



Khapra beetle (*Trogoderma granarium*)

An evaluation of the information regarding its presence in Sweden

Background

Trogoderma granarium is an insect pest of stored food and feed that is believed to be native to the Indian subcontinent, where it was first reported as a pest in 1894 (Athanassiou 2019). It has been recorded as infesting over 100 types of commodities and is currently considered to be one of the most destructive insect pests of stored food worldwide (Athanassiou 2019). The pest is subjected to strict phytosanitary legislations in several countries (EPPO 2020, Australian Government 2020). Interceptions at ports of entry have dramatically increased and the distribution of *T. granarium* has expanded in recent years (Castañé et al. 2020, USDA 2020). It is thus important to determine if this pest is established or not in a particular country since it has implications both for the national pest risk management and for the trade of grain. This report provides a review of the available information of the presence of *T. granarium* in Sweden and an assessment of its current establishment status.

The challenge of reliable identification

There seems to be consensus among experts that it is a major challenge to accurately identify *T. granarium* (Everts, 1898) (EPPO code: TROGGA). The species may be confused with e.g. *T. glabrum* (Herbst), *T. grassmani* Beal, *T. ornatum* (Say), *T. parabile* Beal, *T. simplex* Jayne, and *T. sternale* (French and Venette 2005). Procedures for morphological identification are provided by e.g. FAO (2016) and Klishina and Drugova (2017).

Although identification of adults is easier than for the larval stage, misidentification is still common, so training in preparation, mounting and determination of *Trogoderma* specimens is required and genitalia should always be examined for reliable identification (Day and White 2016, EPPO 2013, FAO 2016). Athanassiou et al. (2019) states that identification requires taxonomic experts specifically trained for it and that there are very few diagnosticians who have had this training. Further, Castañé et al. (2020) claims that there is only a limited number of skilled taxonomists that reliably can identify *T. granarium*.

It has been suggested that morphological identification should be combined with molecular diagnostic tests (Castañé et al. 2020) and several molecular diagnostic protocols have been developed for *T. granarium* (Byrne et al. 2018, Castañé et al. 2020, Furui et al. 2019, Olson et al. 2014, Zhang et al. 2017). Further, both immunological identification and identification based on a visible near infrared hyperspectral imaging technique are under development (Agarwal et al. 2020, Stuart et al. 1994).

Information relevant for the potential establishment in Sweden

Trogoderma granarium prefers hot and dry climates and most areas in Canada and the northern half of the United States do not have climates suitable to allow spread of this pest in the natural environment although the beetle can survive the cold (NAPPO 2019, Wilches et al. 2017). However, controlled environmental conditions, like those that may be found in food and seed processing and storage facilities might allow *T. granarium* to establish and reproduce (Athanassiou 2019, French and Venette 2005, EPPO 2013, NAPPO 2019).

Observations in Sweden

- Collection specimens have been recorded from the counties Närke and Uppland in 1914 and 1943, respectively (Telenius and Shah 2016, Fägerström 2020; a notation in GBIF.org of observations in Södermanland seems to be due to a misinterpretation of the location; personal communication C. Fägerström, Biological Museum, Lund). Further information was obtained from the Biological Museum (C. Fägerström, personal communication); the five specimens from Närke were all collected in the area of Örebro, most likely from the same location, which for at least one of the specimens is stated to be a mill. The locality provided for the 14 specimens from Uppland is Stockholm and most likely refers to the National Swedish Institute for Plant Protection which was located in Bergshamra at the time. The specific details of the sampling is not known, but it could be noted that the institute among other things provided diagnostics of plant pests and was responsible for inspection and import control (Prop. 1974:109). One specimen is also located at the Museum of Evolution in Uppsala and it was collected in the area of Örebro (Telenius and Shah 2016). No other information or specific date of collection was provided, but it was collected before the early 1960's (H. Mejlon, Museum of Evolution, Uppsala, personal communication). The following three publications of presence in Sweden may be based on the same observations as those described above since no details of which observations the statements were based on were provided:
 - In *Catalogus Coleopterorum - Daniae et Fennoscandiae* from 1939 *T. granarium* was reported as found in the county of Närke (Hellén 1939).
 - In *Catalogus Coleopterorum Fennoscandiae et Daniae* from 1960 *T. granarium* was reported as “introduced” in the county of Närke (Hansen 1960).
 - In *Catalogus Coleopterorum Sueciae* (2020) *T. granarium* was reported as found in the counties of Närke and Uppland.

- Mathlein (1961) states that *T. granarium* has appeared only occasionally as a pest in Sweden. In the 1940's infestations were found in imported barley and sugar (most likely as a result of infestations in the storage holds of the ship) and in the 1950's infestations were found in imported shipments of grain and oil cakes.
- Mathlein and Tunblad (1971) states that in Sweden, the species has so far been a pest only on imported fodder, mainly peanut cakes from Africa.
- In 1987, *T. granarium* was used in pest management experiments of stored grain in Sweden but no information was provided from where the insects were obtained. It was only stated that *T. granarium* was selected to be included since it was considered to be a relevant pest for Sweden (Mörner et al. 1987).
- A Swedish company that deals with pest control in stored products reports that they have found *T. granarium* in imported grain lots on 1-2 occasions ca 10 years ago (J. Gröndahl at Rentokil AB, personal communication). The species identification was done at Lunds University (no information was found regarding which identification procedure was used). Other Swedish pest control companies, i.e. Insecta AB and Anticimex, do not report any findings of *T. granarium* but the latter company reports that it is not uncommon that they find adults of *T. angustum* (larvae were only identified as *Trogoderma* sp. and it is thus uncertain which species they belong to)(J. Alvegran and T. Persson Vinnersten, respectively, personal communication 2020). Further, a Danish company that inspect Swedish import and export of grain for e.g. Lantmännen, Svenska Foder, Swedish Agro, have never found *T. granarium* during those inspections (K.S. Mathiesen at Albers-Hansen Danmark A/S, e-mail correspondence 29 September 2020, with K. Nordin, Swedish Board of Agriculture).
- A total of four observations of *T. granarium* has been submitted to SLU Artportalen (Swedish Species Observation System 2020), which is a database where anyone can report observations of species made in Sweden. The findings were made between 2010 and 2016 from two apartments (one in Uppsala and one in Västerås). None of the findings have been validated and the rapporteur included a question mark after the species name for two of the reports. Other similar databases where anyone can report observations of species provides no further observations than those described above i.e. BeetleBase (2020), GBIF (2020) and iNaturalist (2020).

It should be noted that especially for a species like *T. granarium* old records do not provide strong support for that it is currently present. There are many examples of where this pest has become temporarily established but has been eradicated through effective pest management programs or local populations have naturally become extinct (Hagstrum and Subramanyam 2009, Day and White 2016).

Previous assessments of presence in Sweden

The climate in Sweden is not suitable for establishment in unheated environments (Banks 1977). Further, Mathlein (1961) states that *T. granarium* could scarcely be expected to become stationary as a storage pest in Sweden, mainly due to the high temperature requirements for reproduction, i.e. 20-25°C.

The great majority of previous assessments do not include Sweden as part of the distribution of *T. granarium*. Several national and international organizations, governments and researches do not consider *T. granarium* to be established in Sweden, i.e. the Swedish Taxonomic Database (2020), EPPO (2020), CABI (2020), NOBANIS (2020), Australian Government (2020), USDA (2015), Silfverberg (2004), Paini and Yemshanov (2012). Interestingly, some researchers claim that there is no data showing that *T. granarium* is established anywhere in the EU (Castañe et al. 2020, Stejskal et al. 2015). There are only two sources that, on the contrary, claim that *T. granarium* is present in Sweden, i.e. Fauna Europaea (2020) and Hagstrum and Subramanyam (2009) and they provide no information as to which data they base their assessment on.

Conclusion

Most of the observations in Sweden were either very old (e.g. from 1914 and 1943) and with detailed information missing, or were made on imported goods. The more recent reports (2011-2016) are not validated and thus the species identity cannot be ensured. The great majority of previous assessments states that *T. granarium* should not be considered to be established in Sweden.

Our assessment is that the currently available information does not provide support for stating that *Trogoderma granarium* is currently established in Sweden. We refer to the FAO (2019) definition of establishment of a pest, i.e. “Perpetuation, for the foreseeable future, of a pest within an area after entry”.

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