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景观生态学研究热点与前沿:基于 Citespace 的知识图谱分析

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摘　要:为明确景观生态学领域的发展脉络、研究热点和趋势,利用 Web of Science 数据库收录的期刊论文为数据源,借助信息可视化工具 CiteSpace Ⅲ,绘制景观生态学研究的知识图谱,分析景观生态学研究成果的时间分布、国家与研究机构分布以及研究热点和前沿。结果表明,1993－2015年,景观生态学发展迅速,其中美国在景观生态学研究方面起步早、贡献大,而中国在景观生态学研究方面起步晚、发展快;景观生态学由最初探讨景观格局的变化转变为以复杂景观为背景的生态系统功能研究。

关键词:景观生态学;Citespace Ⅲ;知识图谱;研究热点

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Hotspots and Frontiers of Landscape Ecology: Citespace Based Knowledge Mapping Analysis

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Abstract: In order to make the development, research hotspots and trend of landscape ecology clear, we took papers embodied by "Web of Science" database as data source, with the aid of visualization tool Citespace, to draw the knowledge mapping of landscape ecology, and to analyze distribution of time, countries and institutions of research findings as well as hotspots and frontiers of landscape ecology. The results showed that landscape ecology developed rapidly from 1993－2015, among which, the United States started early in the research of landscape ecology and made great contributions to it. The landscape ecology in China started late and developed fast. The landscape ecology changed from the initial study of the landscape pattern changes to the complex landscape as the background of the ecosystem function research.

Key words: landscape ecology; Citespace III; knowledge mapping; hotspot

随着社会经济的快速发展,人类活动造成的地表景观的剧烈变化,导致了生物多样性的快速丧失,致使人类赖以生存的环境遭受严重威胁[1]。为此,从景观尺度去分析和解决人类所面临的社会经济和环境等问题成为了生态学的重要研究议题,景观生态学因此逐渐发展成为了生态学的重要分支学科[2-7]。

目前,景观生态学的理论和方法被广泛应用于与气候变化、土地利用/覆盖变化、生物多样性减少等全球变化息息相关的众多研究中,着重探讨与可持续发展相适应的自然资源开发与利用[8-11]、自然保护区的规划与管理[12-15]、生物多样性保护[16-20]、城乡土地利用规划[21-24]、生态系统恢复与重建[25-30]等领域,生态系统服务功能评价[31-33]等问题。然而,景观生态学作为一门集地理学、生态学、系统科学等众多学科知识的综合性学科,其所涉及学科的多样性决定了其发展的多样性和多向性[34]。因此,了解和掌握景观生态学的发展趋势、研究热点和前沿,有助于促进一些问题的及早解决和学科的快速发展。本研究以 Web of Science™(http://web of knowl-

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edge.com)核心合集为数据源,利用 CiteSpace Ⅲ可视化分析工具,绘制景观生态学知识图谱,通过分析文献的数量变化、机构的学术影响力、突现词探测以及文献共被引等指标,探讨景观生态学的研究动态,明确当前该学科研究的热点和前沿问题,以期为景观生态学研究提供参考和指导。

1 材料与方法

1.1 数据来源

所分析数据来自于 Web of Science™核心合集数据库。数据采集截止时间为 2016 年 1 月 1 日,时间跨度为 1993－2015 年(Web of Science 有关景观生态学的文章最早出现于 1993 年)。通过设定 WOS 检索式(landscape ecology＝主题)、数据下载方式(全记录包含所引用的参考文献以及摘要)、格式(download),选择主题词来源(title、abstract、author、keywords、keywords plus、country)等。

1.2 分析方法

CiteSpace Ⅲ是一款基于 JAVA 平台的可视化分析工具,可以展现某一科学领域中的关键文献、热点研究和前沿方向[35-36]。应用 CiteSpace Ⅲ软件,分别设置“institution”、“key word”、“cited reference”等网络节点,并设置节点数量、引文数量、共被引频次、共被引系数的合理阈值,获得文献记录的研究机构、突现词和被引次数等指标,以及景观生态学的知识图谱。

2 结果与分析

2.1 相关文献的数量变化

通过 Web of Science 核心合集数据库检索,共获得 1993－2015 年发表的景观生态学文献13 964 篇(表 1)。其中,1993 年的发文量最少(共 64 篇,仅占发文总量的 0.46%),之后年发文量呈逐年增加的趋势(年均增加 61.70 篇),表明景观生态学在近 23 a 呈快速发展的趋势(图 1,表 1)。同时,各国学者的发文总量也有明显差别,发文总量排在前 10 的国家共发文10 305篇(占发文总量的73.80%),其中,美国的文献产出总量(共 4 523 篇,占发文总量的 32.39%)、早期发文量(1993 年发文 35 篇,占年度发文总量的 54.69%)和年均增加篇数(16.57 篇)均最多,说明美国在景观生态学研究方面起步早、贡献大;中国的发文总量排世界第 8 位(共 435 篇,占发文总量的 3.12%),中国学者的相关文章最早发表于 1995 年之后发文量在波动中增加(年均增加 2.91 篇),到 2015 年发文量达到最多(共 67 篇,占年度发文总量的4.52%),表明中国在景观生态学研究方面起步晚、发展较快,但与美国等国家相比仍有一定差距。

表 1 国家发文数量统计

Table 1 Statistics of national published articles

序号	国家	发文量/篇	占发文总量的百分比/%	1993 年/篇	2015 年/篇	年均增量/篇
1	美国	4 523	32.00	35	416	16.57
2	澳大利亚	1 058	8.00	3	105	4.43
3	加拿大	924	7.00	8	83	3.26
4	英国	866	6.00	4	103	4.30
5	德国	634	5.00	0	71	3.09
6	法国	623	4.00	1	87	3.74
7	西班牙	483	3.00	0	46	2.00
8	中国	435	3.00	0	67	2.91
9	巴西	382	3.00	0	63	2.74
10	意大利	377	3.00	0	48	2.09
11	其他国家	3 659	26.00	13	394	16.57
12	合计	13 964	100.00	64	1 483	61.70

2.2 研究机构的学术影响力

学术文献的被引频次是衡量其在学科领域中的水平和地位重要指标[37]。文献被引频次排在前 20 名的机构中,有 13 所研究机构隶属于美国,如威斯康星大学(University of Wisconsin)、美国农业部森林服务局(US Forest Service)、科罗拉多州立大学(Colorado State University)等机构(图 2)。其中,美国的威斯康星大学和森林服务局的被引频次最高,分别被引 193 次和 177 次,说明美国的景观生态学研究水平和地位均较高,威斯康星大学、森林服务局等研究机构在该领域具有极高的学术影响力;中国科学院(Chinese Academy Sciences)的被引频次位列第 3,被引频次为 166 次,表明中科院在景观生态学研究上也具有较高的水平和学术影响力。

各研究机构开展对外合作研究的程度不同,被引频次排在前列的研究机构大都与其它机构存在合作研究关系,反映出合作交流对提高研究水平和学术影响力具有极大的促进作用(图 3)。各研究机构中,加州大学戴维斯分校(University of California, Davis)对外联系最多(与其他 6 所机构有合作研究关系),与华盛顿大学(University of Washington)之间的关联强度最高(关联强度达 0.71),说明该校对外交流最活跃,这 2 所大学之间存在最为密切的合作关系。相对而言,中国科学院开展对外合作研究的程度较低,仅与密歇根州立大学(Michigan State University)有明显的合作关系(关联强度仅为 0.18)。

2.3 研究热点与前沿

1993－2015 年景观生态学相关文献的被引突现词较多,排在前 35 的突现词随时间变化明显,说

明该时期景观生态学发展迅速，研究热点与前沿在发展中变化（图 4）。根据被引突现词及时间分布特点，可将该时期景观生态学发展划分为 3 个阶段：第 1 阶段（1993－2001 年）、第 2 阶段（2002－2010 年）和第 3 阶段（2011－2015 年）。

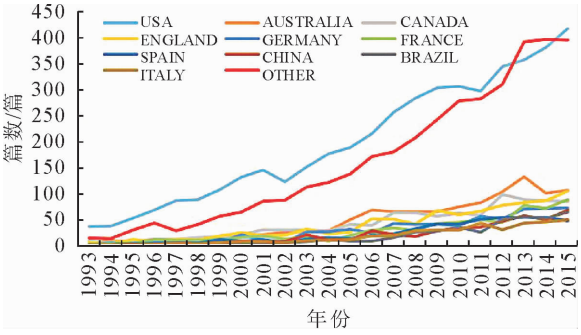

图 1　1993－2015 年各国景观生态学相关文献发文量的动态变化

Fig. 1　Dynamic change of quantity of published articles about landscape ecology in 1993－2015

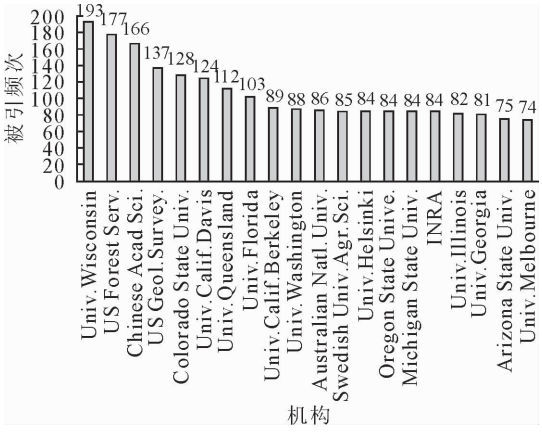

图 2　研究机构被引频次（1993－2015 年）

Fig. 2　Citation frequency of research institutes (1993－2015)

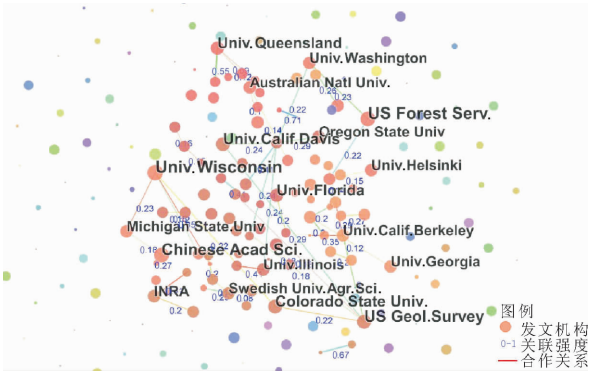

图 3　机构间的研究关联强度

Fig. 3　Strength of research association among institutes

第 1 阶段（1993－2001 年）以“landscape ecology”的突现程度最强（达 45.26），其他还有“ecosystem management”、“extinction”、“small mammal”、“disturbance”、“dynamics”、“environment”、“lyme disease”、“forest management”、“patch”、“old growth forest”、“remote sensing”、“boreal forest”、“history”、“GIS”、“forest fragmentation”等，表明该阶段景观生态学主要以森林、哺乳动物、疾病等为研究对象，利用 3S 技术，在景观尺度上探讨景观格局的变化[38-40]。此期景观生态学的研究特点是注重理论和方法研究[41-43]，研究对象偏向单一尺度的自然景观。研究热点和前沿主要包括景观格局的动态变化[44-50]、干扰对景观格局的影响[51-56]。

Top 35 Keywords with Strongest Citation Bursts

Keywords	Strength	Begin	End	1993-2015
landscape ecology	45.2611	1993	2001	
ecosystem management	14.4029	1993	2001	
extinction	12.6179	1993	2002	
small mammal	10.2018	1993	2000	
disturbance	8.1015	1993	2004	
dynamics	5.2168	1993	2000	
environment	4.8081	1993	2000	
lyme disease	4.5196	1993	2007	
forest management	4.2744	1993	2002	
patch	4.3251	1993	2003	
old growth forest	4.153	1993	2003	
remote sensing	7.1713	1997	2000	
boreal forest	5.4817	1997	2002	
history	3.6956	1997	2001	
GIS	3.3484	1997	2000	
nature reserve	4.1949	1998	2006	
forest fragmentation	7.7162	1999	2002	
edge	4.1448	1999	2003	
scale	3.8673	1999	2000	
patch dynamics	6.3461	2000	2002	
breeding bird	10.4622	2001	2004	
metapopulation	3.5632	2001	2002	
landscape structure	9.1025	2002	2005	
logistic regression	8.8803	2002	2008	
variability	4.5219	2002	2007	
succession	6.9029	2004	2005	
complexity	4.4666	2005	2006	
consequence	4.6651	2007	2008	
landscape genetics	10.5473	2011	2015	
ecosystem service	31.9794	2013	2015	
climate change	31.3922	2013	2015	
city	6.7544	2013	2015	
functional diversity	8.9023	2014	2015	
urban ecology	5.9489	2014	2015	
urbanization	5.0321	2014	2015	

注：红色线条是指突现词所对应的年份，线条的长度越长，表明其影响持续年份越长。

图 4　景观生态学相关文献中的关键词和突现词

Fig. 4　Key words and burst terms of landscape ecology

第 2 阶段（2002－2010 年）以“landscape structure”的突现程度最强（9.10），其他如“logistic regression”、“succession”、“complexity”、“consequence”、“variability”、“breeding bird”等，表明该阶段景观生态学主要探讨景观结构与生态过程相互作用的关系。此时期景观生态学的研究特点是注重多尺度的定量分析、驱动力分析以及景观生态学的应用研究，研究对象由单一景观向复杂景观转变。该时期的热点与前沿主要包括景观结构与生态过程关系的尺度效应[57-66]、基于生物多样性保护的景观规划[67-68]。

第 3 阶段（2011－2015 年）以“ecosystem service”的突现程度最强（31.98），其他还有“landscape genetic”、“climate change”、“city”、“functional diversity”、“urban ecology”、“urbanization”等，表明

该阶段景观生态学以城市为主要研究对象，开始侧重生态系统服务功能的研究[69-75]。此期景观生态学的研究特点是注重多学科交叉、理论指导实践研究，研究对象集中于宏观与微观相结合的景观生态系统。该时期的热点与前沿主要包括景观结构对生态系统功能的影响[76-78]、从遗传学角度探讨生物对景观变化的适应性[79-86]。

3 结论与讨论

通过信息可视化软件 CiteSpace Ⅲ分析文献的数量变化、机构的学术影响力、突现词以及文献共被引等指标，对景观生态学的发展脉络和研究热点进行探讨。景观生态学研究在 1993－2015 年间取得了快速的发展，其中，美国在景观生态学研究方面起步早、贡献大，其研究水平和地位均较高；中国在景观生态学研究方面起步晚、发展较快，但开展对外合作研究的程度较低，仅中国科学院与密歇根州立大学有明显的合作关系；景观生态学研究在 1993－2015 年经历了 3 个发展阶段，分别为 1993－2001 年、2002－2010 年和 2011－2015 年，其研究热点和前沿主要包括景观格局的动态变化、干扰对景观格局的影响、景观结构与生态过程关系的尺度效应、基于生物多样性保护的景观规划、景观结构对生态系统功能的影响、从遗传学角度探讨生物对景观变化的适应性等研究领域。

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