2.0.1.6

Surveillance System for Mosquitoes Carrying Infectious Diseases

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I. INCIDENCES OF MOSQUITO-BORNE INFECTIOUS DISEASES
I. Incidences of Mosquito-Borne Infectious Diseases

● Malaria

➢ Vector: *Anopheles sinensis*, etc.

➢ Route of infection
- Gyeonggi-do Province (Paju City, Yeoncheon County, etc.) in Korea and Cheorwon County in Gangwon-do Province in Korea as well as persons who have travelled to risk areas overseas such as Africa

➢ Infection ratio: Domestic – 86%, imported – 14%

![Anopheles sinensis](image)

<table>
<thead>
<tr>
<th>Year</th>
<th>Nationwide</th>
<th>Seoul</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>1,772</td>
<td>290</td>
</tr>
<tr>
<td>2011</td>
<td>826</td>
<td>93</td>
</tr>
<tr>
<td>2012</td>
<td>542</td>
<td>66</td>
</tr>
<tr>
<td>2013</td>
<td>445</td>
<td>45</td>
</tr>
<tr>
<td>2014</td>
<td>638</td>
<td>96</td>
</tr>
<tr>
<td>2015</td>
<td>705</td>
<td>91</td>
</tr>
</tbody>
</table>
I. Incidences of Mosquito-Borne Infectious Diseases

- **Japanese encephalitis**
  - Vector mosquito: *Culex tritaeniorhynchus*
  - Route of infection: Infected within Korea
  - Infection ratio: Domestic – 100% (28 in Seoul)
I. Incidences of Mosquito-Borne Infectious Diseases

- **Dengue fever**
  - **Vector:** *Aedes albopictus*
  - **Route of infection:** Imported cases who have recently traveled overseas, such as the Philippines, Thailand or other Southeast Asian countries
  - **Infection ratio:** Imported cases – 100% (321 in total)
I. Incidences of Mosquito-Born Infectious Diseases

- **Chikungunya fever**
  - **Vector:** *Aedes albopictus*
  - **Route of infection:** First imported case reported in Seoul (2015, a citizen with a history of travelling to India)

- **Zika virus infection**
  - **Vector:** *Aedes albopictus*
  - **Route of Inspection:** First imported case reported in Seoul
    - *2nd case (April 27, Philippines), *3rd (April 29, Philippines, no symptoms),
    - 4th (May 7, Viet Nam) and 5th (May 11, Philippines)
II. SEOUL METROPOLITAN GOVERNMENT’S MOSQUITO SURVEILLANCE SYSTEM
II. SMG’s Mosquito Surveillance System

- Black light traps and digital (mosquito) monitoring systems (DMS) are in place to monitor mosquitoes carrying major infectious diseases.

**Black light traps**
- Community health centers collect mosquitoes once a week.
- Analysis and feedback by the Institute of Health and Environment (IHE)

**Digital Monitoring Systems**
- DMS automatically measures mosquito populations on a daily basis. DMS data is used for mosquito control activities as well as the Mosquito Forecast System.
II. SMG’s Mosquito Surveillance System

- Black light traps installed in Seoul (54 in total)
  - Two units in each autonomous district
  (※ Three units in Eunpyeong-gu and four in Jung-gu)
II. SMG’s Mosquito Surveillance System

- Number of individual mosquitoes collected in black light traps (2008–2015)

- The total population size in 2015 was 10,321, an increase of 47.8% compared to that of 2014.

* Black light trap: Lighting designed to attract and capture mosquitoes (Two to four units are installed in each district, amounting to 54 in total). Mosquitoes are collected and analyzed once a week from April through November.
III. SMG’s Mosquito Surveillance System

*Species of mosquitoes captured in black light traps (past three years)*

- Among 14 species of mosquitoes living within Seoul, the dominant one is “Culex pipiens pallens” (93%).

- *Aedes albopictus* (0.04%) are also living in Korea, but there have been no reports of any virus being detected from them.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th><em>Culex pipiens pallens</em> (West Nile fever)</th>
<th>Anopheles species (Malaria)</th>
<th><em>Culex tritaeniorhync hus</em> (Japanese encephalitis)</th>
<th><em>Aedes albopictus</em> (Deng fever, Zika fever, chikungunya fever)</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>9,631</td>
<td>9,249</td>
<td>29</td>
<td>-</td>
<td>-</td>
<td>353</td>
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<td>2014</td>
<td>6,891</td>
<td>6,467</td>
<td>43</td>
<td>-</td>
<td>10</td>
<td>371</td>
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<tr>
<td>2015</td>
<td>10,321</td>
<td>9,315</td>
<td>59</td>
<td>-</td>
<td>-</td>
<td>947</td>
</tr>
</tbody>
</table>

* Others: Ochlerotatus koreicus, Aedes vexans nipponii, Ochlerotatus dorsalis, Ochlerotatus togoi, Anopheles (Anopheles) pullus M. Yamada, Culex orientalis, Culex vagans, Culex bitaeniorhynchus and Armigeres subalbatus*
Ⅱ. SMG’s Mosquito Surveillance System

- Digital mosquito Monitoring System (DMS)

**Operation duration**: April 6, 2015–October 31, 2015

**Number of units in operation**: 50 units (two per district)

**Operating system**: First operation started in 2015

**Methods of operation**
- Monitor mosquito populations in each district (automatically every day)
- Collate all measurement data and analyze accumulated data

**Uses of data**
- Run an accurate mosquito forecasting system using DMS-collected mosquito data
- Validate control measures and measure effectiveness (adult/larval, smoke/fogging)
II. SMG’s Mosquito Surveillance System

- DMS installation locations
SMG’s Mosquito Surveillance System

- DMS mosquito collection results (2015)

(As of April 6, 2015 – October 31, 2015)
II. SMG’s Mosquito Surveillance System

Mosquito surveillance data is available for sharing on the Seoul City website (where black light trap and DMS status reports are posted).

<table>
<thead>
<tr>
<th>2016년 서울시 유문등 체집모기 현황(54개소)</th>
<th></th>
</tr>
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<tbody>
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<td>제집 일</td>
<td>밭감잡모기</td>
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<td>4월 3주</td>
<td>17</td>
</tr>
<tr>
<td>4월 4주</td>
<td>40</td>
</tr>
<tr>
<td>5월 1주</td>
<td>35</td>
</tr>
<tr>
<td>5월 2주</td>
<td>109</td>
</tr>
<tr>
<td>총계</td>
<td>191</td>
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</table>

* 기타 : 밭감날개잡모기, 동량잡모기, 줄다리잡모기, 꽃벚열독날개모기, 동률술모기, 한국술모기, 토고술모기, 금빛술모기, 냉

| 2016년 서울시 디지털 모기측정기(DMS) 체집모기수 현황(50개소) |
|---|---|
| 4월 |  |
| 일 | 월 | 화 | 수 | 목 | 금 |토 |
| 187 | 230 | 821 | 1,049 | 1,293 | 741 |
Ⅲ. STRENGTHEN SURVEILLANCE ON *Aedes albopictus* TO RESPOND TO THE ZIKA VIRUS
Strengthen Mosquito Surveillance Against Zika Virus

- Project for monitoring overwintering *Aedes Albopictus* eggs (Zika virus vector)
  - Collection and hatching inspection period: March 21-30, March 22-April 15
  - Collection method: Collect artificial containers and humus soil where overwintering mosquito eggs are likely to exist.
  - Collection sites: 21 in total including forests and residential areas near forests
    - Locations where *Aedes albopictus* have been found for the past three years (7), forest areas such as mountains and parks (11) and *Ochlerotatus-koreicus*-prone areas (3)
Strengthen Mosquito Surveillance Against Zika Virus

- Overwintering eggs of Zika-virus-carrying *Aedes albopictus* are cultured (IHE).
 III. Strengthen Mosquito Surveillance Against Zika Virus

- Mosquito larvae and virus test (IHE)
III. Strengthen Mosquito Surveillance Against Zika Virus

- **Test results:** “*Aedes albopictus*” hatched in 6 (app. 6%) out of 102 samples (no virus detected)

<table>
<thead>
<tr>
<th>Collecting organization</th>
<th>Collection site (surroundings)</th>
<th>Object where found</th>
<th>Sample collection</th>
<th>Adult emergence</th>
<th>Virus (3 species)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gangbuk-gu CHC</td>
<td>Hill near a residential area</td>
<td>Thrown-away cans</td>
<td><img src="image1" alt="Image" /></td>
<td><em>Aedes albopictus: 2</em></td>
<td>ND</td>
</tr>
<tr>
<td>Dobong-gu CHC</td>
<td>Waste tire yard in a residential area</td>
<td>Humus in a waste tire</td>
<td><img src="image2" alt="Image" /></td>
<td><em>Aedes albopictus: 1</em></td>
<td>ND</td>
</tr>
<tr>
<td>Eunpyeong-gu CHC</td>
<td>Mountain at the back of an apartment complex</td>
<td>Earth and other matter in waste tires</td>
<td><img src="image3" alt="Image" /></td>
<td><em>Aedes albopictus: 27</em></td>
<td>ND</td>
</tr>
<tr>
<td></td>
<td>Mountain at the back of an apartment complex</td>
<td>Earth, etc. in a Styrofoam dipper</td>
<td><img src="image4" alt="Image" /></td>
<td><em>Aedes albopictus: 7</em></td>
<td>ND</td>
</tr>
<tr>
<td>Gwanak-gu CHC</td>
<td>Surroundings of the entrance to a hill</td>
<td>Water in a watering pot that lies neglected</td>
<td><img src="image5" alt="Image" /></td>
<td><em>Aedes albopictus: 11</em></td>
<td>ND</td>
</tr>
<tr>
<td>IHE</td>
<td>Near a temple in Daemosan Mountain</td>
<td>Humus in an artificial container</td>
<td><img src="image6" alt="Image" /></td>
<td><em>Aedes albopictus: 7</em></td>
<td>ND</td>
</tr>
</tbody>
</table>

CHC: Community Health Center  
IHE: Institute of Health and Environment  
ND: Not detected
Strengthen Mosquito Surveillance Against Zika Virus

- Preventive early control through surveillance on overwintering Aedes eggs
- Environmental clean-up and integrated control for the areas where the species are found
### III. Strengthen Mosquito Surveillance Against Zika Virus

- **Additional surveillance using DMS and Aedes traps**

  - **Operational duration:** April 19, 2016 – October 31 (seven months)
  - **Target areas:** 13 in total* (focusing on forests, parks, mountains, flood pumping stations, and residential areas)

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<tr>
<th>연번</th>
<th>채집기관</th>
<th>감시지점</th>
<th>장비연번</th>
<th>DMS 및 트랩 장소</th>
<th>검사방법</th>
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<tr>
<td>1</td>
<td>보건소</td>
<td>중랑구</td>
<td>7-1</td>
<td>중랑구 망우동 산30-7 중랑캠프핑숲</td>
<td>매주1회 (화요일) DMS 채집모기 보건환경 연구원에 의뢰</td>
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<td>3</td>
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<td>24-1</td>
<td>송파구 신천동 21 몽촌평포장</td>
<td>※ 유문등 병행</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>강동구</td>
<td>25-1</td>
<td>강동구 아리수로 78길 43-12 동명고린공원</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>부한산</td>
<td>부한산</td>
<td></td>
<td>부한산 일대</td>
<td>매주1회 보건환경 연구원 자체수거</td>
</tr>
<tr>
<td>9</td>
<td>관악산</td>
<td>관악산</td>
<td></td>
<td>관악산 공원 일대</td>
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</tr>
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<td>11</td>
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<td>양재시민의숲</td>
<td>양재시민의숲 일대</td>
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<td>13</td>
<td>서울숲공원</td>
<td>서울숲공원 일대</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 현지점모기 월동일 조사결과, 발생지 포함하여 선정
III. Strengthen Mosquito Surveillance Against Zika Virus

- **Strengthen mosquito surveillance using DMS units and traps**

  - **Study method**
    - Community health centers send mosquitoes collected using the DMS to the IHE for analysis once a week.
    - IHE performs further surveillance on larvae and adults by setting traps in forest areas such as mountains and parks.
    - If an analysis of collected mosquitoes detects an Aedes mosquito and a pathogen inside of its body, the SMG strengthens control activities.
IV. SEOUL METROPOLITAN GOVERNMENT’S MOSQUITO FORECAST SYSTEM
IV. SMG's Mosquito Forecast System

**What is Mosquito Forecast System?**

This daily mosquito forecast service determines the mosquito activity index (MAI) in various areas of Seoul and provides Seoul citizens with guidance on how to act in each stage of mosquito occurrence.

**Process for the implementation of the Mosquito Forecast System**

- Introduced as part of the eco-friendly mosquito control plan to ensure healthy coexistence between humans and the ecosystem.

* Developed for the first time in 2013

A formula for calculating the number of mosquitoes was developed using the DMS in Yeongdeungpo-gu (12 units) and weather factors. After that, a pilot project was implemented.
IV. SMG's Mosquito Forecast System

- Process for developing the Mosquito Forecast System
  - Understand patterns of data based on descriptive statistics (average and standard deviation) for the data collected from 25 DMS units
  - Select meteorological variables for the forecasting formula based on relationships between meteorological variables and data
  - Select an appropriate forecasting formula model after incorporating days of growth and exploring delayed effects.

- Outsourcing of the development (2013) and update (2016) of mosquito forecasting formulas
  - Research team: Ho Kim and Sun-young Kim (health statistics) and Sung-il Cho (health science) of Seoul National University, Yeong-cheol Yang (insects) of Eulji University, and Hun-bok Lee (ecology) of Seoul Women's University
IV. SMG's Mosquito Forecast System

- Mosquito Forecast System: Stage Definitions

<table>
<thead>
<tr>
<th>Stage 1 (Pleasant) [MAI: 0–250]</th>
<th>Stage 2 (Attention) [MAI: 251–500]</th>
<th>Stage 3 (Caution) [MAI: 501–750]</th>
<th>Stage 4 (Unpleasant) [MAI: 751–1,000]</th>
</tr>
</thead>
</table>

- Stage 1 [Pleasant]: No mosquito larval habitats. Little mosquito activity
- Stage 2 [Attention]: Mosquito larval habitats – 20% or lower. *Mosquitoes poised to attack during outdoor activity: 1-2
- Stage 3 [Caution]: Mosquito larval habitats – 20% to 50%. *Mosquitoes poised to attack during outdoor activity: 3-4. Mosquitoes invading a house spotted overnight in a dense residential area (filled with detached houses): 2-4
- Stage 4 [Unpleasant]: Mosquito larval habitats – 50% or higher. *Mosquitoes poised to attack during outdoor activity: 5 or more. Mosquitoes invading a house in a dense residential area (filled with houses): 5-10

*Poised to attack: It is based on the assumption that a subject stays stationery at one spot for 10 to 15 minutes after exercise at night.
IV. SMG's Mosquito Forecast System

Key points of the Action Tips for Citizens at each stage of the Mosquito Forecast System

- Alerts are issued for four different stages: The higher the stage is, the more likely mosquitoes are to appear.

Stage 1 [Pleasant]: Observe mosquito larval habitats. Install window screens to block points of entry for mosquitoes.

Stage 2 [Attention]: Check and repair window screens and septic tanks for any leaks. Remove any stagnant water from empty cans or containers in the surroundings.

Stage 3 [Caution]: Use repellants during hiking or other outdoor activities. Use mosquito nets. Eliminate larvae in the surroundings.

Stage 4 [Unpleasant]: Refrain from activity at night. Spray mosquitocide around the house entrance. Report actively to the community health center.

Key

- Alerts are issued for four different stages: The higher the stage is, the more likely mosquitoes are to appear.

1. Pleasant [MAI: 0–250]
2. Attention [MAI: 251–500]
3. Caution [MAI: 501–750]
4. Unpleasant [MAI: 751–1,000]
IV. SMG's Mosquito Forecast System

- "Mosquito Forecast System" (http://health.seoul.go.kr/mosquito)

- Operation period: May 1, 2016–October 31 (six months)
- Forecasting method: Daily forecasts as well as a code of conduct are posted in the Seoul City website.
  - Websites of Seoul Metropolitan Government, 25 community health centers, Centers for Infectious Disease Control and Korea Meteorological Administration are linked together.
  - YTN TV broadcasts (text displaying mosquito forecasts in real time on the Weather and Life channel)
  - Spread mosquito forecasts through SNS such as Seoul city KakaoStory and send text messages
IV. SMG's Mosquito Forecast System

- Daily forecasts under the Mosquito Forecast System
IV. SMG's Mosquito Forecast System

- Updated mosquito forecast data

<table>
<thead>
<tr>
<th>날짜</th>
<th>모기 활동 지수</th>
<th>모기 발생 단계</th>
<th>사망행동요망</th>
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<td>363.6</td>
<td>2단계 (금심)</td>
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</table>

- 최근 일주일간 변동 추이

- 총 1 2 다음
IV. SMG's Mosquito Forecast System

- Media coverage of the Mosquito Forecast System

260 news broadcasts on KBS, MBC, etc.
Thank you