# Three case studies for control of invasive alien ant spesies, fire ant (Solenopsis invicta,Formicidae) in Japan

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論文

# Three case studies for control of invasive alien ant species, fire ant *(Solenopsis invicta, Formicidae)* in Japan

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**Abstract**

Fire ant (*Solenopsis invicta*) is one of the most harmful invasive alien species on the Earth. In Japan, May 29th, 2017, the ant were found in Amagasaki City, Hyogo Pref. and 24 cases, 18 areas and 12 prefectures were invaded by the ant in 2017. I conducted monitoring and eradication activities in three cities and summarized processes of each city. As a result, each city had different strategies and relationships among the stakeholders. For the next steps of managing against fire ant invading accidents, we should establish effective networks with each stakeholder and make quick decision making of strategies against invading accidents.

**Key words:** fire ant, *Solenopsis invicta*, eradication, management, decision making

## Introduction

Invasive alien species such as largemouth bass, red back widow spider, and raccoon mean that transport and invade into introducing areas and ecosystems from its native populations with human economic activities and/or artificial activities including introduction for biological control of native organisms. Only in Japan invasive species exceed 2,000 species and give some impacts for native ecosystems (National Institute for Environmental Studies 2017). IUCN (International Union of Conservation of Nature and Natural Resources) has designated 100 harmful invasive alien species on the earth (Lowe et al. 2001).

Fire ant (*Solenopsis invicta* Buren) is one of the most harmful invasive alien species on the Earth (Lowe et al. 2001). In Japan, May 29th, 2017 the ant was found in Amagasaki City, Hyogo Pref. and then 24 cases, 18 areas and 12 prefectures were invaded by the ant (Table 1 and Figure 1). However, it has not been confirmed established mature nest of fire ant in 2017 (Ministry of the Environment of Japan 2017).

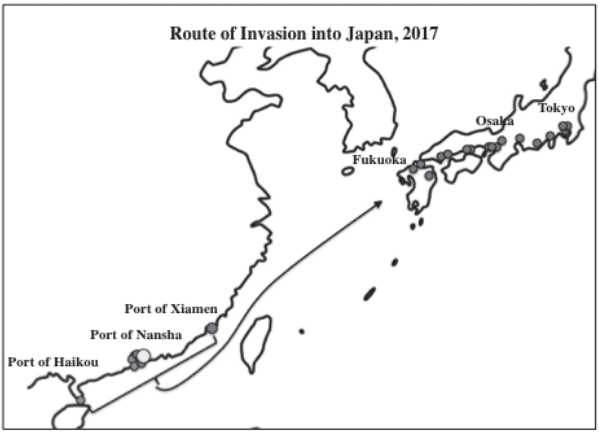


Figure 1 Invaded areas and transport routes of fire ant (*Solenopsis invicta*) in 2017.

Table 1 Cases of invasion of fire ants occurred in Japan, 2017

| | Confirmed area | Discovery Date | Worker | Queen | Brood | Male | Depature Place, stopping point | Site information |
|---|---|---|---|---|---|---|---|---|
| 1 | Amagasaki, Hyogo | 2017. 6. 9. | >500 | + | + | - | Port of Nansha, Guangzhou, China | port are, within a cargo |
| 2 | Kobe, Hyogo | 2017. 6. 18. | >100 | + | + | - | - | container yard, underground |
| 3 | Yatomi, Aichi | 2017. 6 .30. | 7 | - | - | - | Port of Nansha, Guangzhou, China | container yard, outside of a cargo |
| 4 | Osaka, Osaka | 2017. 7. 3. | 50 | + | - | - | - | container yard, underground |
| 5 | Shinagawa, Tokyo | 2017. 7. 6. | >200 | - | + | - | Port of Sanshan, China | container yard, within a cargo |
| 6 | Asukamura, Aichi<br>Kasugai, Aichi | 2017. 7. 10. | 17 | - | - | - | Port of Nansha, Guangzhou, China | container yard, within a cargor |
| 7 | Yokohama, Kanagawa | 2017. 7. 14. | >500 | - | >200 | 5-10 | - | container yard, underground |
| 8 | Fukuoka, Fukuoka | 2017. 7. 21. | 300 | - | - | - | Port of Nansha, Guangzhou, China | container yard, underground, within a cargo |
| 9 | Nakatsu, Oita | 2017. 7. 24. | 20 | - | - | - | Port of Gaolan, Zhuhai, China | carrier company area, within a cargo |
| 10 | Fukuoka, Fukuoka | 2017. 7. 27. | 30 | - | + | - | Port of Schekou, China | container yard, within a cargo |
| 11 | Yatomi, Aichi | 2017. 8. 4. | 100 | - | - | - | Port of Xiamen, China | container mainenance area, within a cargo |
| 12 | Kurashiki, Okayama | 2017. 8. 9. | >200 | 2 | - | - | - | container yard, underground |
| 13 | Sayama, Saitama | 2017. 8. 16. | - | 1 | - | - | Port of Huangu, China | within warehouse |
| 14 | Hiroshima, Hiroshima | 2017. 8. 24. | 131 | - | - | - | - | container yard, trap sites and underground |
| 15 | Shizuoka, Shizuoka | 2017. 8. 27. | >600 | 2 | 50 | 10 | - | container yard, trap sites and underground |
| 16 | Nagoya, Aichi | 2017. 9. 1. | 1000 | 1 | - | - | Port of Tianjin, China | witin a cargo and shippings |
| 17 | Yokohama, Kanagawa | 2017. 9. 6. | 60 | - | - | - | Djibouti Port, Republique de Djibouti via China | within a cargo |
| 18 | Kitakyushu, Fukuoka | 2017. 9. 15, 10. 2, 12, 20. | >500 | - | + | - | - | container yard, underground |
| 19 | Kasaoka, Okayama | 2017. 9. 20. | - | 1 | - | - | Port of Xiamen, China | within a cargo |
| 20 | Yatomi, Aichi | 2017. 10. 3. | 2 | - | - | - | - | container yard, grassland |
| 21 | Yokohama, Kanagawa | 2017. 10. 6, 16. | 5 | - | - | - | - | container yard |
| 22 | Muko, Kyoto | 2017. 10. 12. | 2000 | 2 | + | - | Port of Haikou, China | within a cargo |
| 23 | Hamamatsu, Shizuoka | 2017. 11. 2. | 200 | - | - | - | Guangzhou, China | within a cargo |
| 24 | Kure, Hiroshima | 2017. 11. 3. | 73 | - | - | - | Port of Zhongshan, Guangzhou, China | container yard |

A fire ant colony has over 200,000 workers and 100 reproductive queens. The fecundity is very high, the queen ant can produce around 1,500 eggs per day. Fire ant have toxic substances, named solenopsin and protein poison, Sol 1-4. These substances leading lethal reactions against stung peoples and totally 50-100 peoples were killed by the ant in United States (1950s – 2016). Furthermore, the economic losses by the ant would be reached 500 billion yens annually in United States. The ecosystem and economy of Japan face critical point invading of the fire ant. (Higashi et al. 2008).

The native populations of the ant are located on southern Brazil, northern Argentina and Paraguay. In 1930s, the ant transported into Mobile port in southern United States with imported materials such as woods. From southern United States, fire ant further invaded to Pacific areas, New Zealand (2001), Australia (2001), Taiwan (2004), and Hong Kong, mainland China, and Mexico (2005) (Ascunce et al. 2011). Those areas except for New Zealand (Convention on Biological Diversity 2001, Christian 2006), have been affected by the ant over 10 years and invaded ecosystems partially destroyed.

Although all of the countries and regions invaded by the ant had established eradication and management projects, there is only one country, i.e., New Zealand, to succeed in controlling fire ant completely. Then, rest of the countries failed eradications and had to pay a large cost for control of fire ant (Convention on Biological Diversity 2001, Australian Government of Department of the Environment and Energy 2001, Higashi et al. 2008, National Red Imported Fire Ant Control Center, Taiwan 2004).

In this paper I report three case studies of fire ant control activities and discuss future direction to manage and control invasion of the ant.

## Materials and Methods

### Fire ant surveys

X, Y, Z cities are the places where fire ant found in 2017. I conducted fire ant surveys at X city, Hyogo prefecture (June 17th - 22nd), Y city (August 2nd, 8th, September 1st, 6th, October 3rd, 10th) and Z city (June 30th, July 30th, October 19th), Fukuoka prefecture from June to October. In the surveys, monitoring of presence of a fire ant by observations, identification of an invasion risk area, and ant fauna survey by random sampling were conducted in each area.

I interviewed the administrators of each local government about management plan against fire ant via directly discussion, e-mails, and phone surveys.

A literature survey was conducted on fire ant management and eradication projects in United States of America, New Zealand, Australia Taiwan and China through websites and interviews.

## Results and Discussion

In June 21st a kind of fire ant, *Solenopsis geminate* were found in port area of X city and X city officials, Ministry of the Environment (hereafter MoE), private warehouse contractors, and university researchers jointly had meetings and discussed management plan against invading fire ants. The initiative of its meeting and survey in the port area was taken by MoE. The counterplan including dealing with press presentations was almost decided on the evening of that day and coordination of each stakeholder was made within the meeting.

In August 8th, the Kyushu University Fire Ant Research Group checked

a container yard contaminated by the ant in Y city. The container including the ant had been kept there for a month, because of difficulty getting permission from the owner. After getting permission, staffs of MoE conducted an extermination work and found several hundreds workers in it. Therefore, when we observed the container yard, the ant were still in it, however, there had never been able to do anything at its case. We attended four meetings about fire ant management plans of Y city in August 2nd, September 1st, 6th, October 3rd, and held a seminar about basic information of fire ant for city officials. The counterplan has been still discussing and the initiative of all meetings were taken by city officials. MoE and the university researchers were observers and advisors of meetings. In November 2017, MoE proposed fire ant management plan for the 68 international ports and Y city made local management plan based on this.

In Z city I conducted monitoring surveys of fire ant on June 30th and October 19th. I found several hundreds workers and broods under an asphalt pavement breach and under an electric facility. I held a seminar for Z city officials in October 19th, and had several meetings with them. There is no counterplan against fire ant invasion until now, and every treatment has been made mainly by personnel in Z city. University researchers personally provided detailed advice including identification of ant, and MoE participated as an observer. Although the fire ant management plan established by MoE, Z city officials did not recognize it in detail and until December, 2017, there was no local management plan against fire ant.

As mentioned above, three cities implemented totally different fire ant eradication plans and countermeasures, and the roles of each stakeholder were also three different ways separately (Fig. 2). X city was collaborated with each stakeholder at one meeting opportunity and it was easy to share each information, opinions and backgrounds through densely network community. Those relationships could help to make decision relatively quickly (network type). Y city was established action plans by city officials

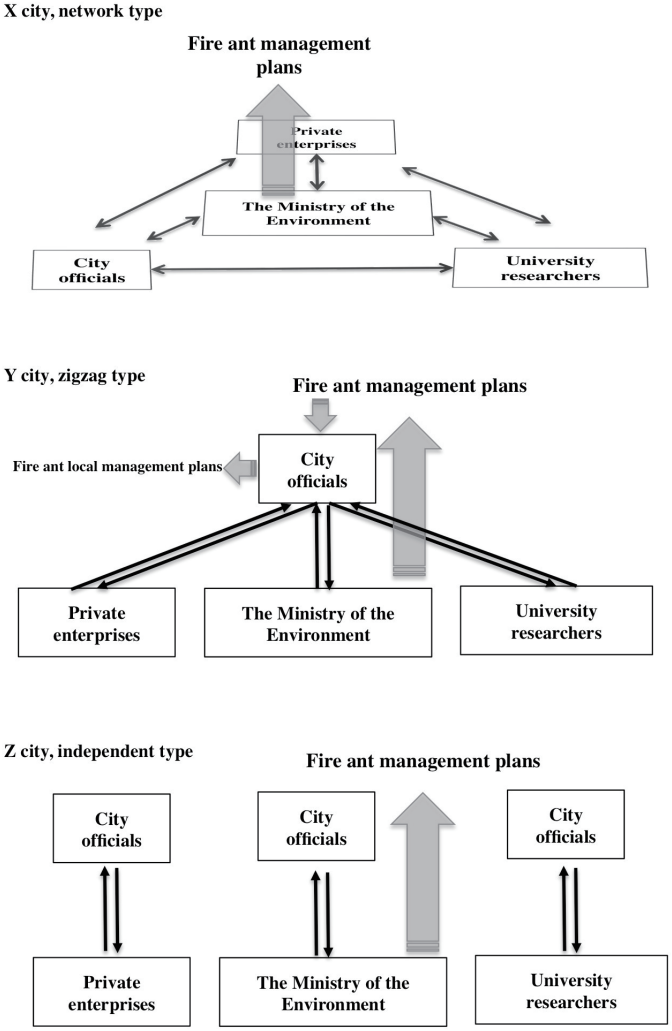


Figure 2 Summarized eradication and management activities in each three cities against fire ant invading in Japan.

as a leader, and it confirmed and divided tasks with MoE staffs. The information and strategies were back and forth among stakeholders and it took relatively long time to decide any activities (zigzag type). In Z city a city official leader arranged and decided to any management plans, and all stakeholder followed its direction. There was few opportunity to share information with other stakeholders, and all the information was transmitted from a leader (independent type). X city has been plagued by various invasive alien species for over 20 years, therefore they were able to quickly establish a very efficient system for the response of fire ant. Other two cities strategies were relatively inefficient compared with X city, but the countermeasures were appropriate as an early stage when it is invaded by a harmful alien species, and for next step, it is important to refine the system with reference to the preceding cases.

Therefore, the key factor in the rapid response against invasive alien species would be whether there are similar cases and have experience dealing with them.

In Pan pacific area, New Zealand (2001), Australia (2001), Taiwan (2004), and China (2005) had already invading and colonization of the ant occurred (Higashi et al. 2008, Ascunce et al. 2011). All of the counties and regions had established national policies and research institute against fire ant eradication and management strategies within a year (Convention on Biological Diversity 2001, Australian Government of Department of the Environment and Energy 2001, Higashi et al. 2008, National Red Imported Fire Ant Control Center, Taiwan 2004). These eradication and management strategies were formulated top-down, and supported by scientific evidences from researchers, and commercial and/or volunteer workforce. In the situation of Japan, 2017, the fire ant has never colonized into any Japanese land area, therefore, it is a fundamentally good timing to establish the strategies and research networks.

Lastly, in a case of Y city, a container kept at the port area for a month

during getting the permission to open from the owner, however, according to Article 10, paragraph 2 of the Alien Biological Law, if the permission of MoE can be obtained, they could confirm inside the container. However, MoE did not enforce this law and they selected to take permission from its owner. As a result, it took relatively long periods to get permission and the container was kept in the port area for one month, and the risk of fire ant escaping was increased. In the future, MoE, city officials and scientists should discuss and establish eradication/management process effectively, and in fact in December, 2017 the fire ant research center will be established in National Institute for Environmental Studies and effort to construct policies and strategies against fire ant invading. As a result and discussion of this manuscript, I would like to emphasize to the new center that experience and information sharing are the most important factors for fire ant management.

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