

# 中国食用昆虫

EDIBLE INSECTS OF CHINA

冯颖 陈晓鸣 赵敏 著



科学出版社

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## 内 容 简 介

本书是在作者多年对我国民间食用昆虫进行实地考察和研究,同时广泛收集相关研究资料的基础上写成的。全书共分上、下两篇15章。上篇较系统地总结了对中国食用昆虫的研究和利用现状,介绍了国外食用昆虫的研究进展和发展趋势,分析评价了昆虫的营养保健价值和食用安全性,提出了食用昆虫利用和养殖过程中的安全性评价和环境保护原则,概述了中国部分食用昆虫的养殖技术。下篇记载了我国分属于11目64科173属的食用昆虫和已分析了营养价值的昆虫324种,较详细地描述了它们的食用习俗、食用方式和营养成分,记载了部分种类的药用保健价值,书中配有彩色图片261张。书后的附录为中国常见食用昆虫名录和部分昆虫食谱相关书籍介绍。

本书是迄今我国较为详尽的食用昆虫专著,可作为广大昆虫学和营养学科技工作者、食用昆虫爱好者、农村食用昆虫养殖者、农林院校学生和研究生的参考书。

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## • Foreword •

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Why publish a book on the edible insects of China? There have been major advances in this field over the last 20 years, both within China and elsewhere. These advances have been due partly to the United Nations Food and Agriculture Organisation encouragement of the greater use of insects in our diets and partly to technological advances that facilitate research on nutritional, safety and farming of insects.

The UN FAO has recognised that with an expected global population of 9 billion people in 2050, there is not enough land to produce enough food to feed everyone at a standard that is rising as countries become more developed. The conventional sources of animal protein, such as cattle, use resources less effectively than insects to produce the same amount of protein, and also they produce more greenhouse gases. Other resources are being over exploited. While plant based proteins are important, they will require more land if we are to produce enough, and suitable agricultural land is diminishing with increasing urbanisation.

China has a long history of using insects as food and as medicine. This information is just as valuable today as it was when it was first written because of the increased interest in developing suitable insects for food. Which species have higher nutritional content? Do any insects have beneficial health values? Which species have characteristics that make them amenable to farming so that high production levels can be achieved? Are there species that contain toxins or allergens? Can we use insects to feed our food animals such as poultry and fish? It is these types of questions that have influenced edible insect research in recent years.

The authors of this book, based at the Research Institute of Resource Insects in Kunming, Yunnan, have conducted research on edible insects addressing many of the questions posed earlier. They have studied the collection and use of edible insects with communities in Yunnan where these insects have been eaten as a traditional food for many generations. They have

assessed the nutritional benefits and the food safety issues associated with these insects. With this background, they are well placed to write their book in a manner that takes account of the recent advances in this topic. There are books available that summarise the use of edible insects in any particular country. This book about edible insects in China is a most valuable resource because it will assist the establishment of insect farms to produce both food for humans and feed for animals in a manner that a fewer detrimental environmental impacts.

*Alan Louie Yen*

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Chief Editor, *Journal of Insects as Food and Feed*

# 序

为什么要出版一本关于中国食用昆虫的书籍呢？最近 20 年来，无论是在中国，还是在世界的其他地方，食用昆虫领域都有了长足的进步。这些进步部分归功于联合国粮食及农业组织对在我们日常饮食中更多地使用昆虫的鼓励，部分则归功于食用昆虫营养、安全和饲养研究方面的科技进展。

联合国粮食及农业组织已经认可到 2050 年全球人口数量预计将增长至 90 亿，到那时，随着各个国家的发展，人民生活标准的不断提高，将无足够的土地来生产充足的食物满足每个人的需求。传统动物蛋白质资源，如家畜，在生产同等数量蛋白质时，利用资源的效率低于昆虫，而产生的温室气体比昆虫多。其他的资源则多被过度开发。植物来源的蛋白质非常重要，但是我们需要更多的土地才能生产足够的植物源蛋白质，而随着与日俱增的城市化进程，适合的农业用地正在减少。

中国具有非常悠久的利用昆虫作为食物和药物的历史。随着人们对开发合适的昆虫作为人类食物的兴趣与日俱增，这类信息在当今仍然和它第一次被文字记录一样具有价值。哪些种类的营养成分含量较高？是否任何一种昆虫都具有有益于健康的价值？哪些种类具有适合养殖的特征，从而在饲养中能获得较高的产量？在这些利用的昆虫中，是否存在含毒素和过敏原的种类？我们能否利用昆虫去饲喂家禽和鱼之类的食品动物？这一类的问题影响着近年来的食用昆虫研究。

这本书的作者供职于位于中国云南省昆明市的中国林业科学研究院资源昆虫研究所，他们一直从事上述食用昆虫领域的多个问题的研究，研究了云南当地各民族采集和利用的食用昆虫，在这一地区，昆虫一直作为传统食物世代食用，还评估了这些昆虫的营养价值和食品安全问题。结合自己的研究背景和参考最新的食用昆虫研究进展，作者有充分的条件完成《中国食用昆虫》一书的写作。市面上已经有不少概括特定国家食用昆虫利用的书籍，但这本介绍中国食用昆虫的书籍颇具价值，因为它有助于选择可用于生产人类食物和动物饲料、对环境的不良影响较小的种类用于食用昆虫人工养殖。

Alan Louey Yen

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昆虫作为食物和饲料期刊主编

# • 前 言 •

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中国具有悠久的食用昆虫的历史，是利用昆虫作为食物最早的国家之一。一些昆虫在秦朝以前就是帝王食品，是贡奉皇室的珍品；即便是现代，许多地方和民族还保留着丰富多彩的食用昆虫习俗和文化，各地在长期的生产生活中形成了各具特色的食用昆虫采集、加工和食用方法，如冬虫夏草汽锅鸡、油炸蚕蛹、胡蜂蛹、虫茶等都是我国常见的富有特色的食用昆虫。中国现代对食用昆虫的系统研究从 20 世纪 80 年代开始兴起，内容涉及食用种类与习俗、营养价值、人工培育等。近年来，随着对食用昆虫认识的改变，食用昆虫正逐渐得到更多人的认可，回到人们的餐桌。食用昆虫的利用促进了食用昆虫的研究与开发、养殖、半人工培育、野外采集的发展，从黄粉虫、蝗虫等的人工养殖，到竹虫、胡蜂等的野外采集和半人工干预养殖，正逐步形成一个新兴的昆虫产业。

现代科学研究表明，昆虫体内含有丰富的蛋白质、氨基酸等营养成分，可成为人类未来重要的食用和饲用蛋白资源。昆虫蛋白的研究与利用已经成为国际农业关注的热点，许多国家对食用昆虫及饲料用昆虫给予了极大的关注，通过报纸、杂志、电视等介绍食用昆虫的价值和食用昆虫在应对食物短缺和营养失衡等方面的重要性。美国 and 欧洲的一些国家和地区相继开展了食用和饲用昆虫养殖、昆虫蛋白安全性评价和立法等方面的工作；泰国在食用昆虫的养殖、加工利用等方面做了大量工作，食用昆虫产业已在当地的经济中发挥了一定的作用；韩国已将几种昆虫正式列入食品名录。联合国粮食及农业组织（FAO）也非常重视昆虫蛋白的利用，将其视为未来解决人类发展的重要营养来源（动物饲料和人类高蛋白食品），近 10 年来，通过出版物、资助项目、召开会议等方式，积极促进食用昆虫的利用和开发，分别在 2008 年、2012 年和 2014 年成功召开了以食用昆虫为单一主题的会议。

中国林业科学研究院资源昆虫研究所从 1990 年就开始较系统地调查西南地区食用昆虫种类和食用习俗，并于 1999 年出版了《中国食用昆虫》（陈晓鸣，冯颖编著，中



国科学技术出版社)一书。之后在科学技术部科技基础性工作项目(编号2001-014)、国家林业局西南特色昆虫资源及经济树种种质资源收集保存与良种繁育基地建设项目(林规批字[2011]236号)、中国林业科学研究院资源昆虫研究所中央级公益性科研院所基本科研业务费专项资金(riricaf2014002Z)等项目的资助下,继续开展我国食用昆虫的考察和研究。在研究过程中,我们参加了FAO举办的3次国际食用昆虫会议,对食用昆虫有了更全面的认识。最近10多年来,我国陆续发表了许多食用昆虫相关论文,基于食用昆虫研究成果的快速增加和食用昆虫越来越受到重视,我们萌生了撰写本书来梳理我国食用昆虫的主要研究和利用情况、分享我们的新认识的想法。在本书中,我们结合自己的研究成果和收集到的文献资料,总结了国内外最新的研究进展,阐述了对食用昆虫营养价值、利用和环境安全性等问题的认识,以期对我国食用昆虫的研究、开发和利用有所裨益。

本书共分上、下2篇15章,上篇主要论述了国内外食用昆虫的研究进展和发展趋势、昆虫的营养保健价值和食用安全性、食用昆虫利用对人类健康及环境的潜在影响、中国主要食用昆虫的养殖技术、食用昆虫利用方式等。下篇结合文献资料和我们自己的研究结果,介绍了我国常见的食用昆虫种类及其营养成分和利用状况,以及部分虽不常见但已分析了营养价值的昆虫。第一章至第三章、第六章和第十五章由冯颖执笔完成;第五章、第七章至第十一章和第十四章由陈晓鸣和赵敏共同完成,第四章、第十二章、第十三章由冯颖、陈晓鸣共同完成,冯颖负责全书的统稿。书中附有图片261张,绝大多数为作者在研究和考察中所摄,部分来源于他人的照片(已在书中做了标注),图片由陈晓鸣和赵敏整理。

在食用昆虫的研究和本书的撰写过程中,得到了许多人的支持和帮助。中国林业科学研究院资源昆虫研究所李昆研究员、王绍云高级工程师、杨子祥副研究员、程志魁技师、马宏博士、张弘研究员、马利女士,中国林业科学研究院资源昆虫研究所景东试验站的李文良实验师和周静工程师,云南省禄劝县刘喜文先生,云南省澜沧县何晓东先生,云南省弥渡县张成祥先生等在野外考察、标本采集、昆虫养殖等方面提供了大力支持和帮助;标本鉴定得到西南林业大学徐正会教授与和秋菊副教授,云南农业大学李强教授、马丽博士和朱健硕士,中国科学院北京动物研究所武春生研究员,中国科学院昆明动物研究所熊江研究员,贵州大学郭建军教授,中国林业科学研究院资源昆虫研究所李帅峰博士的支持;中国林业科学研究院亚热带林业研究所王浩杰研究员、新疆拓普生物科技有限公司、北京市农林科学院畜牧兽医研究所王海宏副研究员、贵州省林业科学研究院邱建生研究员和杨再华副研究员、贵州大学杨茂发教授和刘健锋博士、云南省昭通学院王徽教授、云南省摄影家协会张建林先生、云南省林业科学院易传辉研究员、云南省农业科学院蚕桑蜜蜂研究所钟健副研究员、云南省德宏师范



高等专科学校郭云胶教授、湖南省林业科学院梁军生先生等提供了部分照片；西南林业大学学生杨粉珍、陈艳、罗杨和朱绪鼎在标本整理和室内照片拍摄方面参与了部分工作，在此表示衷心的感谢。在本专著撰写过程中，作者所在研究团队的丁伟峰博士、孙龙博士、王成业博士、何钊博士、张欣博士、李娴博士、吴海霞博士和袁东强硕士等在完成自己的研究和试验之余，在文献资料收集、野外考察、数据整理、书稿校对等方面做了大量细致的工作，非常感谢他们！本书的出版得到了中央级公益性科研院所基本科研业务费专项资金（riricaf2014002Z）资助，同时，澳大利亚拉筹伯大学应用系统生物学学院副教授、*Journal of Insects as Food and Feed* 期刊主编 Alan Louey Yen 为本书作序，并修改了英文介绍，在此一并致谢。

为了更好地认识和比较食用昆虫的营养价值，我们对书中采用的不同年代发表的数据单位进行了换算和统一，由于数据较多，可能会有一些矛盾；在上篇中阐述了作者对食用昆虫研究与利用的认识和观点，鉴于著者的学识和能力所限，书中的不足之处在所难免，希望读者给予批评指正。

著者

2015年3月

# • Introduction •

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Insects are commonly used as food by people in many parts of the world. Over 1900 species have been used as food in Asia, Africa, Oceania, North America, Mexico, and in South America. In many regions, a large biomass of insects can be obtained as food, partly due to the high diversity of insects associated with different environments, and partly due to the ability of many species to breed quickly. Scientific research has found that many species of insects are highly nutritious and are a healthy food source for people. Insect can convert their food into protein efficiently, and some species can be reared on organic waste. Compared to conventional meat producing animals such as cattle, insects can provide the equivalent amount of animal protein using less land and water, and they do so producing lower levels of greenhouse gases. With the increasing global population, insects are a potentially important source of food which can be produced sustainably and with less environmental damage. The potential of insect food has seen increased global interest in utilizing and developing insects as food, and there is now much more research and development on edible insects happening. One important fact that cannot be overlooked is that many countries have a history of using insects as food, and this knowledge can make an important contribution to the future development of insects as food across the world.

China has history of over two thousand years of the use of edible insects, and despite global changes in people's diets, insects are still consumed in China. Edible insects were, and still are, eaten in many parts of China by different ethnic groups. There are many different colorful customs associated with edible insects. There is ancient Chinese literature that describes the collecting and cooking of insects. Since the 1980s, there has been increased scientific research on the species identification of edible insects, their nutrition evaluation, insect farming, and the culture associated with human entomophagy. In recent years, edible

insect research has become even more vigorous because of the recognition of the nutritional benefits of insects and their potential to ensure food security. This has resulted in an increased number of published scientific papers and books on edible insects.

*Edible Insects of China* has been written to highlight the importance of edible insects, both within China and in other countries. It is based on the results of scientific research that the authors have been engaged in for over 20 years. The book is composed of two main sections; the first provides background information on edible insects and the second is about edible insects in China. It covers the 324 species of edible insects in China, found in 11 insect orders, and includes the common edible insect species in China, some not so common species, and some medicinal insect species for which nutritional information is available. The nutrient composition data of 174 species are included. The Appendix has a list of edible insects from China and an introduction to some books with edible insect menus. A summary of each of the 15 chapters of this book is presented.

## **Section one** General introduction of edible insects

### **Chapter 1** Introduction

This chapter provides a general introduction to edible insects in China and elsewhere. It discusses the recent opinion of the FAO regarding increasing the use of insects as food, the potential use of insects for improved global food security, and the challenges and opportunities associated with edible insects. Although the nutritional value and importance of edible insects in food security have been recognized by scientists and people who traditionally consume insects, there is still a lot to be done to promote insects as a future general food source.

### **Chapter 2** Nutrition and health benefits of edible insects

Information on the nutritional value of insects, although limited, show that insects contain levels of protein, fats, vitamins and minerals that can meet human nutrition requirement levels. Many insects have high levels of good quality protein. The amounts of essential amino acids in insect protein are high. The quantity of fat in some insects is large, often with high levels of unsaturated fatty acids. Besides nutritional benefits, some insects have demonstrated health benefits and these could be developed into health foods. The use of chitin and polysaccharides of some insects are also discussed.

### **Chapter 3** The food safety of insects

The food safety of insects and possible allergic reactions associated with eating insects are discussed in this chapter. Food toxicology, harmful microorganisms, harmful metal elements, and pesticide residues are the four areas food safety are discussed. Food toxicology



evaluation takes time and resources to conduct, and only 13 kinds of insects and insect products have been evaluated according to Procedures for Toxicological Assessment of Food in China. The limited data showed that they are safe for food or feed. Insects can be a source of allergens for some people, and this issue requires further study in the future.

**Chapter 4** The potential influence of edible insect utilization on humans and the environment

There are many interactions between insects, humans and their environments. Insects are involved in important ecological processes essential for healthy functioning environments such as the decomposition of organic matter, pollination, soil turnover, animal feed, and they are important natural enemies. There are also insects that are detrimental to human welfare, such as species that are vectors of human diseases and pests of crops and forest trees. The wild collecting and the farming of edible insects can affect humans and the environment either adversely or beneficially.

**Chapter 5** Insect farming

The general principles of insect farming are discussed in this chapter. It covers the breeding behavior of mealworms, grasshoppers, wasps, bamboo caterpillars, dragonflies, alderfly nymphs, and cockroaches. The production technique of insect tea is also outlined. At present, not every kind of insects could be raised completely in artificial conditions. Some species, like mealworms and cockroaches, are fully domesticated and can be reared completely in captivity. Other species, such as grasshoppers, wasps, bamboo caterpillars, and dragonflies, can only be partially raised in captivity.

**Chapter 6** Utilization and prospect of edible insects

Edible insects can be utilized by human directly or indirectly. People can directly consume insects or consume products made from insects. People may consume insects indirectly by eating livestock, such as chickens, chicken eggs and fish that have been fed insects.

**Section two** Edible insects of China

**Chapter 7** Ephemeroptera (mayflies) and Megaloptera (alderflies)

Mayfly and alderfly nymphs are edible aquatic species in China, but only one species of mayfly in Yunnan Province has been researched. Nymphs of Megaloptera which contain high protein levels are commonly eaten in Yunnan and Sichuan Provinces.

**Chapter 8** Odonata (dragonflies)

Dragonfly nymphs and adults are often consumed in Yunnan Province. Chicken egg fried with dragonfly nymphs, a soup of dragonfly nymphs mixed with vegetable, and roasted

dragonfly adults and nymphs are popular dishes. The nutritional composition of the nymphs of three species of dragonflies have been analyzed.

#### **Chapter 9** Isoptera (termites)

Termites are often consumed in southern China. People collect the termites when they fly out of their nests after rain to start new colonies. People also try to dig out termite hills to collect the queen, and soldier and worker termites to eat. Termite are also used to feed chickens. The nutritional composition of five species are analyzed.

#### **Chapter 10** Orthoptera (grasshoppers, locusts, katydids, crickets)

Grasshoppers, crickets, gryllotalpa and katydids are common edible Orthoptera. In this order, the nutritive elements of many species have been analyzed, although some of these species are not commonly used as human food.

#### **Chapter 11** Hemiptera (bugs)

Cicadas, scale insects and stinkbugs are three groups that are frequently consumed. Some species have been used as medicine in traditional Chinese medicine. The nutritive elements of more than ten species have been analyzed.

#### **Chapter 12** Coleoptera (beetles)

There are many edible beetles, such as long-horned beetles, dung beetles and aquatic beetles. Both larvae and adults are edible. Mealworms and super mealworms are the best known, although they are usually reared for bird feed. As mealworms can be easily cultivated in captivity, they are used to produce products such as insect protein, insect oil and chitin. The beetles of Meloidae and *Blaps* are important folk medicinal insects in China.

#### **Chapter 13** Lepidoptera (moths and butterflies)

There are many edible species in this order. The famous Chinese caterpillar fungus can be used as both medicine and as food in China. Insect tea, feces excreted by several caterpillars eating certain species of plants, is a special drink in some area of southern China. Silkworms and Eri silkworms are well known edible moths. The larvae and pupae of some butterflies and moths are edible. However, some species of butterflies and moths are toxic for human consumption and a caution on the need to consider food safety is necessary.

#### **Chapter 14** Hymenoptera (bees, wasps and ants)

The larvae of honey bees and wasps are popular edible insects in China. The larvae of wasps are especially welcomed as food in many areas. Honey and other products coming from honey bees are developed and well utilized. Local people cook the larvae of honey bees and wasps in different ways, such as boiling, frying, and roasting. Uncooked raw larvae are also

consumed in some areas. In summer and early autumn, wasps are common edible insects in local markets in Yunnan Province and other places of southern China. Several species of ants are edible and also be used as traditional Chinese medicine.

### **Chapter 15**    Diptera (flies) and Blattaria (cockroaches)

Different species of flies, such as the house fly and the black soldier fly that feeding on organic matter, can be used to convert wastes into feed for other livestock. People could utilize them indirectly. Before using them as human food, scientific research on food safety is necessary. Cockroaches, which are used as medicinal material in traditional Chinese medicine and in the modern pharmaceutical industry, can be reared successfully in the complete artificial conditions in China. Besides their use in medicine, cockroaches also be used as animal feed and as human food in some regions.



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