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## Original Article

First confirmation of the distribution of rice weevil, *Sitophilus oryzae*, in South KoreaQ8 Ki-Jeong Hong<sup>a,\*</sup>, Wonhoon Lee<sup>b</sup>, Young-Ju Park<sup>c</sup>, Jeong-Oh Yang<sup>c</sup><sup>a</sup> Department of Plant Medicine, Suncheon National University, Suncheon, 57922, Republic of Korea<sup>b</sup> Department of Plant Medicine and Institute of Agriculture & Life Science, Gyeongsang National University, Jinju 52828, Republic of Korea<sup>c</sup> Plant Quarantine Technology Research & Development, Animal and Plant Quarantine Agency, Gimcheon, 39660, Republic of Korea

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## ABSTRACT

In Korea, the classification of the *Sitophilus* weevil group occurring in stored grains has been confused, resulting in its misidentification in most references reporting *Sitophilus oryzae* (Linnaeus). However, we recently found and identified rice weevil (*S. oryzae*) populations in stored rice grains in the rice processing complex in South Korea. Here, we report the distribution of rice weevil in South Korea and summarize morphological and molecular characteristics, as well as provide a pictorial identification key for *Sitophilus* weevils occurring in stored grains.

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## Introduction

*Sitophilus* weevils, including the rice weevil (*Sitophilus oryzae* Linnaeus), maize weevil (*Sitophilus zeamais* Motschulsky), and granary weevil (*Sitophilus granarius* Linnaeus), are well-known insect pests of stored grains worldwide. These weevils have a nearly cosmopolitan distribution, occurring throughout all warm and tropical parts of the world (CABI 2015). Generally, a female adult *Sitophilus* weevil bores a hole in a cereal grain, lays an egg, usually one egg per individual grain, and then seals the hole with a waxy secretion. Upon hatching, the larva develops while feeding inside the grain, then pupates. It usually leaves the grain completely hollow when it exits as an adult (Longstaff 1981).

The taxonomy of the *Sitophilus* group has been confused until now (CABI 2015). After first being described by Linnaeus in 1763 as *Curculio oryzae*, many researchers subsequently recognized that two distinct forms of the species existed, which were described as “large” and “small” forms. In 1855, Motschulsky recognized the large form as a distinct species and named it *S. zeamais*. In 1928 and 1931, Takahashi complicated matters by raising the small form to a

specific status as *Calandra sasakii*. Unfortunately, the size difference between *S. oryzae* and *S. zeamais* is not consistent, so it is not possible to be sure that references to the large and small forms of *Calandra oryzae* refer to *S. zeamais* and *S. oryzae*, respectively (CABI 2015; Morimoto 1961). Therefore, it is also possible that some references to *S. oryzae* published in the 1960s and early 1970s were actually referring to *S. zeamais* misidentified by use of old keys (CABI 2015). Currently, the genus *Sitophilus* and its species may be identified by using the keys of Gorham (1987).

In Korea, the classification of this group has also been confused. Currently, two species, *S. zeamais* and *S. oryzae*, are recorded in Korea; however, most references reporting *S. oryzae* have been dealing with the misidentified species, *S. zeamais* (Cho et al 1988; Hyun 1960; Hyun 1962; Hyun 1964; Hyun and Ryoo 1974; Kim and Ryoo 1982; Ryoo and Cho 1988; Ryoo et al 1988; Ryoo and Cho 1992; Yoo and Ryoo, 1989; Yoon et al 1997). Hong et al (2001) also confirmed specimens preserved in the Insect Collection of Seoul National University and reported that *S. oryzae* was not distributed in Korea.

We recently found and identified *S. oryzae* populations that were collected from stored rice grains in the rice processing complex (RPC) in Korea. Therefore, in this study, we report a distribution of rice weevil in South Korea and summarize morphological characteristics and molecular data for identification of *Sitophilus* weevils in stored grains in Korea.

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**Materials and methods**

*Collecting specimens of Sitophilus weevils*

We surveyed 52 RPCs throughout South Korea in 2015–2016 for stored rice insect pests using corrugated cardboard traps (30 × 30 cm) and by sampling rice grains. Two weevil pests, *S. zeamais* and *S. oryzae*, were mainly collected during this period. The specimens were deposited in the Insect Collection of Suncheon National University.

*Morphological characteristics for identifying Sitophilus weevils*

The genus *Sitophilus* contains four major economic pests, the granary weevil (*S. granarius*), tamarind weevil (*Sitophilus linearis*),

rice weevil (*S. oryzae*), and maize weevil (*S. zeamais*). Adult samples were identified using the following external morphological characteristics: antennal scrobe, microsculptures of pronotum, length of antennal funicle I and II, and lateral elevation of scutellum. However, some of these external characters are not entirely reliable to distinguish adults of *S. oryzae* and *S. zeamais*. Therefore, we also used external genitalia characteristics for adults, as well as the epipharyngeal rod and apical sensory organ on the labial palp of larvae for identification of these two species. Many pictures of specimens displayed in these figures were taken using a Leica DFC2900 digital camera and stacked using the Leica Application Suite Program (LAS Version 4.6.0; <http://www.leica-microsystems.com>).

Additionally, an identification key for four *Sitophilus* species known as stored grain insect pests was also constructed based on morphological characteristics. These specimens were collected



**F**

**Figure 1.** Populations of *Sitophilus zeamais* (○) and *Sitophilus oryzae* (●) were confirmed at rice processing complexes of South Korea in this survey (2015–2016).

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