MIGRATION ANALYSIS AND FORECASTING OF MIGRATORY INSECT PESTS

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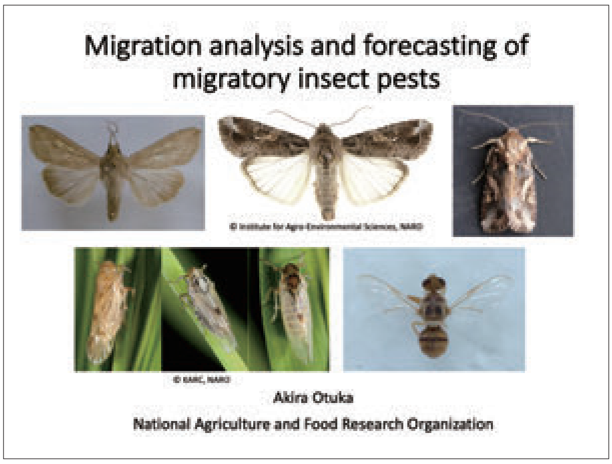
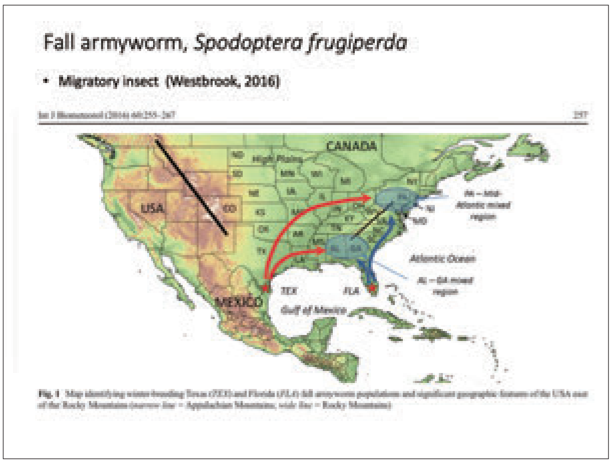
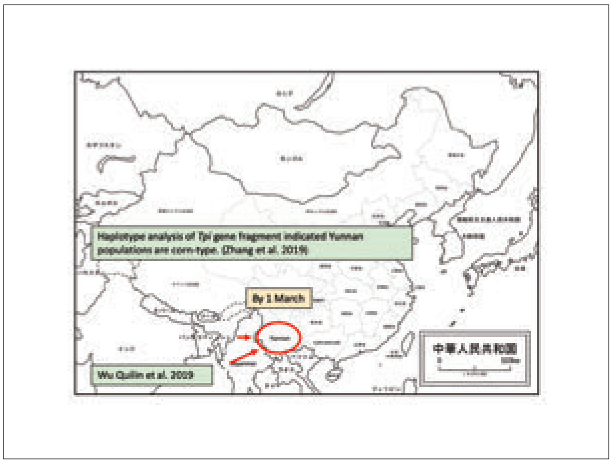
ABSTRACT

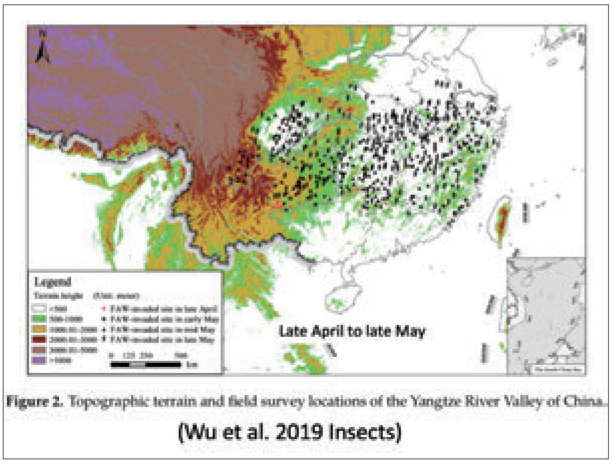
Japan is located at mid-latitudes on the globe where westerly winds constantly prevail. The Asian Continent where many insect pests occur is also situated west of Japan. Some of these insect pests can fly a long distance, sometimes for over 1,000 km crossing the East China Sea. A variety of migratory insect pests, therefore, arrive in Japan. These environmental conditions basically explain why we have many migratory insects. So far, we have studied the migration of seven species including rice planthoppers, a fruit fly and nocturnal moths. The fall armyworm, Spodoptera frugiperda, originally native to the Americas, is a very recent one having arrived in Japan in summer 2019. The moth was rapidly expanding this spring in China, thus we evaluated the risk of possible immigration with forward trajectory analysis using meteorological data from the past five years. We also quickly developed a preliminary migration prediction system and monitored favorable winds from southern China on a daily basis. This prediction was shared with colleagues in Taiwan. The result showed that Japan would be invaded from Fujian and Zhejiang Provinces in 1 June–15 July, and Kyushu, Shikoku and southwestern Honshu could face the highest risk of S. frugiperda invasion. The migration prediction system predicted a possible migration from Guangdong Province emigrating on 20 and 23 May, and late instar larvae were found in Taiwan on 8 June. These timings quite matched the developmental time from oviposition to 6th instar of 14 to 17.7 days, based on reference estimates. In Japan, the first two larvae were found in Minami-Kyushu City, Kagoshima Prefecture, southwestern Japan, on 27 June 2019. A total of 78 larvae were found in six prefectures of Kyushu-Okinawa region by 16 July. A predicted possible migration from southern China on 6 June suggested the first immigration timing for Japan. Topological analysis of larvae collection sites suggested for the first time that S. furgiperda's flight height during overseas migration reaches an altitude of up to over 800 m. We are also studying the migration and dispersal of the oriental armyworm, Mythimna separata, and the common cutworm, Spodoptera litura. The cutworm is a highly dispersible insect pest and attacks soybean leaves in summer in western Japan. Its dispersal was monitored with searchlight traps and an entomological radar. The armyworm usually arrives in northern Japan and its migration source is being estimated with trajectory analysis and stable isotope analysis of wing samples. Technologies related to insect migration studies are also introduced in this presentation.

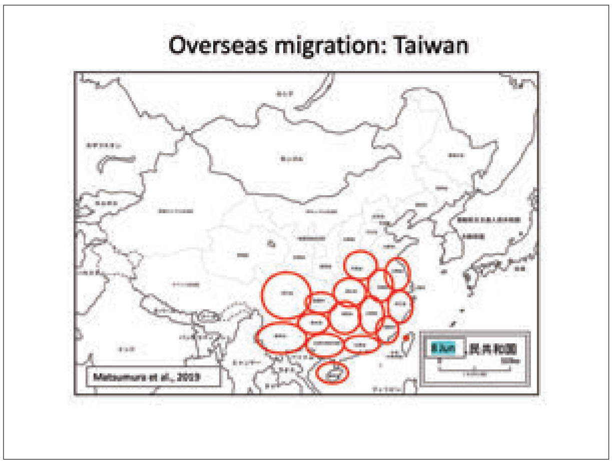


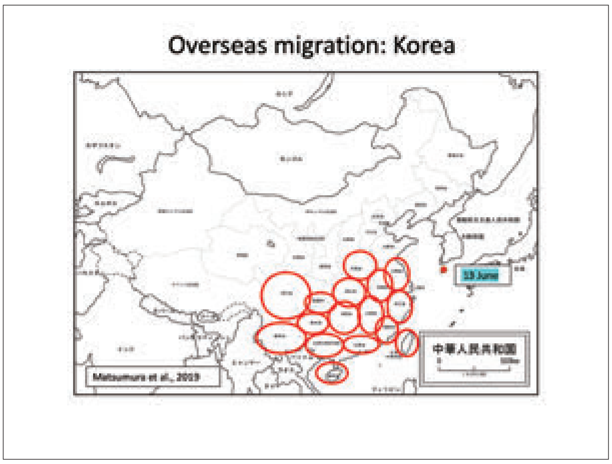


Arrival of the fall armyworm and expansion of its distribution in East Asia

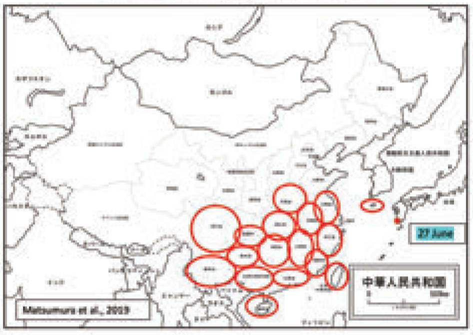








Overseas migration: Japan



Summary: FAW overseas migrations

Case	Arrival Date	Meteorol. condition	Estimated source	Flight duration
Taiwan	17-20 May	Rainy front	Fujian, Guangdong	17-21 h
Korea	6 June	Low pressure system	Fujian, Guangdong	24 h
Japan	7 June	Low pressure system	Zhejiang, Fujian, Guangdong	14, 9 38 h

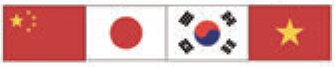
Case	Flight distance	Take-off night	Assumed flight height	Host
Taiwan	325-800 km	16-19 May	1000-1500 m	Maize (young)
Korea	1100-1600 km	5 June	1000-1500 m	Maize (young)
Japan	1000, 270 km 1600 km	6 June 5 June	1000-1500 m Up to 800 m	Maize (young)

First estimation of parameters of FAW's overseas migrations

What would happen in 2020?

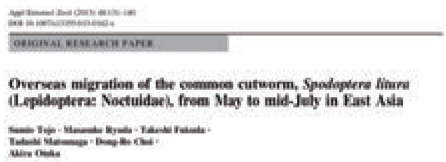
- Autumn populations in China and Japan exist
  - They migrate to the south and overwinter there.
  - Guangdong, Henan, Guangxi, Yunnan provinces as well as probably Vietnam would be overwintering areas (>10 deg.C in winter).
  - Spring population could become larger than that in 2019.
  - Spring-summer migration could get intense.

International cooperation on migration studies



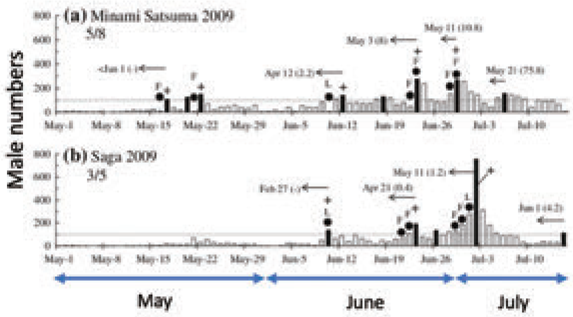
- JIRCAS
- P.R. China
  - Henan Academy of Agricultural Sciences
  - Nanjing Agricultural University
  - Jiangsu Academy of Agricultural Sciences
  - Guangdong Academy of Agricultural Sciences
- Korea
  - National Institute of Agricultural Science, RDA
- Vietnam
  - Plant Protection Research Institute
  - Southern Region Plant Protection Center
- Taiwan Agricultural Research Institute

Comparison with *Spodoptera litura*


ORIGINAL RESEARCH PAPER

Overseas migration of the common cutworm, *Spodoptera litura* (Lepidoptera: Noctuidae), from May to mid-July in East Asia

Insects caught in pheromone traps in 2009



- Suggestion: possible overseas migration in East Asia could occur from spring, early summer to the *Baiu* rainy season.
- This is the same as Ma et al. 2019 J Appl Entomol
- Monitoring of the overwintering population in southern China is key.