

# 基于文献计量的中国苹果害虫组成及演替特点分析

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**摘要:**【目的】探究中国苹果害虫的组成及演替特点。【方法】以中国知网(CNKI)收录的有关苹果害虫的期刊论文为数据源, 统计分析苹果害虫的组成、演替特点、研究趋势等。【结果】苹果害虫共计94种, 隶属8目、45科, 主要为鳞翅目害虫, 以食叶、花、芽类害虫为主; 对苹果害虫种类组成和研究文献统计表明, 苹果害虫类群随时间变化, 食叶类害虫比例明显减少, 刺吸类害虫和蛀果类害虫增加, 其种类主要向刺吸类害虫演替; 苹果害虫种类组成随年份未见明显变化; 近十几年, 主要集中在食心虫、蚜类等重要害虫研究上, 其文献量随时间递增明显。【结论】食性杂、个体小、隐蔽性强、发生代数多的害虫渐演替为苹果的主要害虫类群, 一些检疫类害虫有分布扩大、发生加重趋势。

**关键词:** 苹果; 害虫; 演替; 种群; 文献计量

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## Analysis of composition and succession characteristics of apple pests based on bibliometrics in China

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**Abstract:** 【Objective】Apple industry is of great significance to China's economy, resident consumption and ecological protection, etc. With the development of the apple industry, growing techniques, cultivation models, and pest management related to apple production have undergone major changes. Apple pests were associated with the apple production, and the species composition as well as quantity characteristics also changed accordingly. With the development of apple industry in recent years, there are obvious changes in apple cultivation and plant protection techniques. Taking apple pest management as an example, the types of pesticides have increased and pesticides have been replaced frequently, and other prevention and control measures have also been greatly improved. How did the pests respond to these changes? To understand their composition and succession characteristics is helpful to make out relevant control strategies, breeding, and cultivation directions. 【Methods】In this paper, based on CNKI (China National Knowledge Infrastructure) as the data source, the theme "Apple insect pests" was used as the search term. The searching year was limited to 2019 and earlier, and the literatures on controlling and prevention of apple pests were selected. Information about apple insect pests' species, times and location were analyzed, which were involved in the literature, and the reported apple pests were classified according to their feeding habits, namely, piercing-sucking injurious, trunk boring, defoliator and fruit boring pests. Different types of apple pests were analyzed according to the frequency of their literatures in different periods. The apple pest species were analyzed and a number of related apple pests and the number in related literatures were compared to study the succession characteristics of pest species. After screening out, a total of 672 valid documents and a total of 94 insect pests were obtained. The 94

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pest species were used as keywords to retrieve in the CNKI data base. In order to prevent different names of the same species from being missed, the advanced search method was chosen, two or more names were searched in a related manner. The selected apple pests' literatures were sorted according to the publication times. The top ten pests of different types were selected to study the research and focus trends. 【Results】There were 94 species of apple pests belonging to 8 orders and 48 families, mainly Lepidoptera pests, followed by Coleoptera and Hemiptera. The characteristics of apple pests were: before 1980, defoliator pests were the research focus followed by piercing-sucking injurious pests; from 1981 to 1989, the proportion of defoliator pests decreased, the proportion of fruit boring pests increased significantly, and piercing-sucking injurious pests increased slightly. During 1990-2019, the proportion of the defoliator pests were basically constant, and the number of fruit boring pests increased, although the number of piercing-sucking injurious pests' literature was decreasing, but it was still the research focus of four major types of pests. No significant changes were found in the number of pest species by time, mainly concentrating on several important apple pests. Taking the literature of pest species as a statistical data sources, it was found that its research characteristics were different from the former. The number of piercing-sucking injurious pests was increasing with time; the number of trunk boring pests was basically constant; the number of defoliator pests decreased with time before 2000, and it was basically stable after 2000. The characteristics of fruit boring pests were increasing before 2000, though it was declined after 2000, the number was still the highest among the four types of pests. Among the boring pests, literatures on cotton bollworm were the highest and reached a peak around 2000. Literatures on oriental fruit moth, peach fruit borer, peach borer, except the codling moth decreased slightly in 2000, and all showed an upward trends, and reached a peak in 2010—2016. Among the main piercing-sucking injurious pest groups, the number of pest mites were the largest, followed by green leaf bug, aphids and giant mealy bug, and apple yellow aphids showed a slight decrease in 2000, with an increase later. The main defoliator pests were Asiatic apple leaf miner and the small leaf-rolled moth of the apple, which increased gradually with the year, and after 2014, the literature number began to decrease. Among the apple trunk boring insect, the literatures on *mulberry longicorn* and *Anoplophora chinensis* were the largest, the literature of *Agrilus mali* Matsumura has increased since 2000. 【Conclusion】The main species of apple pests changed with time, and the number of pest species did not change significantly. However, the species composition of pests showed obvious succession, the number of defoliator pests decreased and the number of piercing-sucking pests increased, the piercing-sucking pests were the main current or the future control target. At present, research on apple insect pests was mainly concentrated on several major pests. Some quarantine pests may expand the distribution areas and aggravate in the future. This research is of great significance for making and guiding the prevention and control of apple pests.

**Key words:** Apple; Pest; Succession; Population; Bibliometrics

中国是世界上最大的苹果生产国,也是世界上苹果消费最高的国家<sup>[1]</sup>。近年来,随着苹果产业的不断发展,苹果种植逐渐向规模化、集约化方向发展<sup>[2]</sup>。苹果害虫作为果园伴生的一种生物,一直以来是影响苹果产业发展的一个重要因素。随着苹果产业及相关管理技术的发展,苹果害虫的种类、发生数量也表现出不同的变化特点。对上世纪三

十年代到八十年代苹果园害虫汇总表明,部分害虫消失,主要害虫发生较大演替变化<sup>[3]</sup>。如套袋技术的引入,使一些蛀果类害虫的发生数量降低,但一些喜阴害虫康氏粉蚧等却呈递增趋势。另在化学农药的大量和频繁使用下,易形成抗性的害虫得以生存,一些抗药性低的害虫如食叶类害虫的发生数量则明显降低<sup>[4]</sup>。进入本世纪,随着相关研究的深

入,有关苹果害虫的文献报道逐渐增多,其中蚜虫类、食心虫类、螨类害虫占较大比重<sup>[5]</sup>,在害虫的组成特点上也呈明显演替变化,一些次要害虫如金纹细蛾、苹果黄蚜等演替成为主要害虫,蠹蛾、康氏粉蚧等成为套袋苹果的新发害虫<sup>[6]</sup>。在苹果害虫的治理中,卷叶蛾类等害虫得到有效控制,一些重要害虫的致灾特点和机制已明确,苹果害虫的绿色防控技术渐已成熟<sup>[7]</sup>。另在苹果产业转型升级和节本增效的现代化生产需求下,苹果免套袋、果园免耕等资源节约型生产技术将成为主要趋势<sup>[8]</sup>。在这些变化的共同影响下,苹果害虫的种类、变化趋势却是未知。为了探明我国苹果害虫种类、发生与变化特点,笔者以中国知网收录的有关苹果害虫期刊论文为主题,根据某一时间段的研究热点,通过文献计量方式进行整理,对苹果害虫的发生种类、演替规律进行分析,旨在了解我国苹果害虫的种类特点及演替方向,为治理害虫和促进生产提供借鉴和参考。

## 1 数据来源与研究方法

以中国知网中收录的有关苹果害虫的期刊论文为数据源,以主题“苹果 害虫”为检索项,检索年份限制在 2019 年前(包含 2019 年),对检索到的结果进行识别,去除无效信息(如广告、农药推荐信息)筛选出有关苹果害虫防治类的文献总计 672 条。利用 Microsoft Office Excel 2016 对 672 条文献逐一整理,将文献资料中涉及到的害虫种类信息、防治方法、文献来源、试验地点按题目形式进行

统计,以时间顺序进行编排。在此基础上划分不同类型害虫研究随时间的变化特点、害虫发生的地域特征等。对上述 672 条文献中涉及的害虫名录经过删除重复,合并同种别名后,共得到 94 种害虫。以此 94 种害虫名称逐一作为关键词再检索,为了防止同种别名被漏检,采用高级检索法,两种或两种以上名称采用“关键词”或“关键词”的方式进行检索,如苹果黄蚜虫采用“苹果黄蚜”或“绣线菊蚜”作为关键词进行检索。通过该方法共得到 27 689 条文献信息,按其性质进行归类,以了解研究重点变化,另根据时间变化,研究某时间段文献数量和涉及害虫种数的变化特征,并根据相关害虫文献研究数量分析其趋势。

## 2 结果与分析

### 2.1 苹果害虫组成种类

通过对有关苹果害虫的文献统计和筛选,共获得 8 个目,45 个科,94 种苹果害虫,主要以鳞翅目害虫为主,其次为鞘翅目和半翅目害虫,详见表 1。

### 2.2 苹果不同危害类型害虫变化趋势

根据不同苹果害虫种类的危害特点,将苹果害虫分为 4 大类,其中包括刺吸类害虫,食叶、花、芽类害虫,蛀果类害虫,蛀干类害虫。其中以食叶、花、芽类害虫的种类、数量最多见(表 2)。从有关苹果虫害防治类文献中害虫出现频次可看出,1980 年以前,以食叶、花、芽类害虫研究出现的次数最多,其次为刺吸类害虫;1980—1989 年,食叶、花、

表 1 苹果害虫科目组成特点

Table 1 The composition characteristics of apple insect pests

目 Order	科 Family
鳞翅目 Lepidoptera	透翅蛾科、灯蛾科、大蚕蛾科、蓑蛾科、麦蛾科、枯叶蛾科、螟蛾科、木蛾科、粉蝶科、毒蛾科、尺蛾科、细蛾科、蛀果蛾科、木蠹蛾科、刺蛾科、舟蛾科、斑蛾科、巢蛾科、夜蛾科、潜叶蛾科、卷蛾科 Sesioidea, Arctiidae, Saturniidae, Psychidae, Gelechiidae, Lasiocampidae, Pyralidae, Xyloryctidae, Pieridae, Lymantridae, Geometridae, Gracilariidae, Carposinidae, Cossidae, Limacodidae, Notodontidae, Zygaenidae, Yponomeutidae, Noctuidae, Tischeriidae, Tortricidae
鞘翅目 Coleoptera	吉丁甲科、象甲科、小蠹科、叶甲科、天牛科、金龟甲科 Buprestidae, Curculionidae, Scolytidae, Chrysomelidae, Cerambycidae, Scarabaeidae
半翅目 Hemiptera	蚜科、粉蚧科、绵蚧科、蚧科、叶蝉科、蝉科、蜡蚧科、盾蚧科、瘿绵蚜科、网蝽科、盲蝽科、蝽科 Aphididae, Pseudococcidae, Monophlebidae, Coccidae, Cicadellidae, Cicadidae, Coccidae, Asterolecaniidae, Pemphigidae, Tingidae, Miridae, Pentatomidae
蜱螨目 Acarina	叶螨科 Tetranychidae
真螨目 Acariformes	瘿螨科、跗线螨科 Eriophyidae, Tarsonemidae
膜翅目 Hymenoptera	叶蜂科 Tenthredinidae
缨翅目 Thysanoptera	蓟马科 Thripidae
革翅目 Dermaptera	蠹蛾科 Labiduridae

表2 苹果害虫的分类特点

Table 2 Classification characteristics of apple insect pests

分类 Classification	种名 Species
刺吸类害虫 Piercing-sucking insect pests	苹果绵蚜、苹果黄蚜、梨圆蚜、苹果瘤蚜、康氏粉蚜、朝鲜球坚蚧、苹果球蚧、长绵粉蚧、桑白蚧、草履蚧、梨花网蝽、大青叶蝉、绿盲蝽、小绿叶蝉、茶翅蝽、二斑叶螨、乱跗线螨、果苔螨、斯氏刺瘿螨、李始叶螨、苹果全爪螨、山楂叶螨 <i>Eriosoma lanigerum</i> , <i>Aphis citricola</i> , <i>Quadraspidiotus perniciosus</i> , <i>Myzus malisuctusmatsumura</i> , <i>Pseudococcus comstocki</i> , <i>Didesmococcus koreanus</i> , <i>Rhodococcus sariuoni</i> , <i>Phenacoccus pergindei</i> , <i>Pseudaulacaspis pentagona</i> , <i>Drosicha contrahens</i> , <i>Stephanitis nashi</i> , <i>Cicadella viridis</i> , <i>Lygocoris lucorum</i> , <i>Empoasca flavescens</i> , <i>Halyomorpha halys</i> , <i>Tetranychus urticae</i> , <i>Tarsonemus confusus</i> , <i>Bryobia rubrioculus</i> , <i>Aculus schlehtendali</i> , <i>Eotetranychus pruni</i> , <i>Panonychus ulmi</i> , <i>Tetranychus viennensis</i>
食叶、花、芽类害虫 Leaf, flower, shoot insect pests	苹掌舟蛾、苹果小卷叶蛾、苹果褐卷叶蛾、苹果大卷叶蛾、黄刺蛾、梨星毛虫、苹果小透羽蛾、苹果巢蛾、苹果梢夜蛾、枣尺蠖、苹果大毒蛾、梅木蛾、天幕毛虫、旋纹潜蛾、金纹细蛾、顶梢卷叶蛾、苹果尺蠖、黑星麦蛾、山楂绢粉蝶、梨潜皮蛾、黄斑卷叶蛾、大蓑蛾、苹果枯叶蛾、青刺蛾、丽绿刺蛾、白眉刺蛾、扁刺蛾、舞毒蛾、折带黄毒蛾、美国白蛾、金毛虫、绿尾大蚕蛾、红缘灯蛾、苹果异形小卷蛾、苹梢鹰夜蛾、果剑纹夜蛾、苹果叶蜂、黑绒鳃金龟、苹毛金龟子、铜绿金龟子、白星花金龟、小青花金龟、小黄鳃金龟、苹毛丽金龟、铜绿丽金龟、大灰象、苹果瘿蚊 <i>Phalera flavescens</i> , <i>Adoxophyes orana</i> , <i>Pandemis heparana</i> , <i>Choristoneura lonicellana</i> , <i>Cnidocampa flavescens</i> , <i>Illiberis pruni</i> , <i>Conopia hector</i> , <i>Yponomeuta padella</i> , <i>Hypocala subsatura</i> , <i>Sucra jujuba</i> , <i>Lymantria mathura</i> , <i>Oditēs ishikii</i> , <i>Malacosoma neustria</i> , <i>Leucoptera malifoliella</i> , <i>Lithocolletis ringoniella</i> , <i>Spilionota lechriaspis</i> , <i>Geometrid apocbeima</i> , <i>Telphusa chlorodermes</i> , <i>Aporia crataegi</i> , <i>Acrocercops astanrola</i> , <i>Acleris fimbriana</i> , <i>Clania veriegat</i> , <i>Odonestis pruni</i> , <i>Latoia consocia</i> , <i>Latoia lepida</i> , <i>Narosa edoensis</i> , <i>Thosea sinensis</i> , <i>Lymantria dispar</i> , <i>Polyhedrosis virus</i> , <i>Hyphantria cunea</i> , <i>Prothesia similes xanthocampa</i> , <i>Actias selene</i> , <i>Amsacta lactinea</i> , <i>Thaumatotibia leucotreta</i> , <i>Hypocala subsatura</i> , <i>Acronicta strigosa</i> , <i>Priophorus</i> sp., <i>Maladera orientalis</i> , <i>Proagopertha lucidula</i> , <i>Anomala corpulenta</i> , <i>Potosia brevitarsis</i> , <i>Oxycetonia jucunda</i> , <i>Metabolus flavescens</i> , <i>Proagopertha lucidula</i> , <i>Anomala corpulenta</i> , <i>Sympiezomias velatus</i> , <i>Dasineura mali</i>
蛀果类害虫 Fruit-boring insect pests	单梦尼夜蛾、苹小食心虫、苹果蠹蛾、桃小食心虫、梨小食心虫、棉铃虫、桃蛀螟、白小食心虫、苹果实蝇 <i>Monima gracilis</i> , <i>Grapholitha inopinata</i> , <i>Cydia pomonella</i> , <i>Carposina niponensis</i> , <i>Grapholitha molesta</i> , <i>Helicoverpa armigera</i> , <i>Dichrocrocis punctiferalis</i> , <i>Spionota albicana</i> , <i>Rhagoletis pomonella</i>
蛀干类害虫 Trunk boring insect pests	苹果小吉丁虫、金缘吉丁虫、皱小蠹、梨眼天牛、黄蓝眼天牛、星天牛、苹果枝天牛、苹楔天牛、桑天牛、苹果透翅蛾、榆木蠹蛾、芳香木蠹蛾、蒙古木蠹蛾、豹纹木蠹蛾、香梨优斑螟、苹果折梢象 <i>Agrilus mali</i> , <i>Lampra limbata</i> , <i>Scolytus rugulosus</i> , <i>Bacchisa fortune</i> , <i>Bacchisa guerryi</i> , <i>Anoplophora chinensis</i> , <i>Linda fraternal</i> , <i>Saperda candida</i> , <i>Apriona germari</i> , <i>Conopia hector</i> , <i>Holcocerus vicariou</i> , <i>Cossus cossus</i> , <i>Cossus mongolicus</i> , <i>Zeuzera leuconolum</i> , <i>Euzophera pyriella</i> , <i>Involvulus</i> sp.

芽类害虫出现比例有所下降,蛀果类害虫比例增加明显,刺吸类害虫数量略有增加;1990—2019年,食叶、花、芽类害虫的比例基本恒定,蛀果类害虫发文数量呈递增趋势,虽然刺吸类害虫出现次数呈减少态势,但仍为四大类害虫的主要研究对象(图1-a)。以害虫种名作为检索项按其研究文献数量进行统计,发现其研究特点有别于前者,刺吸类害虫发文数量随时间呈递增趋势;蛀干类害虫发文数量基本恒定;食叶、花、芽类害虫发文在数量2000年前随时间变化呈递减趋势,2000年后基本稳定;蛀果类害虫发文特点在2000年前呈递增趋势,2000年后虽有下降,但数量仍是4类害虫研究的最高者(图1-b)。

### 2.3 苹果害虫发文数量及种类个数随年份变化特点

以时间为单位,有关苹果害虫发文数量变化如图2所示。从图2看出,随年份变化,有关苹果害虫的发文数量在1990—2000年间增长明显,次后渐缓,总体呈递增趋势。文献所报道的害虫种类个数与年发文献数量变化趋势一致,随年份变化整体

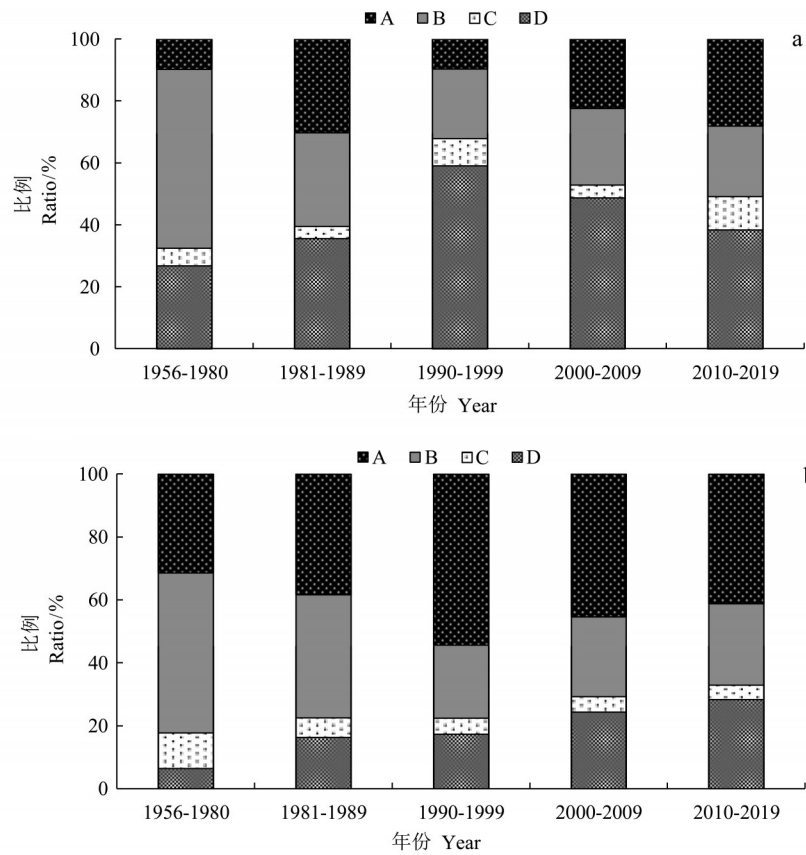
呈递增趋势,但每年份害虫种类个数变化却相对较低,所涉及的害虫种类数量多分布在40~55,研究越来越集中化(图3)。

### 2.4 苹果重要害虫研究数量分析

对文献涉及到的害虫种类按其文献数量进行排列,研究最多者多为杂食性害虫,涉及寄主广泛,除危害苹果外还危害其他作物或树种。研究发文最高为棉铃虫,其次为舞毒蛾,排列前20名主要害虫如图4所示。

在蛀果类害虫中,棉铃虫发文量具首位,在2000年左右达到峰值,主要与棉花相关,涉及基础及应用基础研究最多。其他4种蛀果害虫梨小食心虫、桃小食心虫、桃蛀螟、苹果蠹蛾,除苹果蠹蛾发文量在2000年略有降低外,均呈上升趋势,并在2010—2016年达到峰值,其主要涉及蛀果类害虫防控与应用基础研究(图5)。

在苹果主要刺吸害虫类群中,以螨类害虫发文数量最多,其次为绿盲蝽、蚜虫等害虫,除草履蚧、山楂叶螨、苹果黄蚜发文数量呈双峰外,有关刺吸



A. 蛀果类害虫; B. 食叶、花、芽类害虫; C. 蛀干类害虫; D. 刺吸类害虫。a. 以苹果害虫防治文章中害虫出现频次制作; b. 以苹果害虫文献数量制作。

A. Fruit boring insect pests; B. Defoliator insect pests; C. Trunk boring insect pests; D. Piercing-sucking injurious insect pests. a. Produced by the frequency of occurrence of apple pests in the a literatures on apple pest prevention and control; b. Produced by the number of apple insect pests literatures.

图1 苹果不同危害类型害虫比例随年份变化特点  
Fig. 1 The proportion of different type apple insect pests with years

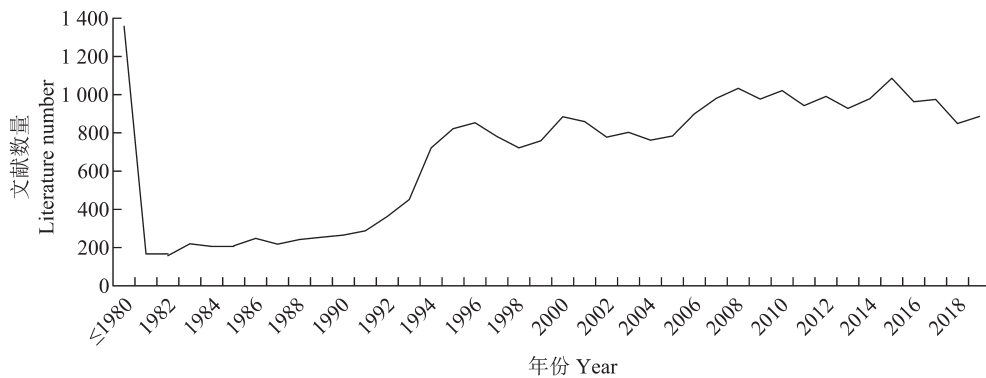


图2 苹果害虫的发文数量随年份变化特点  
Fig. 2 The number of literatures on apple insect pests varies with the year

类害虫的发文数量除 2000 年略降低外均呈递增趋势(图 6)。

食叶类害虫除去杂食类害虫天幕毛虫、舞毒蛾、美国白蛾,与苹果相关程度最高的为金纹细蛾

和苹果小卷叶蛾,其中以金纹细蛾的研究发文数量最高,两者的变化随年份呈递增趋势,2014 年后数量有所下降(图 7)。

由图 8 可以看出,苹果蛀干害虫中桑天牛和星

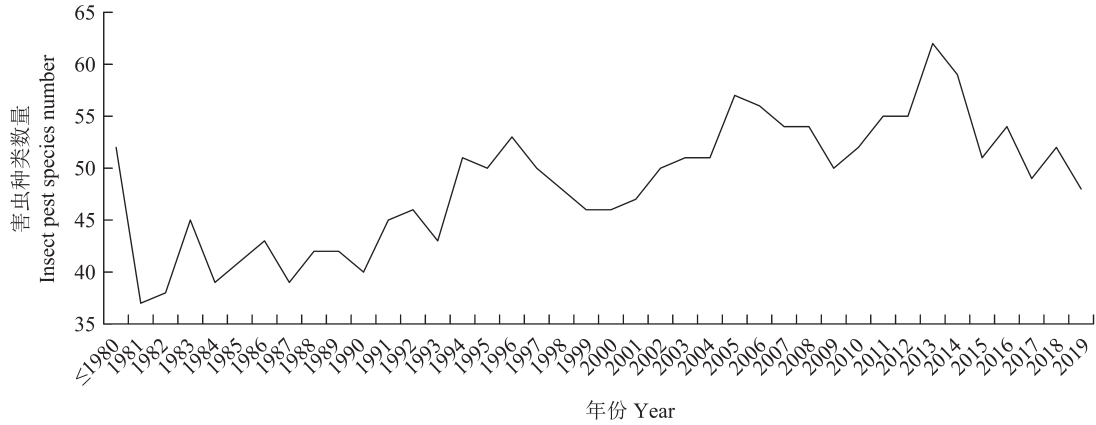


图3 文献报道的苹果害虫种类数随年份变化特点

Fig. 3 The number of apple pest species reported in the literature varies with the year

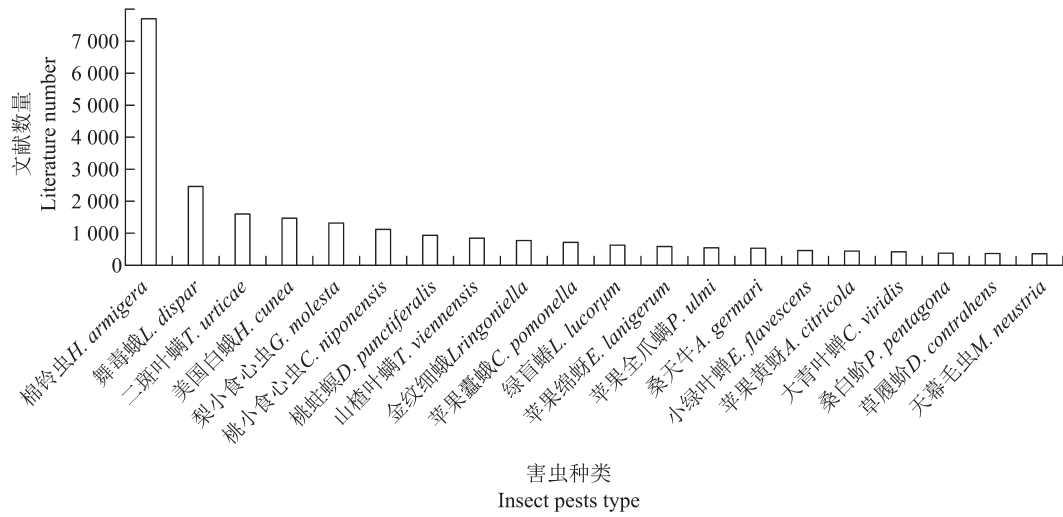


图4 苹果主要害虫种类发文数量

Fig. 4 The number of literatures on different major apple insect pests

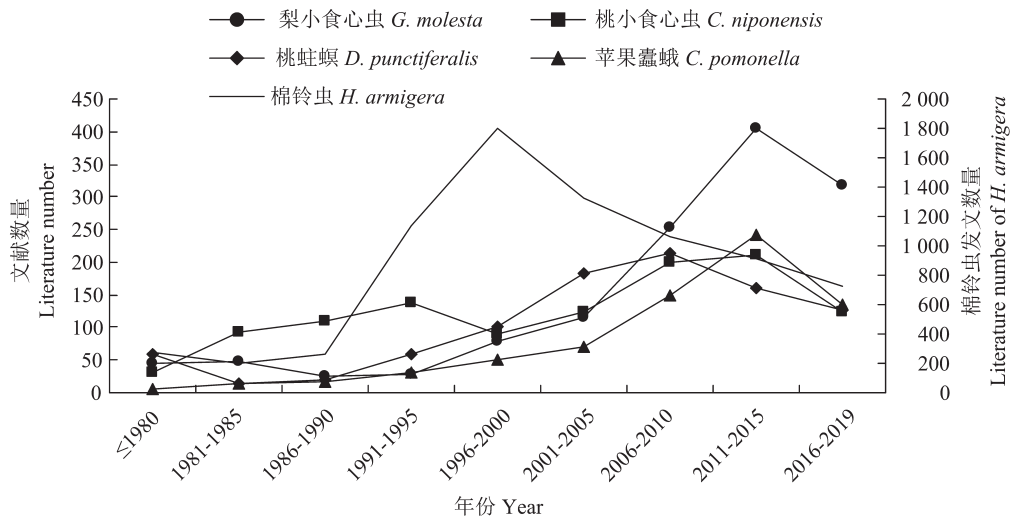


图5 主要蛀果类害虫发文量变化

Fig. 5 Number of literatures about main fruit boring insect in each 5 years

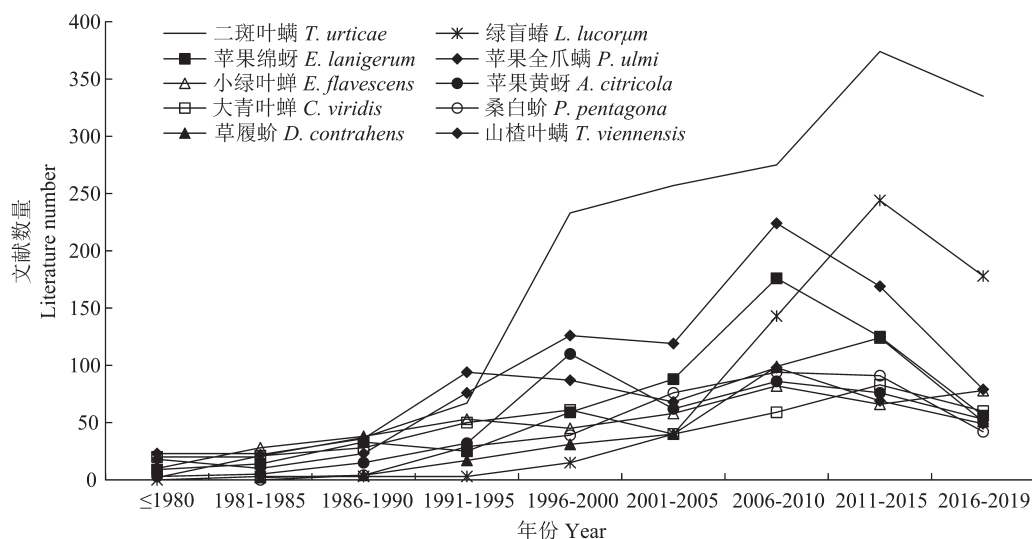


图 6 苹果主要刺吸类害虫文献数量变化

Fig. 6 Number of literatures about main piercing-sucking pests in each 5 years

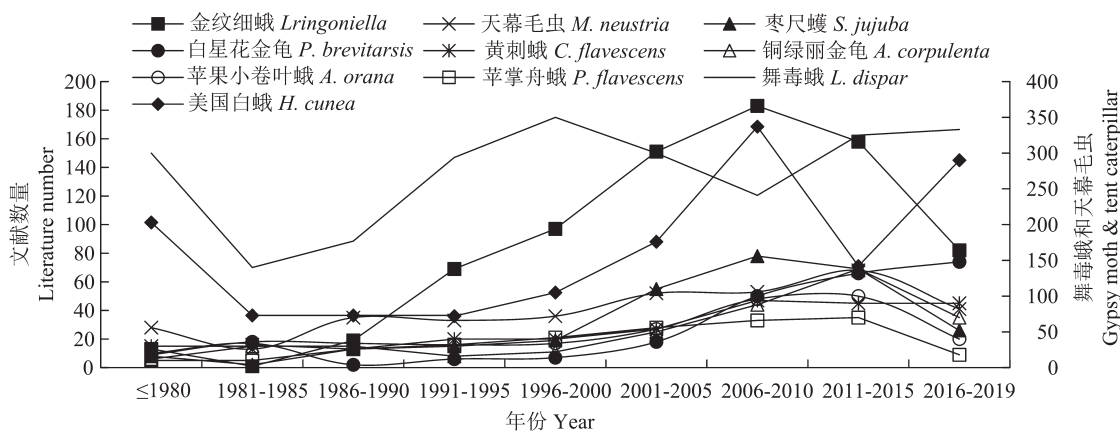


图 7 苹果主要食叶类害虫文献数量变化

Fig. 7 Number of literatures about main defoliator insect pests in each 5 years

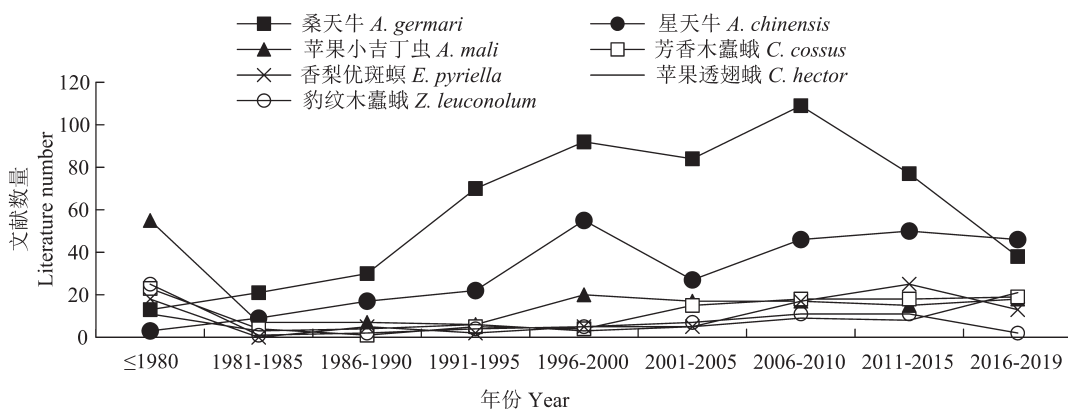


图 8 苹果主要蛀干类害虫文献数量变化

Fig. 8 Number of literatures about main trunk boring insect pests in each 5 years

天牛的相关文献数量最多,其他蛀干害虫中,苹果小吉丁虫的文献数量自 2000 年后有所提高,其余蛀干虫在近十年的文献数量有所提高,但平均每年文献数量不超过 5 篇。

### 3 讨 论

通过苹果害虫文献计量分析,可反映出某一时间段的研究与关注重点,也可从中得知害虫种类的

变化特点及演替趋势。上世纪80年代,孙益知等<sup>[1]</sup>统计发现我国苹果害虫共有473种,仅陕西地区苹果害虫达227种,但对生产有威胁的害虫有30多种。樊景超<sup>[2]</sup>统计发现,我国2007—2017年苹果害虫种类共有49种。笔者统计表明,文献报道的苹果害虫有94种,对苹果构成威胁的有20多种,害虫种类、数量未见减少,但文献的关注重点呈集中化。自2000年后,这种变化趋势尤为明显,以几种主要害虫研究为主,如桃小食心虫、梨小食心虫、苹果蠹蛾、蚜类、蚧虫类等害虫,与当前果树虫害发生特点吻合。在刺吸类害虫演替上,蚜类害虫自上世纪90年代开始一直为苹果上的常发害虫,也是当前的防控重点<sup>[6]</sup>;苹果绵蚜、康氏粉蚧、绿盲蝽自2000年左右后成为防控和研究重点;朝鲜球坚蚧、苹果瘤蚜、苹果球蚧、梨花网蝽自报道以来,属偶发害虫,相关研究也较少。在食叶类害虫的演替特征上,以杂食类害虫舞毒蛾、美国白蛾等为主,属常发害虫;苹果叶蜂、红缘灯蛾、苹梢鹰夜蛾、果剑纹夜蛾、山楂粉蝶等食叶类害虫为偶发害虫,近几年少见发生。苹果蛀果类害虫除白小食心虫为偶发性害虫外,桃小食心虫、梨小食心虫、苹果蠹蛾、桃蛀螟等一直为主要蛀果类害虫;苹果实蝇自2000年后开始,只见相关检疫报道。在蛀干类害虫当中,桑天牛和星天牛为当前主要蛀干害虫类群;有关苹果小吉丁虫的发生报道多在西北、东北果区,有扩大发生趋势<sup>[9]</sup>;其他鳞翅目蛀干害虫多为偶发性害虫;梨眼天牛、苹果枝天牛、苹楔天牛在近几年已少见发生。

因不同种类苹果害虫对环境、气候、防治措施等干扰适应能力的差异,不同地区、时间段呈现出不同的组成和演替特点。研究表明,在全球气候变暖的大尺度影响下,害虫分布区扩大,发生代数增加,尤以对小型刺吸类害虫等的影响明显<sup>[10]</sup>。自1951年统计以来,我国年平均气温自1998年后明显高于1981—2010年平均值(数据来自中国气象局2019年中国气候公报),与之相应的是有关苹果刺吸类害虫的出现比例也在同期明显提高,苹果黄蚜、蚜类等刺吸类害虫的发文数量增加明显。除气候在宏观尺度的影响外,在空间格局上,我国苹果种植面积自1980年后呈明显增长趋势,1996年左右达到高峰期,并形成两大重心区域——渤海湾(山东、辽宁等)和西北黄土高原(陕西和甘肃)<sup>[11]</sup>,在发文量上也表现出递增趋势,其中发文最多的为山

东、陕西相关研究机构。害虫种类组成上表现为:华北地区虫害种类基本一致,西北地区(甘肃、新疆)、东北地区苹果蠹蛾、苹果小吉丁虫的发生为其明显特征。随着西部果区的扩大,苹果蠹蛾的研究文献量也呈明显增长趋势<sup>[12]</sup>。另随果园更替频率、老果园改造进程的加快,金缘吉丁甲、苹果透翅蛾等蛀干类害虫发生相对减轻。在苹果虫害的治理上,上世纪80年代前,主要依赖人工和化学防治,对危害特征相对明显的食叶类害虫梨星毛虫、卷叶蛾等起到了一定的控制作用,但对隐蔽程度较高的蛀果和蛀干类害虫控制较差<sup>[4]</sup>,在此期间,相关研究也较少,主要涉及苹果害虫的防治报道。上世纪80—90年代,随着化学农药有机磷类、菊酯类农药的推广和应用<sup>[13]</sup>,食叶类、卷叶蛾类、刺蛾类害虫得到有效控制,蛀果类害虫桃小食心虫成为主控对象,另在农药的筛选压力下,小型害虫蚜类、蚧虫等的发生数量开始有所提高,文献主要以害虫防治方法探索和研究为主。1990年代到2000年,随套袋技术的推广和应用,蛀果类害虫危害有所下降,蚜类害虫仍为主控对象,苹果黄蚜和苹果绵蚜危害渐次扩大并加重<sup>[5]</sup>,在此期间信息素防治技术和生物防治技术开始推广并应用。2000年后,刺吸类害虫(蚜类、蚧虫类)仍占主要组成部分,其次为蛀果类害虫,但一些喜阴害虫如康氏粉蚧、蠹蛾成为套袋后的新治理对象<sup>[6]</sup>。在用药种类上,有机磷类农药使用比例下降,烟碱、生物类农药的应用比例有所提高<sup>[13]</sup>,防治方法上逐渐多元化,如生物制剂、频振灯、黑光灯、生物天敌、信息素防治等均有不同程度的应用<sup>[7-14]</sup>。在以化学农药防治为主的措施下,对比2000年前后苹果害虫种类的组成可发现,2000年以前可见多发的黑星麦蛾、苹果尺蠖、苹果巢蛾等在近几年几乎不见。近十几年,苹果害虫种类增加主要以检疫性害虫为主,如苹果绵蚜<sup>[15]</sup>、苹果小吉丁虫<sup>[9]</sup>、苹果蠹蛾<sup>[12]</sup>等,有渐次扩大分布趋势<sup>[16-17]</sup>。

苹果产业作为农业的重要支柱产业,对农村经济发展和农民收入均起到重要作用,随着苹果产业的扩大和发展,虫害防控作为果树生产中的重要环节,对苹果产业的影响不容忽视。长期以来,在果树害虫的管控上主要依赖化学防治进行调控,但引发后果是环境污染、害虫耐药性提高、害虫演替变化明显、防治难度加重。针对此,我国植保科技工作者已在苹果主要害虫的分布布局、发生规律、灾



变机制、生物生态学、测报与综合防控等方面均取得重要进展<sup>[7]</sup>,有关苹果害虫绿色防控技术体系正逐步完善,在此推动下将有助于推动苹果产业健康发展,实现可持续、健康发展的目的。

## 4 结 论

从文献计量学角度分析了我国苹果害虫的组成、演替特点,发现有关苹果害虫的报道和研究一直呈上升趋势,虽然食叶类害虫种类数量最多,但随时间变化,其关注度却在下降,重心集中在几种主要害虫的研究上;在近十几年对苹果生产构成威胁的害虫主要有20多种;食性杂、个体小、隐蔽性强、发生代数多的害虫渐演替为主要害虫类群,主要以刺吸类害虫和蛀果类害虫为主;一些检疫类害虫有扩大并加重发生趋势。通过本文的研究可为治理苹果害虫等提供依据。

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