Prior to being eradicated from the Republic of Korea (ROK) in 1979, *Plasmodium vivax* Grassi and Feletti, the causative agent of vivax malaria, was endemic and widespread throughout the ROK [1,2]. In 1993, vivax malaria reemerged on the Korean peninsula [2,3], and in the ROK, most malaria cases have since been contracted near the demilitarized zone (DMZ) that borders North Korea (Democratic People’s Republic of Korea, DPRK) [4-6]. Unique conditions in the vicinity of the DMZ, such as the exposure of large numbers of soldiers to malaria parasites and the unmanaged nature of the environment that encourages mosquito breeding, are thought to exacerbate the malaria situation [2,7]. Little information is available as to how widespread malaria is in the DPRK, what mosquito species are involved in malaria transmission, and the relative abundance and distribution of potential malaria vector populations. Ongoing mosquito surveillance data is available for the ROK [5,6] and parasite rates for different species have been reported [8,9], but few data of a similar nature are available for the DPRK.

Anopheles belenrae Rueda, Anopheles pullus Yamada, and Anopheles sinensis Wiedemann have been recorded in the DPRK in two provinces (Hwanghae and Pyongyang) by Rueda and Gao [10]. Foley et al. [11] produced ecological niche models for 8 anopheline species using collection location data from the ROK that predicted suitable habitat in the ROK and southern DPRK. An. sinensis is the predominant species collected south of Seoul; however, in malaria risk areas in the north, other species are frequently more common [4,12] and may play a greater role in malaria transmission.

Baengnyeong-do is a 45.8 km² island located near the Northern Limit Line (Fig. 1). This island is the westernmost point of the ROK, and is 16 km from the DPRK coast. As such, entomological conditions on Baengnyeong-do may more closely reflect those in the southwestern DPRK than the rest of the ROK. We collected mosquitoes from Baengnyeong-do in 2007...
Mosquito Species Composition and Plasmodium vivax Infection Rates on Baengnyeong-do (Island), Republic of Korea

Vivax malaria is a significant military and civilian health threat in the north of the Republic of Korea (ROK). The island of Baengnyeong-do is the westernmost point of the ROK and is located close to the southwestern coast of the Democratic People's Republic of Korea (DPRK). Mosquitoes were collected using a black light trap on Baengnyeong-do, and Anopheles spp. were assayed by PCR, to identify the species, and screened for sporozoites of Plasmodium vivax. Of a subsample of 257 mosquitoes, Anopheles lesteri was the most frequently collected (49.8%), followed by Anopheles sinensis (22.6%), Anopheles pullus (18.7%), Anopheles kleini (7.8%), and Anopheles belenrae (1.2%). The overall sporozoite rate was 3.1%, with the highest rates observed in An. kleini (15.0%), An. sinensis (5.2%), and An. lesteri (1.6%). No sporozoite positive An. pullus or An. belenrae were observed. The results extend our knowledge of the distribution and potential role in malaria transmission of An. kleini, An. lesteri, and An. sinensis, for an area previously considered to be at a low risk for contracting vivax malaria.
to better understand the composition of mosquito species and their potential role in malaria transmission in locations where ROK military are deployed.

Mosquitoes were collected using a black light trap near a cowshed on 15 July 2007 at Baengnyeong-do, Jinchon-2ri, Baengnyeong-myeon, Ongjin-gun, Incheon, 37°57’24.5”N 124°41’55.5”E. Specimens were transported to the 5th Medical Detachment, Yongsan Army Garrison, Seoul, ROK, where they were identified to species or Subgroup using a dissecting microscope and standard keys [13,14]. It was impossible to identify members of the An. sinensis Subgroup (An. belenrae, An. kleini, An. lesteri Baisas and Hu, An. pullus, and An. sinensis sensu stricto) by morphological techniques. For members of the An. sinensis Subgroup, the abdomen was separated from the thorax and head of the mosquito to reduce the probability of detecting DNA from parasite oocysts in the midgut. The head and thorax of a subsample of 257 mosquitoes were identified by PCR for species [15,16], and by single step and semi-nested multiplex-PCR to identify P. vivax sporozoite infections [17].

A total of 9,971 female mosquitoes were collected (Table 1), 79.0% of which were Aedes vexans nipponii Theobald, and 8.8% Culex tritaeniorhynchus Giles, the primary vector of Japanese encephalitis virus (JEV) in the ROK. Overall, An. sinensis Subgroup species made up 11.8% of the collections, of which An. lesteri predominated (49.8%), followed by An. sinensis (22.6%), An. pullus (18.7%), An. kleini (7.8%), and An. belenrae (1.2%). Overall, the sporozoite rate for members of the An. sinensis Subgroup was 3.1%, with highest rates in An. kleini (15.0%), followed by An. sinensis (5.2%), and An. lesteri (1.6%). Sporozoite positive An. pullus and An. belenrae were not observed (Table 2). Ae. vexans nipponii, is considered a nuisance mosquito that is not readily attracted to humans. It is an early-season floodwater mosquito whose populations rapidly increase with the flooding of rice paddies or heavy rains [5]. Ae. vexans nipponii is usually collected less frequently than members of the An. sinensis Sub-

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**Table 1.** Total numbers of mosquitoes collected by black-light trap near a cowshed in Baengnyeong-do (Island), Incheon, Republic of Korea, on 15 July 2007

<table>
<thead>
<tr>
<th>Species</th>
<th>Female (%)</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ochlerotatus dorsalis (Meigen)</td>
<td>27</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>Aedes vexans nipponii Theobald</td>
<td>7,877</td>
<td>88</td>
<td>7,965</td>
</tr>
<tr>
<td>Anopheles sinensis Subgroup</td>
<td>1,174</td>
<td>42</td>
<td>1,216</td>
</tr>
<tr>
<td>Culex bitaeniorhynchus Giles</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Culex pipiens Linnaeus</td>
<td>16</td>
<td>6</td>
<td>22</td>
</tr>
<tr>
<td>Culex tritaeniorhynchus Giles</td>
<td>873</td>
<td>2</td>
<td>875</td>
</tr>
<tr>
<td>Mansonia uniformis (Theobald)</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>9,971 (100.0)</td>
<td>138</td>
<td>10,109</td>
</tr>
</tbody>
</table>

Fig. 1. Mosquito collection site (○) at a cowshed on Baengnyeong-do in the northwest part of the Republic of Korea.
An. sinensis  

of the extrinsic incubation period of  

were found in this study, this species has been re-  

Anopheles sinensis  

by ELISA to have sporozoite infections of  

serves by ELISA to have sporozoite infections of  

ratios (unpublished data). Although no sporozoite positive  

Anopheles sinensis was the most frequently collected  

Species Number identified (%) Sporozoite rate (%)a  
Anopheles belenrae 3 (1.2) 0.0  
Anopheles kleini 20 (7.8) 15.0  
Anopheles lesteri 128 (49.7) 1.6  
Anopheles pullus 48 (18.7) 0.0  
Anopheles sinensis 58 (22.6) 5.2  
Total 257 (100.0) 3.1  

Sporozoite rate (%) = (Malaria infected/number identified) × 100.

group in New Jersey light trap catches throughout most of the  

An. lesteri was the most frequently collected anopheline, but  

Anopheles sinensis  

An. belenrae  

1. World Health Organization. Synopsis of the world malaria situa-  


3. World Health Organization Regional Office for Southeast Asia.  


5. Kim HC, Chong ST, Collier BW, Klein TA. Seasonal prevalence