

Development of microsatellite loci from the soybean aphid, *Aphis glycines* Matsumura (Hemiptera: Aphididae)

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Ten novel microsatellite loci were isolated and characterized from the soybean aphid, *Aphis glycines*. The soybean aphid was recently introduced into North America where it has become a serious pest of soybeans. This invasive pest has rapidly spread throughout the midwestern United States and southern Canada since 2000. The isolated loci were polymorphic, with two to 18 alleles in 20 individuals from a single population in Korea. The analyses revealed that 19 individuals had different multilocus genotypes, showing expected heterozygosity values ranging from 0.180 to 0.891. We report the development of microsatellite markers for *A. glycines* potentially suitable for further studies of population structure, dispersal, and host alternation.

Key words: aphid, *Aphis glycines*, microsatellite, population genetics, soybean aphid

The analysis of hexapod mitochondrial sequences for assaying the utility of DNA barcode

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DNA barcode projects in Hexapoda have been initialized and progressed accumulating large number of mitochondrial gene sequences. However, due to large number of data, overview of DNA barcode projects was not conducted until now. Here we reported the current status of DNA barcode projects with the aid of Insect Mitochondrial Genome Database (IMGD; <http://www.imgd.org/>) which archives 128,562 partial mitochondrial gene sequences (PMEs) of Hexapoda. Among 37 mitochondrial genes, *COI* has been used popularly (22,379 PMEs; 17.40 %) through all 33 orders. Through 513 researches, different parts of *COI* PME have been utilized differently along with hexapod orders. In addition, by calculating genetic divergences of *COI* PMEs, intra-species and inter-species in 21 hexapod orders were distinguished by 5% divergence and some of mitochondrial genes in certain order present higher genetic divergences than that of *COI*. Based on these results, we confirmed that DNA barcode is a useful tool to identify hexapod species and several mitochondrial genes can be good molecular markers to support *COI*.

Key words: Hexapoda, DNA barcode, *COI*, and mitochondrial genes

리의 장기발전 전략

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산림곤충이란 산림으로 규정되는 지역에 서식하는 모든 곤충으로써 중요한 생물자원이며, 그 중요성이 점차 증대되고 있는 실정이다. 산림곤충에 관한 연구는 현재까지 해충위주로 수행되어 왔으며, 이를 제외한 희귀곤충, 산림생태계의 토양분해자 역할, 화분매개자로서의 역할 등 유용곤충이나 의약용으로 활용되는 다양한 여러 산림곤충에 대한 보호관리 차원의 연구 접근은 아주 드물다. 국내 곤충자원 연구는 농촌진흥청을 중심으로 잡업, 양봉, 애완곤충 분야 등, 농가소득증대 차원의 응용분야나 환경부의 법적보호종 중심의 생물다양성 조사 및 보전방안에 관한 연구, 국립수목원의 생물표본 및 종의 DB사업 등을 통해서 부분적으로 활발하게 진행되고 있다. 그러나, 국가적인 곤충자원의 종합적인 보호와 관리·이용을 위해서는 곤충의 주서식지인 산림을 중심으로 체계적인 분포조사, 수집, 분류, 활용방안, 보호·관리 등의 종합적·장기적인 기반사업 추진이 절실히 함에도 현재까지 산림청내 곤충업무는 산림병해충과를 중심으로 해충 생태 및 방제위주의 연구를 주로 수행 중이며 국립수목원에서 자생곤충종의 분포연구, 주요 산림곤충의 분류연구 및 정보화 등 기초연구 수행이 부분적으로 이루어지고 있을 뿐이다. 한편 선진국에서는 국가기관을 중심으로 자국내 곤충자원의 탐색조사 및 활용성에 대한 연구개발이 활발히 이루어지고 있어서, 미국은 농무성 산하 「경제곤충연구소」에서 곤충자원의 조사 및 확보업무가 추진되며, 영국은 국가생물기록센터가 주축이 되어 곤충을 포함한 다양한 생물의 조사 및 이들에 대한 정확한 데이터를 수집·관리함으로써 생물다양성 관리에 활용하며, 일본은 국책연구과제인 「곤충기능이용기술개발연구(1993-)」를 추진하고 있으며, 네덜란드 등 유럽에서는 친환경농업을 위한 곤충자원의 활용기술 개발 등 다각적인 곤충연구가 활성화되어 있다. 또한 유엔 생물다양성협약 (CBD)이 발효된 이후 곤충의 이용 및 자원화를 위한 국가간 경쟁이 치열해 지고 있다. 우리나라의 곤충은 90% 이상이 산림 내에 서식하는 주요 산림자원이지만 이들의 활용, 자원화 및 보전에 대한 체계적 관리정책이 미약하며, 산림 곤충자원에 대한 조사, 분류, 산업화, 보호·관리에 관한 연구를 위한 연구 인프라가 극히 취약한 실정이다. 따라서 산림청 등 산림을 관리하는 부처에서는 산림곤충을 대상으로 이들의 보호 관리와 이용방안에 대한 체계적인 조사연구를 통해서 산림자원의 보전과 지

속적인 활용이란 측면에서 적극 검토되어야 할 것이다.

본 발표에서는 다음과 같은 내용에 초점을 두고 발표 및 논의하고자 한다: 산림내에 서식하는 곤충에 대한 보호·관리 및 자원화를 위한 중장기 마스터플랜 수립; 국토의 64%인 산림의 생물다양성 유지관리를 위한 산림곤충의 종합적·체계적 조사 가이드라인 마련; 종합적인 산림곤충의 조사·수집, 보호·증식 등을 위한 연구인프라 강화 및 민간네트워크 구축방안 연구; 희귀곤충 및 그 서식지 보호를 위한 정책개발 제안; 국내·외 곤충시장의 조사분석 및 활용기술 적용범위 분석을 통한 유용한 산림곤충의 이·활용 방안 제안. 이상의 원활한 수행을 위한 산림곤충 업무 추진을 위한 법적·제도적 근거 마련, 특히 「산림자원법」, 「산림보호법」 등 관련 현행법의 문제점 및 개선할 분야에 관해서 심도있는 분석이 이루어져야 할 것이다.

Year-Round Production System of the Korean Native Bumblebee *Bombus ignitus* for Crop Pollination

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The bumblebee is an important pollinator of various greenhouse crops, especially for tomatoes and there has been increasing interest in commercial use of the insects for pollination. Recent advances in commercial rearing of the European bumblebee (*Bombus terrestris*) made it possible to package bumblebee for crop pollination. Bumblebees are distributed world widely including alpine, cool temperate and even arctic environments of the northern continents. We chose *B. ignitus* out of seven Korean native bumblebees, because the species showed the best results both in artificial multiplication and in pollinating ability. Now, we are studying an artificial year-round mass rearing of *B. ignitus* selected as the most reliable native species in crop pollination. Therefore, we investigated the optimum temperature and humidity, effect of photoperiod and CO₂-treatment, facilitating effects of helper, and artificial hibernation of *B. ignitus* to establish year-round mass rearing of *B. ignitus*.

The experimental regimes of temperature and humidity were defined as 23°C, 27°C and 30°C under a constant humidity of 65% R.H., and 50%, 65% and 80% R.H. under a constant temperature of 27°C, respectively. Among the temperature regimes, 27°C-rearing showed the best results, i.e., the rates of colony initiation, colony foundation and progeny-queen production at 27°C were 83%, 63% and 46%, respectively, which corresponded to 2.2-5.5 times the respective values at other temperature regimes. The numbers of progeny produced at 27°C-rearing, 164±33 workers, 553±174 males and 33±48 queens were also higher, corresponding to 21.8 and 1.5 times those at 23°C and 30°C, respectively. In terms of humidity, 65% R.H. was favorable for big colony formation. Under the same humidity, the rates of colony initiation, colony foundation and progeny-queen production were 85%, 70% and 50%, respectively, and the number of progenies reached 180±30 workers, 578±179 males and 35±38 queens. Therefore, 27°C and 65% R.H. were determined to be the favorable environmental conditions for colony development of *B. ignitus* in indoor rearing.

It was investigated whether developmental characteristics of foundation

queens of *B. ignitus* collected in the 4 localities in Korea would be affected by the first oviposition days of them. The first oviposition day was classified as 1 - 4 days (immediate early), 5 - 6 days (early), 7 - 10 days (delayed early), 11 - 20 days (medium), 21 - 40 days (late), and above 41 days (very late). The queen that had the early first oviposition day, i.e., laid eggs so early after starting to be raised indoors, showed much higher rate of colony foundation and progeny-queen production and much shorter period of colony foundation and worker emergence. Besides, the numbers of worker and progeny-queen emerged from the queen that had the early first oviposition day were higher than those of the queen that had the late first oviposition. In results, the queen that had the early first oviposition day could make colony stronger and could make colony formation period shorter, therefore, the first oviposition day of foundation queen was proved to be a criterion for the selection of super colonies when *B. ignitus* is raised indoors.

It was investigated whether or not such helpers as worker bee, bee-cocoon and egg-cup etc, have any effects on oviposition and colony foundation of the bumblebee queen, *B. ignitus*. Among the helpers tested, the callow workers of *B. ignitus* and *B. terrestris* showed the most remarkable effects on the oviposition rates to 92% and 88%, respectively. The live cocoon as a helper improved oviposition rate over 60%. A narcotized old worker 10 days-aged after emergence, showed similar effects to a callow worker on the colony development such as oviposition rate, colony foundation and progeny-queen production. On the other hand, dried cocoon, callow honeybee worker or egg-cup did not show a positive effect as a helper. In the number of workers recruited to a foundation queen, two workers showed better effect than one worker on the colony development, with no difference between two and more.

The effect of photoperiodic regimes on the oviposition and colony development of *B. ignitus* queens was examined with 0L, 8L, and 16L under 27°C and 65% R. H. Among these photoperiod regimes, the oviposition rate at 8L and 16L was 80.2% and 83.1%, respectively, which was 12-15% higher than that at the dark condition (0L). Duration up to first oviposition at 8L and 16L was 17.5 days and 16.5 days, respectively, which was 2-3 days shorter than that at 0L. The colony foundation rate at 8L and 16L was 9.2% and 10.4%, respectively, which corresponded to 1.7-2.0 fold the value at 0L. In addition, the rate of progeny-queen production at 8L and 16L was also two fold higher than that at 0L. Taken there together, the light conditions (8L and 16L) rather than dark condition (0L) were more suitable for oviposition and colony development for *B. ignitus* in the indoor rearing condition.

We investigated mating conditions of photoperiod, illumination and

temperature during mating periods, care temperature of queen before mating, mating period and number of queen per mating cage to improve mating rate of *B. ignitus*. Among photoperiodic regimes of 12L, 14L and 16L during mating periods, queen mated at 14L showed better results than at 12L and 16L in egg-laying characteristics and colony development. In case of illumination during mating periods, intensity of 1000 lux was more effective than at intensity of 100 lux and 2000 lux in mating *B. ignitus* queen. Mating temperature and care temperature of queen before mating favorable for *B. ignitus* queen were 22-25? and 19?, respectively. The period need to mating *B. ignitus* queen was 3 days, and the number of queen suitable per mating cage of 55× 45× 65 cm was 30.

The effect of CO₂-treatment on interrupting diapause of *B. ignitus* was examined to provide a means for year-round rearing of the bumblebee. When mated young queens were exposed to 65% or 99% CO₂ for 30 min daily during two consecutive days, oviposition rate increased to 75% and 77%, respectively, comparing 50% in CO₂-untreated queens. At the same time, the days needed to first oviposition shortened to 17-18 days in CO₂-treated queens, comparing to 30 days in CO₂-untreated queens. CO₂-treatment at the second day after mating was appropriate to the oviposition and colony development. CO₂-treatment showed a positive effect on the oviposition and colony development, but less than them of over-wintered queen in numbers of produced progeny. It can be concluded that CO₂-treatment to *B. ignitus* is insufficient to produce commercial grade bumblebee colony in spite of its capability for promoting oviposition, because the treatment failed to form a big colony.

Artificial hibernation is essential for year-round rearing of the bumblebee, *B. ignitus* that undergoes one generation per year. It is known that keeping the queens in low temperature for two or three months is effective to terminate their diapause and develop the colony. Temperature, time and surroundings to keep the queens during artificial hibernation were investigated. Among the tested temperatures, -2.5°C, 0°C, 2.5°C, and 5°C, the optimum temperature was 2.5°C. At the temperature (2.5°C), survival rate after chilling of the queens was high and colony development thereafter was enhanced. The proper time to initiate chilling queen was 10 to 14 days after adult eclosion, and the survivability of the queens after chilling was good during the upper period. For the surrounding to keep the queen during artificial hibernation, we proposed the method to preserve them in a bottle filled with perlite and keep it around 80% R. H.

Key words: Bumblebee, *Bombus ignitus*, Temperature, Humidity, Photoperiod, Helper, Mating, Preoviposition, CO₂-treatment, Artificial hibernation. Oviposition, Colony development

살충제 등록시험법

김시용

동부하이텍 농생명연구소 작물보호연구팀

살충제 등록시험법을 최근에 발생하고 있는 주요 해충과 재배방법 및 살충제 특성을 고려하여 합리적인 시험방법을 제시하고, 살충제 등록시험의 신규 담당자가 쉽게 이해하여 시험을 수행할 수 있도록 아래의 순서로 정리하여 제시합니다.

1. 수도(벼) 등록시험법
2. 과수 등록시험법
3. 잔·특작 등록시험법
4. 화훼 등록시험법
5. 수목·잔디 등록시험법

검색어: 등록시험법, 수도, 과수, 잔·특작, 화훼, 수목·잔디

Registrational setbacks in Insecticide Items failed in Reviews

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In pesticide registration, the most of applicants are manufacturing companies which have richly experience in applying registration. With their experience, registration applications of pesticide shows excellent ratio of pass, but still some of application still fail to pass, and are judged as disqualifications or to be returned for supplement. In 2009, There were 6 items failed in registrational reviews. Two of them were for their active ingredient contents lower than specifications, Other two were for trials conducted wrong, so sent back to applicants to add supplement. But the rest of them, two items showed low efficiency in one trial, and were judged as disqualifications, which mean that ingredient cannot be registered for that target crop forever. Disqualification from low efficiency has highly strict criterion and usually don't have any flexibility to lower efficiency than criteria, unless there was no pesticide available for that pest. The way to remedy this criterion is very delicate and controversial issue, and needs more reconciliation of various views.

Key words: pesticide registration, registrational criteria, disqualification

Considering Insecticide Resistance to Insecticides

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Insecticide resistance development of insect pests is one of the main threatening factors against stable crop production and keeping human life safe from insect pest disease vector. To know properties of insecticides resistance is very important to develop a management program against insecticide resistance pests. Insecticide resistance development is an event of evolutionary process. We have to deal with insecticide resistance of insect pests by interaction between insecticide and insect pests in their chemical, physical and biological environment. We can glimpse at and infer the evolutionary process of insects from investigating and comparing the resistance level of insect pests to insecticides. Huge amount and many kinds of insecticides have been sprayed to control insect pests. Development of insecticide resistance of insect such as housefly and mosquito, known as most common medical insect, is a result of adaptation to environment covered with insecticides. We can easily assume that the amount and kind of insecticides sprayed the evolutionary force to the diversity of insecticide resistance. The resistance diversity will be very good character of good markers for determining geographical isolation.

Key words: Insecticide, Resistance, Vector, Evolution, Development

살충제 등록시험 합리적 추진방향

이종섭

작물보호협회

한국작물보호협회에서는 농약품목등록시험을 주관하여 추진하고 있다. 외부 위탁시험일 경우 하작물은 약 170여 항목에 400여개 약제를, 동작물은 약 50여 항목에 60여개 정도의 약제에 대하여 매년 시험을 추진하고 있다. 그러나 이제는 수년간 걸쳐 진행되고 있는 농약품목등록 절차 및 추진현황에 대하여 면밀히 고찰하고 문제점과 개선방안을 도출, 시험 신청자 및 시험 담당자, 평가자에게 제안함으로써 높은 시험의 신뢰성을 확보하여야 할 중요한 시점에 이르러 있다. 농약등록 시험이 보다 합리적이고 투명하게 이루어졌을 때 사용자는 물론 더 나아가 농산물 소비자에게 안전과 안심을 전해 줄 수 있을 것이다.

나방파리(moth flies)의 생물학적 특징과 방제

양영철

을지대학교 위생해충방제연구소

- 일반적 특징 -

나방파리를 보통 drain fly 그리고 sewer fly 또는 filter fly 라고도 부르며, 몸과 날개에 많은 털을 가지고 있다. 주로 하수구 주변에서 볼 수 있고, 소형 곤충으로 몸 길이는 3-4mm 정도인데, 체색은 대체로 검은색을 띄나 갈색으로 보이기도 한다. 분류는 날개시맥의 독특한 특징으로 종을 구별한다.

나방파리의 주요 서식처는 하수구(관), 정화조, 오물로 오염된 토양에서 주로 발생한다.

- 생물학적 특징 -

1. 완전변태를 하며 생활사 기간은 8-24일 정도이다.
2. 적절한 유기물과 습기가 있는 곳에 약 30-100개의 알을 집단으로 산란한다.
3. 알은 48시간 이내에 부화한다.
4. 알을 불규칙하게 세워 산란하는데: 더러운 음식쓰레기를 모은 곳, 배관시설에 고인 물, 오수 필터, 유기물이 부패한 장소에 주로 산란한다.
5. 유충과 번데기는 하수, 정화조 안의 얇은 젤라틴 같은 막에서 볼 수 있으며, 침전물이나 썩은 식물체 그리고 미세한 식물성과 동물성 물질을 먹고 산다.
6. 유충기간은 9-15일 이며, 번데기 기간은 20-40시간 정도이고, 우화된 성충은 성적으로 성숙해지고 수 시간 내에 교미하며, 성충의 수명은 보통 2주이다.
7. 성충은 비행력이 약하고, 휴식하는 벽면에 기어가는 듯이 보이기도 하며, 비상할 때는 짧은 거리를 날고 높이 날지 못한다.
8. 휴식은 배관시설물이나 벽면의 그늘진 곳에서 휴식하며, 야간활동성이다.

- 관리 -

1. 서식처(발생원)를 파악하는 것이 매우 중요
2. 욕실바닥의 잦은 청소 및 물이 고이지 않도록 관리

3. 반 밀폐된 발생원 주변에 공간살포: 정화조 내 물이 차 있지 않은 벽면에 휴식하는 나방파리도 방제할 수 있도록 조치해야함
4. 발생원에 고농도의 IGR(성장억제제) 처리: 물 사용을 자제해야 함
5. 욕조 하부의 빈 공간에 물이 고이면 발생원이 되므로 공간 내 에어로솔 살포
6. 제한된 공간 내에는 전기살충기, 유인등을 이용한 끈끈이 활용
7. 성충과 유충을 동시에 방제할 수 있는 시스템 운영