Survey and Analysis of Core Competencies of Library and Information Science Graduate Students in the New Era: Postprint

Authors: Chu Jingli, Zhang Ying, Xie Hejia, Chu Jingli

Date: 2022-04-02T13:09:52+00:00

Abstract

[Purpose/Significance] Library and information science graduate students constitute the emerging force in the development of the LIS profession. Development in the new era has presented new demands for LIS education, requiring further enhancement of core competencies among LIS graduate students. [Research Design/Method] Through 297 valid questionnaires administered to library and information science practitioners, this study investigates employers' evaluations of LIS graduate students by examining their mastery of core competencies, capability differences between LIS and non-LIS graduate students, and analyses and judgments regarding future development trends of LIS core competencies. [Conclusion/Finding] The study recommends: maintaining traditional competency advantages, strengthening innovation capability cultivation, perfecting interdisciplinary knowledge systems, keeping abreast of practical developments, enhancing technical capabilities, and attracting multidisciplinary talents. [Innovation/Value] This research reveals employers' evaluations of the core competencies of LIS graduate students post-employment, which can contribute to improving educational models and enhancing the core competitiveness of LIS graduate students.

Full Text

Investigation and Analysis of Core Competencies of Library and Information Science Postgraduates in the New Era

Authors: (National Science Library, Chinese Academy of Sciences, Beijing, 100190; Department of Library, Information and Archives Management, School of Economics and Management, University of Chinese Academy of Sciences, Beijing, 100190)

Abstract

[**Purpose/Significance**] Library and information science (LIS) postgraduates represent the emerging force driving the development of the LIS profession. The new era imposes new requirements on LIS education, necessitating further enhancement of core competencies among LIS postgraduates. [**Design/Methodology**] Through 297 valid questionnaires administered to LIS practitioners, this study investigates their assessment of LIS postgraduates' mastery of core competencies, differences between LIS and non-LIS postgraduates, and future development trends of LIS core competencies, thereby evaluating employer perspectives on LIS postgraduate competencies. [**Findings/Conclusion**] The research proposes: maintaining traditional capability advantages, strengthening innovation capability cultivation, improving interdisciplinary knowledge systems, keeping pace with practice, enhancing technical capabilities, and attracting multidisciplinary talents. [**Originality/Value**] This study reveals employer evaluations of core competencies among employed LIS postgraduates, offering insights for improving educational models and enhancing the competitive edge of LIS postgraduates.

Keywords: LIS postgraduates; core competence; educational pattern; practice competence; innovation competence

---

1. Introduction

The modern information environment and knowledge economy have placed new demands on library and information work, profoundly challenging traditional core competencies in the field [1]. There is an urgent need for high-level professional talent capable of meeting personalized user needs, reconstructing open resource systems, applying intelligent information technologies, and delivering novel knowledge services. As future high-level professionals in the LIS sector, LIS postgraduates must develop new professional capabilities and core competitiveness. Consequently, LIS education must reconsider its training objectives, curriculum design, teaching methods, and pedagogical approaches, focusing on cultivating new core competencies and making timely adjustments and reforms to postgraduate training programs to meet the challenges of new-era LIS education.

The cultivation of core competencies for LIS postgraduates in the new era has long been a topic of academic concern. Gary Marchionini, Dean of the School of Information and Library Science at the University of North Carolina at Chapel Hill [2], argues that iSchools should strive to cultivate talent in data curation and data science in the digital environment. Seamus Ross, Dean of the Faculty of Information at the University of Toronto [3], points out that as the disciplinary landscape evolves, traditional job demands are increasingly shifting toward emerging big data positions such as data analysis and data curation. The Institute of Museum and Library Services (IMLS) in its *Positioning Li-*

brary and Information Science Graduate Programs for 21st Century Practice [4] notes that library work has shifted from collection-centered to user-centered, with data services such as data curation and open data initiatives being important manifestations of this transformation, thus requiring enhanced data science capabilities among LIS postgraduates.

Domestically, the "China-US Digital Era Library and Information Science Education International Symposium" has been successfully held for four sessions, and the first "National Forum on Library, Information and Archives Management Postgraduate Education and High-level Talent Cultivation" was convened in Beijing in September 2018. Numerous LIS experts continue to explore pathways for LIS education (including postgraduate education) to adapt to social development, discussing issues related to professional competencies, talent cultivation, and educational reform. Professor Chen Chuanfu et al. [5] propose that in response to new changes in libraries, cultivated talent must possess new capabilities for solving complex problems and be able to propose corresponding solutions for specific tasks and scenarios. Professor Wang Shiwei [6] notes that in the data-driven era, the LIS profession has entered a development track of data sharing and intelligent integration, requiring accelerated cultivation of various big data talents. Professor Deng Shengli et al. [7] argue that the big data era highlights the importance of intelligence analysis capabilities and propose directions for LIS educational reform based on intelligence analysis. Professor Duan Yufeng et al. [8] find through statistical analysis that the Master of Library and Information Science (MLIS) professional degree emphasizes cultivating talent in data management and industry-specific domains. Professor Chu Jingli et al. [9] contend that the LIS discipline system and capabilities should be constructed around information and data as the core.

Overall, while considerable discussion exists both domestically and internationally, there remains a lack of data-supported employer evaluations regarding what competencies LIS postgraduates possess after employment. This study aims to address this gap through empirical research, investigating and analyzing employer assessments of LIS postgraduates' core competencies to guide LIS postgraduate teaching practice and enhance their professional competitiveness.

2. Research Design and Methods

This study employs a questionnaire survey targeting LIS practitioners to examine employer evaluations of LIS postgraduates' core competencies, compare competency differences between LIS and non-LIS postgraduates, and explore future development trends of LIS core competencies.

Questionnaire Design: Building upon existing research [10] and our own understanding, we identified 13 competencies as core for LIS postgraduates: literature management, literature services, information collection, knowledge organization, intelligence research, subject services, think tank services, digital publishing, publishing services, data curation, intelligent technology, and smart

services. Based on these, questionnaire items were designed.

Survey Administration: The questionnaire was distributed via the online platform Wenjuanxing (https://www.wjx.cn) from July 5 to 15, 2019, yielding 338 responses. To ensure data quality, we applied the following screening principles: (1) responses from non-LIS practitioners (e.g., current students, professionals from other industries) were excluded; (2) responses with patterned answers (e.g., completely identical answers, answers arranged in a specific order) were excluded. After screening, 297 valid questionnaires were obtained. The demographic distribution of valid samples is shown in Table 1.

Reliability and Validity: Reliability and validity analyses of the questionnaire scales showed Cronbach' s α coefficients all greater than 0.9, indicating excellent consistency and reliability. KMO test values exceeded 0.8, and Bartlett' s test of sphericity was significant at the 0 level, passing all tests and demonstrating strong correlations among variables. The questionnaire exhibits very good reliability and validity.

3. Results and Analysis

3.1 Mastery of Core Competencies by LIS Postgraduates 3.1.1 Survey Results

To understand the current mastery level of the 13 core competencies among LIS postgraduates, the questionnaire employed a 5-point Likert scale, asking respondents to rate each competency based on postgraduates' work performance. Scores from 1 to 5 represent "not mastered," "poorly mastered," "mastered," "well mastered," and "completely mastered," respectively. All 297 respondents completed the ratings, with results shown in Table 2.

3.1.2 Results Analysis

Employer evaluations indicate that LIS postgraduates have achieved some mastery of all 13 core competencies, though none were rated as "well mastered" or "completely mastered." Seven competencies fell between "mastered" and "well mastered" : information collection, literature services, literature management, knowledge organization, intelligence research, data analysis, and subject services. Six competencies fell between "poorly mastered" and "mastered" : intelligent technology, smart services, think tank services, digital publishing, data curation, and publishing services. Additionally, the survey revealed that LIS postgraduates demonstrate relatively good mastery of literature research and academic writing capabilities.

Employers assess that LIS postgraduates have relatively better mastery of traditional domain capabilities and relatively poorer mastery of innovative capabilities. Two potential reasons may explain this phenomenon. **Education:** Traditional capabilities are supported by profound knowledge accumulation and complete curriculum systems, providing a solid foundation for postgraduates to

acquire such competencies. Innovative capabilities, however, often rely on interdisciplinary background knowledge, and comprehensive knowledge systems have yet to be formed, leaving the cultivation of these competencies in an exploratory stage. **Practice:** Services based on literature resources, basic intelligence research, and subject services represent traditional library industry operations. Postgraduates entering libraries have a high probability of encountering relevant positions, providing numerous practical opportunities for training and application. In contrast, publishing services, think tank services, and smart services pose highly challenging innovative services for libraries, with most libraries' related businesses still immature, thereby limiting postgraduates' opportunities to engage in such work and restricting their space for development. Furthermore, LIS postgraduates possess solid research foundations and demonstrate strong research capabilities upon entering the workforce, which is closely related to currently high graduation requirements.

3.1.3 Perspectives from Different Groups

Comparing evaluations of LIS postgraduates' core competencies across different positions and disciplinary backgrounds reveals varying perspectives. From the viewpoint of different professional groups (directors/vice directors; middle-level managers; key staff; general staff), one-way ANOVA analysis examined whether significant differences exist in their evaluations. Results showed P-values for publishing services and smart services were less than 0.05, indicating significant differences and suggesting that the four respondent groups did not reach consensus on these two competencies. P-values for the remaining 11 competencies exceeded 0.05, showing no significant differences. All four groups rated information collection, literature services, and literature management as relatively well mastered, and data curation as relatively poorly mastered (see Table 3).

From the perspective of different disciplinary backgrounds, independent samples t-tests analyzed whether significant differences exist in evaluations. Results showed all P-values exceeded 0.05, indicating no significant differences. Both LIS and non-LIS background respondents agreed that LIS postgraduates have best mastered information collection, literature services, and literature management, and have poorest mastery of publishing services and data curation (see Table 4).

Information collection, literature management, and literature services reflect the ability to participate in the most fundamental and traditional operations of LIS institutions. That these three competencies are universally recognized as best mastered by postgraduates indicates they acquire solid foundational knowledge during their studies that aligns well with practical work. It also reflects that LIS postgraduates engage more with related businesses after entering LIS institutions. Publishing services and data curation represent key transformation directions for LIS institutions under the backdrop of new publishing models and open scientific data, yet postgraduates' poor mastery of related competencies reveals an imbalance between LIS academia and practice, with education still

lagging behind practical developments.

3.2 Comparison with Non-LIS Postgraduates 3.2.1 Survey Results

LIS institutions are large and diverse, requiring multidisciplinary support. Currently, LIS institutions are employing increasing numbers of non-LIS professionals. This study also examined the LIS core competencies of non-LIS postgraduates, with 236 respondents providing assessments. Independent samples t-tests comparing competency scores between LIS and non-LIS postgraduates found all P-values less than 0.05, indicating significant differences. Results show that LIS postgraduates generally demonstrate better mastery of LIS core competencies than non-LIS postgraduates. Non-LIS postgraduates' mastery of LIS core competencies is poor, with average scores for all 13 competencies between 2-3 points, indicating mastery levels between "poorly mastered" and "mastered." Their relatively best-mastered competencies are information collection, literature services, and literature management, while the poorest are publishing services, digital publishing, and data curation. The largest competency gaps between the two groups are in information collection, literature management, literature services, and intelligence research, while the smallest gaps are in intelligent technology, subject services, smart services, and data curation. The survey also found that non-LIS postgraduates have good mastery of domain-specific knowledge, representing a significant advantage.

3.2.2 Results Analysis

Compared with non-LIS postgraduates, LIS postgraduates' advantages primarily lie in mastering fundamental LIS skills. Although non-LIS postgraduates relatively best master information collection and literature management, the gaps with LIS postgraduates are largest in these areas, suggesting that while basic LIS services are easy to learn and simple to enter, truly excelling at them still requires professional knowledge. LIS work increasingly requires participation from multidisciplinary talent, and possessing specialized domain knowledge enhances the depth of LIS work. Non-LIS postgraduates hold advantages in this regard and should strengthen fundamental LIS knowledge after entering LIS institutions to achieve integration of both knowledge systems. Notably, LIS postgraduates hold only slight advantages in intelligent technology, indicating that mastery and application of technology needs strengthening. LIS disciplines require technology-driven development, yet current LIS education provides insufficient cultivation of technology-related competencies. Additionally, LIS postgraduates do not show clear advantages in subject services, as these require not only professional information collection and analysis capabilities but also relevant domain knowledge. Enhancing subject service capabilities may explore collaborative models between LIS professionals and domain experts. Non-LIS postgraduates severely lack data curation capabilities, and regrettably, LIS postgraduates also show no clear advantage in this area, suggesting that data curation currently lacks sufficient professional talent and may represent a key future development direction for LIS postgraduates.

3.2.3 Perspectives from Different Disciplinary Backgrounds

Examining competency mastery of LIS and non-LIS postgraduates from different disciplinary background perspectives, independent samples t-tests analyzed whether significant differences exist in scores between the two groups from different disciplinary viewpoints. Results showed all P-values less than 0.05, indicating significant differences. Both groups agreed that LIS postgraduates' competency mastery is generally superior to that of non-LIS postgraduates (see Table 5).

3.3 Future Development of Core Competencies 3.3.1 Survey Results

The core competencies of a discipline must be fundamentally demand-driven, and user needs change with the environment, naturally causing LIS core competencies to evolve accordingly. Some core competencies gradually weaken or are replaced by others, while some require continuous strengthening. Which core competencies need enhancement, and to what degree? Respondents rated each competency on a scale of 1 to 5, representing "no need to enhance," "somewhat unnecessary to enhance," "need to enhance," "relatively need to enhance," and "strongly need to enhance." All respondents provided judgments, with results shown in Table 6.

Results indicate that all 13 core competencies require some degree of enhancement. Eight competencies fell between "relatively need to enhance"and "strongly need to enhance" : data analysis, subject services, intelligence research, smart services, intelligent technology, knowledge organization, think tank services, and information collection. Five competencies fell between "need to enhance" and "relatively need to enhance" : data curation, literature services, literature management, digital publishing, and publishing services.

3.3.2 Results Analysis

Data analysis, subject services, intelligence research, and smart services were identified as requiring relatively high enhancement. Combined with the earlier finding that LIS postgraduates' mastery of these four competencies is unsatisfactory, it is evident they will play increasingly important roles in future LIS industry development, with significant talent shortages currently existing in these areas. Enhancing these competencies could become key breakthrough directions for LIS postgraduates.

The advancement of open science data initiatives and increasingly convenient social data access methods are rapidly pushing LIS core competencies toward deep data analysis and knowledge discovery capabilities. Subject services represent an expansion and deepening of traditional library services and are an inevitable requirement for libraries to become more knowledge-based, personalized, ubiquitous, and intelligent [11]. Intelligence research is the core of intelligence work and the foundation for fulfilling the functions of "eyes and ears, vanguard, and advisor" [12]. Regarding scientific and technological intelligence research, de-

ficiencies remain in demand understanding, problem analysis, and viewpoint formulation [12]. The national strategy of building new types of think tanks with Chinese characteristics imposes even higher requirements on intelligence research, representing both a tremendous challenge and a rare development opportunity for the LIS industry. Smart services are the core of future smart library services [13] and an important focal point for library value reconstruction [14]; enhancing smart service capabilities is a crucial component in realizing the smart library vision.

We also note that literature services and literature management require relatively lower enhancement, and LIS postgraduates have mastered these two competencies well, indicating such basic operations are already quite mature, with adequate staffing and satisfactory literature-based service capabilities. Additionally, digital publishing and publishing services were identified as requiring the lowest enhancement, yet LIS postgraduates' mastery of these two competencies is currently very unsatisfactory, suggesting that respondents do not consider publishing-related capabilities as priority directions for LIS education.

4. Recommendations for LIS Education

Maintain Traditional Capability Advantages

Resources constitute the foundation of library services, and providing literature resource services to users has long been the basic business content of LIS institutions (especially libraries). Related traditional LIS competencies such as literature management and literature services have always been highly emphasized in LIS competency cultivation systems, with courses like information organization, information retrieval, user studies, and information services remaining required core courses. Even though literature resources are abundant and information access is convenient, the fundamental position of literature resource services in library business layouts remains unchanged. Therefore, LIS postgraduates need to continue maintaining advantages in these traditional capabilities while steadily improving upon them. Improvement pathways include competency deepening and competency expansion. Competency deepening involves strengthening learning and understanding of foundational knowledge. Competency expansion involves developing other capabilities related to literature resources. The quantity of resources is not the standard for judging library development; providing satisfactory services based on available resources is what libraries should pursue. Therefore, expanding related capabilities can focus on 挖掘用户个性化需求 (mining personalized user needs) and providing diversified services beyond traditional literature services, such as teaching literature management tools and conducting information literacy training.

Strengthen Innovation Capability Cultivation

The national strategy of building new types of think tanks with Chinese characteristics, the impact of new publishing models on libraries' positions in scholarly communication systems, and the transformation of scientific research toward

data-intensive fourth paradigms all present new development opportunities for LIS institutions. LIS institutions can seize these opportunities to expand and optimize business layouts, accelerating transformation from traditional to new capabilities. Specifically, innovative services such as think tank services, publishing services, and data management services are fertile ground worth cultivating for LIS institutions. Currently, most LIS institutions' related businesses remain in exploratory stages, requiring support from specialized talent. Under these circumstances, LIS programs should focus on cultivating postgraduates' relevant new capabilities. Cultivation can begin with studying policy planning and practical cases, including examining national and local government think tank construction policies, new publishing development reports, scientific data management regulations, and studying development models of top-tier think tanks both domestically and internationally, libraries' practical involvement in publishing, and best practice cases of scientific data management across various fields.

Improve Interdisciplinary Knowledge Systems

Innovative services often exist in interdisciplinary domains. During initial development stages of innovative services, theoretical guidance is relatively lacking. As previously mentioned, relevant theoretical knowledge initially exists in policy documents and scattered practical cases. While highly cutting-edge and practical, this knowledge is fragmented and 不利于系统学习与吸收 (not conducive to systematic learning and absorption). Therefore, in competency cultivation education, emphasis should be placed on knowledge system construction. Advocate for theoretical exploration to take the lead, emphasizing theoretical knowledge exploration in interdisciplinary fields. Support knowledge system construction with in-depth theoretical research, and ensure professional course offerings with comprehensive knowledge systems. This systematically imparts foundational knowledge to students. Specific operational pathways include: researching the connotation and extension of think tanks in the Chinese context, think tanks' influence mechanisms on decision-making bodies, and roles LIS institutions can play; researching basic concepts of new publishing, its impact on LIS institutions, and LIS institutions' response strategies and transformation models; and researching the impact of open scientific data on academic research, its impact on LIS institutions, and roles LIS institutions can play in the data open movement.

Keep Pace with Practice

The characteristics of the discipline and environmental impacts require LIS postgraduate education to keep pace with practice. On one hand, LIS originates from and serves practice. The discipline possesses highly applied and practical features. LIS education must serve practice, emphasizing the cultivation of applied talent. On the other hand, the LIS industry is sensitive to changes in policy, technology, and academic environments. Developments such as open science, artificial intelligence, and scholarly publishing bring unprecedented impacts, challenges, and opportunities to the LIS industry while adding numerous

practical elements. Consequently, LIS education, especially postgraduate education, must keep pace with industry practice and strengthen postgraduate practical skills cultivation in the following ways. First, offer specialized seminars on domain practices to understand and explore cutting-edge practical status and future development trends. Second, establish more solid and stable partnerships with LIS institutions to increase internship opportunities and exposure to actual operations. Finally, internships should not be limited to traditional literature service businesses but can include more diversified and innovative positions.

Enhance Technical Capabilities

The technology-driven characteristics of the LIS discipline are increasingly prominent. Depth and efficiency improvements in LIS work require technology as effective support, development of LIS practice frontiers needs technology as an important innovation tool, and the social influence of the LIS discipline also requires technology as a unique demonstration means. Therefore, enhancing LIS postgraduates' technical capabilities should be an important component of education. Although information technology courses have been incorporated into LIS postgraduate training systems, due to limited course knowledge and diverse postgraduate backgrounds, overall technical proficiency remains unsatisfactory. Several pathways can be attempted to change this status. First, offer seminars on LIS technology frontiers, introducing technology applications in the LIS industry to recognize and grasp development trends. Second, increase collaboration with technology schools, such as computer science and software engineering schools, to jointly offer courses, increasing the variety and difficulty of technology electives and providing more choices for postgraduates with technical potential. Third, provide opportunities to participate in LIS industry technology practices or projects to apply and enhance technical capabilities in practice.

Attract Multidisciplinary Talent

The LIS discipline has interdisciplinary characteristics, and exchanges with other disciplines have generated many promising interdisciplinary domains. Many LIS industry services are supported by multidisciplinary knowledge, thus LIS institutions require composite talent with diverse disciplinary backgrounds. Three models exist for cultivating such talent: (1) intensifying training for in-service non-LIS background personnel, encouraging more departments or libraries to offer 1-2 year advanced study programs; (2) LIS undergraduates supplementing other disciplinary knowledge during postgraduate studies; (3) students with other disciplinary knowledge foundations pursuing LIS master' s (including professional master' s) or doctoral degrees. Obviously, the third model demonstrates clear advantages in both cultivation quality and efficiency. However, current LIS postgraduate recruitment from other disciplines is not ideal, perhaps primarily due to "lack of understanding" and "lack of attraction." This can be addressed through: offering LIS general education electives university-wide to eliminate misconceptions about the LIS discipline based on existing impressions, introducing positive interactions with other

disciplines and development trends in interdisciplinary directions; and actively conducting recruitment activities targeting other departments to expand outreach. In recent years, several schools have admitted MLIS students primarily from non-LIS backgrounds, which may be a positive phenomenon, though their employment may not be primarily in LIS domains—a trend warranting vigilance.

In conclusion, LIS postgraduates are the most important driving force for LIS industry development. To accelerate the cultivation of high-level LIS postgraduate talent, multiple proactive measures must be adopted to transform postgraduate education models, strengthening both traditional LIS capability cultivation and new LIS capability development. Postgraduate education should cultivate urgently needed talent oriented toward LIS practice, narrowing the gap between education and practice. Departments should develop their own educational characteristics and cultivation advantages, establishing comprehensive LIS high-level talent cultivation systems including professional master' s, academic master' s, doctoral, and postdoctoral programs to cultivate more and higher-level professional technical talent for LIS transformation and development.

References

[1] Zhang Xiaolin. Toward Knowledge Services: Seeking Growth Points for Library and Information Work in the New Century[J]. Journal of Library Science in China, 2000(5): 85-90, 95.

[2] Guo Xiaowan, Ran Congjing, Wu Dan, et al. Theoretical and Educational Development Strategies for Library and Information Science in the Big Data Era—A Review of the Fourth China-US Digital Era Library and Information Science Education International Symposium[J]. Library and Information Knowledge, 2016(1): 116-121.

[3] Positioning Library and Information Science Graduate Programs for 21st Century Practice[EB/OL]. [2019-08-01]. https://www.imls.gov/sites/default/files/publications/documents/imlspositioningreport.pdf.

[4] Chen Chuanfu, Chen Yi, Si Li, et al. A Study on the "Four Decades" of Library and Information Science Graduate Degree Authorization in China[J]. Journal of Library Science in China, 2017, 43(1): 4-15.

[5] Wang Shiwei. Data-Driven Era Characteristics and Innovative Transformation of LIS Education[J]. Library and Information Knowledge, 2016(1): 15-20.

[6] Deng Shengli, Ling Fei. LIS Education Reform Based on Intelligence Analysis in the Big Data Era[J]. Journal of Information Resources Management, 2014, 4(3): 88-94.

[7] Duan Yufeng, Zhao Nan. Survey Report on the Development of Master of Library and Information Science (MLIS) Education (2017)[J]. Library and Information Knowledge, 2019(2): 60-73.

[8] Chu Jingli, Zhang Ying. Constructing the LIS Discipline System and Capabilities with Information and Data as the Core[J]. Journal of Data and Information Science, 2019, 1(1): 21-31.

[9] Chu Jingli, Kong Qingqing, Luan Guannan. Research Progress on Embedded Subject Services[J]. Library and Information Service, 2013, 57(22): 11-17.

[10] Xiao Anbang. Thoughts on Enhancing Scientific and Technological Intelligence Research Capabilities[J]. Information Studies: Theory & Application, 2015, 38(7): 36-38.

[11] Li Xiaohong. Research on Smart Services in Public Libraries: Key Elements, Implementation Paths, and Practical Models[J]. Information and Documentation Services, 2019, 40(2): 95-99.

[12] Chu Jingli, Sun Jie. Library Publishing: New Domain, New Capabilities, New Challenges[J]. Library and Information Knowledge, 2018(6): 86-93.

Author Contributions

Chu Jingli: Topic selection and design, revision of final manuscript; Zhang Ying: Framework conception, manuscript writing and revision, data collection and analysis; Xie Hejia: Participated in manuscript writing and revision, data analysis.

Data Availability

Supporting data is stored by the authors and available upon request at zhangying@mail.las.ac.cn.

Received: July 14, 2019

Note: Figure translations are in progress. See original paper for figures.