



国内外瓢虫数据集研究综述——资源现状、应用与挑战

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摘要: 瓢虫是生态系统中重要的捕食性天敌, 对抑制害虫种群的增长、维护生态系统的稳定具有重要作用。本文对国内外瓢虫资源现状及数据集进行了深入梳理和评估, 通过分析瓢虫的分布范围、农作物种植类型及监测技术等关键信息, 旨在揭示瓢虫资源动态分布对精准农业发展的深刻意义, 并为后续研究提供坚实的数据支撑及为瓢虫保护和利用策略制定提供科学依据。

关键词: 瓢虫; 数据集; 动态分布; 多样性; 资源保护与利用

1 引言

瓢虫科 (Coccinellidae) 隶属于鞘翅目 (Coleoptera), 种类繁多且分布广泛, 全球已知瓢虫约 6900 余种, 中国已记录约 840 种^[1-2]。其食性多样, 包括植食性、菌食性和捕食性, 其中 80% 种类为捕食性瓢虫^[3], 如异色瓢虫 *Harmonia axyridis*、龟纹瓢虫 *Propylea japonica*、七星瓢虫 *Coccinella septempunctata* 等, 可捕食蚜虫、粉虱等害虫。瓢虫是农业系统中重要的天敌昆虫, 在生物多样性保护和农业害虫生物防治中发挥关键作用^[4-6]。近年来, 随着生态学研究的不断深入以及生物防治需求的增加, 国内外对瓢虫资源现状、多样性调查等研究逐渐增多, 不仅丰富了瓢虫资源的本底数据, 也为瓢虫生物防治的资源开发、制定合理的害虫防控措施、保护生物多样性以及实现农业生态的可持续发展等提供了重要参考, 对提升生物防治精准度至关重要, 瓢虫资源的开发与利用也因此成为诸多国内外天敌企业的重要探索方向^[7-9]。

瓢虫资源现状研究及多样性调查数据集的构建为瓢虫研究提供了系统、全面的数据支持。数据集记录了瓢虫的种类、数量、分布、生态环境等信息, 部分还包括生境图像、物种标本照片等。这些数据集在瓢

虫分类鉴定、生物防治、生态研究等方面具有重要应用价值。但目前瓢虫数据集存在挑战, 如种类覆盖不全, 瓢虫种类的记录仍有待完善; 缺乏分子数据佐证; 数据维度单一, 多数数据集仅记录瓢虫种类和数量等基本信息, 瓢虫与环境关联数据收集较少; 标注标准缺失或不统一。

因此, 本文对国内外瓢虫数据集进行系统梳理和评估, 分析瓢虫分布区域、栖息植物以及监测技术等内容, 旨在加深天敌长期性观测的科学意义, 为精准农业发展提供重要数据支撑。为此, 本文开展了以下工作:

(1) 全面收集和整理国内外已有的瓢虫数据集, 包括数据集的来源、涵盖的地理范围、瓢虫种类、样本数量、监测时间跨度以及数据的存储格式等基本信息。对这些数据集进行详细的对比分析, 评估其在瓢虫多样性研究和生物防治应用中的价值和局限性, 为后续的深入研究奠定基础。

(2) 深入探究瓢虫数据集的应用情况。在生物多样性保护方面, 进行物种鉴定, 分析瓢虫数据集、分布特点等, 提出数据集基本特征和要求; 在农业害虫生物防治领域, 研究瓢虫数据集如何为瓢虫的田间释放、监测和管理提供科学依据, 提高对害虫的控制效果; 在生态研究中, 探讨瓢虫数据集对于揭示瓢虫与

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其他生物之间的相互作用、生态系统功能以及环境变化响应等方面的重要作用。

(3) 详细分析瓢虫数据集面临的挑战,并提出相应的优化建议和未来研究方向。针对瓢虫数据集存在的种类覆盖不全、数据维度单一、标注标准缺失等问题,提出解决方案;探讨如何利用先进的技术手段,如人工智能、大数据分析等,提升瓢虫数据集的质量和效能,推动瓢虫数据集的智能化发展;展望未来瓢虫数据集在跨学科研究、国际合作等方面的发展趋势,为瓢虫研究提供新的思路。

2 瓢虫数据集资源调查

瓢虫多样性调查数据集来源于多种方式,而不同方式获得的数据集在覆盖范围、来源作物、调查时间和方法、数据质量等方面存在差异。其数据来源主要包括:(1) 田间实地调查,主要通过对各种农田、试验田、自然保护区等环境中的瓢虫进行样本收集、鉴定,并以文字和/或高分辨率图像的形式进行记录;(2) 标本馆、历史图像或数据记录。本文对目前已公开发表的数据集进行归纳总结,从数据和研究性论文、数据网站中搜集国内外相关研究结果,并对数据集或论文的名称、作物类别、调查时间、研究内容等信息进行汇总。

2.1 数据来源与采集方法

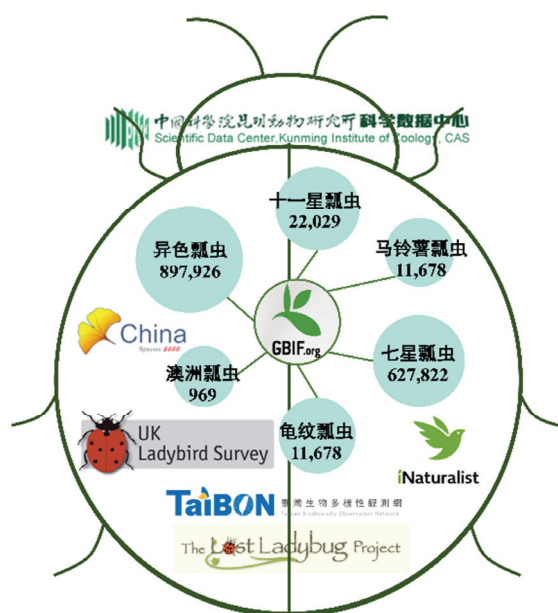
瓢虫多样性调查数据集的构建整合了多源数据库,目前全球已形成多个区域性和全球性的瓢虫分布与分类数据库,为物种多样性和生物防治应用提供了基础支撑(图1)。本研究在此基础上,系统检索了国内外公开发表的数据论文和研究性论文,对现有瓢虫数据集的特征与应用价值进行全面梳理。

2.1.1 数据论文

截至2025年4月,在国家农业科学数据中心进行检索,以“瓢虫”为关键词搜索数据集名称,对符合要求的数据论文中的数据集进行归纳,得到与瓢虫物种多样性相关的有效数据集12条;类似地,在中国农业科技文献与信息服务平台中也展开相关工作,获得有效数据论文6条。综合数据论文搜索结果,共获得有效数据集13条(附表1)^[10-22]。

2.1.2 研究性论文

本文对国内外论文展开检索研读。国内文献检索依托国家农业图书馆中国农业科技文献与信息服务平台,以“瓢虫+多样性”为主题进行文献检索,共返



注:数据库包括:中国科学院昆明动物研究所科学数据中心、全球生物多样性信息服务网络平台(GBIF)、物种2000(Species 2000)、英国瓢虫调查(UK Ladybird Survey)、全球自然观察平台(iNaturalist)、台湾生物多样性观测网(TaiBON)。GBIF数据库,瓢虫物种下的数字为其全球发生记录数。

Note: Databases include: Science Data Center of the Kunming Institute of Zoology, Chinese Academy of Sciences; Global Biodiversity Information Facility (GBIF); Species 2000; UK Ladybird Survey; iNaturalist; and Taiwan Biodiversity Observation Network (TaiBON). In the GBIF database, the numbers listed under each ladybird species represent the number of global records.

图1 国际部分国家(地区)主要瓢虫分布与分类数据库概况

Fig. 1 Overview of major ladybug distribution and taxonomic databases in selected countries (regions)

回193篇文献;为了保证数据集的质量,仅勾选“SCI来源期刊”“EI来源期刊”“北大核心”“CSSCI”及“CSCD”作为来源期刊,最终筛选获得167篇文献,其中7篇为综述性文章^[5-6,23-27]。这些研究性论文主要发表在《生态学报》《应用生态学报》《环境昆虫学报》《农业大数据学报》《山东农业大学学报》等期刊上^[28-182]。

国外文献则通过Web of Science网站进行检索,以“ladybugs or lady beetles or ladybirds or ladybug or lady beetle or ladybird + diversity”为关键词检索文献,共返回13 907条结果,由于数据量庞大,且返回结果中多数论文与本研究不相契合。因此通过勾选“Article”锁定文献类型为论文形式,并进一步在研究主题中设置关键词“resources survey”等与瓢虫资

源多样性紧密相关的领域，共获得文献 147 篇^[183-324]。这些研究性论文主要发表在《Journal of Biological Control》《Insects》《ZooKeys》和《Redia-Journal of Zoology》等期刊上。

2.2 数据集特征采集

根据数据集的来源和内容，对各数据集特征进行

归纳。对于研究性论文数据集，主要记录论文的题目、作者、期刊、采样地点、作物、采样方法和数据集等信息；对于已发表的数据集，主要记录其数据集名称、作者、来源网站、作物、介绍、采样时间、采样地点、采样方法、服务系统网址/获取网址/DOI、版权协议等信息。各个字段的解释如表 1 所示。

表 1 瓢虫数据集特征归纳的主要目录字段
Table 1 Primary catalog fields for describing ladybird dataset characteristics

字段	字段解释	
论文	题目	论文的标题，明确研究聚焦的主题
	作者	研究并撰写论文的学者名单
	期刊	论文发表的学术期刊名称
	采样地点	论文调查的地理区域
	作物	论文研究的具体作物对象
	采样方法	论文调查取样的具体方法
	采样时间	论文调查的时间范围统计
	数据集	是否关联数据集，或仅发表研究性论文
数据集	名称	数据集的正式名称，通常反映数据的内容和用途
	作者	数据集的创建者或贡献者，包括个人或机构
	来源网站	提供数据集的平台或网址
	作物	数据集所涉及的作物类别
	介绍	对数据集的内容和特点进行简要描述，包括数据量、采集方法、主要特征等
	采样时间	数据采集的时间范围
	采样地点	数据采集的地理位置
	采样方法	论文调查取样的具体方法
	服务系统网址/获取网址/DOI	主要是准确定位到数据集，便于数据引用和跨平台检索其中 DOI 为数据集的永久唯一标识符
	获取/版权协议	数据集是否可获取/使用条款和限制

2.3 数据集关键特征分类

搜集到的数据集中，瓢虫多样性调查分别来自不同的生态系统，国内研究中农田、试验田、果园、茶园、烟田和自然保护区的研究较多；而国外研究多集中于对农田、果园、森林和稻田等生态系统的调查。根据其研究内容，多为种类鉴定和多样性研究；此外，还有关于“作物-害虫-瓢虫”互动、瓢虫色斑规律、环境响应（季节动态变化、不同生境）等研究涉及不同种类瓢虫，可侧面反映不同地区瓢虫种类多样性差异。

2.4 数据集分布情况

本文进一步对已发表的各类文章的内容进行分析，

分别统计了现有数据集在空间覆盖、时间覆盖以及数据集来源的分布情况（表 2）。其中，我国关于瓢虫多样性调查数据最多，占据目前所有研究的一半以上，覆盖黑龙江、吉林、辽宁、内蒙古、新疆、宁夏、青海、甘肃、北京、天津、河北、山东、山西、陕西、河南、安徽、江苏、上海、浙江、福建、湖北、湖南、广西、广东、四川、重庆、贵州、云南、西藏、海南、香港等 31 个省（市、自治区）；其次是印度和美国，这些也是国际上农业生产占比较重的国家；此外，瓢虫数据集覆盖了除南极洲以外的 6 大洲，表明其调查覆盖度较广。从时间尺度来看，各季度均有调查数据覆盖，各季度数据占比

相对均匀，第一季度的调查数据集偏少，且南半球（各季度调查数分别为 8、7、7、7）相比北半球各季度调查数据分布更均匀；国内的调查年度跨度为 1990 以后的 30 余年间，国外为 1977—2016 年约 40

年间，反映出国内关于瓢虫种类多样性调查工作开展较晚，但一直持续到近五年内。在数据集来源方面，主要由各类农业院校和科研院所提供并开展研究，且以研究性论文为主，数据论文占比较少。

表 2 数据集分布情况
Table 2 The distribution of datasets

特征类型	指标	统计内容
空间覆盖	覆盖国家/区域	中国（181，55.18%）、印度（22，6.71%）、美国（15，4.57%）、巴基斯坦（11，3.35%）、巴西（9，2.74%）、其他（90，27.44%）
	覆盖洲	亚洲（252，76.83%）、欧洲（32，9.76%）、北美洲（17，5.18%）、南美洲（15，4.57%）、非洲（9，2.74%）、大洋洲（1，0.30%）
		北半球（309，94.21%）、南半球（19，5.79%）
时间覆盖	采集时间	一季度占 25.08%、二季度占 47.37%、三季度占 46.44%、四季度占 35.91%
	采集年度	国内：1990 年—2022 年，国外：1977 年—2016 年
数据集来源	机构类型	院校（186，56.71%）、科研院所（117，35.67%）、其他（25，7.62%）
	主要来源	数据论文（13，3.96%）、研究性论文（300，91.46 %）、综述（15，4.57%）

注：表格括号内数字代表符合统计类别的论文数量，百分比为该类别已发表论文数量占总论文数量（328 篇）的比例。采集时间：分别涵盖各季度的文献数量占总文献数量的比例，具体见附表 1 和附表 2 中标注。

3 瓢虫图像数据集

近年来，瓢虫图像数据集的采集与整理在我国多地广泛开展，涵盖了多个地区和不同的生态环境（附表 1 和附表 2）。从地域范围来看，这些研究涉及黑龙江省哈尔滨市、吉林省公主岭市、青海省海西州德令哈市、河北省承德市隆化县和衡水地区、陕西杨凌、江苏省盐城市、浙江省杭州市、湖北省恩施市及鄂东地区、湖南省常德市、云南省楚雄市、广东省东莞市等不同省市的特定区域。针对的作物和生境类型也丰富多样，包括云南红梨、玉米田、荔枝园、茶园、柑橘园、茶树、农田以及柴达木盆地特殊生境等多种环境，反映出瓢虫在各种农业生态系统中的生存分布情况。研究时间主要集中在 2018—2022 年，部分数据集时间跨度稍短至 2020 年结束，且数据的获取方法多样，包括实地调查、马氏网诱捕采集等多种手段，确保了数据的可靠性和全面性。部分研究除调查了瓢虫种类多样性以外，还囊括了其他捕食性天敌，如蜘蛛、食蚜蝇、草蛉等，均详细记录其种类、数量、分布范围以及监测地的环境、气候等信息。

4 国内外数据集特征比较

本研究汇总分析了中国及南亚、欧洲、非洲等地

的瓢虫多样性数据集(其中国内 176 项、国外 147 项)。研究发现国内数据集聚焦区域性物种普查，而国际研究更关注功能生态学机制，关于瓢虫图像数据集的研究均较少。

4.1 国内数据集特性

我国瓢虫多样性调查及数据集研究地域覆盖广、生态环境及收集方法多样，其涵盖的地域具有一定的集中性，其中，过半研究集中于北纬 30°—45°的温带区（如河北、山东、安徽、河南等），呈现“东北—东南—西南”三极分布。基于全球生物多样性信息服务网络平台（GBIF）、农业农村部天敌等昆虫资源野外科学观测研究数据中心 2018—2024 年天敌种群动态监测及 CNKI 文献的多源数据整合分析显示，异色瓢虫、龟纹瓢虫和七星瓢虫三种农业优势种类在中国各省的分布存在显著空间差异（表 3）。在研究方法上，综合运用了人工调查、马氏网采集、图像采集等多种手段，不仅收集了瓢虫的种类、数量等基本信息，还包括生境图片、标本图片及环境图片等辅助数据。根据附表 1 和附表 2 中数据信息的统计，从观测维度分析，56.82%的研究仅记录物种组成与数量，仅有少量研究（22.73%）涉及“瓢虫—害虫—作物”互作网络，还有部分研究涉及瓢虫的色斑差异以及环境、农事等因素对瓢虫群落动态的影响。数据集中有 137 项研究记录了调查时间，其平

均监测周期为 1.02 年，以季节动态为主。国家农业科学数据中心的瓢虫数据集为数据的共享和进一步研究提供了便利，但调查分布不均匀且监测持续周期较短，特别是西北地区调查研究较少；在瓢虫与环境关系研究上，多停留在初步的关联分析，对深层次的作用机制探究不足，难以准确预测环境变化对瓢虫多样性的影响。

表 3 三种瓢虫在中国各省份报道的次数统计
Table 3 Number of records of three ladybird species across provinces of China

省/市/自治区	报道次数			省/市/自治区	报道次数		
	龟纹瓢虫	七星瓢虫	异色瓢虫		龟纹瓢虫	七星瓢虫	异色瓢虫
安徽省	55	59	184	江西省	80	68	389
北京市	35	109	567	吉林省	173	2	196
重庆市	7	4	16	辽宁省	26	3	137
福建省	4	5	4	宁夏回族自治区	2	2	3
甘肃省	10	26	54	青海省	5	15	12
广东省	9	3	6	陕西省	3	27	81
广西壮族自治区	39	1	5	山东省	86	52	298
贵州省	3	2	24	上海市	83	69	126
海南省	0	0	0	山西省	33	47	60
河北省	19	17	74	四川省	74	1	101
黑龙江省	173	2	196	台湾省	3	5	4
河南省	39	12	56	天津市	4	3	22
湖北省	48	10	58	西藏自治区	0	2	3
湖南省	35	5	34	新疆维吾尔自治区	0	24	16
内蒙古自治区	17	20	95	云南省	3	86	67
江苏省	131	167	302	浙江省	80	68	389

4.2 国外数据集特性

国外瓢虫多样性调查同样涵盖了多种生态环境，如森林、农田、果园、温室等，系统收集瓢虫的种类、分布和数量数据。一些研究结合环境变量分析，探究气候、植被等对瓢虫多样性的影响^[193,202,205,305,317]；或运用统计模型和生态学分析深挖数据，以揭示瓢虫群落结构和生态位。数据集中 100 篇文献记录了调查时间尺度，除六斑月瓢虫（*Cheilomenes sexmaculata*）探究了其过去 100 年间受气候变暖的影响^[197,244]，其余研究的平均监测周期为 1.46 年，较我国瓢虫的监测时间持续长。研究多偏向于研究季节变化、耕作模式等因素对瓢虫种群的影响。由于缺少对瓢虫种类及其生境等方面的图像信息收集，使数据管理工作仍显不足。

5 瓢虫数据集的应用

瓢虫作为一类重要的捕食性天敌，在生物多样性保护和害虫生物防治等方面发挥了重要作用，依据上

述收集归纳的瓢虫数据集的研究内容，进一步对其应用研究进行总结。这些研究大部分都是基于田间瓢虫物种多样性水平的研究，为探究瓢虫资源的保护与利用提供科学依据。

5.1 物种鉴定与分类

目前，瓢虫数据集中物种鉴定大多采用形态鉴定的方法，传统的方法依赖于专家的专业知识和经验，效率较低且易受主观因素影响。瓢虫图像数据集的建立，为基于图像识别技术的物种鉴定提供了可能。

5.2 生物防治资源及效能评估

瓢虫作为多种农业害虫的天敌，了解不同地区或生态环境中瓢虫的种类、数量和分布，将有助于更好地制定生物防治策略，提高害虫防治效果。例如，在我国海南北部蔬菜园中，六斑月瓢虫和龟纹瓢虫为优势种类^[70]，而冀东板栗园中异色瓢虫和龟纹瓢虫为优势种^[53]。通过对不同地区数据集的分析，可以确定优势瓢虫种类及其发生规律，从而为当地害虫的生物防治

提供指导，减少化学农药的使用，实现绿色农业发展。

5.3 种群动态监测

近年来，国内外瓢虫多样性调查及图像数据集研究不断深入，为瓢虫种群监测提供了丰富的数据资源基础。在数据收集方面，多个研究通过长期、定点的监测获取了瓢虫种群动态数据。例如，2018—2021 年黑龙江省哈尔滨和 2018—2020 年河北省衡水地区瓢虫数据集，通过人工调查和马氏网采集的方法，收集了大量瓢虫数据及其生境信息^[16, 20]，为分析其种群动态变化以及本地农田生态系统的研究及虫害的防控提供数据支撑。这些研究不仅关注瓢虫的种类和数量，还收集了当地的环境和气象信息等辅助数据，有助于研究特殊生境下瓢虫种群动态与环境因素的关系，为制定合理的害虫防控措施、保护生物多样性以及实现农业生态的可持续发展提供了重要参考；此外，在监

测过程中发现物种濒危或接近灭绝的情况下，应通过系统的数据分析与生态评估明确其衰退原因，提出相应的保护和恢复对策，为政府制定生物多样性保护政策提供科学支撑。

综上，目前已发表的瓢虫数据集的研究内容主要包括上述三类，研究中涉及的具体数据类型包括物种组成与数量、空间分布、作物类型、害虫—瓢虫共发生、时间动态、图像与标本、环境与农事管理等数据。其中，物种组成、数量和空间分布数据可用于识别不同区域和作物系统中的优势天敌资源；作物类型、害虫种类、瓢虫种类及其同步调查数据可用于分析作物—害虫—瓢虫互作关系；时间动态、环境因子和农事管理信息则可用于判断天敌种群发生规律及其与害虫发生期的匹配程度，从而为天敌保护利用、生态调控和农药减量施用提供依据（表 4）。

表 4 不同类型瓢虫数据资源的应用场景
Table 4 Applications of different types of ladybug data resources

数据资源类型	关键字段/信息	可开展的分析	数据集应用方向
物种组成与数量数据	瓢虫种类、相对丰度、优势度等	优势种识别、群落结构分析、区域资源评价	筛选本地优势天敌种类，确定保护利用对象
空间分布数据	采样地点、经纬度、海拔、区域、生境类型等	适生区分析、空间聚集性分析、区域差异比较	指导区域化天敌资源配置和重点保护区域划定
作物类型数据	作物种类、种植模式、生育期等	作物生境偏好、作物间差异分析	明确不同作物系统中适宜保护或释放的瓢虫类群
害虫—瓢虫共发生数据	害虫种类及数量、瓢虫种类及数量、调查时间等	捕食者—猎物同步性、相关性、生态位重叠分析	分析作物—害虫—瓢虫互作关系，优化生态调控措施
时间动态数据	采样日期、季节、年份、虫口动态等	种群消长规律、发生高峰、时序匹配	确定天敌保护、田间释放和农药减量施用窗口期
图像与标本数据	成虫/幼虫图像、标本照片、生境图像等	自动识别、快速监测、标准化标注	支撑田间智能识别和绿色防控数字化监测
环境与农事管理数据	温湿度、植被、景观格局、间作模式、用药方式等	环境驱动因子分析、管理措施效应评价	筛选有利于瓢虫保育的栖境管理和农艺措施

6 讨论及展望

6.1 多维度丰富数据集

全球生物观测数据集普遍存在覆盖范围有限、动态监测连续性不足、多维度生态数据缺失（如缺少遗传信息）等问题。我国自 2017 年起开展了农业基础性长期性工作，农业农村部天敌等昆虫资源野外科学观测研究数据中心牵头在全国设置了百余个监测点，覆盖了除台湾省的 33 个省、自治区和直辖市。然而，结合实际情况，观测站点逐年收缩，建议国家加大对天敌昆虫观测的稳定支持。其次，在空间维度方面，不

同气候区数据密度也存在显著差异，单一的或局限于某一地区的数据集往往无法适用于其他地区或不同环境条件，如我国青藏高原等关键生态区尚未覆盖；在时间维度方面，仅少量研究（如国内的吉林公主岭、山东青岛、河北衡水和承德地区、甘肃庆阳、江苏盐城、广东东莞、云南楚雄等，国外的印度、伊朗、厄瓜多尔、德国、美国、捷克等国家）持续超 3 年，数据覆盖范围及持续监测上仍有很大提升空间。因此，未来应加强对不同地区、不同季节以及不同环境下瓢虫样本的长期监测和收集，以提升数据集的代表性和适用性。

6.2 构建国家级瓢虫数据采集及规范标准

目前,瓢虫采集或标记数据缺乏一致性和标准性。不同机构、不同研究团队使用的标注标准和分类方法存在差异,这增加了数据共享的难度。例如,瓢虫色斑分类系统存在不同的并行标准^[325],这也导致数据难以整合与共享。因此,制定统一的图像数据标注标准显得尤为迫切,从采样流程、图像质量控制、标注字段标准(时间、地点、环境、生物学特征、分子序列等)到数据库格式进行统一规范。因此,推动跨机构的数据互通机制,采用统一色斑分类体系和生物多样性元数据标准,可提升数据集的可比性与可共享性。

6.3 传统分类方法结合现代分子技术

瓢虫物种鉴定长期依赖形态特征,但存在色斑变异性大、易受经验影响等问题。从而导致鉴定结果产生偏差。可结合遗传条形码(DNA barcoding)鉴定方法,即利用物种基因组中相对保守且易于测序的特定基因片段(如COI基因)作为参考,通过序列比对来确定物种,提高物种鉴定的准确性和效率,特别是对于形态学特征相似或难以区分的物种。条形码还能能为瓢虫的系统发育研究提供分子层面的证据,有助于进一步了解瓢虫的系统进化关系。

此外,构建多维度瓢虫数据集还需要从单一图像或形态信息向综合生态信息拓展。为此,建议建立“形态-行为-分子”的数据体系标准,通过整合形态特征、行为记录(如取食、交配、飞行、栖息位置等)以及分子序列信息,实现多源数据的深度融合。这一体系不仅能够提升物种鉴定的准确度和稳定性,还能在生态位研究、群落动态分析以及系统发育推断中发挥更大的作用。同时,将环境因子(如温湿度、植被类型、景观格局)、时空信息(如地点,包括海拔及经纬度;年月日时)以及高质量图像(多角度、多光照、完整个体)共同纳入数据框架,可增强数据集的生态解释能力和对深度学习模型的训练价值。

6.4 推动智能化识别与数据共享的跨平台合作

基于已收集的瓢虫图片信息,通过深度学习算法,对大量瓢虫图像进行训练和学习,利用高质量图像训练完善的识别模型,实现自动化物种定位、计数与识别,提高数据生成速度和一致性。这也对数据集的图像质量提出了要求,高分辨率包含更多的细节信息,有助于模型学习到更丰富的特征。此外,通过建立统一的数据结构和共享机制,可以有效整合全球范围内的瓢虫等优质天敌图像数据,实现跨地区、跨平台的

数据互操作,最终形成支持全球瓢虫多样性保护和生态功能研究的高质量、多维度大数据基础。

7 数据可用性

附表1 国内瓢虫多样性调查数据集汇总(各季度统计信息中的1代表存在该季度的瓢虫数据调查)

附表2 国外瓢虫多样性调查数据集汇总(各季度统计信息中的1代表存在该季度的瓢虫数据调查)

附表地址: <https://www.scidb.cn/s/aqEFbm> (DOI: 10.57760/sciencedb.37812)。

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A Review of Research on Domestic and International Ladybug Datasets: Resource Status, Applications, and Challenges

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Abstract: Ladybugs are important predatory natural enemies in ecosystems, playing a critical role in suppressing pest population growth and maintaining ecosystem stability. In this study, we systematically reviewed and evaluated the current status of ladybug resources and related datasets in China and abroad. By analyzing key information, including the distribution of ladybugs, host plants, and monitoring technologies, this work aims to elucidate the significance of the dynamic distribution of ladybugs for the development of precision agriculture. It also provides a valuable data support for subsequent research and a scientific basis for formulating strategies for the conservation and utilization of ladybugs.

Keywords: ladybugs; datasets; dynamic distribution; diversity; resource conservation and management