

S1-1

Insect population dynamics according to environmental change: Prediction of forest pest distribution

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Global warming and changes in ecosystems are either causing a rapid decline in insect diversity on earth or, on the other hand, are increasing the likelihood of unexpected insect pests emerging. This study summarizes and reports the followings: Introduction to the Insects of Red Data Book of Korea and Nationally Protected species, the establishment of monitoring strategy for exotic insects by the investigation of species distribution range through field surveys and others, the dispersal of exotic insects, and with the expansion of exotic insects and development of ecosystem impact prediction model.

Key words: biodiversity, extinct, exotic forest pests, dispersal, prediction

S1-2

Diversity and future of Hymenoptera in South Korea

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곤충 생물다양성의 파괴는 결국 인류의 몰락을 가져올 정도로 심각하지만, 생물다양성을 지키는 것이 그리 간단하지만은 않은 것 같다. 벌목의 곤충은 잎을 섭식하는 식식성부터 숙주의 개체수를 조절해주는 기생성과 집단으로 생활하며 먹이를 공급받는 사회성에 이르기까지 다양한 습성을 갖는 분류군이다. 뿐만아니라 나비목, 딱정벌레목, 파리목, 노린재목과 같이 다양성이 매우 높은 5대 분류군 중 하나이다. 2021년 발간된 한국곤충명집에 따르면 현재 우리나라 벌목의 곤충은 67과 1,137속 4,223종으로 알려져 있다. 국내 분류학 전문가들의 꾸준한 연구 노력의 결과 우리나라 벌목 뿐만아니라 곤충의 분포 정보는 해마다 늘어가고 있으나, 생물다양성의 손실은 세계 곳곳에서 가시화되고 있다. 국내에 서식하는 다양한 벌목 곤충들이 앞으로 이 곳을 떠나지 않고 우리와 함께 하기를 바라며 이번 심포지움이 국내 곤충다양성 유지를 위한 작은 움직임이 되길 바란다.

검색어: 기생벌, 벌목, 사회성, 생물다양성, 식식성, 해충

S1-3

Current status and biodiversity of aquatic insects in Korea

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수서곤충은 일반적으로 하루살이목, 날도래목, 강도래목, 잠자리목, 노린재목, 딱정벌레목, 뱀잠자리목, 파리목의 8개의 목(Order)에 속하며, 물을 기반으로 서식하는 곤충들을 의미한다. 국내 수서곤충의 연구는 도입기(40-50년대), 형성기(60년대), 발전기(70-80년대), 도약기(90-2010년대)를 거쳐 왔다. 물을 기반으로 수질을 평가하기 위해 수서곤충은 생태학적 연구가 먼저 시작되었으며, 이후 분류학적 연구가 시행되고 현재는 유전학적 및 응용학적 연구로 다양성을 증명하고 있다. 하지만, 물을 기반으로 하는 수서곤충의 서식처는 도시화로 인한 다양한 개발과 교란으로 감소하고 사라지고 있다. 서식처뿐만 아니라 수서곤충을 연구하는 학자들과 학생들도 정체기와 쇠퇴기를 거치고 있다. 국내 수서곤충의 다양성 종 목록은 1999년 처음으로 학술논단에서 491종이 정리되었으며, 이후 약 10년 만에 개정목록이 2011년에 988종으로 수정되었다. 이후 지속적인 국가생물다양성 확보 및 보전 전략에 따라 미발굴된 수서 파리류들이 대거 기록되면서 2018년에는 처음 기록보다 3배 이상 증가하여 1,567종이 보고되었다. 이처럼 표면적으로는 수서곤충의 연구가 활성화되어 다양성은 늘어가고 있는 것처럼 보이지만 다양한 문제점들이 나타나고 있다. 수서곤충은 성충보다는 유충을 주로 연구하는 학문으로 많은 연구자가 어려움을 겪고 있다. 단기간의 다양성 증진보다는 심도 있는 다양한 주제로 접근하는 방법이 필요할 것으로 보이며, 수서곤충의 다양성과 함께 서식처 회복 및 복원 방안도 함께 마련되어야 할 것으로 판단된다. 본 발표에서는 국내 수서곤충의 다양한 연구주제와 피해 상황 및 활용방안을 소개하여 미래의 수서곤충의 방향성과 연구 방향을 심도 있게 논의하고자 한다.

검색어: 수서곤충, 다양성, 분류, 생태, 한국

S1-4

Human fatalities caused by social wasp in Korea

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전국적으로 매년 말벌 벌집 신고수는 약 20만건이 넘으며 부상자는 1-2만명, 사망자도 10-15명씩 나타나고 있다. 이에 따라 매년 소방청에서는 여름과 가을에 벌 쏘임 사고 ‘주의보’를 발령하고, 벌 쏘임 사고 예방에 대한 주의를 요하고 있다. 이처럼 말벌은 강력한 독침을 가진 사회성 곤충으로 외부 천적으로부터 그들의 군집을 지키기 위한 방어행동이 매우 잘 발달되어 있다. 말벌은 외부의 인위적인 자극에 대해 천적의 침입으로 인식하고 집단 공격을 하는데 주로 검은색과 같은 짙은색의 긴털을 가진 대상에 대해 강한 공격성을 보였으며, 초록색, 노란색과 같은 자연색에는 크게 반응하지 않았다. 집단 공격시 약 10-15m 정도까지 추적하면서 공격을 하였고 천적이 벌집으로부터 약 3m 이내에 들어오면 경계 비행 후 공격하였다. 따라서 말벌 위험 지역에서는 이러한 특성을 잘 파악하여 행동하는 것이 말벌의 피해를 줄이는 방법이다. 또한 말벌의 독성 강도는 장수말벌의 독이 가장 강했으며 그 뒤로 꿀벌, 쏘말벌, 털보말벌, 등검은말벌, 말벌, 왕바다리 순으로 나타났다.

검색어: 말벌, 쏘임 피해, 방어행동, 검은색, 독성강도

S1-5

Ecological understanding of Q fever diseases transmission among rodents, ticks, and cow

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Q fever is a highly infectious tick-borne zoonotic disease caused by *Coxiella burnetii*, a major pathogen that can cause reproductive disorders in ruminants such as cattle. Being one of the livestock infectious diseases with unclear causative factors and transmission routes, there is a high possibility of transmission between wildlife, disease vectors, and livestock. Despite extensive research due to its high infectivity and significant economic losses, much of the focus has been on aspects such as pathogen detection, immunodiagnosis, and veterinary medicine. However, understanding the ecological interaction between the vector (ticks) and reservoir hosts (rodents) is crucial for elucidation the transmission dynamics to livestock. In this presentation, we aim to discuss genetic variation analysis approaches and ecological co-occurrence analysis to understand the transmission pathways between rodents, ticks, and cow.

Key words: Disease Ecology, Spatio-Temporal Dynamics, Transmission Mechanism, Urbanization, Climate change

S2-1

Study on the application of repellents from natural products for the control of two-spotted spider mites in greenhouse

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The series compounds from natural products are an effective repellent and deterrent against various kinds of pests. In this study, we evaluated the spatial repellency of fifteen compounds from natural products on the two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae), in the laboratory and field by using two-choice and no-choice bioassays. In laboratory two-choice tests, six compounds displayed active spatial repellency against female adult mites at a 2mg dose. The repellency of each compound was also as effective as the 6-compound blend. Three of the six compounds showed the predominant repellent activity (over 90%) that lasted for at least 3 days in laboratory no-choice tests. In a field test, we found that the number of *T. urticae* was fewer in strawberry seeding treated lure with 2mg of these compounds than in strawberry seeding treated lure with solvent control. Given that the findings are efficacious, economical, and natural products, they can be used in the sustainable management of *T. urticae* in greenhouse.

Key words: *Tetranychus urticae*, natural product, spatial repellency, choice test

S2-2

Seasonal occurrence of bark and woodboring Coleoptera in stands of *Pinus densiflora* (Pinales: Pinaceae) and *Larix kaempferi* (Pinales: Pinaceae) and monitoring method using multi-funnel traps baited with pine volatiles

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This study investigated the seasonal occurrence of bark and wood-boring Coleoptera in *Pinus densiflora* (Siebold & Zucc.) (Pinales: Pinaceae), and *Larix kaempferi* (Lamb.) (Pinales: Pinaceae) stands using multi-funnel traps baited with pine volatiles in Korea. The number and species of bark and woodboring beetles caught in traps baited with ethanol, α -pinene, and ethanol+ α -pinene were compared to determine the effective attractants. In addition, the effects of other pine volatiles, such as (-)- β -pinene, β -caryophyllene, (\pm)-limonene, β -myrcene, and 3-carene, were investigated. A total of 13,134 wood-boring beetles from 150 species were collected from pine and larch stands from 2019 to 2020. *Tomicus minor* (Hartig) (Coleoptera: Curculionidae) adults were more attracted to traps baited with α -pinene, whereas *Xyleborinus saxesenii* (Ratzeburg) (Coleoptera: Curculionidae), *Cyclorhipidion pelliculosum* (Eichhoff) (Coleoptera: Curculionidae), and *Phloeosinus pulchellus* (Blandford) (Coleoptera: Curculionidae) adults were more attracted to traps baited with ethanol. *Hylurgops interstitialis* (Chapuis) (Coleoptera: Curculionidae), Shirahoshizo genus group, *Rhagium inquisitor* (Linne) (Coleoptera: Cerambycidae) and *Rhadinomerus maebarai* (Voss & Chûjô) (Coleoptera: Curculionidae) were more frequently attracted to traps baited with ethanol+ α -pinene than to traps baited with other attractants. The addition of 3-carene to ethanol+ α -pinene enhanced the capture of *H. interstitialis*, *R. inquisitor*, and *Hylobius (Callirus) haroldi* (Faust) (Coleoptera: Curculionidae).

Key words: pine, larch, pine volatiles, bark and woodboring beetle, seasonal occurrence, monitoring

S2-3

Field Application of a combination treatment of pheromone and kairomone against Citrus Longhorned Beetle, *Anoplophora chinensis*

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최근 친환경 블루베리 및 감귤 과원을 중심으로 알락하늘소 피해가 증가하고 있지만 효과적인 예찰 수단이 부족한 실정이다. 본 연구에서는 알락하늘소의 예찰 효율 증진을 위하여 페로몬과 기주식물 휘발성 물질(카이로몬)을 조합하여 복합유인제를 구성하였고, 알락하늘소가 다발생한 친환경 과원에 유인제와 트랩을 설치하여 성충 유인효과를 확인하였다. 포장 실험 결과, caryophyllene과 limonen을 페로몬과 조합하여 유인제를 구성한 경우 성충이 대량으로 유인되는 것을 확인할 수 있었다. 이는 알락하늘소가 종내 신호물질을 인지할 때 서식지로서 적합한지 판단의 기준으로 기주식물의 존재여부를 동시에 확인하기 때문인 것으로 판단된다. 향후 알락하늘소에 대한 복합유인제 현장적용 연구를 통하여 효과적인 알락하늘소 예찰도구로 활용될 수 있을 것으로 판단된다.

검색어: 알락하늘소, 카이로몬, 방출기, 페로몬

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S2-4

Development and effectiveness testing of *Conogethes punctiferalis* mating disruptor emitter and treatment method

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AD Corp.

밤나무 과원에서 복숭아명나방을 대상으로 친환경 성페로몬 교미교란 실험을 진행하였다. 충북 충주 소재 유기농 밤과원과 관행농 밤과원에서 처리 방법을 달리하여 교미교란 효과를 검증하였다. 기준 처리량은 OECD Series on Pesticide number 12에 기록된 미국 EPA 기준, 50g AI/ha를 적용(한 시즌 동안 교미교란 효과가 발현할 수 있는 최소량)하였다. 처리량은 산지 지형을 생각하여 기준량의 두 배를 적용하였으며, 처리 방법은 1회 처리 방법과 2회 처리 방법을 선택하였다. 1회 처리는 기준량의 두 배를 한 번에 처리한 방법이고, 2회 처리는 기준량을 2회에 걸쳐 처리한 방법이다. 교미교란제 첫 번째 처리는 1회, 2회 모두 6월 15일에 진행하였고, 두 번째 처리는 2회 처리 방법만 8월 9일에 실시하였다. 실험 결과 유기농 밤과원 1회 처리 교미억제율은 87.8%였고, 교미교란 효과는 72.5%(무처리 대비 방제가)였다. 2회 처리 교미억제율은 94.9%였고, 교미교란 효과는 82%였다. 관행농 밤과원에서는 1회 처리 교미억제율은 89.6%였으며, 교미교란 효과는 66.9%였다. 2회 처리 결과 교미억제율은 95%였고 교미교란 효과는 74%였다. 관행농보다 유기농에서 더 높은 효과를 보였는데, 두 과원의 지형적 차이로 보인다. 아울러, 2회 처리 방법이 밤과원에서 복숭아명나방을 대상으로 더 효과적인 처리 방법이라 판단한다.

검색어: 복숭아명나방, 교미교란제, 성페로몬, 친환경, 밤나무

S2-5

Approaches of urban forest pest management using pheromone-based mating disruption

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최근 가로수, 공원 등에 수목이 많이 식재되어 우리 생활 주변에 녹지가 조성되고 있었고, 이를 생활권 수목 또는 도시숲으로 불린다. 이러한 생활권 수목의 증가로 따른 현상으로, 대상 수목을 가해하는 해충 또한 증가하였다. 생활권 해충에 대한 방제 수단으로는 농약 살포, 나무 주사 등의 화학적 방제법이 있으나, 생활권 주변이라는 특성으로 인하여 농약 살포나 나무주사 등은 바람직한 방제 수단으로 여기기 어렵다. 이에, 친환경적인 방제 방법중의 하나인 페로몬을 이용한 교미교란제법이 하나의 대안으로 판단되어 수목 해충 중 나비목 해충에 대한 교미교란제의 적용해 보았다. 대상 수목과 해충으로는 무궁화-큰붉은잎밤나방, 동백나무-차독나방, 왕벚나무-복숭아유리나방으로, 잎을 가해하는 해충 2종과, 천공성 해충 1종을 선택하였다. 큰붉은잎밤나방은 무궁화의 가장 큰 식엽성 해충이다. 차독나방은 남부지역 동백나무에 발생하는 식엽성 해충으로, 접촉시 피부염을 일으켜 일부 관광지에서 문제가 되고 있다. 복숭아유리나방은 줄기를 가해하는 천공성 해충으로, 화학방제가 어려운 해충이다. 본 발표에서는 큰붉은잎밤나방, 차독나방, 복숭아유리나방의 교미교란제를 이용한 방제 효과와 방제 효과 평가법에 대하여 발표하고자 한다.

검색어: 페로몬, 교미교란제, 생활권 수목, 화학 방제 대체

S2-6

Technical aspects of sensory electrophysiology in insect chemical communication studies: EAG, GCEAD and SSR

Kye Chung Park

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Sensory electrophysiological recording techniques such as EAG (electroantennogram), GCEAD (coupled gas chromatograph-electroantennogram detection) and SSR (single sensillum recording) have been useful in the chemical ecology studies of insects and plants. Numerous pheromones and other semiochemicals have been identified through GCEAD analysis, and the response profiles of antennae and individual olfactory receptor neurons have been characterized by using EAG and SSR techniques. In this talk, the practical aspects of these techniques are presented in detail. Standard setup and procedure of each electrophysiological recording technique, and important parameters and proper data analysis methods will be introduced as well as its applications. Common mistakes and limitations of these techniques will also be discussed.

Key words: chemical ecology, EAG, electroantennogram, electrophysiological recording technique, GC-EAD, olfaction, single sensillum recording, SSR

S2-7

Chemical communication system of three *Spodoptera* moth species for pheromones and plant volatiles

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Spodoptera 속의 담배거세미나방, 열대거세미나방 및 파밤나방은 여러 나라에 분포하는 광식성 해충으로, 본 연구에서는 이들의 페로몬 및 식물냄새물질과 관련한 화학통신시스템에 대해 이해하기 위해 냄새감각기의 종류와 분포, 냄새활성물질 동정 및 야외행동 반응에 대한 연구를 진행하였다. 주사전자현미경 관찰을 통해, 세 종 나방의 암, 수컷 촉각에 여러 종류의 냄새감각기가 존재하며, 형태적으로 구분되는 종특이적 또는 성특이적 냄새감각기들이 존재한다는 것을 확인하였다. GC-EAD 실험을 통해 세 종 나방에 냄새활성을 나타내는 식물 냄새물질과 페로몬 관련 물질들을 동정하고, 이들을 개별 또는 조합하여 야외 트랩실험을 통해 행동활성을 검정한 결과, 이 중 여러 물질이 담배거세미나방과 파밤나방의 성페로몬에 대한 유인행동 반응을 저해하는 것을 알 수 있었다. 열대거세미나방은 발생이 저조하여 야외에서의 행동반응을 확인할 수 없었다.

검색어: *Spodoptera*, 담배거세미나방, 열대거세미나방, 파밤나방, 주사전자현미경, GC-EAD, 야외행동검정

S3-1

Insect gut microbiome as a novel source for synthetic plastic biodegradation

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Over the last decade, there has been growing interest in the plastic degradation capabilities of insect because herbivorous insects may be a valuable resource for microorganisms that can break down synthetic plastics. Insects that can digest plastics using their gut microbiota are gaining interest for use in bioremediation, although their environmental benefits remain unknown. However, most plastics biodegraded by insect gut microbes are polyethylene, polystyrene with little knowledge available on the gut microbiome of insects capable of degrading other synthetic plastics. Therefore, there is an urgent need to secure microbial resources based on insect-microbiome interactions and promote end-of-life solutions for synthetic plastics.

Key words: Insect-gut symbionts, plastic biodegradation, plastic waste management, bio-upcycling

S3-2

EpOMEs act as immune resolvins in insects

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Upon immune challenge, recognition signals trigger insect immunity to remove the pathogens through cellular and humoral responses. Various immune mediators propagate the immune signals to nearby tissues, in which polyunsaturated fatty acid (PUFA) derivatives play crucial roles. However, little was known on how the insects terminate the activated immune responses after pathogen neutralization. Interestingly, C20 PUFA was detected at the early infection stage and later C18 PUFAs were induced in a lepidopteran insect, *Spodoptera exigua*. This study showed the role of epoxyoctadecamonoenoic acids (EpOMEs) in the immune resolution at the late infection stage to quench the excessive and unnecessary immune responses. In contrast, dihydroxy-octadecamonoenoates (DiHOMEs) were the hydrolyzed and inactive forms of EpOMEs. The hydrolysis is catalyzed by soluble epoxide hydrolase (sEH). Inhibitors specific to sEH mimicked the immunosuppression induced by EpOMEs. Furthermore, the inhibitor treatments significantly enhanced the bacterial virulence of *Bacillus thuringiensis* against *S. exigua*. This study proposes a negative control of the immune responses using EpOME/DiHOME in insects.

Key words: Innate immunity; Insect; Oxylipin; EpOME; DiHOME; Resolution

S3-3

Insect host-pathogen interaction: Signaling pathway for antimicrobial peptides production

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It is well known that invertebrates do not have adaptive immunity because of their short life cycle. Especially, insects have a strong innate immune system, including antimicrobial peptides (AMPs) production, to protect themselves from a wide range of pathogens. Previously, we identified over 60 genes related to AMP production, including Toll and Imd pathways, and characterized their immunological role in response to pathogenic infection through target gene-specific RNAi. This resulted in decreased expression levels of most AMPs in the larvae which were injected with target gene-specific dsRNA and microbes. Currently, we are focusing on studying the regulation of AMP production through epigenesis. It may help us understand how to regulate the innate immune system induced by pathogenic infection.

Key words: antimicrobial peptides, host-pathogen interaction, signaling pathway, epigenetic regulation

S3-4

Introduction of BRL: Insect-microbe interaction Lab

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Climate change has led to increased insect pests and pest distribution changes. Traditionally, chemical control using synthetic pesticides has been the main method for pest management, but the emergence of pesticide-resistant pests has become a problem. There is a need to develop new pest control agents to overcome these issues. Entomopathogenic fungi used in pest management have minimal environmental side effects and possess a mechanism of action distinct from that of synthetic pesticides. However, there is a need for the development of technologies to maximize the insecticidal effects of fungi against pests, and expressing and releasing dsRNA within the fungi can preemptively knock out the activation of the insect's defense system, thereby enhancing the insecticidal effect. Controlling insect defense genes and using entomopathogenic fungi as bio-carriers forms a new pest management strategy. This approach, described as a "microbial insecticide agents development strategy of cassette concept," can versatily modify genes and microbes. It is expected to overcome the limitations of synthetic pesticides.

Key words: BRL, dsRNA, entomopathogenic fungi, microbial insecticides, pest management

S4-1

Importance of vector surveillance in the era of climate change

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IPCC가 발간한 "지구온난화 1.5°C 특별보고서에서는 전 지구적인 경제피해, 생태계, 종다양성에 대한 피해를 언급하고 있다. 우리나라를 기준으로 보았을 때 평균 기온이 상승하는 경우 가장 우려되는 현상 중 한가지는 매개체들의 서식범위가 북쪽으로 확대되어지고 이에 따라 매개체가 옮기는 질병들에 대한 우려가 매우 크다. 특히 국내에 서식하지 않던 매개체들의 유입 위험이 증가되고 있다. 이에 질병관리청은 16개의 매개체감시거점 센터를 운영하고 있다. 하지만 최근 5년간 매개체 관련 과재 숫자는 감소하고 있어 매개체 감시의 중요성이 대두 되어질 필요가 있다.

검색어: Climate Change, Vector, RVSC (Regional Vector Surveillance Center)

S4-2

Development of Smart Aerial Net Trap (SANT) for monitoring of migrating pests

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The brown planthopper (BPH) and white-backed planthopper (WBPH), significant rice pests, cannot overwinter in Korea and primarily originate and migrate from Southeast Asia and China, where they cause considerable damage. These planthoppers, along with other pests, annually migrate to the Korean Peninsula. Monitoring their migration is essential for controlling their populations and maintaining agricultural productivity. Traditional monitoring methods often struggle with timeliness due to time and manpower constraints. To address this, we developed the Smart Aerial Net Traps (SANT) for immediate tracking of pests. The SANT system is installed in 43 locations across the country and has been used for over 10 years to track migrating insects. Our research shows that SANT is a more effective method for monitoring migratory pests compared to traditional methods. SANT enables real-time tracking of various migratory pests and can also be utilized in different areas, such as analyzing pest population changes and determining pest origins through the study of air currents.

Key words: pests, monitoring, migrating pest, brown planthopper, SANT

S4-3

National monitoring of mosquito populations in the Republic of Korea in 2023

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About 1 billion cases of vector-borne infectious diseases occur every year, of which more than 1 million is dead in worldwide. Japanese encephalitis and malaria continue to occur, and infectious diseases such as dengue fever being imported abroad have been increasing significantly due to the increasing number of overseas travelers in Korea. The Korea Disease Control and Prevention Agency has established local centers to monitor pathogen vector population density related to climate change at 16 locations. We collected 59,389 mosquitoes in traps at 36 collection sites in 30 urban regions and migratory bird habitats in 2023. The trap index was 34.6, and the predominant mosquito species were the *Culex pipiens* complex, *Aedes albopictus*, *Armigeres subalbatus*, *Aedes vexans*, and *Ochlerotatus Koreacus*. The mosquitoes were pooled into 4,371 pools to monitor flavivirus infection. In flavivirus detection, no virus was detected.

Key words: mosquito, flavivirus, Japanese encephalitis

S4-4

Surveillance of vectors for arthropod-borne animal diseases

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2023년 10월 국내 소 럼피스킨이 최초 유입이 확인된 이래, 4주만에 전국적으로 확산됨에 따라, 국가 인접국의 유입 가능한 가축질병 전파 매개체의 감시·예찰을 확대하고 강화할 필요성이 높아지고 있다. 농림축산검역본부(이후, 검역본부)는 해외 유입 가능한 가축전염병 전파 매개체와 가축에 대한 매개체성 질병 모니터링을 수행하고 있다. 매개체 감시 사업은 '07년부터 전국 공항만을 중심으로 시작 후, '17년부터는 가축농장으로 확대하여, 현재는 전국 공항만(계류장) 4개 지점와 가축 농장 32개 지점에서 모기와 등에모기 대상으로 수행 중에 있다. '17~'23년까지 모기는 6속 15종 236,752마리, *Culex pipiens*(25.8%), *Aedes vexans*(25.5%), *Anopheles spp.*(24.6%), *Culex tritaeniorhynchus*(12.0%)가 우점종으로 확인되었다. 등에모기는 20종 127,267마리, 우점종은 *Culicoides*(*C. punctatus*(40.0%), *C. arakawae*(37.5%)였다. *C. tainanus* 등 3개 종에서 블루팅바이러스(1종 가축전염병)가 검출되고, '23년 럼피스킨 양성농장(7개소)의 채집된 침파리에서 원인체가 확인됨에 따라, 가축(동물)에 대한 매개체의 감시·예찰을 강화하기 위해 민·관 협력 지역별 가축질병 매개체 감시 센터 구축, 방제기술 개발 등 기후변화 대응 가축질병 연구개발에 박차를 가할 예정이다.

검색어: 럼피스킨, 블루팅, 등에모기, 모기, 침파리

S4-5

AI-IoT based automated imaging trap system for monitoring vector mosquito population

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Due to climate change and the rise in international transportation, there is an emerging potential for outbreaks of mosquito-borne diseases such as malaria, dengue, and chikungunya. Consequently, the rapid detection of vector mosquito species, including those in the *Aedes*, *Anopheles*, and *Culex* genera, is crucial for effective vector control. Currently, mosquito population monitoring is manually conducted by experts, consuming significant time and labor, especially during peak seasons where it can take at least seven days. To address this challenge, we introduce an automated mosquito monitoring system designed for wild environments. Our method is threefold: It includes an imaging trap device for the automatic collection of mosquito data, the training of deep-learning models for mosquito identification, and an integrated management system to oversee multiple trap devices situated in various locations. Using the well-known Faster-RCNN detector with a ResNet50 backbone, we've achieved mAP (@IoU=0.50) of up to 81.63% in detecting *Aedes albopictus*, *Anopheles spp.*, and *Culex pipiens*. As we continue our research, our goal is to gather more data from diverse regions. This not only aims to improve our model's ability to detect different species but also to enhance environmental monitoring capabilities by incorporating gas sensors.

Key words: Artificial Intelligence, Insect Monitoring, Internet of Things, Mosquito Trap, Vector Control

S4-6

Paradigm shift to control strategy based on mosquito surveillance data

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In the Republic of Korea, public health centers conduct vector mosquito control in accordance with infectious disease prevention laws. However, most public health centers have traditionally conducted periodic, uniform vector control across their respective regions without considering specific information on vector occurrence. In 2021, The Korea Diseases Control and Prevention Agency(KDCA) launched a control project to shift the paradigm toward mosquito control strategy based on mosquito surveillance data. In 2024, 18 local public health centers will participate in this project, which will progressively expanding so that it can be used countrywide. Local public health centers evaluate mosquito monitoring data using data gathered from Daily Mosquito Monitoring System(DMS), which enables them to pinpoint the best times and locations for vector control. Vector control activities carried out by local public health centers are computerized utilizing Vector Control Geographic Information System(VCGIS). Using the new control strategy with mosquito surveillance, the number of mosquito occurrences, number of control activities, and amount of insecticides have decreased compared to the periodic control activities. Based on mosquito surveillance data, it is anticipated that evidence-based mosquito vector control will offer a more efficient and effective means of mosquito control.

Key words: mosquito control, surveillance data, Daily Mosquito monitoring System(DMS), Vector Control Geographic Information System(VCGIS)

S4-7

Differences in insecticide resistance profiles among medical insects: Status and patterns

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Medically significant indoor/ectoparasitic insect populations, including bed bugs and head lice, have developed considerable resistance to insecticides due to limited introduction of new genetic traits and the absence of an overwintering barrier. In contrast, outdoor pests like *Anopheles* and *Culex* mosquitoes exhibit fluctuating resistance patterns, likely influenced by factors such as overwintering barriers and relatively wider open habitats. Mosquitoes also face selection pressure from diverse sources beyond public health insecticides unlike bed bugs or head lice. Understanding different factors driving resistance among pests is essential for effective resistance management.

Key words: Medical insect, bed bug, head louse, mosquito, resistance, insecticide

S5-1

Beyond visuals: unveiling the multifaceted applications of AI in entomology

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This presentation explores the application of Artificial Intelligence (AI) in entomology beyond traditional image analysis. It highlights AI's potential in auditory and olfactory analysis, areas less explored in entomological research. Utilizing machine learning, AI enhances insect classification and ecosystem assessment through improved analysis of existing data. The discussion includes AI's capability in developing indices for habitat evaluation using insects as bioindicators, emphasizing its versatility across different research areas within entomology. This approach aims to broaden the scope of AI applications, promoting a deeper understanding of ecological dynamics through entomological studies.

Key words: machine learning, acoustic analysis, habitat index, olfactory analysis

S5-2

Construction of an insect protein 3D structure prediction system using AlphaFold2

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단백질의 구조 예측은 생명 과학 및 의학 분야의 핵심적인 연구 주제 중 하나로, 단백질의 기능 및 상호작용을 이해하기 위한 주요 정보를 제공할 수 있어 다양한 연구가 수행되고 있다. 이러한 연구의 일환으로 최근 Google DeepMind의 AlphaFold2가 등장하였으며, 단백질 구조 예측 성능을 대폭 향상시켜 CASP(Critical Assessment of Protein Structure Prediction)에서 뛰어난 평가점수를 받아 단백질 구조 예측 분야의 최신 기술을 크게 향상시켰다. 이러한 컴퓨터 기반의 단백질의 구조 예측 방법은, 고전적인 방법을 사용하여 직접 단백질 구조를 결정하는 방법에 비해 매우 정확하고 빠르며 경제적인 비용으로 수행될 수 있어 단백질 구조 예측 및 생리학 연구를 수행하는 연구자들에게 유용한 방법론이 될 것으로 사료된다. 따라서 본 연구소에서는 곤충을 포함한 무척추 자생동물을 연구하는 연구자들을 위해 단백질 구조 예측을 수행할 수 있도록 64Core/128Threads의 CPU, 256GB의 RAM과 6장의 GeForce RTX 3090으로 이루어진 GPU(Graphical Processing Unit) 고성능 컴퓨터 시스템에 AlphaFold2 program을 구축하였다. 최근 인간을 대상으로 한 단백질 구조 예측 연구는 상당한 진전을 보이고 있지만, 곤충을 포함한 자연계의 동물을 대상으로 한 연구는 여전히 미비한 상황이다. 이러한 자생동물자원연구의 확대를 위해 본 연구소에서 구축한 GPU 시스템 및 생물정보학적 분석 방법이 많이 활용되어야 하며, 이를 위해서는 연구자들의 협력과 참여가 필요하다.

검색어: Alphafold2, Protein 3D Prediction

Advances in artificial intelligence for vector identification and monitoring

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Recent advances in artificial intelligence and machine learning, such as the use of convolutional neural networks (CNNs) for image recognition, have emerged as a promising modality with the capability to visually differentiate between mosquito species. Here we present the first performance metrics of IDX, Vectech's system for AI mosquito identification, as part of Maryland's mosquito control program in the USA. Specimens were collected over fourteen weeks from twelve CDC gravid trap collection sites, identified morphologically by an entomologist, and imaged using the IDX system. By comparing entomologist identification to the algorithm output by IDX, we are able to calculate the accuracy of the system across species. Over the study period, 2,591 specimens were collected and imaged representing 14 species, 10 of which were available in the identification algorithm on the device during the study period. The micro average accuracy was 94.9%. Of these 10 species, 7 species consisted of less than 30 samples. The macro average accuracy when including these species was 79%, while the macro average when excluding these species was 93%. In the next iteration of this technology, Vectech is translating the vector identification capabilities of IDX into systems capable of processing greater numbers of specimens at large public health facilities, and remote sensing systems that will allow public health organizations to monitor vector abundance and diversity from the office. These advances demonstrate the utility of artificial intelligence in entomology and its potential to support vector surveillance and control programs around the world.

Key words: artificial intelligence, machine learning, mosquito, tick, vector identification