of South Korean *Olethreutes* with a new species, *O. oculata* Kim, Byun et Bae. Illustrations of adults of examined species are provided.

Key words: Olethreutinae, distribution, Palearctic Region, taxonomy

P139

Taxonomic notes on the subfamily Arctiinae (Lepidoptera: Noctuoidea: Erebidae) from Korea

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The subfamily Arctiinae is one of the most species-rich groups in the family Erebidae, about 11,000 described species in 750 genera have been described from all over the world (Heppner 2005). Most recent study of Korean arctiine had been provided by Bayarsaikhan *et al.* (2017) with illustrated catalogue of 71 species in 39 genera belonging to three tribes. Recently, one new species, three newly recorded species and one new combination are provided by Bayarsaikhan *et al.* (2020, 2022a, 2022b), Choi *et al.* (2021), and Volynkin and Saldaitis (2022). Therefore, at the moment 74 species from 38 genera and three tribes are confirmed in South Korea.

Key words: Insect, tiger moth, updated faunistic list, Palaearctic region

P140

Taxonomic notes on the genus *Termioptycha* Meyrick, 1889 (Lepidoptera, Pyralidae, Epipaschiinae) in Korea

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The genus *Termioptycha* was established by Meyrick, 1889, with type species *Termioptycha cyanopa* Meyrick, 1889. It consists of 16 described species (Nuss *et al.*, 2003–2023) in the world. In this study, we provide all Korean *Termioptycha* based on the external characters, with information of host plants and illustrations of adults. Additionally, one *Termioptycha* is newly recorded in Korea.

Key words: Lepidoptera, Pyraloidea, taxonomy, new record, host plants

P141

***Acrotrichis (Flachiana) similaris* Sundt and *Acrotrichis (Flachiana) yazakii* Sundt
(Coleoptera: Ptiliidae) new to Korea**

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The genus *Acrotrichis* Motschulsky, 1848 is the largest genus of the family Ptiliidae Erichson, 1845, with 233 valid species worldwide. Currently, four subgenera are recognized in the genus. Among the genus *Acrotrichis*, 10 species belong to subgenus *Flachiana* Sundt, 1969. *Flachiana* species are distinguished from other subgenera based on broad, domed, and strongly curved rearward pronotum, extended apical parts of aedeagus, as well as not rudimentary spermatheca. In Korea, only one species *Acrotrichis (Flachiana) lewisii* (Matthews, 1884) is recorded, although seven species have been recorded in neighboring country, Japan. In this study, we report two additional species of the subgenus *Flachiana*, *Acrotrichis (Flachiana) similaris* Sundt, 1969 and *Acrotrichis (Flachiana) yazakii* Sundt, 1969 from Korea for the first time.

Key words: *Acrotrichis*; *Flachiana*; new records; featherwing beetle; taxonomy

P142

**First report of the genus *Semioscopis* and two species of Gelechioidea (Lepidoptera)
from Korea**

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We report the presence of the genus *Semioscopis* Hübner, 1825 and two species of the superfamily Gelechioidea for the first time in Korea. The two species are *Semioscopis japonicella* Saito, 1989 (Depressariidae) and *Dichomeris syndyas* Meyrick, 1926 (Gelechiidae). In addition, we provide redescription and diagnostic characteristics for each species, based on previous descriptions and additional morphological data acquired.

Key words: flat-bodied moths, twirler moths, Korean fauna, Korean peninsula, new record

P143

First record of the genus *Eriostethus* (Hymenoptera, Ichneumonidae, Pimplinae) from South Korea

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The subfamily Pimplinae is a moderately large group of parasitoid wasps which is, comprising more than 1,730 species in 77 genera within three tribes, Delomeristini, Ephialtini, and Pimplini, worldwide. Among them, tribe Ephialtini are endo- and ectoparasitoids of Lepidoptera, Coleoptera, Hymenoptera, and Araneae. The genus *Eriostethus* Morley, 1914 belongs to Ephialtini which is, 88 species in 26 genera have been reported from South Korea. In this study, a newly species of the genus *Eriostethus* and this genus are studied for the first time from South Korea. Diagnosis of *E. rufus* with photographs is provided.

Key words: Ephialtini, new records, parasitoids, wasps

P144

New host plant of *Charops striatus* (Hymenoptera, Ichneumonidae, Campopleginae) from South Korea

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Campopleginae is one of the two largest ichneumonid radiations of parasitoids of Lepidoptera. More than 2,100 described species in 66 genera have been recorded worldwide. The genus *Charops* Holmgren, 1859 is a small group of endo-parasitoid wasps which is comprising 30 species in worldwide. The host plant of *Charops striatus*, *Hibiscus syriacus* (Malvales: Malvaceae), was recorded from South Korea by Choi and Lee (2008). In this study, add a new host plant and redescription of *Charops striatus* with photographs are provided.

Key words: host plant, new records, parasitoids, wasps

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P145

The first record of *Setylaides* Stebnicka (Coleoptera: Scarabaeidae: Aphodiinae) in Korea

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The genus *Setylaides* Stebnicka is reported for the first time in the Korean Peninsula. While working on Korean Aphodiinae, we identified *Setylaides tsujii* Kakizoe, Kawahara & Ochi from the Chungnam National University Insect Collection. This species was found in the southern region of the Korean Peninsula. A key to the Eupariini species in Korea and illustrations of habitus and diagnostic characters are provided to facilitate identification.

Key words: saprophagous, Aphodiinae, Eupariini, *Setylaides*, new record

P146

A taxonomic review of the order Blattodea in Korea based on morphological characters

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A taxonomic study of Korean Blattodea is present. Eleven species [*Pycnoscelus surinamensis* (Linnaeus), *Asiablatta kyotensis* (Asahina), *Blattella germanica* (Linnaeus), *B. nipponica* Asahina, *Symploce striata* (Shiraki), *Margattea nimbata* (Shelford), *Periplaneta americana* (Linnaeus), *P. fuliginosa* Serville, *P. japonica* Karny, *Cryptocercus kyebangensis* Grandcolas, *C. relictus* Bey-Bienko] belonging to seven genera in five families are recognized based on morphological characters. A pictorial key, habitus photographs and illustrations of the diagnostic characters of Korean Blattodea species are provided to facilitate identification.

Key words: Blattodea, cockroach, taxonomy, review, pictorial key

P147

A new species of the genus *Bryaxis* Kugelann (Coleoptera: Staphylinidae: Pselaphinae) in Korea

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The largest pselaphine genus *Bryaxis* Kugelann, 1794 composed of approximately 416 species. Most species of the *Bryaxis* (362 spp.) were distributed in Palaearctic region. Male adults of this genus are generally characterized by the enlarged first or second antennomere with glandular nodule. In Korea, Löbl (1974) first recorded this genus based on two species, *B. pawlowskii* and *B. validicornides*, and Nomura and Lee (1992, 1993) revised the genus *Bryaxis* in South Korea. Currently, fourteen species are recorded in Korea, eleven of which are endemic. In this study, we report a new species of the genus *Bryaxis* represented by three specimens from Chungbuk National University Insect Collection (CBNUIC). The specimens were collected by sifting soil and leaf litter. Illustrations of habitus, diagnostic characters including aedeagus, a distribution map are also provided.

Key words: *Bryaxis*, pselaphine beetle, new species, Korea, taxonomy

P148

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

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The genus *Boucekiella depressa* Hoffer, 1954 belonging to the family Encyrtidae is known to include only one species worldwide. This genus is a parasitic wasp on scale insects. *Boucekiella depressa* Hoffer, 1954 is recognized for the first time in South Korea. This species was collected from *Phragmites communis* in Gunsan, South Korea. *Boucekiella depressa* is characterized by a very flattened body and black patterned wings. Descriptions, diagnosis, distribution and illustration are provided.

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

P149

Review of the Korean species of the tribe Bythinoplectini Schaufuss, 1890 (Coleoptera: Staphylinidae: Pselaphinae)

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The tribe Bythinoplectini Schaufuss, 1890 (Staphylinidae: Pselaphinae: Euplectitae) includes only one species, *Parapyxidicerus carinatus* Sawada, 1964 in South Korea. Three new species, *Zethopsus* sp. **new species**, *Euplectomorphus* sp. **new species**, and *Parapyxidicerus* sp. **new species**, are described from the Korean Peninsula. An additional species, *Parapyxidicerus carinatus*, is redescribed. As a result, the number of Korean species of Bythinoplectini is increased to four.

Key words: Ant-loving beetle, Palearctic, New species, *Parapyxidicerus*, *Zethopsus*, *Euplectomorphus*

P150

Preliminary study of the development of web-based identification system on diptera larvae for the plant quarantine inspection in Korea

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식물검역은 식물에 해를 주는 병·해충이 국경을 넘어 유입되는 것을 방지하는 것을 목적으로 한다. 본 연구는 식물검역 과정에서 나올 수 있는 파리목 유충을 신속하고 효과적으로 동정하여 식물에 피해를 주는 종을 판별하는데 필요한 기초자료를 제공하는 것이다. 파리목은 전 세계에 161과 16만 종 이상 기록되어 있으며, 형태와 습성이 매우 다양하다. 파리는 농업 분야에서 매우 중요한 해충이며, 특히 과실파리과는 성충과 유충 시기에 다양한 식물 및 과일을 공격하여 매년 막대한 경제적인 피해를 주고 있다. 식물에 피해를 주는 것으로 알려진 파리목은 40과 이상으로 알려져 있다. 하지만 식물검역 과정에서는 더 많은 분류군이 검출되었고 검출 빈도도 매년 증가하고 있다. 우리는 식물검역 과정에서 해외로부터 유입될 수 있는 파리목 60과를 선정하였으며, 신속하고 효과적인 동정을 위해 각 분류군의 과별 도해집을 만들고 루시드 프로그램을 이용한 대화형 검색표를 제작하고 있다. 이번 발표에서는 파리목 중 식물검역 과정에서 유입 가능한 60과의 리스트와 모기아목(Nematocera) 14과의 대화형 검색표를 제공한다.

검색어: 식물검역, 파리목, 유충, 도해집, 대화형 검색표

P151

Overwintering conditions of the differential grasshopper, *Melanoplus differentialis* in Korea

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북미 원산인 빗살무늬미주메뚜기(*Melanoplus differentialis*)는 2020년 국내에 유입되었으며 현재까지 울산 일부지역에서 서식이 확인되고 있다. 토양 속에서 알로 월동하는 빗살무늬미주메뚜기는 국내 월동 환경에 대해 알려진 바가 없다. 이를 파악하기 위해 국내 유일한 서식지인 울산 온산항 일대 빗살무늬미주메뚜기 월동지에서 겨울철 지온을 측정하였다. 2020년, 2021년 월동 시기(12월~이듬해 3월)에 지온을 측정하였으며 평균값을 산출하였다. 조사결과 월평균 최저지온은 2020년 1월에 4.68°C, 2021년 1월에 6.10°C였고, 일평균 최저지온은 2020년 1월에 0.37°C, 2021년 12월에 2.30°C로 분석되어 겨울철 지온이 영하권으로 떨어지지 않았다. 빗살무늬미주메뚜기 서식지인 울산지역의 겨울철 평균 지온은 영상으로 비교적 온화한 것으로 파악되었다. 알로 월동하는 메뚜기류의 생존율은 겨울철 온도에 영향을 받는 것으로 알려져 있다. 기후변화로 인한 온도 상승은 외래곤충의 생존과 새로운 서식지로의 확산 가능성을 증가시킨다. 따라서 겨울철 기온 상승으로 인해 서식지인 울산 온산항 이외의 다른 유사한 서식지로 빗살무늬미주메뚜기의 확산이 가능할 것으로 예측되며, 이를 파악하기 위한 지속적인 모니터링이 이루어져야 할 필요가 있다.

검색어: 빗살무늬미주메뚜기, *Melanoplus differentialis*, 월동, 지온, HOB0

P152

Seasonal abundance pattern of *Delia antiqua* (Diptera: Anthomyiidae) in climatically different regions

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고자리파리는 전 세계적으로 백합과에 속한 작물의 중요한 해충으로 양파, 마늘, 대파, 쪽파, 부추 등을 기주식물로 하고 있으며, 우리나라에서는 양파를 중심으로 마늘의 중요한 해충으로 알려져 있다. 유충이 지하부를 가해하기 때문에 방제가 어려워 토양살충제를 과다하게 투입하는 요인이 되기도 한다. 백색점착트랩(원통형)을 이용하여 제주지역에서 성충의 연간 유살량 변동을 조사한 결과 (2021~2022년) 특이한 발생양상이 발견되었다. 성충은 4월 중순부터 발생이 증가하기 시작하여 5월 중순에서 6월 중순경에 발생최성기를 보였고, 여름철이 시작되면서 발생이 중단되었다. 우리나라 진주 등에서 여름철 발생 중단 후 가을철에 9월 상중순부터 10월 말까지 재발생을 보이는 것과는 크게 다르게 제주에서는 가을철에 유의미한 발생피크가 형성되지 않았다. 우리나라보다 고위도에 있는 미국 제네바, 캐나다 온타리오, 독일 파덴부르크 등 지역의 발생양상과 비교한 결과 이들 지역에서는 여름철 발생이 중단되는 현상이 크게 나타나지 않았다. 이러한 현상은 고자리파리의 하면생태와 여름철 온도(고온) 간 상호작용에 의한 것으로 추정되었다.

검색어: 고자리파리, 마늘 양파해충, 페놀로지, 발생소장, 기상환경

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Thermal requirements for the development of *Spodoptera litura* (Lepidoptera: Noctuidae): Natural host vs artificial medium

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The tobacco cutworm, *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae), is a highly polyphagous and destructive insect pest, damaging a wide range of vegetables and field crops in Korea. This study examined the effects of temperatures (15, 20, 25, 27, 30, 35, and 40°C), on the development of *S. litura* on the natural host (maize) and the artificial medium. Stage-specific parameters such as threshold development temperature (LDT) and thermal constant (K) were determined by linear (GLM) and nonlinear (Sharpe Schoolfield Ikemoto) models, respectively. The total developmental time (egg-adult) decreased with increasing temperature on natural host and with an artificial medium. The findings of this study can be used to predict the number of generations, spring emergence, and population dynamics of *S. litura*.

Key words: Tobacco cutworm, mathematical models, spring emergence, forecasting, management

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P154

Flight capability of *Monochamus alternatus* estimated in computerized flight mills

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Genus *Monochamus* beetles are main vector species of pine wood nematode (PWN) and play an important role in the spread of pine wilt disease (PWD). Effective management of PWD requires knowledge of *Monochamus* beetle dispersal behavior. Therefore, we investigated the flight capability of *M. alternatus* (Coleoptera: Cerambycidae), a native species of East Asia including Korea, using a computerized flight mill. Flight distance and time of emerged adult beetles were measured individually during 2-hour experiments that were conducted once a week for eight weeks that is about whole life span of adults. We also analyzed the influence of biological characteristics of beetles on flight capability. During their lifespan, 85% of beetles flew up to 16km, with a maximum flight distance of 29km. While there were no significant differences in the total cumulated distance between sexes, there were variations in the distance flown based on age. For cumulated flight distance per session, there was significant difference between sexes. Flight velocity of fliers (cumulated flight distance per session > 100 m) was negatively influenced by thorax height.

Key words: dispersal capability, pine wilt disease, Coleoptera, Cerambycidae

P155

Survey of major plant-parasitic nematodes in regional specialized crops

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최근 지역특화작물에 대한 경제적 가치가 향상되고, 1시군 1특화작목 육성 등 정책적으로도 지원이 확대되고 있다. 전북지역의 땅콩 재배면적은 625 ha로 전국의 15.3% 수준이며, 생강 재배면적은 296 ha로 전국의 14.8%를 차지하는 지역 특화작물이다. 땅콩과 생강의 식물기생선충 종류별 지리적 발생분포, 발생빈도 및 피해 분석 등을 포함한 실태 조사 연구는 미비한 실정이다. 이에 본 연구는 땅콩과 생강에 발생하는 식물기생선충의 종류와 발생분포 등을 조사하여 작물의 안정생산을 뒷받침하기 위한 기초자료로 확보하고자 하였다. 2020년부터 2022년까지 3년 동안 전북지역 땅콩재배지 66 지점을 조사한 결과, 18지점이 나선선충, 뿌리혹선충, 참선충에 감염되었다. 재배 시기별 발생양상은 7~8월에 발생이 많았으며 연작 재배지에서 뿌리혹선충이 우점하는 것으로 나타났다. 또한 사질토양에서 뿌리혹선충 밀도가 높았다. 생강재배지는 뿌리썩이선충이 가장 많았으며 고도 21~50m에서 밀도가 가장 높았다. 토성에 따른 식물기생선충의 종별 밀도와 포장 검출률을 조사한 결과, 포장 검출률은 양토, 미사질식양토, 식양토에서 검출되었으며 양토에서 뿌리썩이선충의 밀도가 높았다.

검색어: 지역특화작물, 땅콩, 생강, 뿌리혹선충

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Seasonal occurrence and damage of *Scirotothrips dorsalis* to kiwifruit in plastic-film house in Jeju, Korea

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최근 제주지역 시설재배 키위에서 볼록총채벌레에 의한 피해가 증가함에 따라 2022년 도내 키위 과수원을 대상으로 발생 및 피해특징을 조사하였다. 시설 내에서 월동한 볼록총채벌레는 2월 하순~3월 중순 비산하여 기주식물로 이동하는 것으로 나타났으며, 주 발생 시기는 7~10월로 판단되었다. 특히, 농약안전사용기준으로 수확 전 약제를 살포하지 않는 9월부터 10월까지 밀도가 급증하는 경향을 보였다. 키위 잎에서의 전형적인 피해 증상은 밝은 갈색~흑갈색 부정형 무늬였으며, 잎이 전개되기 시작하는 단계에 피해를 받는 경우 뒤틀리거나 찢어지는 증상도 함께 발생하였다. 과실에서의 피해는 비대초기 검은색 점무늬로 나타났다가 수확기에는 갈색~검은색 얼룩으로 보이는 특징이 있어 다른 피해 증상으로 오인할 여지가 있었다. 키위 종류에 따라 레드, 골드, 그린 순으로 피해 증상이 확연하게 관찰되었다. 볼록총채벌레로 인한 키위 과실 피해는 관행 과수원에서 24~33.5%였으며, 그 중 비상품 분류가 우려되는 과실이 3.5~5.5%로 나타나 시기별 발생 양상을 고려한 적절한 방제전략 수립이 요구된다.

검색어: 볼록총채벌레, 생태, 월동, 발생시기, 피해증상

P157

Status of invasive alien insects with habitat in natural ecosystem

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2019년부터 2021년까지 3차(19년 충청, 전라, 대전, 광주), (20년 경상, 부산, 대구, 울산), (21년 경기, 강원, 서울, 인천)에 걸쳐 자연생태계에서 발견되는 외래곤충 서식현황을 조사하였다. 그 결과 총 9목 49과 77종의 외래곤충이 확인되었다. 분류군별로는 노린재목이 27종으로 가장 많았고, 딱정벌레목 14종, 나비목 11종 순으로 확인되었다. 지역별로는 경상남도에서 55종으로 가장 많은 외래곤충이 발견되었고, 전라북도과 충청북도에서 각각 25종의 외래곤충이 발견되었다. 외래곤충의 서식지 유형을 PC-ORD를 이용하여 군집분석을 하였을 때, 습지, 수변, 계곡 등 물과 가까운 환경보다 건조하고 교란된 환경(공원, 거주지, 도로변, 경작지 등)에서 더 많은 외래곤충이 서식하는 것으로 확인되었다.

검색어: Invasive alien insects, Nationwide Survey of Non-native Species, Cluster analysis

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Adult emergence seasons of *Ostrinia furnacalis* (Lepidoptera: Crambidae) in the northernmost regions of Rep. Korea

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The Asian corn borer, *Ostrinia furnacalis*, is the most destructive pest against maize (*Zea mays*) in Asia. We investigated the occurrence seasons of the pest using its sex pheromone trap in Baengnyeong-do (westernmost), Goseong (easternmost), and Yeoncheon (middle of the two regions) of three northernmost areas, Rep. Korea. Three batches of adult emergence seasons were observed in all the three regions in a year. The seasons were covered by the first emergence period from early May to mid-July, the second from early July to late August, and the third from mid-August to mid-October. The trivoltinism was supported by a phenology modelling for this insect in each region. Estimation of 50% emergence dates of overwintering generation using Sharpe-Schoolfield (thermodynamic) and Logan-6 development rate models showed a discrepancy of 0~20 days from the observed dates. A phenology modelling through full insect stages (based on Lactin-2 development rate model) for 50% emergence dates of the second and third seasons showed a discrepancy of 0~19 days to the observed dates.

Key words: *Ostrinia furnacalis*, Korean northernmost regions, sex pheromone trapping, annual emergence

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Estimation of voltinism of *Sesamia inferens* (Lepidoptera: Noctuidae) in Korea

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The Asiatic pink stem borer, *Sesamia inferens* is a pest which attacks stems of rice and maize. In this study, we investigated the adult emergence season of the insect in several regions, and analyzed voltinism using a single sine degree-day model with 10.74°C for the lower development threshold and 687.90 degree-day for the accumulated effective temperature for complete development of immature stages. The adult trapping results confirmed the fact that the insect can be detected in all areas of South Korea. It was estimated that the populations in Baengnyeong-do, the westernmost and northernmost island, showed bi- or trivoltine properties depending on the corresponding temperatures of different years. Direct accumulation of degree-days expected the fourth emergence after the third one in Gimhae, Milyang and Gimje regions, although the actual adult emergences during the seasons have not been validated.

Key words: *Sesamia inferens*, adult trapping, annual emergence, voltinism, degree-day model

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Characteristics of pollinator inflow according to environmental factors (temperature, humidity, illumination) of *Adonis pseudoamurensis*, *Amsonia elliptica* and *Dendranthema zawadskii* on Garden in the Korea National Arboretum

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화분매개곤충은 생태계에서 중요한 역할을 하지만 기후변화 등의 외부요인으로 점차 종 다양성이 쇠퇴하고 있다. 따라서 본 연구에서는 국립수목원 전시원 내 식재되어있는 식물 3종(개복수초, 정향풀, 울릉국화)을 대상으로 유입되는 화분매개곤충과 환경요인에 따른 생태적 특성을 파악하여 종 보존을 위한 자료를 제공하고자 하였다. 2022년 각 식물 군락의 꽃이 70% 이상 개화하였을 때, 오전과 오후로 나누어 5일 동안 총 10회 조사하였으며, 포충망을 활용하여 채집하였고, 동시에 온습도계(DM-303)와 조도계(TES-1334A)를 활용하여 환경요인(온도, 습도, 조도)을 측정하였다. 그 결과 각 식물의 우점종은 개복수초에서 양봉꿀벌, 정향풀에서 호리꽃등에, 울릉국화에서 점박이꽃검정파리로 나타났다. 환경요인과 우점종의 출현 개체수 변화를 시간의 흐름에 따라 비교해보면 호리꽃등에의 출현 개체수는 습도와 비슷한 변화 양상을 보였으며, 점박이꽃검정파리의 출현 개체수는 온도와 조도와 비슷한 변화 양상을 보였다.

검색어: 화분매개곤충, 개복수초, 정향풀, 울릉국화, 온도, 습도, 조도

P161

Changes in soil microbial community structure by *Allonychiurus kimi* (Collembola) and their effects on glyphosate degradation

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Collembola are involved in various soil ecosystem functions, but the role of Collembola in organic contaminant degradation has not been sufficiently studied to assess its contribution. This study investigates changes in the microbial community in glyphosate-contaminated soils inoculated with different densities of *Allonychiurus kimi* (Lee, 1973) (0, 10, and 30 per 30 g of soil) and the subsequent effects on glyphosate degradation. Our study determined that the presence of *A. kimi* altered the microbial community structure and accelerated the degradation of glyphosate in soil.

Key words: Organic contaminants, Interaction, PLFA, Glyphosate-based herbicide, Soil process

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Predicting metamorphosis of dragonfly larvae in rice fields considering irrigation period

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논에 서식하는 잠자리의 활동은 물대기 시기에 영향을 받으며, 유충의 우화시기를 추정하기 위해서는 이를 고려해야 한다. 잠자리 우화는 천적기능이 공간적으로 수서에서 육상으로 전환되는 시점으로 기후변화 생물계절 모니터링을 위한 지표로 중요하다. 논에서 우점종인 된장잠자리와 고추잠자리를 대상으로 유충의 사육실험을 통해 두폭에 따라 우화까지 소요되는 적산온도를 측정하여 우화시기를 추정하였다. 물대기 시기는 전라북도 지역에서 주로 재배하는 중만생종 벼를 대상으로 지역별 일평균기온 자료를 이용하여 출수일과 모내기 시기를 순차적으로 계산하였다. 이러한 결과는 온난화와 논 물관리 변화에 따른 잠자리 유충의 우화시기 변동 예측에 활용할 수 있다.

검색어: 논, 물대기, 잠자리, 우화, 적산온도, 기후변화

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Larva occurrence according to release times of fall armyworm adults on corn field

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열대거세미나방은 아메리카의 아열대지역이 원산지인 해충으로 2019년 국내에 첫 비래한 이후 매년 국내로 비래하여 옥수수 등 벼과작물에 피해를 주고 있다. 열대거세미나방 유충은 성장함에 따라 옥수수 내부로 들어가는 경향이 있고, 노숙유충은 방제효과가 낮아 어린 유충시기에 방제하는 것이 효과적이다. 따라서 열대거세미나방의 효과적인 방제를 위하여 비래 이후 유충 영기변화 양상을 구명하여 방제적기를 설정하는 것이 중요하다. 열대거세미나방은 4월 하순부터 비래하는 것으로 보고되어 있으므로 5~6엽기의 옥수수 포장에 망실을 설치한 후 비래시기에 맞추어 2022년 4월 30일, 5월 7일, 5월 25일에 성충 3쌍을 방사한 결과, 4령 유충이 4월 30일 방사구에서는 방사 23일, 5월 7일 방사구는 방사 19일, 5월 25일 방사구는 15일 이후 관찰되었다. 따라서 열대거세미나방 유충 방제적기는 5월 상순비래시 비래 후 3주 이내, 5월 하순 비래시 비래 후 2주 이내로 판단되었다.

검색어: 열대거세미나방, 옥수수, 방제적기

P164

Diversity and relationship between mycophagous insects and mushrooms in Korea

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Insects have diverse and unique ecological characteristics, as many recorded species from the world. A large proportion of them are phytophagous while some are predaceous, saprophagous and mycophagous. In particular, mycophagous insects are the ones feeding in various mushroom. In the present presentation, we introduce a study to investigate the diversity of the mycophagous insects and their relationships with mushrooms. For the present study, we collected 65 species of mushrooms from the fields and reared them until mycophagous insects emerged under the laboratory condition. As a result, we identified a total of 1,783 individuals, 84 species, including 7 newly recorded species. Based on our results, we compiled a species list and a relationship graph of insect pests for each host mushrooms.

Key words: mycophagous, fungi, mushroom

P165

Parasitism survey of *Anastatus orientalis* (Hymenoptera: Eupelmidae), released for biological control of spotted lanternfly by RDA

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Since there had been no survey data after release of *A. orientalis* by RDA, the parasitic rate and emerging rate were investigated through a field surveys. A total of eight field surveys were conducted once a month from March to October in 2022, and patterns of emergence and parasitism were observed through collected spotted lanternfly (SLF, *Lycorma delicatula*) eggmasses. In the 1st~4th field survey, more than 30 eggmasses were collected, but none were collected in the 5th~6th because only hatched eggmasses were found. In the 7th~8th, SLFs were laying new eggs, and it was observed that those were parasitized by *A. orientalis*. The average parasitic rates of 1st~4th were 90.22%, 87.91%, 12.57%, and 80.5%, respectively, and the hatch failure rates were 1.29%, 3.47%, 0.83% and 3.31%, respectively.

Key words: egg parasitoid, field investigation, natural enemy

P166

Investigating the occurrence of *Lepidoptera* pests in Gangwon, Gyeongsang, and Jeolla provinces at 2022

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The *Lepidoptera* pests, especially *Helicoverpa armigera* (BAW) and *Spodoptera exigua* (CBW) are causing severe damage on crop production field for the fast adaptation. We tried to investigate the occurrence of these pests in Gangwon, Gyeongsang, and Jeolla provinces. The occurrence peak of BAW was noticed first at May 23rd in Wanju, early June in Andong, and June 20th in Jinbu, respectively. In case of CBW, that was at May 23rd in Wanju and July 7th in Jinbu, not in Andong and Seongju county of Gyeongsang province. The peak number of BAW was 9, 3~4, 3 at each fields. That of CBW was 2, 0, 1~2. The occurrence of CBW was noticed in Hongcheon and Hoengseong county where possessing big corn production field. We found the occurrence of BAW was dependent on the temperature and the number of BAW was not reduced after the pesticide application at Hoengseong county.

Key words: Lepidoptera pest, BAW, CBW, Gangwon, Gyeongsang, Jeolla

P167

Major pests and damage symptoms of mango and banana in Jeollanamdo province

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기후변화에 따른 전남지역 아열대 작물의 재배 면적이 2022년 기준 망고 60농가 18.9ha, 바나나 10농가 2.5ha로 증가하고 있으나, 관련 해충 정보 부족으로 농가들이 어려움을 겪는 실정이다. 따라서 본 연구는 전남지역 망고와 바나나의 주요 해충 정보를 농가에 제공하고자 조사하였다. 육안조사 또는 황색끈끈이트랩을 설치하여 발생 해충 종류, 발생량, 피해 증상 등을 조사한 결과, 망고의 주요 해충은 볼록총채벌레(*Scirtothrips dorsalis*) 등 2종이 발생하였고 볼록총채벌레가 망고의 신초를 가해하여 기형화, 열매를 가해하여 갈변 및 코르크화 된다. 바나나의 주요 해충은 차응애(*Tetranychus kanzawai*) 등 3종이 발생하였고 차응애 피해 증상은 잎 표면의 색이 탁해지고 심할 경우 잎이 마른다. 본 연구를 통해 전남지역 망고와 바나나 재배 농가에 주요 해충 종류 및 피해 증상에 관한 정보를 제공하고, 해충 방제용 농약 등록 및 유기농업자재 선발을 위한 기초자료로 활용하고자 한다.

검색어: 아열대, 바나나, 망고, 해충, 방제

P168

Surveillance of sporadic and subtropical insect pests in Jeollanamdo province

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본 연구는 전남지역에서 발생하는 돌발 해충과 남방계 해충의 발생 정보를 농민들에게 제공하고 자 발생실태를 조사하였다. 전남 18개 시군에서 돌발 해충인 미국선녀벌레는 감나무를 기주식물로 육안 조사, 남방계 해충인 썩덩나무노린재, 담배거세미나방은 콩을 기주식물로 페로몬 트랩을 설치하여 발생 밀도를 조사하였다. 미국선녀벌레는 장성, 곡성, 영암에서 발생했으며 전남 평균 약충기에 가지당 0.2마리, 성충기에 가지당 0.2마리 발생하였다. 썩덩나무노린재는 영광, 담양, 나주, 영암 등에서 발생 밀도가 높았으며 전남 평균 7월에 트랩당 11마리, 성충기에 트랩당 21마리 발생하였고, 담배 거세미나방은 나주, 화순, 강진, 해남 등에서 발생 밀도가 높았으며 전남 평균 7월에 트랩당 110마리, 9월에 트랩당 62마리 발생하였다. 돌발 해충과 남방계 해충의 발생 밀도가 높은 지점은 대부분 주위에 방치된 밭이 있거나 산림 인근이었으며, 주위 식생이 다양하였다.

검색어: 전남지역, 돌발해충, 남방계해충, 발생실태

P169

Effects of temperature on the oviposition model of *Myzus persicae* (Sulzer) (Hemiptera: Aphididae)

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We evaluated the direct effect of eight different temperature conditions (6.5, 8.4, 11.3, 15.8, 18.9, 24.6, 30.2, and 32.4°C) on the longevity and fertility of green peach aphid, *Myzus persicae* for constructing temperature-dependent oviposition model, while being fed on cabbage. We investigated the adult longevity and fertility of *M. persicae* under teight different temperature conditions. Oviposition model was constructed by adult aging rate, age-specific survival, age-specific cumulative oviposition rate and temperature-dependent total fecundity models. The daily nymph production was simulated with respect to temperature conditions and adult age.

Key words: *Myzus persicae*, Fecundity, Longevity, Oviposition model, Temperature

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

P170

Effects of temperature on the development model of *Myzus persicae* (Sulzer) (Hemiptera: Aphididae)

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The green peach aphid, *Myzus persicae*, is one of the significant aphid pests of several crops, damaging various tissues of plants, and acting as a vector for the transport of plant viruses. We investigated the effects of temperature on development of *M. persicae* under different temperature conditions, 6.5, 8.4, 11.3, 15.8, 18.9, 24.6, 30.2, and 32.4°C, respectively. In this study, we collected detailed data on development periods of *M. persicae* under eight different temperatures. We constructed temperature-dependent development model of *M. persicae* and the adult emergence frequency over the full range of temperature was simulated.

Key words: *Myzus persicae*, Development, Modelling, Temperature

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

P171

Development of smart trap for unmanned prediction in fields

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The current prediction system mostly relies on manpower to conduct visual inspections. To develop unmanned prediction and pest control systems capable of making future pest control decisions, it is necessary to standardize the data and collect real-time data. This study is to develop a technology that automates pest trap prediction, uses deep-learning to identify and count pests from images. We performed image labeling work for about 2,000 images to identify and count pests, specifically the Fall Armyworm. We also collected additional images, including overlapping images, by taking pictures in batches of 10 pests at a time. We also collected additional images, including overlapping images, by taking pictures in batches of 10 pests at a time. It is based on the principle of trapping descending air currents with a constant power supply, enabling continuous acquisition of pest images of various organisms. The camera for capturing images was relocated under the suction fan to eliminate interference with the field of view during image capture. The structure was improved to prevent reinfestation by automatically ejecting and crushing pests after capture. The classification key was selected as the upper symmetrical pair of spots on the center of the wings and the pattern on the bottom. And each organism was labeled to be used in constructing the deep learning model. We plan to improve issues such as pest attraction reduction due to pheromone diffusion with future descending air current traps, and server errors in data transmission.

Key words: Smart trap, Occurrence amount, Unmanned forecasting

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P172

The effect of tobacco as a banker plant for natural enemy and a trap plant for white fly in tomato greenhouse

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This study was conducted to determine the feasibility of utilizing tobacco as a banker plant for *Nesidiocoris tenuis* and trap plant for *Bemisia tabaci* in the tomato greenhouse. Treatments with both tobacco and natural enemy tended to decrease the capture of *B. tabaci* in sticky traps compared to the natural enemy alone. Furthermore, the density of *N. tenuis* in tomato tended to be higher in the treatment with both tobacco and natural enemies than in the natural enemy alone, showing the potential use of *N. tenuis* as a banker plant. *B. tabaci* prefers over tomato. By utilizing this attractant effect, tobacco was treated with dinotefuran, a systemic effect pesticide, at recommended concentrations and placed in tomato greenhouse. The density of *B. tabaci* in the traps. *B. tabaci* density was found to be lower in the dinotefuran treatment compared to the control, confirming the possibility of controlling *B. tabaci* density without direct pesticide application to tomato. Future studies that utilize both natural enemies and tobacco treated with systemic effect pesticide are needed.

Key words: banker plant, trap plant, natural enemy, *Nesidiocoris tenuis*, *Bemisia tabaci*, tomato

P173

Evaluation of soybean banker plant for establishing of *Binodoxys communis* (Hymenoptera, Braconidae)

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We evaluated the availability of the soybean banker plant system(*Binodoxys communis* and *Aphis glycines*). *B. communis* has been known as a parasitoid for controlling the cotton aphids as well as the soybean aphid. For this banker plant system, approximately 50 soybean aphids(*A. glycines*, aphid starter population) were inoculated on a 2 week old soybean plant pot after sowing. After 3 days of aphid colony inoculation, 5 pairs of *B. communis* were released. From the 6th day of releasing, mummies were identified. The number of the *Binodoxys* breeding colony per banker plant was 348.7 on average and was maintained up to 18.8 days after releasing without the additional host aphid inoculation. For this soybean banker plant system to work effectively, the appropriate installation number and interval of banker plant system per acre must be investigated.

Key words: parasitoid, soybean aphid, cotton aphid, banker plant

P174

Susceptibility of pine wood nematode vectors to spraying using UAV

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The efficacy of spinetoram sprayed from an unmanned helicopter to control two insect vectors of pine wood nematodes, *Monochamus alternatus* and *M. saltuarius* was assessed. By using a ULV (Ultra Low Volume) sprayer, the mortality rates of phenthoate, bifenthrin, etofenprox, and diflubenzuron, which are registered for use against coleopteran insects, indoxacarb and spinetoram, which are registered for use against lepidopteran insects, were evaluated for efficacy as aerial spraying agents. The ULV test, using 33- and 55-fold dilutions of phenthoate, bifenthrin, indoxacarb, and spinetoram demonstrated a 100% insect mortality rate upon contact and feeding mortality on the third day after treatment, while etofenprox and diflubenzuron exhibited a slightly lower mortality rate than the remaining compounds. Consequently, spinetoram was selected as a candidate pesticide for aerial spraying and its efficacy to control the insect vectors was assessed. The x 33 dilution of spinetoram resulted in a 98.6-100% control efficacy against two insect vectors. However, risk assessment for bees following aerial spraying will be necessary before applying the pesticide to control insect vectors.

Key words: *Monochamus alternatus*, *Monochamus saltuarius*, Unmanned helicopter, Aerial control

P175

A survey on the usage status of agricultural antibiotics in Korea

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본 연구는 국내 농업인구의 변화와 농업용 항생제 사용량에 대해 분석하고자 하였다. 통계청 자료에 따른 최근 20년간 국내의 농업 인구는 감소하고 있으나 농업인의 중위연령이 높아지고 있어 농업인의 고령화가 심화되고 있다. 또한, 최근 귀농의 대한 관심의 증가와 베이비붐 세대의 은퇴로 인해 새로운 농업인의 유입이 증가하고 있다. 이로 인해 농작물에 발생하는 병해충에 대한 적절한 대응이 어려운 상태이다. 국내 등록된 농업용 항생제는 항세균성, 항곰팡이성, 항바이러스성 등으로 각 식물의 세균병, 곰팡이병, 바이러스병에 사용되고 있으며, 그 외에도 해충을 방제하기 위해 spinosad, spinetoram 등이 개발되어 사용되고 있다. 농업용 항생제의 전체 시장규모는 660억 원으로, 연간 300톤 이상이 생산되고 약 100개 이상의 농작물에서 항생제 사용이 추천되고 있으나, 농업인의 고령화 및 신규 농업인의 유입으로 전문성이 부족하여 사용량 초과, 혼용, 중복사용 등 부적절한 사용의 사례가 빈번히 발생되고 있다. 따라서, 본 연구에서는 국내 등록된 농업용 항생제의 사용량 등을 관리할 수 있는 관리 제도의 필요성을 제안하고자 한다.

검색어: 국내 농업인, 농업용 항생제, 농업인의 고령화, kasuganycin, streptomycin

P176

Effects of insect pheromones on *Varroa* mites (*Varroa jacobsoni*)

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Varroa mites (*Varroa jacobsoni*) cause economic damage to honey bees by feeding on their fat body and transmitting viruses. To manage these mites, pesticides were frequently used. However, various natural substances have been replaced due to the toxicity and side-effects of pesticides. Among these natural substances, we used insect pheromones to evaluate whether they can attract or repel *V. jacobsoni*. To test their effects, a filter-paper (diameter 9cm) with three circles (i.e., radius 3, 8.5, and 19cm from the center) was put in a petri-dish (diameter 9cm). Ten mites were put on the innermost circle and a pheromone was applied in the middle circle, in each replication. The location and number of these mites were checked at 0.5, 1, 2, 3, and 4 hours after the experimental setting. Among 21 tested pheromones, the Z8-12Ac showed the most attractive effect among all tested pheromones. Especially, this pheromone showed the highest attractive effects on mites at the relatively low concentration of 1/16. Thus, Z8-12Ac could be a good candidate for attraction experiments of *V. jacobsoni* in field conditions.

Key words: honey bee, *Varroa* mites, insect pheromone, attractants

P177

Rearing of the codling moth, *Cydia pomonella*, from Germany in quarantine pest reserach facility

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일말이나방류의 일종인 코드린나방은 국내에서 검역 대상으로 금지해충에 속해있다. 코드린나방의 유충은 과일 속으로 파고 들어가 살충제가 작용하기 어려운 난방제 해충이다. 따라서 검역을 통해 국내로 유입을 막는 것이 최선의 방제법이다. 현재 일말이나방류에 대한 예찰용 페로몬이 사용되고 있지만 개별 종에 대한 표적 예찰은 이뤄지지 않고 있다. 본 연구는 금지해충인 코드린나방의 성페로몬을 이용한 코드린나방 표적 예찰용 유인제 개선을 목표로 하고 있다. 현재 코드린나방은 국내에 분포하지 않아 독일의 Julius Kuhn Institute로부터 수입 후 검역해충실험동(25°C, 16L:8D, RH 60%)에서 계대사육하였다. 인공사료로 사육한 결과 부화에서 우화까지 약 30일 정도의 발육기간을 가지고 있었다. 산란 후 부화까지 5일, 용화까지 15~19일, 우화까지 5일의 시간이 소요되었다. 성충의 평균 수명은 14일이었으며, 교미 후 3일째부터 산란하였다. 사육된 개체들은 개발될 유인제의 유인력 효과검정을 위한 기초자료로 활용될 예정이다.

검색어: 코드린나방, 생활사, 금지해충, 성페로몬, 유인제

P178

The Susceptibility of red pepper chemical insecticides to *Aphis gossypii*

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목화진딧물은 기주 범위가 넓어 고추, 가지, 수박, 오이, 참외, 멜론, 무궁화, 석류, 부용, 국화, 장미 등 다양한 작물을 흡즙하여 작물생육과 상품성이 저하하고 CMV 등 50여 종의 식물 바이러스병을 매개하며 2차 피해가 확산된다. 해충 방제를 위한 장기간 무분별한 화학 약제 사용이 약제 저항성 발현 개체 출현과 다른 약제에 대한 교차저항성을 유발하여 농가 현장에서는 이로 인한 약제 효력 저하에 대한 의구심 증대와 함께 점차 사용할 수 있는 살충제 종류가 감소하여 해충 방제의 어려움을 호소하고 있다. 고추에 등록된 유기합성 살충제 39종에 대한 목화진딧물의 약제 감수성을 실내 검정한 결과 deltamethrin (합성피레로이드계) + profenofos (유기인계)와 esfenvalerate (합성피레로이드계)를 함유한 살충제가 살포 1일 후 100%, Lambda-cyhalothrin (합성피레로이드계) + sulfoxafloor (설폰시민계)는 92%의 살충효과를 나타냈다. 고추 재배 중 목화진딧물의 발생 밀도가 높을 경우 이러한 속효성 약제 살포로 효율적인 방제가 가능할 것으로 판단된다.

검색어 : Melon aphid, Insecticide, deltamethrin+profenofos, esfenvalerate

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Not Presented

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Influence of indoor rearing hosts on parasitic efficacy of *Telenomus remus* (Hymenoptera, Scelionidae) to control the target pest, *Spodoptera frugiperda*

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Prior to mass rearing and practical application of parasitoids, investigating of host preference is the most important factors for successful biological control. We obtained the egg parasitoid, *Telenomus remus* from parasitized *Spodoptera frugiperda* eggs collected from corn fields in South Korea. *T. remus* has been observed parasitizing eggs of three different species of *Spodoptera*. The host preference for oviposition of *T. remus* was high in the order of *S. litura* > *S. exigua* > *S. frugiperda*. Regardless of host species on which this parasitoid was reared, *T. remus* female completely preferred to oviposit on the *S. litura* eggs in the 2 choice test between *S. litura* and *S. frugiperda*. When *T. remus* females reared on *litura* or *frugiperda* eggs were exposed to eggs of *S. frugiperda*, average parasitisms were 32.6 and 37.1%, respectively. However, this result didn't show a significant difference in statistics.

Key words: host preference, egg parasitoid, Noctuidae

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Insecticidal effect of five essential oils against fall armyworm, *Spodoptera frugiperda*

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열대거세미나방은 아메리카의 아열대지역이 원산지인 해충으로 2019년 국내에 첫 비래한 이후 매년 국내로 비래하고 있으며 옥수수 등에서 피해가 많다. 열대거세미나방 방제약제로 50품목 이상 등록되어 있으나 친환경방제를 위한 방제 자재는 부족한 상황이다. 이에따라 옥수수와 땅콩 재배팻트에 실내에서 사육한 2~3령 유충을 접종한 후 에센셜오일 5종(클로브, 마늘, 삼나무, 계피, 레몬)을 1,000배와 500배로 희석하여 분무처리한 결과, 처리 5일 후 마늘오일 처리시 옥수수와 땅콩에서 살충률이 각각 88.3~98.0%와 93.3~100%로 가장 우수하였으며, 계피오일은 각각 74.0~87.7%와 73.3~86.7%이었다. 클로버오일, 삼나무오일, 레몬오일은 1,000배 처리시 처리 5일 후 살충효과가 44~66%로 낮았으나 500배 처리시 71~83%의 살충효과를 보여 열대거세미나방 방제에 이용할 수 있을 것으로 판단되었다.

검색어: 열대거세미나방, 에센셜오일, 옥수수, 땅콩, 살충효과

P182

Effect of reflective film mulching on the occur of thrips (*Frankliniella occidentalis*) controlling density in a pepper greenhouse

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꽃노랑총채벌레는 성충과 약충이 고추에 은백색의 섭식흔과 산란흔을 남겨 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 대안의 물리적 방제 방법으로 2022년 완주, 함천의 시설하우스에서 반사필름, 흑색, 적색의 멀칭필름을 바닥에 설치한 뒤 고추를 정식하여 총채벌레의 발생 밀도를 조사하였다. 반사필름, 적색, 흑색 순서로 총채벌레의 발생 밀도가 낮았으며 특히 반사필름의 경우 흑색 대비 3배 이상 밀도가 낮게 나타났다. 본 결과를 토대로 고추 정식(4월 하순~5월 중순)전 반사필름을 토양에 피복할 경우 꽃노랑총채벌레 발생 밀도를 약 30% 경감시킬 수 있을 것으로 생각된다. 고추 생육에 미치는 영향에 관한 조사는 진행 중이며 총채벌레의 방제를 위해 효과적으로 활용될 것으로 기대한다.

검색어: 고추, 총채벌레, 반사필름, 밀도, 억제

P183

Chromosome-level genome assembly of *Helicoverpa assulta* and its comparative genomics provides insight into the biology of the host-plant specialist

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Helicoverpa assulta, is a major agricultural pest in many parts of Asia, including Korea. The larvae feed on only a few plants of the Solanaceae family, causing significant damage to the crops such as hot pepper and tobacco. Here we present the chromosome-level genome assembly of a Korean strain of *H. assulta* (Pyeongchang strain, K18), which was obtained using a combination of the Nanopore long-read (ca. 78X) and Illumina NovaSeq short-read (ca. 54X) sequencings. The total assembly spans 424.36 Mb with an N50 length of 14.54 Mb and 35.44% GC contents. The final assembly (JAQOZT000000000, 424.36 Mb) consists of 62 scaffolds, of which the largest 31 scaffolds account for 98.7% of the assembly, confirming the expected number of chromosomes (n = 31). Complete BUSCOs values were 99.0% and Repeat contents were 33.01%. Based on this assembly, genome annotation predicted 18,593 protein-coding genes. This draft genome of *H. assulta* will shed light on various aspects of the biology of this specialist pest, including the host-plant interactions, chemical communications, insecticide resistance, and the evolutionary relationship of the genus *Helicoverpa*.

Key words: *Helicoverpa*, genome assembly, insecticide resistance, insect-plant interactions, evolution

P184

Biological control of *Phytoseiulus persimilis* to *Tetranychus urticae* in large-fruited strawberry field

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딸기는 육묘기간부터 점박이응애의 발생이 심하며 정식기인 8월에 본포로 이식되어 재배 초기부터 방제 노력이 요구되는 농작물이다. 우리는 대과종 딸기인 킹스베리의 8월 정식 후 점박이응애의 밀도를 조사하면서 칠레이리응애의 방사량 차이에 따른 방제 가능성을 검토하였다. 딸기에 발생하는 점박이응애 조사는 1주 간격으로 수행되었다. 방제 정보가 제공된 포장에서는 9월에서 이듬해 3월까지 총 8회의 화학방제가 이루어졌으며 점박이응애의 밀도는 엽당 약 30마리 이하로 낮게 유지되었으나 점차 밀도가 증가하는 추세였다. 농가의 주관으로 화학약제의 사용이 이루어지는 포장에서는 같은 기간 총 11회의 화학방제가 행해졌고 방제 정보가 제공된 포장보다 더 많은 화학약제의 사용이 이루어졌으나 방제효과는 더 낮았다. 딸기 정식 후 초반에 칠레이리응애가 집중적으로 방사(10,000마리/200평)된 포장에서는 점박이응애의 발생이 거의 없었다. 딸기 정식 후 정량(2,000마리/200평)의 천적이 방사된 곳에서는 점박이응애의 밀도가 다소 증가하였으나 급격히 증가하지는 못하는 양상이었다.

검색어: 칠레이리응애, 점박이응애, 대과종 딸기, 생물적 방제

P185

Development of packaging to prevent pest damage in agri-food using anti-insect hurdle technology

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가공식품 비닐포장을 천공하여 소비자 클레임을 유발하는 저장해충 피해를 저감화하는 허들방충 포장 개발을 위해 천공성 저장해충(화랑곡나방, 수시렁이 유충)의 천공 유발 형태적 특성과 천공 흔적을 SEM을 통해 분석하고 생태행동학적 특성 분석을 통해 주로 천공이 유발되는 포장 부위의 문제점을 규명하여 기존 개발된 천연방충성분을 경제적으로 식품 포장에 적용하는 방안을 개발하였다. 형태적으로 천공성 저장해충은 씹고 갉는 구기구조를 가지고 있으며 식품 향과 어두운 환경에 유인되는 특성을 가지고 있어 식품 포장의 열처리부분에서 발산되는 식품 향과 배접 부분으로 유인, 천공이 발생하는 것으로 분석되었다. 천연방충성분을 천공 유발 부위에만 처리한 포장을 제작하여 천공성 저장해충의 유인, 천공율을 조사한 결과 포장 전체에 처리한 포장과 통계적으로 유의한 차이 없이 미처리 포장에 비해 천공, 유인을 효과적으로 억제하는 것으로 조사되었다.

검색어: 허들방충포장, 가공식품 비닐포장, 천공성 저장해충, 소비자클레임, 천연방충성분

P186

Insecticide susceptibility of the Black cutworm (*Agrotis ipsilon*) according to host plants

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The black cutworm is a major lepidopteran pest that damages agricultural crops as well as weeds and turfgrass in agricultural fields. In this study, we compared the insecticide susceptibility of black cutworm (3rd instar larvae) reared for more than 8 generations with 4 species of host plants through an indoor test (spray method). The insecticidal activity of chlorantraniliprole (28) and imidacloprid (4a) showed the same tendency according to the host plant species, chlorantraniliprole showed very strong toxicity (LC₅₀ values after 48 hours of drug treatment were 1.42, 6.85, 14.39, and 21.28ppm in corn, pepper, Korean cabbage, and soybean, respectively), and the LC₅₀ values of imidacloprid were 12.89, 16.29, 23.77, and 25.33ppm in corn, pepper, Korean cabbage, and soybean, respectively. On the other hand, the LC₅₀ value of novaluron (15) was the lowest in red pepper (36.82) and the highest in Chinese cabbage (70.43). Based on this study, the host plant has a significant effect on the insecticide susceptibility of the black cutworm, and chlorantraniliprole is judged to be a strong insecticide for controlling the black cutworm larvae.

Key words: insecticide, susceptibility, black cutworm, host plants

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Control of eggs of the Asian spongy moth (*Lymantria dispar asiatica*) with plant extract mixture

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The Asian spongy moth (ASM, *Lymantria dispar asiatica*) is a destructive pest of forests, agricultural fields, and urban areas. Plant extract mixtures were evaluated as alternative tools for integrated pest management targeting the overwintering eggs of ASM. When formulated with an adjuvant able to penetrate the hairy egg mass, plant extract mixtures inhibited egg hatching. The extract mixture (cinnamon extract 5% + citronella oil 10% + citrus oil 30% + derris extract 10% + neem extract 20% + penetrating surfactant 25%) with the highest ovicidal activity (97.6% mortality) is a potential botanical insecticide for use against ASM eggs. Susceptibility to mortality from plant extract mixtures increased with egg maturation. Optimal timing for control of overwintering ASM eggs corresponded to the period in spring when larvae inside eggs were fully differentiated. These results will help improve control efficacy with a day-degree model that predicts egg hatch as well as future development nano-formulations.

Key words: *Lymantria dispar asiatica*, eggs, plant extract mixtures, ovicidal activity

P188

Machine learning-based prediction of occurrence probability of an insect vector of *Xylella fastidiosa* (*Aphrophora pectoralis*) in Korea

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Xylella fastidiosa (Xf) is the causal agent of Pierce's disease and spread through insect vectors, damaging to agriculturally valuable crops. Thus, prediction of insect vectors helps confining risk areas exposed to the disease outbreak, which can be used to decide the areas to be controlled. In this study, we evaluated the occurrence probability *Aphrophora pectoralis*, a vector of Pierce's disease, by using Random Forest, a machine learning-based classification algorithm, in Korea according to climate change. As a result, *A. pectoralis* showed a high occurrence probability in the eastern (Gangwon-do) and inland regions (Jeolla-do and Chungcheong-do) under the current climate, while the potential risk areas are expected to decrease with climate change. In conclusion, Korea is exposed to the risk of Pierce's disease through potential distribution of an insect vector. In addition, we expected that the model can be integrate with other models, such as Maxent and artificial neural networks, to improve shortcomings of individual models.

Key words: machine learning, occurrence possibility, Pierce's disease, Random Forest, species distribution model

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Constructing recent meteorological database applicable for species distribution modeling

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Climate is a major variable in species distribution modeling (SDM) as its large impact on biological and ecological systems. However, although climate data is continuously updated, the database widely used for species distribution modeling is up to 2000, and the recent climate is not reflected. Accordingly, in this study, a 29-year average climate database spanned from 1990 to 2018 was to be created to update climate database available for the SDM. Initial meteorological data sets at 1 km (for domestic application) and 5 km (for global application) resolutions were obtained from CHELSA (climatologies at high resolution for the earth's land surface areas) and WorldClim, respectively. The obtained data sets were converted into a form suitable for each model algorithm by using libraries and functions implemented in R, Python, ArcGIS, and MetManager. For the correlative models, such as MaxEnt and Random Forest, the climatic database was formed into bioclimatic variables, while mm file that merged location and meteorology was generated for the CLIMEX model, a mechanistic model.

Key words: database, meteorology, public database, species distribution modeling, resolution

P190

Double-stranded RNA and food additives for eco-friendly management of insect pest

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In order to develop an eco-friendly control method that can manage insect-pests without harm to humans or the environment, we conducted research using species-specific double-stranded (ds)-RNAs and food additives. It was confirmed that the insecticidal effect was enhanced when ds-RNA or food additive was used in combination rather than separately.

Key words: double-stranded RNA, food additives, insect, pest, management

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P191

Control efficacy of some insecticides to winterform adult of pear pest, *Cacopsylla jukyungi*

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배에 발생하는 해충인 주경배나무이(배나무의 거친껍질 밑에서 겨울을 난 후 2~3월경 나무 위로 올라가 산란한다. 월동 후 방제적기는 겨울형 성충이 나무 위로 이동 후 산란을 시작하기 전이며 주로 기계유유제를 사용한다. 그러나 매년 저온피해가 발생하거나 나무의 세력이 약한 농가는 방제 후에 나무와 가지에 언피해가 더 심할 수 있어 대체 가능한 약제를 확인하고자 하였다. 주경배나무이 대상 등록 약제 중 아바멕틴, 아세타미프리드, 이미다클로프로이드, 설펡사플로르를 시험약제로 선정하였으며, 1차 검정결과 살충률은 아세타미프리드 > 이미다클로프로이드 > 설펡사플로르 > 아바멕틴 순으로 확인되었다. 살충력 추가 검정 후 기계유유제 대신 사용이 가능한 약제 성분을 권장할 수 있을 것으로 사료된다.

검색어: 배, 해충, 주경배나무이, 약제검정

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Evaluation of available chemical and physical phytosanitary treatments for fruit fly, against *Bactrocera scutellata* surrogate of oriental fruit fly

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Fruit flies are well known to cause severe damage to tropical/subtropical plantation such as tangerines worldwide. As increased tropical/subtropical crops in Korea due to climate changes, changing domestic consumer preferences, increased concerns about introducing of exotic fruit flies. In a preliminary studies for evaluating available chemical (ethyl formate fumigation) and physical phytosanitary (cold treatment at 1. 7°C), EF followed by cold treatments showed the potential promise to disinfest *Bactrocera scutellata* larvae which was used for modeling studies and surrogate of oriental fruit fly, *B. dorsalis*.

Key words: fruit fly, *Bactrocera scutellata*, ethyl formate, cold treatment

P193

Development of ethyl formate phytosanitary treatment for hitchhiked insect pests on imported miscellaneous goods

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The number of quarantine cases for imported miscellaneous goods is increasing every year, and the insect pests detection rate is increasing. A new phytosanitary treatment standards are required for hitchhiked flies, moths, ants, and stink bugs on imported diversifying miscellaneous goods. In this study, efficacy of ethyl formate (EF) fumigation, as methyl bromide (MB) alternatives against hitchhiked insect pests (*Lycoriella mali*, *Halyomorpha halys*) and sorption rate of EF on miscellaneous goods was evaluated. In two commercial trials on plant product (cocopeat) and agricultural machinery (drilling machine), 4h-EF-fumigation applied 70 and 35 g/m³ at 23°C. It was confirmed 100% the mortality of *L. mali* and *H. halys*.

Key words: imported miscellaneous goods, hitchhiked insect pests, ethyl formate, alternatives

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Report on the not-distributed hitchhiker insect pests in Korea detected from the foreign vessels entering into Korean ports in 2022

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2022년도에 우리나라에 입항한 국제선 선박을 대상으로 편승자 해충에 대한 예찰을 실시하였다. 그 결과, 947개체의 편승자 해충을 확보하였으며, 이 중 856개체가 통합분류학적 중동정 방법을 통해 10목 86과 374종으로 동정되었으나 91개체는 과 수준까지만 동정되었다. 중 수준까지 동정된 374종 856개체에 대해 한국 분포 여부를 검토한 결과, 6목 26과 43종 76개체는 한국미분포종(not-distributed species in Korea)이었으며, 이 중 6종 11개체는 농림축산검역본부에서 지정 관리하고 있는 관리해충으로 확인되었으며, 검출 당시 2 종만 죽어있는 상태로 확인되었고 나머지 종들은 살아있는 개체가 확인되었다. 또한, 6종 모두 원서식지에서 출항한 선박에서 검출되어 침입 방지를 위한 지속적인 예찰과 함께 입항지 주변 지역에 대한 모니터링을 강화할 필요가 있을 것으로 사료되었다. 2021년도와 비교해 보면, 3종이 2022년도에도 검출되어 지속적인 예찰이 필요할 것으로 판단된다.

검색어: 편승자해충, 한국미분포종, 국제선선박, 모니터링, 검역검사

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Distribution of disease-borne mosquitoes and pathogen infection in Ulsan

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도시화와 기후변화로 인해 모기매개 감염병이 증가함에 따라 울산지역에서의 질병매개모기 분포와 병원체(말라리아, 플라비바이러스, 치쿤구니아) 감염 여부를 조사하고자 하였다. 조사지역은 서식환경별로 농촌지역, 공원지역, 도심지역으로 구분하여 선정하였다. 모기 채집 기간은 4월부터 10월까지로 장비는 유문등과 BG-Sentinel trap을 이용하여 채집하였다. 2022년 울산지역에서 채집된 모기는 5속 10종으로 총 21,851마리의 모기가 채집되었고, 기온의 영향으로 5월부터 증가하기 시작하여 8월에 가장 많이 채집되었으며, 9월에는 급속히 감소하였다. 서식환경별로는 농촌지역, 공원지역, 도심지역 순으로 많이 채집되었고, 각 지역의 우점종은 금빛숲모기(*Aedes vexans nipponii*), 흰줄숲모기(*Aedes albopictus*), 빨간집모기(*Culex pipiens pallens*)로 나타났다. 총 모기개체수 21,851마리 732 묶음(pooling)의 병원체 검사 결과 병원성 바이러스 및 원충은 검출되지 않았고, 플라비바이러스에 속하는 차오양바이러스(*Chaoyang virus*) 5건이 검출되었다.

검색어: 모기, 말라리아, 플라비바이러스, 치쿤구니아

P196

Target and non-target species caught in the sex pheromone traps of *Leguminivora glycinivorella* in the northernmost regions of Rep. Korea

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Adult species caught in the sex pheromone traps of *Leguminivora glycinivorella*, which were installed in Baengnyeong-do and Yeoncheon, were identified through comparing those cytochrome c oxidase 1 gene (COX1) sequences with accessions in GenBank of NCBI. Adults identified as *L. glycinivorella* were divided into two groups (A and B), in which the genetic distance was maximum 3.8% between the groups. The two groups were detected during the period from late August to early September. A species of the tribe Grapholitini was detected during the period from mid July to late August. The COX1 sequences of the species showed maximum 7.7% and 6.1% genetic distance to *L. glycinivorella* A and B, respectively. It was presumed that *Epiblema foenella*, *Matsumuraeses phaseoli* and *M. falcana* among other non-target species caught in the traps were attracted to the traps because of a common component, (E,E)-8,10-dodecadienyl acetate, in those sex attractants.

Key words: *Leguminivora glycinivorella*, sex pheromone trap, species identification, cytochrome c oxidase 1

P197

Infection of Tomato Yellow Leaf Curl Virus changes metabolites of the whitefly, *Bemisia tabaci*

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Metabolome changes were investigated in the whitefly *Bemisia tabaci* caused by Tomato yellow leaf curl virus (TYLCV) infection. Thirty-eight metabolites were identified among the derived entities through statistical analysis in positive and negative ion mode. Insect attractants such as methyl-isoeugenol and isovaleric acid were up-regulated in TYLCV-infected whiteflies. TYLCV infection also increased the expression of naltrindole and isoprostan (= (±) 5-IPF2α-VI), which affects the immune response and female reproduction. These results suggest that TYLCV infection can alter a variety of metabolites involved in the physiology and behavior of whitefly.

Key words: metabolomics, TYLCV, *Bemisia tabaci*, isovaleric acid, methyl-isoeugenol

P198

Changed pupation periods of Korean variety “Joohwangjam” on temperature treatments

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Silkworms are industrial insects that have long been bred in Korea. More than 300 silkworm resources have been preserved in Korea and is utilized to develop various and useful silkworm varieties. The “Joowhangjam” is a unique silkworm variety that produces orange color silk. Joohwangjam is produced by crossbreeding Jam325 and Jam326, the original species of silkworms. However, in the case of male Jam325 X female Jam326 crossing, most of the female Jam326 pupae cannot be used for breeding because the eclosion of the female Jam326 pupae is very early compared with that of the male Jam325 pupae, resulting in a large economic loss. In order to overcome this, the pupation period was regulated by low temperature treatment on the female pupae and high temperature treatment on the male pupae. High temperature treatment on the male Jam325 pupae was not effective, but low temperature treatment on the female Jam326 pupae showed a significant effect, greatly delaying the eclosion of the female pupae. The results of this study might contribute greatly to the stable production of Joowhangjam by regulating the parent pupation period of Joowhangjam artificially.

Key words: Silkworm, Joohwangjam, Pupation, Low temperature

P199

International joint research, comparative analysis of haplotypes of foreign *Solenopsis invicta* and red imported fire ants found in Korea

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The red fire ant (*Solenopsis invicta*) is native to Central America. In Korea, since its first discovery at Gamman Port in Busan in 2017, continuous intrusion through trade cargo has been detected. The Animal and plant quarantine agency (APQA) has been conducting control and molecular epidemiological investigations of this invasive species. However, it was difficult to trace the country of origin due to the lack of diversity in foreign samples that could compare genotypes with domestic invasive individuals. Therefore, through international joint research, we cooperated with foreign researchers to secure samples of *S. invicta* from Taiwan and the United States. DNA extraction was performed on 860 individuals of 36 groups of red fire ants in the USA and Taiwan. COI-II haplotype information was extracted from 560 individuals in 101 groups from 4 countries (China, Taiwan, USA, Korea). Of the average length of 940 bp, 765 common bases excluding gaps and missing data were used for haplotype comparison. In total, 129 base mutations were found. The entire population was classified into 38 haplotype types, and the haplotype diversity (Hd) was 0.7342.

Key words: *Solenopsis invicta*, microsatellite, population, invsion, loci, international joint research

P200

Preceding study of population genetics using microsatellite of fall armyworm *Spodoptera frugiperda*

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The Fall armyworm (FAW), *Spodoptera frugiperda* (Lepidoptera: Noctuidae), is native to the Americas and damages more than 80 species of plants. This pest is a food competitor to humans, as it mainly attacks Poaceae crops. In Korea, since it was first discovered on Jeju Island in June 2019, it has also been found in inland areas, and signs of settlement and spread have been detected. In the meantime, Animal and plant quarantine agency (APQA) has tried to distinguish the group and trace the invasion route using the mitochondrial DNA and the Z-chromosome of FWA found in Korea, but it was not enough to trace the origin. Therefore, we found 184 candidate marker sequences from a lot of previous studies to perform population genetic analysis using microsatellite (MS) loci of *S. frugiperda*. Thirty markers available for invading populations were identified. Several multiplex PCR sets are being developed using selected markers. The MS Multiplex set developed by this study will be used for epidemiological investigations of FAW and it can provide scientific evidence to identify the origin and route of invading *S. frugiperda* in Korea.

Key words: fall armyworm, microsatellite, population, invasion, loci

P201

Expression of the photoconversion fluorescent protein in fibroin H-chain of transgenic silkworm

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We constructed the fibroin H-chain expression system to produce enhanced photoconversion fluorescent proteins, mIrisFP protein, in the silk of transgenic silkworm. Fluorescent silk could be made by fusing mIrisFP cDNA to the heavy chain gene and injecting it into a silkworm. The mIrisFP fusion protein, each with N- and C-terminal sequences of the fibroin H-chain, was designed to be secreted into the lumen of the posterior silk glands. The expression of the mIrisFP/H-chain fusion gene was regulated by the fibroin H-chain promoter. The photoconversion fluorescence proving that the fusion protein was present in the production of novel biomaterial based on the transgenic silk.

Key words: Bombyx mori, Silk, Fibroin, Near infrared Fluorescence, Transgenic silkworm

P202

Expression of the near infrared fluorescent protein in cocoon of transgenic silkworm

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We constructed the fibroin H-chain expression system to produce enhanced near infrared fluorescent proteins, IFP protein, in the silk of transgenic silkworm. Fluorescent silk could be made by fusing IFP cDNA to the heavy chain gene and injecting it into a silkworm. The IFP fusion protein, each with N- and C-terminal sequences of the fibroin H-chain, was designed to be secreted into the lumen of the posterior silk glands. The expression of the IFP/H-chain fusion gene was regulated by the fibroin H-chain promoter. The near infrared fluorescence proving that the fusion protein was present in the production of novel biomaterial based on the transgenic silk.

Key words: Bombyx mori, Silk, Fibroin, Near infrared Fluorescence, Transgenic silkworm

P203

Producing strain-specific monoclonal antibodies for *Vibrio cholera* O1 or O137

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Generating strain specific monoclonal antibodies were the first step to make a lateral flow immuno-diffusion kit for detecting strain specific pathogens. In this study, various strains of *Vibrio* sp. were mixed and used for producing monoclonal antibodies. More than 15,000 clones were screened and found that 100 clones secreted antibodies specific to certain strains of pathogens. These monoclonal antibodies could be used for producing lateral flow immuno-diffusion kits in the future.

Key words: Monoclonal antibody, *Vibrio*, strain specific, lateral flow, immuno-diffusion

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P204

Effect of agricultural byproducts on the larval growth and nutritional contents of mealworms, *Tenebrio molitor* (Coleoptera: Tenebrionidae)

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갈색거저리는 식용곤충 중 국내에서 많이 생산되는 산업곤충 중의 하나지만, 유충의 사료로 주로 이용되는 밀기울 가격 상승 때문에 사육 농가에서는 먹이원 수급에 어려움 겪고 있으며 생산비용 대비 식용곤충 판매가격 하락으로 생산비 절감과 유충 품질향상을 위한 대체 혹은 첨가 사료 개발이 요구되고 있다. 본 연구는 농업부산물 3종의 30, 50, 70%의 다양한 함량을 밀기울과 혼합하여 사료로 제공한 갈색거저리 유충의 생육 특성과 영양성분 변화에 미치는 영향에 대해 밀기울만 급이한 대조군과 비교하였다. 부산물의 일반성분을 조사하였을 때 밀기울보다 부산물 A와 B의 조단백질 함량은 1.9~2.7배, 조지방 함량이 4.8~6.3배 이상 함유되어 있음을 확인하였다. 갈색거저리 유충 무게는 70% 부산물 A를 함유한 사료 처리구에서 대조구에 비해 59.1%로 가장 적었으며, 30% 부산물 A와 B, C가 각각 함유된 처리구에서 대조구(205.83±6.70 mg/마리)의 76.8~86.8%의 성장을 확인하였다. 부산물 B와 C를 각각 함유한 사료 급이시 밀기울만 먹인 대조구보다 조단백질 및 조지방 함량은 5.2~14.3%와 8.5~31.4% 증가하였다. 이를 통해 밀기울에 부산물 3종을 30% 이하로 첨가하면 유충의 생장은 조금 느리더라도 조단백질과 조지방 함량이 높은 품질의 갈색거저리 유충을 저렴한 비용으로 생산할 수 있는 사료 소재로 활용될 수 있을 것으로 사료된다.

검색어: 갈색거저리, 사료, 유충무게, 일반성분

P205

Comparison of fatty acids and volatile compounds in edible insect oil

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Currently, related studies are being actively conducted on edible insects as a source of alternative proteins. Edible insects have strong advantages, especially in terms of low greenhouse gas emissions and low water use. Lipids are being removed during the separation process to extract proteins from edible insects. In order to utilize the discarded lipid, the study was conducted by extracting it with oil. Insect samples were extracted with oil using *Tenebrio molitor*, *Protaetia brevitarsis*, *Allomyrina dichotoma*. It contains the highest unsaturated fatty acid in *Protaetia brevitarsis*. Also, saturated fatty acids were low in content. SPME-Arrow GG/MS analysis results, the edible insect oil with the highest concentration of volatile compounds was *Tenebrio molitor*, and a total of 51 types of compounds were detected. This study attempted to see the possibility of using insect oil as a food resource.

Key words: fatty acid, volatile compounds, edible insect oil

P206

Does caring for emotional insects help the elderly to alleviate insomnia?

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불면증 환자의 비율이 증가하고 있다. 특히 70대 이상 노인의 불면증 유병률은 15.22%에 이른다 (국민건강보험공단). 불면증은 단순히 잠을 제대로 이루지 못하는 것에 그치지 않고, 집중력과 인지 능력을 저하시켜 우울증을 유발하기도 한다. 본 연구에서는 정서곤충을 돌보는 활동이 노인의 불면증 완화에 도움이 되는지 살펴보았다. 2022년 경기도에 있는 요양원 시설에 거주하는 노인들이 대상자이며, 이들은 인근 지역의 농가에 직접 방문하여 총 6회차 동안 정서곤충 돌보기 활동에 참여하였다. 자료는 매 회차마다 사전·사후에 설문지를 이용해 수집하였다. 분석 결과, 사전에 측정한 불면 점수는 ‘약간의 불면증이 있는 상태’에 속하는 12.44점에서 사후에 8.78점으로 감소하였다($p<0.05$). 이를 통해 곤충치유프로그램이 노인의 불면증을 완화시키는데 긍정적 효과가 있음을 확인하였고, 치유평업의 소재로서 곤충자원의 가능성을 기대할 수 있을 것이다.

검색어: 정서곤충, 치유평업, 곤충 돌보기, 불면증, 치유효과

P207

The effect of 2, 4-dichlorophenoxyacetic acid on foraging-related senses of Honeybee (*Apis mellifera*)

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World population growth and increasing food demands have led to higher agrochemicals use in crops to prevent. Honeybees are often adversely impacted direct or indirectly from agrochemical treatments. Little is understood, however, about how 2,4-dichlorophenoxyacetic acid (2,4-D) affects honeybee foraging-related sensory modulation. In this study, we tested the proboscis extension response (PER) to sugar taste, learning and memory in forager bees that received sub-lethal dose of 2,4-D. As a result, sub-lethal dose of 2,4-D caused a considerable decline in sucrose responses and cognitive impairment in honeybees. Our findings are strong evidence that sub-lethal dose of 2,4-D affect foraging-related senses in honeybee.

Key words: Honeybee, 2,4-dichlorophenoxyacetic acid, PER, learning and memory

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P208

A survey on new emotional insects selection

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곤충을 이용한 치유농업프로그램에 대한 관심이 높아졌다. 그러나 아직까진 활용 곤충이 일부 종 (왕 귀뚜라미, 호랑나비 등)에 한정되어 있다. 곤충치유프로그램에 대한 수요가 증가하고, 프로그램 운영자와 이용자가 다양화됨에 따라 소비자의 요구에 맞는 새로운 정서곤충 종을 선정할 필요가 있다. 이를 위해 2022년 4월 응용곤충학회 학술대회에 참가한 전문가 106명을 대상으로 ‘곤충 교감치유에 적합한 신규 정서 곤충 종 선정’을 목적으로 설문조사를 실시하였다. 주요 내용은 치유프로그램 운영 시 중요하다고 생각하는 감각, 곤충 종 추천과 그 이유, 곤충 돌보기 경험, 향후 참여 의사, 곤충에 대한 이미지에 대한 항목으로 구성되었다. 분석 결과, 중요하게 생각하는 감각으로는 시각(75%), 청각(15%), 촉각(11%), 미각(4%), 후각(1%) 순이었으며, 신규 종에 대한 추천 항목에서는 반딧불이(불빛이 시각적으로 화려함), 사슴벌레(사육이 간편하고 미관상 멋짐), 물방개 등의 딱정벌레목이 추천되었다. 주된 이유로는 관찰이 쉽고 시각적 자극이 높다는 점이었다. 이러한 결과를 통해 신규 정서 곤충 종 선발 시 생김새 및 독특한 외관 등의 시각적인 자극과 낮은 사육 난이도 등의 항목이 중요하게 고려될 사항이라 볼 수 있다.

검색어: 정서 곤충, 치유농업, 선호도, 감각자극

P209

Improved activity of lipases from entomopathogenic fungi by protein structure-based mutagenesis

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Lipase derived from an entomopathogenic fungi, *Cordyceps militaris*, was recently found to act specifically at position *sn*-1,3 of triacylglycerol. In this study, activities of lipases isolated from *C. militaris* (CML) and *Beauveria bassiana* JEF-351 strain (BBL351) were comparatively investigated. When the hydrolysis efficiency of these lipases were investigated, the BBL351 showed approximately 2-fold higher activity than that of CML. In addition, 19 mutant CML were constructed through muti-site-directed mutagenesis based on protein tertiary structure and amino acid sequence comparison between CML and BBL351. Among them, several structure-based mutants showed higher activity than that of wild-type CML. These results suggested that lipase from entomopathogenic fungi could be a novel natural source of useful biocatalists in various industries.

Key words: lipase, entomopathogenic fungi, *Cordyceps militaris*, *Beauveria bassiana*

P210

Usage of global biodiversity information facility data in entomology

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The Global Biodiversity Information Facility (GBIF) is an international network and data infrastructure that provides open access biodiversity data to around the world. Entomological data is an important component of GBIF, and the platform provides a wealth of information on insect species distribution, occurrence, and diversity. GBIF's entomological data can be used by researchers, policy makers, and conservationists to better understand and manage insect populations, identify threats to species and ecosystems, and make informed decisions about conservation and resource management. Additionally, GBIF's collaborative platform provides entomologists who looking to work together, share data and resources, and ensure the accuracy and reliability of their research. Overall, the usage of entomological data in GBIF has the potential to contribute significantly to our understanding of insect biodiversity and inform conservation efforts around the world.

Key words: GBIF, biodiversity, information, usage, policy, decision making, conservation

P211

Characteristics of the development of *Protaetia brevitarsis* (Coleoptera: Cetoniidae) larvae according to the storage period after the fermentation sawdust

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베리류 톱밥과 참나무 톱밥을 발효시켜 상온 저장하면서 흰점박이꽃무지 먹이로 공급하고, 발효톱밥 저장기간에 따른 발육특성을 조사하였다. 베리류 톱밥은 뽕나무, 복분자, 블루베리 3작물의 전정가지를 톱밥으로 파쇄하여 혼합한 후 60일간 발효하였고, 참나무톱밥은 농가에서 90일간 발효시킨 톱밥을 사용하였다. 톱밥 발효후 저장기간은 각 0개월, 6개월, 12개월, 18개월 4처리로 하였다. 흰점박이꽃무지를 처리별로 개체사육과 집단사육을 실시하여 발육특성을 비교한 결과 집단사육과 개체사육 모두 0, 6, 12개월 저장된 발효톱밥에서는 생존율과 무게에 큰 차이가 없었고, 18개월 된 톱밥에서 생존율이 떨어지고, 무게도 감소하였다. 개체사육에서 집단사육보다 생존율이 높고, 무게가 더 무거운 경향이었다. 또한, 개체사육에서 흰점박이꽃무지 유충 발육기간 및 무게를 비교하여 본 결과 유충 발육기간은 저장기간이 길수록 길어지고, 개체당 무게는 비슷하였다. 참나무톱밥 대비 베리류 톱밥에서 1령과 2령 발육기간이 짧고, 3령기간은 길어지는 특성을 보였으며, 유충 무게 역시 참나무 톱밥에 비해 높게 나타나는 경향이었다.

검색어: 흰점박이꽃무지, 발효톱밥, 저장기간, 베리류톱밥, 참나무톱밥

P212

Effect of blanching time and temperature on quality properties of extracted protein from *Hermetia illucens* larvae

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The study investigated the effects of blanching time and temperature on quality properties of extracted protein from *Hermetia illucens* larvae. The larvae were blanched at various temperature (70 and 90°C) and time (30 and 90 s), and the resulting protein extracts were analyzed for their physicochemical properties and functional properties. pH value of blanched sample was decreased and lower pH value was observed at 70 °C. The higher lightness, yellowness and water activity and the lower moisture content were observed at the higher temperature and blanching time. Higher protein solubility and lower carbonyl content were observed at 70°C treatment than control and 90°C treatments. Protein molecular weight distribution was also different. In emulsifying properties, emulsifying capacity was increased after blanching and similar emulsion stability with control was observed in 70°C treatment. In conclusion, protein functional properties of *Hermetia illucens* were increased after blanching and blanching at 70°C for 30 s might be the best condition when extract insect protein.

Key words: *Hermetia illucens*, blanching time, blanching temperature, drying, protein extract

P213

Effect of blanching time and salt concentration on protein quality of *Hermetia illucens* larvae

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In this study, we investigated the quality characteristics of proteins extracted after blanching *Hermetia illucens* larvae under various conditions. The larvae were blanched before drying by adjusting the time (30 and 90 s) and the salt concentration (0.1 and 0.4 M). The pH value of the blanched sample decreased and a lower pH value was observed at 0.1 M. The higher the blanching time and salt concentration, the higher the brightness and yellowness, and the lower the moisture content and water activity overall. The blanched sample had a higher protein solubility than the control. After blanching emulsifying capacity was increased overall, and emulsifying stability was similar to that of the control at 90 s, 0.4 M treatment. In addition in the 0.1 M treatment group, the protein band of 15-20 kDa was increased compared to the control. In conclusion, blanching with appropriated salt concentration and time can improve protein quality and functional properties.

Key words: *Hermetia illucens*, blanching, drying

P214

Diversity on insect succession of decomposing carcasses during summer and winter season in Jangsu-gun, Jeollabuk-do, Korea

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전북 장수군에서 2022년 여름과 겨울에 고라니사체를 노출된 상태로 설치하여 부패과정에 따른 곤충상을 관찰하였다. 고온다습한 환경의 여름철에는 사체의 부패속도가 빨라짐과 함께 곤충의 발생이 늘어나는 것을 확인하였으며, 기온이 영하로 유지되는 겨울철에는 부패속도가 현저히 늦어짐과 함께 곤충의 발생이 줄어드는 것을 확인할 수 있었다. 여름철 사체에는 5 목 14 과 22 종이 확인되었고, 겨울철 사체에는 2 목 5 과 8 종이 확인되었다. 주로 검정파리과 곤충과 송장벌레과 곤충이 확인되어 법곤충학적 지표종으로 이용할 수 있음을 확인하였다. 각각의 계절차이에 따라 사체에 접근하는 곤충의 종류가 달라지는 것을 확인하였으며, 특히 겨울철 부패가 진행되는 사체에는 파리목 곤충보다 딱정벌레목 곤충이 먼저 접근하는 점이 확인되어, 실제 사건현장에서 법곤충학적 현장재구성 시 계절 및 환경변화에 따른 지표종 설정이 고려되어야 할 것으로 생각되었다.

검색어: 법곤충학, 검정파리과, 송장벌레과, 부패과정, 사체

P215

Enhanced memory promoting effects of enzyme-digested HongJam

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Hongjam is a natural food known to improve various forms of memory. In this study, we conducted on the memory improvement effect of diverse HongJam products processed in various ways. As a result, we found that the enzymatically digested HongJam had the most outstanding memory improvement effect.

Key words: HongJam, Memory, promoting, enzyme digestion

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P216

Enhancing immune response of bone marrow-originated macrophages by White-jade HongJam extracts

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Hongjam is a natural health food that has been shown to have various health-promoting effects, but studies on immunity enhancement have not been done so far. In this study, using bone marrow-originated macrophages, HongJam's immune enhancing effect was revealed.

Key words: immune response, bone marrow, macrophage, HongJam

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P217

Psychological effects of insect healing program in insect garden - Case of Elderly -

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This study examined the psychological effects of insect healing programs in ecological garden. A sample of 16 female elderly participated in the survey from near study area in Sangju, Gyeongbuk. The elderly in the experimental group participated in an insect experience activity healing programs using silkworm and butterfly. We surveyed depression and life satisfaction using SGDS and LS (life satisfaction). The results of this study showed that the healing program of insect experience activities had a positive effect on the elderly's depression and life satisfaction. The elderly preferred insects more than before healing program of insect experience activities. Female elderly who participated in the insect healing program showed high satisfaction. As a result, we are going to investigate the effect of the family type insect healing program in this year.

Key words: Insect, elderly, healing program, ecological insect garden, silkworm, butterfly

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P218

Profitability analysis of *allomyrina dichotoma* farming

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장수풍뎅이는 딱정벌레목 장수풍뎅이과에 속하는 곤충으로 단백질 함량이 높고 불포화지방산이 풍부하며, 항산화 효능이 있어 새로운 식품원료로 인기를 끌고 있다. 이에 장수풍뎅이 사육에 대한 관심이 증대함에 따라 장수풍뎅이 사육의 수익성을 분석하여 경영정보를 제공하고 농가의 의사결정을 위한 자료로 활용하고자 본 연구를 수행하였다. 2022년 전국 장수풍뎅이 사육 경영체는 312호로 조사되었으며, 이 중 20호를 대상으로 경영 현황을 조사하였다. 조사표는 농촌진흥청 농축산물 소득조사표를 바탕으로 작성하였고, 경영체에 방문하여 면접청취 조사를 실시하였다. 장수풍뎅이 1만 마리 사육에 따른 수익성 분석 결과, 생산량은 유충 6,520마리, 건조물 4,584마리, 가공품 79마리이며, 마리당 단가는 각각 1,568원, 4,752원, 2,328원으로 총수입은 32,192천 원이었다. 소득은 14,910천 원, 소득률은 45.7%, 노동생산성은 시간당 47천 원으로 나타났고, 생산비는 23,328천 원으로, 고용노동비(18.7%), 자가노동비(18.6%), 영농시설상각비(12.5%), 위탁영농비(10.8%), 조사료비(8.5%) 등의 순으로 비중이 높았다. 이때 노동 투입시간은 고용노동 383시간, 자가노동 304시간이었다.

검색어: 장수풍뎅이, 경영성과, 수익성, 곤충산업, 곤충소득

P219

Profitability analysis of *Tenebrio molitor* farming

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갈색거저리는 단백질과 지방이 풍부하여 동물 사료용, 식용 및 산업용 등 다양한 방면으로 활용되고 있다. 또한 번식률이 높고, 강한 적응력과 짧은 생육기간으로 인해 산업화에 용이한 곤충 중 하나이다. 이에 곤충 사육 농가의 갈색거저리에 대한 관심이 증가함에 따라 갈색거저리 사육의 수익성을 분석하여 경영정보를 제공하고 농가의 의사결정을 위한 자료로 활용하고자 본 연구를 수행하였다. 2022년 전국 갈색거저리 사육 경영체는 245호로 조사되었으며, 이 중 26호를 대상으로 경영 현황을 조사하였다. 조사표는 농촌진흥청 농축산물 소득조사표를 바탕으로 작성하였고, 경영체에 방문하여 면접청취 조사를 실시하였다. 갈색거저리 100박스 사육을 기준으로 수익성을 분석한 결과, 생산량은 유충 581kg, 건조물 356kg, 가공품 21kg이며, kg당 단가는 각각 11,036원, 5,560원, 65,853원으로 총수입은 9,774천 원이었다. 소득은 3,212천 원, 소득률은 32.9%, 노동생산성은 시간당 42천 원으로 나타났고, 생산비는 8,134천 원으로, 임차료(34.4%), 자가노동비(16.7%), 고용노동비(16.4%), 영농시설상각비(8.3%), 농후사료비(7.9%) 등의 순으로 비중이 높았다. 이때 노동 투입시간은 고용노동 138시간, 자가노동 94시간이었다.

검색어: 갈색거저리, 경영성과, 수익성, 곤충산업, 곤충소득

P220

The behavior control of *Myzus persicae*, *Tetranychus urticae* and *Frankliniella occidentalis* in indoor plants using mesh and essential oil

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해충은 식물의 안정적인 생산 및 품질에 직·간접적 영향을 주며, 이것은 농업 및 식품산업에 경제적 피해를 줄 수 있다. 국내에는 2,618종이 기록되어 있으며 대표적인 식물해충에는 점박이응애, 꽃노랑총채벌레, 복숭아혹진딧물 등이 있다. 이러한 해충은 육안으로 식별하기 어렵고, 증식도 빠르기 때문에 물리·화학적 방제를 병행하여 방제하는 것이 효과적이다. 본 연구에서는 효과적인 물리·화학적 방제법을 모색하기 위해 곤충 차단망과 5가지의 Essential oil을 사용하여 여러 가지 해충의 기피 반응을 확인하였다. 실험에 사용한 곤충은 28±1°C, RH 70% 환경에서 사육하였고, 130T (0.25 mm), 200T (0.075 mm), 300T (0.055 mm) 크기의 메쉬(mesh) 소재로 만든 곤충 차단망으로 각 곤충의 이탈율을 확인하였다. 가장 작은 크기의 300T에서는 모든 해충이 이탈하지 못하였지만, 130T에서는 복숭아혹진딧물을 제외한 곤충이 이탈하였다. 또한, Y-tube olfactometer bioassay를 통해 5가지 Essential oil (Clove, Eucalyptus, Lemongrass, Lavender, Sage oil)을 각각 5%, 10%로 희석하여 기피효과를 확인하였다. 10%로 희석한 Lemongrass oil, Clove oil이 세 종의 해충에 대해 기피 효과를 나타냈다. 5%로 희석한 Essential oil 중, Lemongrass oil은 복숭아혹진딧물과 점박이응애에 대해 효과적으로 기피하였고, 꽃노랑총채벌레는 Clove oil에 대해서 기피행동을 보였다. 이 연구를 통해 실내식물에서 해충의 침입을 억제할 뿐만 아니라 인간에게 무해한 방제방법을 제시하고자 한다.

검색어: 점박이응애, 꽃노랑총채벌레, 복숭아혹진딧물, Mesh, Essential oil



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SG1-1

The economic and non-economic impact of natural enemy uses: The case of Korea

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There is a growing interest in natural enemy uses in response to increased demand for safer food products, an emergence in pests resistant to chemical pesticides, a transition to environmentally-friendly farming, and climate change. This study analyzes the economic and non-economic impact of natural enemy use. We conduct scenario analysis to calculate potential cost-benefit changes in farm income from natural enemy uses, focusing on greenhouse horticultural farms (paprika, strawberry, and chili pepper). The scenarios are based on our in-depth farm interview, and farm income data from Rural Development Agency are employed for our analysis. The scenario analysis results show that, on average, paprika farms are likely to get farm income loss by 132.0% or higher farm income by 81.2%. In the case of strawberries, the farm income is likely to get gain/loss in the range between -74.1% and +45.2%. For chili pepper, farm income is likely to change between -77.0% and 46.3%. Using natural enemies also has positive non-economic effects on human and environmental health due to the reduction of pesticide use. Improving human health includes a decrease in pesticide poisoning of farmers and alleviating consumers' concerns about pesticide residues. Examples of environmental improvement are maintaining beneficial insects, restoring biodiversity, restoring natural control mechanisms, revitalizing eco-tourism, improving water quality, increasing producer awareness and changing behavior (restoring self-esteem), enhancing consumer awareness, and restoring trust.

Key words: 천적이용, 농가소득, 경제적 효과, 비경제적효과, 천적시장

SG1-2

Some suggestions for transitioning from natural enemy agriculture to natural enemy industry

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우리나라의 천적농업이 천적산업으로 발전하기 위해 천적농업을 실현하고 있는 농업인, 천적을 생산·유통하는 업체, 천적산업 기반 구축을 지원하는 정부·지자체, 우수 천적을 탐색·선발하여 농업현장에서 활용에 관한 이론과 실용기술을 연구하는 천적 전문가, 및 천적을 이용하여 생산된 농산물을 소비하는 입장에서 천적농업이 천적산업으로 전환되는데 필요한 요인을 분석하고, 천적산업 발전 모델을 제안하고자 한다.

검색어: 기생성천적, 포식성천적, 천적활용기술, 천적농업, 천적산업

SG1-3

Biological control industry: Challenges and opportunities

Eunhye Ham and Juntae Kim

OR (Our lady's bird Research institute) Inc.

국내에서 천적을 활용한 해충방제 연구는 1995년 이후 지속적으로 수행되었으며, 천적의 대량증식 및 현장적용 연구와 더불어 국내 농업환경 최적의 천적중심 해충관리모델(Natural Enemy in First method, NEF)도 제시된 바 있다. 세계 생물적 방제시장은 2016년 3조 원 규모에서 2020년 5조 원 규모로 성장했으며, 2025년까지 연평균성장률 15~18%를 기록할 것으로 예측되고 있다. 그에 반해 천적 산업의 성숙도는 낮아, 국내 농업현장에서의 천적 사용률은 5% 미만으로 농업선진국의 80~90%에 비해 크게 뒤쳐져 있는 실정이다. 국내 천적산업의 활성화를 위해서, 농업선진국과의 성숙도 차이를 인식하고 정부의 개입과 함께 이를 뒷받침할 수 있는 정책적 지원이 필요 할 것이다. 본 천적소모임에서는 이를 위해 국내 천적산업의 현황을 공유하고 그 발전방향을 제안하고자 한다.

검색어: 천적산업, 농업환경, 해충방제

SG1-4

The role of regional government for expanding of natural enemy utilization in South Korea

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Duck-Oung Jung², Hwal-Su Hwang² and Kyeong-Yeoll Lee²**

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전라북도농업기술원은 2016년부터 천적활용 현장컨설팅과 교육을 실시하였고, 농업인실습형천적증식실을 운영하고, 활용기술, 품질검정, 자가증식 등 애로사항 해결을 위해 시·군농업기술센터와 함께 시범사업을 추진하면서 기술과 네트워크를 접목했다. 농업현장에서 천적농업 성공사례가 축적되면서 2020년 농업인을 중심으로 전라북도천적농업연구회를 창립하였다. 또한, 2019년 이후로 천적전문가 모임을 구성하고 천적농업 활성화 방안에 관한 기획보고서를 작성하여 2020년에 농촌진흥청에 제출하였다. 경북대학교 친환경농업연구센터는 2016년부터 농업인에게 천적 자가생산 실습교육을 실시하면서, 천적에 대한 긍정적인 인식이 크게 증가하였다. 최근 안동, 고령 및 경주 지자체에서 딸기재배 농업인을 대상으로 천적자가증식 프로그램을 추진했다. 앞으로 농업인구감소 및 고령화로 인하여 규모화된 스마트팜이 주도하게 된다. 이에 대한 작물보호 대책으로 지방정부가 주도하는 지역거점 천적활용기지 구축을 제안한다. 안정적인 천적 활용으로 저비용 친환경 농산물 생산을 증대하고 국내 천적농·산업 발전에 크게 기여할 수 있다. 본 소모임에서 이에 대한 발전방안을 같이 모색하고자 한다.

SG2-1

A review of the genus *Ericydnus* (Hymenoptera: Chalcidoidea: Encyrtidae) from Korea

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The genus *Ericydnus* was established by Haliday in 1832 including 33 described species worldwide. In this study, a total of 3 species, *Ericydnus hunagi*, *E. infuscatus*, *E. longicornis* are reported for the first time from Korea. All available information, including a key to the Korean *Ericydnus* species, distribution and photos of females for each species is provided.

Key words: Encyrtid, new record, parasitoids, Tetracneminae, Korea

* 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 (NIBR202333201).

SG2-2

Taxonomic study of Aphidiinae (Hymenoptera: Braconidae) in South Korea

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The subfamily Aphidiinae which has solitary endoparasitoids solitary koinobiont to aphids is considered as a biological control agent in agriculture. It consists of 53 genera about 650 species worldwide, and in Korea is recorded as 60 species of 13 genera based on NIBR (National List of Species of Korea). Because several species were not only endemic but also found as being misidentified in personal communication, it is necessary to review the samples. Even although it is clearly different from the morphology, there are cases in which the genes used for identification are very similar or vice versa. Therefore, it is important that both morphology and molecular should be considered for identification. In this community, the overall contents of Aphidiinae will be briefly dealt with.

Key words: Ichneumonoidea, Aphidiini, Ephedrini, Praini

* 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 (NIBR202333201)

SG2-3

Taxonomic study of Eurytomidae Walker, 1832 (Hymenoptera: Chalcidoidea) from Korea

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Eurytomidae Walker, 1832 are relatively medium-sized group in the superfamily Chalcidoidea, comprising approximately 1600 species across three subfamilies and 73 valid genera. In the Palearctic region, over 600 species have been recorded, with only 13 species reported in Korea.

In this study, we report the species diversity of the family Eurytomidae in Korea and provide information on their generic replacement.

Key words: Taxonomy, Biodiversity, morphological, genus, species

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SG2-4

First report of the genus *Euplectromorpha* Girault (Hymenoptera: Eulophidae) from South Korea, with a newly recognized species

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The genus *Euplectromorpha* Girault (Hymenoptera: Eulophidae) is newly recognized from South Korea. In this presentation, we report this genus for the first time from Korea, with a newly recorded species. A key to the genera of Euplectrini in Korea is also provided.

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

* 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 (NIBR202333201).

SG2-5

Taxonomic study of the tribe Alysiini (Hymenoptera, Braconidae, Alysiinae) from South Korea

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As one of the large taxon in the family Braconidae, the subfamily Alysiinae includes two tribes (Alysiini, Dacnusiini) and consists of over 2,440 valid species worldwide. Among them, 180 species in 21 genera are recorded in Korea. Parasitoid wasps in the Alysiinae generally attend on larvae of dipteran as koinobionts, thus most of species are useful for biocontrol of insect pests. I have studied taxonomy of tribe Alysiini since 2019, and described thirteen new to science and six newly recorded species. The genus and species were described and illustrated herein.

Key words: *COI* barcode, cyclostome, natural enemy, koinobiont, parasitoid wasp, systematics, 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 (NIBR202333201).

SG2-6

Taxonomic study of the family Halictidae (Hymenoptera: Apoidea) in South Korea

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The family Halictidae, called sweat bees, is one of the large families in the superfamily Apoidea (Hymenoptera). Approximately 4,000 species within four subfamilies and 79 genera of Halictidae recorded worldwide. In Korean Peninsula, Hirashima (1957) firstly reported *Lasioglossum occidens* smith, and 74 species belonging to three subfamilies are recorded subsequently. In this study, we report newly recorded species of Halictidae in South Korea with illustrations and general information of this group.

Key words: Hymenoptera, Halictidae, new record, Korea

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SG2-7

**Current status and future prospect on the faunastic study of Korean Miridae
(Hemiptera: Heteroptera: Miridae)**

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Faunastic study of Miridae of the Korean peninsula was initiated from the early 20th century by several Japanese researchers, and Korean researchers started to contribute from the mid-1940s. Since then, numerous taxonomic studies including diverse new species and records were conducted for the Korean Miridae. In this work, we provide a brief information about research history and current status of Korean Miridae fauna, with suggestions of further studies.

Key words: Hemiptera, Miridae, Taxonomy, new species, new record

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SG2-8

**Taxonomic review of the genus *Neolethaeus* (Heteroptera: Lygaeoidea:
Rhyparochromidae) from Korea**

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The genus *Neolethaeus* Distant, 1909 is comprised of 27 species worldwide, and only two species are recorded in Korea. In the study, three species of the genus *Neolethaeus* are recognized from Korea. Among them, *Neolethaeus lewisi* (Distant, 1883) is reported for the first time from Korea. We provide descriptions, diagnoses, photographs and genitalia of adult specimens. And we provide a key to the species of the genus in Korea.

Key words: Hemiptera, Rhyparochrominae, taxonomy, the Korean Peninsula

* 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 (NIBR202333201).

SG2-9

Taxonomic study of the genus *Plecia* (Diptera: Bibionidae) in South Korea

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The genus *Plecia* Wiedemann is the largest genus of Bibionidae with approximately 257 species recognized mostly in pantropical regions. Members of this genus can be distinguished from other bibionids by fore legs without apical spines and the presence of short wing vein R2+3 diverged before middle of R4+5. There is little information available for general biology and behavior of bibionids, but few species of *Plecia*, namely *Plecia nearctica* in the Nearctic Region are commonly called as “lovebugs” due to their characteristic copulation process and synchronous outbreaks. In South Korea, only two species of *Plecia*—*P. adistola* and *P. thulinigra*— are reported in prior to 2022 outbreaks of “lovebugs” with distinct rufous thorax, now identified as *P. longiforceps* in Seoul Metropolitan Area. Few bibionid species are notable pests, not only mass emergence of mating adult pairs but also most of their larvae are phytosaprophagous and known to cause serious damage to crops. Here, we provide a regional keys and lists the species of *Plecia* in South Korea, with an additional molecular phylogenetic analysis of *Plecia* based on mitochondrial cytochrome oxidase *c* subunit I (COI) barcode data.

Key words: Bibionidae, COI barcode, Diptera, *Plecia*, phylogeny

* 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 (NIBR202333201).



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