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From stored-product psocids to the other pests: the developments, problems and prospects on research and application of molecular identification

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Abstract

Psocids, beetles, moths and mites are regarded as the common kinds of stored-product pests in the world. The rapid and correct identification of stored-product pests is significant for quarantine, monitoring and control purposes. Molecular methods and techniques have been studied and applied for stored-product pest identification. Based on collection and analysis of literature in the last decade, this paper reviews the developments, questions and prospects for molecular identification of stored-product pests. As a representative model, the molecular methods and techniques for species identification of stored-product psocid pests were developed and applied systematically based on international collaboration involving China, Czech Republic, the United States and other countries. More than 10 studies on stored-product psocids related to RFLP, DNA barcoding, PCR, real-time PCR and gene chip have been published during this decade. Subsequently, DNA barcoding, PCR and real-time PCR techniques for the identification of common species of *Tribolium* and *Cryptolestes* pests of stored products have been reported by the same international team. Recently, a web system called Grain Pests DNA Barcode Identification System (GPDBIS) has been established in China using SOL SERVER and C#. Like a marathon that requires persistence, we should do our best to continue to promote research and application of molecular identification of stored-product pests with more international collaboration.

Keywords: stored-product pests, molecular identification, review, research, application

Globally, stored-product arthropod pests include a large number of species. The rapid and correct identification of stored-product pests is significant for quarantine, monitoring and control purposes. In recent decades, molecular methods and techniques have been studied and applied for stored-product pest identification. There is quite a substantial amount of literature related to stored-product pests and their molecular identification. In this work, literature from 1900 to 2017 was collected and analyzed using Web of Science (http://apps.webofknowledge.com/). The total count of articles on stored-product pests was found to be 32,123 whereas the total count of articles on molecular identification of stored-product pests was 179. The years with the highest counts for these two categories were 2015 and 2012, respectively. In decreasing order, countries with the most contributions to literature on stored-product insect pests were USA, China, UK and India (Figure 1).

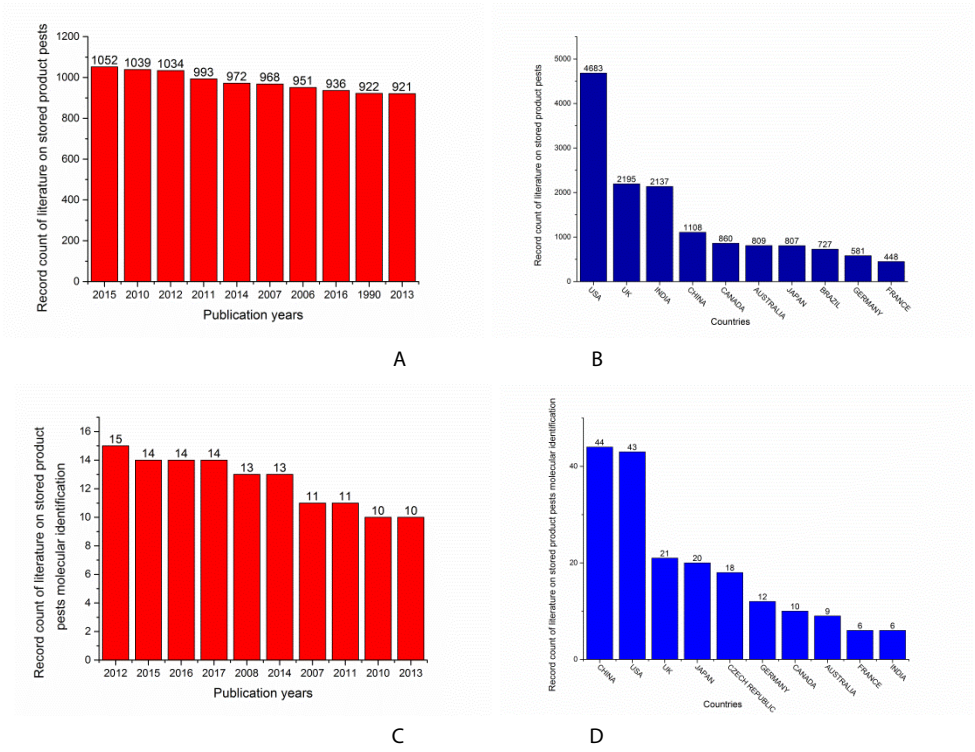

Fig. 1 The top 10 contributors to literature on stored-product pests and molecular identification. A: top 10 years of stored-product pest literature, B: top 10 countries contributing to stored-product pest literature, C: top 10 years of literature on molecular identification of stored-product pests, D: top 10 countries contributing to literature on molecular identification of stored- product pests.

Psocids, beetles, moths and mites are the common kinds of stored-product pests. From the number of articles on molecular identification of stored-product pests, most of the research and application have obviously been in the last 10 years (Table 1). As a representative model, the molecular methods and techniques for species identification of stored-product psocid pests were developed and applied systematically based on international collaboration involving China, Czech Republic, the United States and other countries. More than 10 articles, theses and dissertations on molecular identification of stored-product psocids have been published between 2008 and 2017; methods used including RFLP (Qin et al. 2008; Qin 2009), DNA barcoding (Li et al. 2011; Yang et al. 2012; Cui 2013; Yang et al. 2013b; Yang 2014), PCR (Arif et al. 2012; Yang et al. 2013a; Zhao et al. 2016), real-time PCR (Pang 2017), and gene chip (Liu et al. 2017). Recently, this team discovered the highly divergent mitochondrial genomes and indicated that *Liposcelis bostrychophila* was a cryptic species, which provided a taxonomic basis for species identification of stored-product psocids (Feng et al., 2018). Subsequently, the techniques such as DNA barcoding, PCR and real-time PCR have been reported for the identification of common species of *Tribolium* (Wang 2015; Zhang et al. 2016; Zhang 2017), *Cryptolestes* (Wang et al. 2014; Varadínová et al. 2015; Chen, 2018) and predatory mites (Wu et al. 2016) by the same international team. For more application of DNA barcoding, a web system which was entitled as Grain Pests DNA Barcode Identification System (GPDBIS) has been established in China using SOL SERVER and C# (Figure 2) (Li 2016; Wu et al. 2017).

Tab. 1 Number of articles on molecular identification of common stored-product pests during the period 2008–2017

Arthropods	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	Total
Beetles	9	7	10	8	7	8	3	4	2	8	66
Moths	3	2	1	1	2	2	0	2	0	0	13
Psocids	1	1	1	1	2	3	4	3	0	2	18
Mites	2	3	0	1	0	0	1	1	0	0	8
Total	15	13	12	11	11	13	8	10	2	10	105

A B C

Fig. 2 The main pages of molecular identification in GPDBIS. A: page of sequence input, B: page of sequence similarity, C: page of phylogenetic tree

Globalization accelerates the spread of stored-product pests among different countries and regions. What are the related questions and prospects for research and application on molecular identification of stored-product pests? Apparently, there is more need for molecular identification and common action for the prevention and control of stored-product pests. There is still a gap between the research and application. Like a marathon that requires persistence, we should do our best to continue to promote research and application of molecular identification of stored-product pests with more international collaborations that involve the sharing of more representative samples, development of more practical techniques, and establishment of a more common platform through further research, training and application.

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Enhancing surveillance for exotic stored pests in the Australian grains industry using a partnership approach with industry and government.

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Abstract

Verifying freedom from exotic pests such as Khapra beetle (*Trogoderma granarium*) & Karnal Bunt (*Tilletia indica*) is critical to supporting & maintaining access for Australian grain producers to international markets. Despite Australia's geographical isolation & strong quarantine systems, increasing levels of travel & trade continues to place pressure on our biosecurity systems, emphasising the need for improving our regional efforts in prevention, preparedness & surveillance to mitigate risks. The Australian Grains Farm Biosecurity Program (GFBP) is a national initiative to assist in the development & implementation of improved biosecurity practice, playing a vital role in the education of exotic pests & the role of surveillance by industry. The GFBP has undertaken a targeted surveillance program for stored product pests, with Khapra beetle as the main focus. A range of sites based on potential risk groups & pathways (e.g. farming enterprises, seed distributors & agricultural stores) were targeted, with different approaches used across the three grain growing regions of Australia depending on State