

The Entire 80-year Research History of Sichuan Snub-nosed Monkeys (*Rhinopithecus roxellana*): A CiteSpace-based Bibliometric Study

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ABSTRACT

The Sichuan snub-nosed monkey (*Rhinopithecus roxellana*) is a flagship species that has received worldwide attention, and its study is of great importance. In this paper, we analyzed the entire 80 years of research on Sichuan snub-nosed monkeys worldwide with the web of science database as the basic data source and the visualization software CiteSpace to summarize the status of Sichuan snub-nosed monkey research. The study shows that: 1. Throughout the 80 years of Sichuan snub-nosed monkey research, it can be summarized into three developmental stages. During the 57 years from 1942 to 1998, which was the beginning stage of Sichuan snub-nosed monkeys; while during the 8 years from 1999 to 2006, which was the development stage of Sichuan snub-nosed monkeys; from 2007 to the present, which was the peak stage of Sichuan snub-nosed monkey's research. 2. Investigating the countries/regions, institutions, authors, and core journals of Sichuan snub-nosed monkey research throughout the past 80 years, we found that the research on Sichuan snub-nosed monkey, as an endemic species in China, is still dominated by Chinese research units and personnel, and the research units and researchers from various countries or regions are very close in their research relationships, and the papers published by these researchers are also concentrated in some core journals. 3. Throughout its 80-year history, the subject of Sichuan snub-nosed monkeys has undergone two explosive periods, after which it gradually reached saturation in the research field.

Keywords: Sichuan snub-nosed monkey, *Rhinopithecus roxellana*, Research history, CiteSpace.

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INTRODUCTION

Flagship species, endangered species selected to represent a particular habitat in need of conservation, are a group of megafauna that use their “charisma” alone to gain public support.^[1] It is when there is a habitat that needs to be protected, or other reasons to protect an environment, that the mood of the people to protect these flagship species is used to call for and achieve the protection of the entire habitat or environment. They look like the spokesperson stars in an ecological conservation advertisement.

Sichuan snub-nosed monkey, *Rhinopithecus roxellana*, is an Asian colobine endemic to the temperate forests of the mountainous regions in central China,^[2,3] which has a typical multi-level social structure discovered in primate.^[2] The society of this monkey consists of four levels: unit, band, herd, and troop.^[4] Furthermore, the bands can be classified into the breeding band (BB) and the all-male band (AMB).^[2,4] This

primate once ranged widely across southern, southwestern, and central China.^[5] However, due to climate change and anthropogenic activities associated with population growth,^[6] including extensive deforestation, agricultural expansion, hunting, logging, and habitat destruction, the population size and distribution of golden snub-nosed monkeys have declined dramatically and their range has shrunk.^[6-8] Sichuan snub-nosed monkeys inhabit mountain forests at elevations of 1500–3400 in four provinces of Sichuan, Hubei, Shaanxi, and Gansu, China,^[9,10] and its current estimated population size is no more than 20,000 individuals.^[3,11,12] A study of the conservation effectiveness of Sichuan snub-nosed monkeys in the Shennongjia Nature Reserve showed that only 59% of the habitat area and 61% of the predicted potential habitat area were protected.^[13] We analyzed the literature on Sichuan snub-nosed monkeys in the past 80 years, and provided research directions for the conservation of Sichuan snub-nosed monkeys in the future.

Method Selection and Research Data

CiteSpace is a Java application program for visualized analysis.^[14] This program can display the evolution route,

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tendency, and critical nodes of the research in a diversified knowledge graph and helps demonstrate the research focus and frontline in the discipline.^[15] It can analyze nodes of the authors, keywords, work units, and themes of the literature; debug different parameters; and obtain the optimal results. At present, CiteSpace is used extensively in computer, medics, and various other fields. In this essay, CiteSpace 5.7 R2 is adopted to mine the data related to the theme of Sichuan Snub-nosed Monkey in the foreign essays, to grasp the evolution route and the future tendency of relevant studies abroad. Compared with sci2, the CiteSpace network node can not only express the number of occurrences, but also give the node centrality, and the time domain diagram in CiteSpace can more accurately reflect the characteristics of the study over time, which are more useful for this study.

To ensure the quality of literature analysis, this essay makes sure that the foreign literatures collected in this study are all from SCIE and SSCI journals, two core databases on the Web of Science (Wos) platform. More than the most authoritative and influential 9000 academic journals in the field of natural science has been included in SCIE database, and SSCI includes more than 3300 authoritative journals in the field of social science with the themes of economics, business, law, and many others. Using SCIE and SSCI data can fully guarantee the quality and quantity of foreign-language literature. Subject terms are set for retrieval: (*Rhinopithecus roxellanae*) OR (*Rhinopithecus roxellana*) OR (Sichuan Snub-nosed Monkey). Then, after an advanced search, the literature types are selected: (ARTICLE), and the years are set from 1942 to 2021. The retrieval time is March 10th, 2021. As a result, 257 valid pieces of literature are obtained after the repeated ones are excluded.

RESULTS AND DISCUSSION

Analysis of the Number of Published Papers

The number of papers published each year reflects the concern of the research field to some extent. According to the exported literature data, the graph of year distribution of the research documents on Sichuan snub-nosed monkey is prepared with Excel, as shown in Figure 1. "The myology of *Rhinopithecus roxellanae* and *Cynopithecus niger*." published by Patterson^[16] was the first paper for studying Sichuan snub-nosed monkey and was published in 1942. This article describes in detail the muscular anatomy of a female Sichuan snub-nosed monkey and describes its appearance and distribution, so it can be said that this study is of great significance to make us understand the species. During the 57 years from 1942 to 1998, there were only 0.2 papers on Sichuan snub-nosed monkey research per year on average, indicating that very few researchers paid attention to this field during this period; while during the 8 years from 1999 to 2006, as many as 26 papers were published

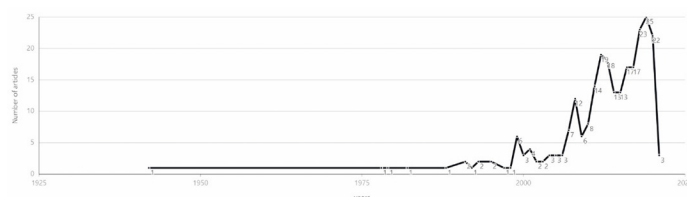


Figure 1: Distribution of research literature on Sichuan snub-nosed monkey.

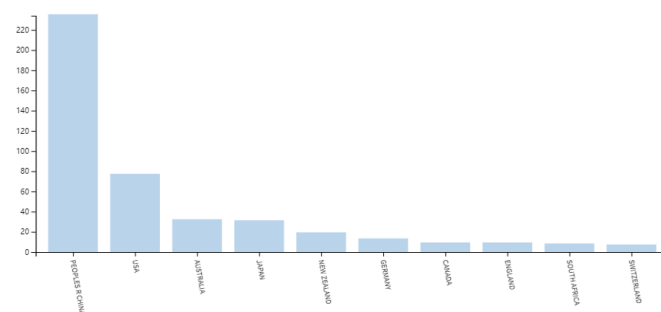


Figure 2: Main source countries/ regions of papers in the field of Sichuan snub-nosed monkey.

in this field, with an annual average of 3.3 papers, indicating that researchers from various countries and regions began to pay attention to this field, and the annual publication volume entered a The number of articles published in this field is 214 with an average of 15.3 articles per year during the 14 years from 2007 to 2020, with the highest number of articles published in 2018, 2019 and 2020 with an average of 23.3 articles per year. As of March 10, 2021, three papers on Sichuan snub-nosed monkeys have been published, and the number of papers published in 2021 is expected to remain high.

Analysis on Different Nations

Counting all the countries and regions that studied Sichuan snub-nosed monkeys, a total of 26 were recorded. Looking at the top 10 countries in terms of the number of publications on Sichuan snub-nosed monkey research (Figure 2), China had the highest number of publications (234), followed by the United States (76), Australia (31), Japan (30), New Zealand (18), Germany (12), Canada (8), the United Kingdom (8), South Africa (7), and Switzerland (6). This result is very interesting because, among the top 10 countries, only the first (China) and ninth (South Africa) are developing countries, while the rest are developed countries. China is far ahead in research on Sichuan snub-nosed monkeys, with about three times more publications than the United States (ranked second), which is related to the fact that Sichuan snub-nosed monkeys are an endemic species in China. Although China is a developing country and is still far behind in science and technology compared to other countries, the geographical factor will make up for the backwardness in science and technology from the research on Sichuan snub-nosed monkeys, but of course,

this so-called science and technology level is only represented by the number of articles.

Running Citespace, the cooperative network mapping of countries/regions is shown in Figure 3. According to Figure 3, China ranks first in the country/region network with the largest number of nodes. Comparing the research influence of each country on Sichuan snub-nosed monkeys, China has the largest node centrality, indicating that the vast majority of countries/regions in this network have direct or indirect collaborative relationships with China. This is followed by the United States and Switzerland. The nodes of China, the USA, and Switzerland have darker outer rings and are connected by critical paths, constituting the core academic community in the field of Sichuan snub-nosed monkey research.

Analysis of the Units Publishing Papers

The obtained data were imported into CiteSpace software, and institutional co-occurrence analysis was conducted in the institutional co-occurrence software, with the time limit of 1942–2021, and each year was taken as a time segment, and the institutions with the top 10 postings were selected to obtain the institutional distribution map of global literature in the field of Sichuan snub-nosed monkey (Figure 4). In Figure 4, the font size of node labels represents the issuance in the institution, and the font size of node labels represents the issuance volume of the institution, and the larger font size indicates that the institution has issued more articles. The connecting lines between institutions indicate the institutional cooperation relationship to which the authors of the literature belong, and the thicker the connecting lines indicate more cooperation. By looking at the graph, we can find that the Chinese Academy of Sciences has the most publications, followed by Northwestern University in China. Most of the institutions in the Figure show a reticulated distribution, i.e., most of them have collaborative research with other institutions. This indicates that there is a well-established academic research community in the field of Sichuan snub-nosed monkeys worldwide, which is conducive to further

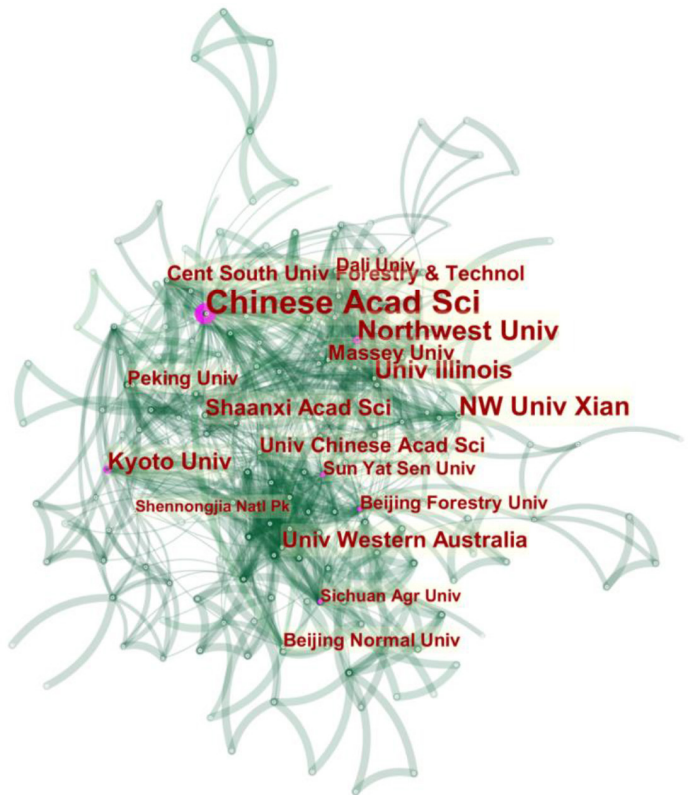


Figure 4: Distribution of document sending mechanism.

in-depth research on Sichuan snub-nosed monkeys. The top 10 domestic institutions in the field of credit publication in the era of big data are shown in Table 1. The top 10 institutions ranked by global Sichuan snub-nosed monkey research are Chinese Academy of Sciences, Northwestern University (China), Northwestern Polytechnic University, University of Illinois, University of Western Australia, Kyoto University, Shaanxi Academy of Sciences, Massey University, Peking University, and Central South University of Forestry Technology. The volume of published articles was 111, 53, 41, 37, 26, 24, 21, 18, 18, and 17, respectively. Table 1 shows that the world's Sichuan snub-nosed monkey research is mainly concentrated in the research institutions affiliated with the Chinese Academy of Sciences.

Author and Author Co-citation Analysis

Authors are an important indicator of the development of a discipline or research field. Therefore, characterizing the authors of Sichuan snub-nosed monkey research and understanding the core authors in this research field can help to examine the current progress of Sichuan snub-nosed monkey research worldwide from a side perspective. An Excel sheet was used to count the number of authors' publications, which is summarized in Table 2. running CiteSpace, this paper mapped the research authors of Sichuan snub-nosed monkeys (as in Figure 5). The main parameters were set as



Figure 3: Mapping of cooperation networks by country/region.

Table 1: Top 10 institutions of document quantity.

No.	Institutions	Number of papers	No.	Institutions	Number of papers
1	Chinese Acad Sci	111	6	Kyoto Univ	24
2	Northwest Univ	53	7	Shaanxi Acad Sci	21
3	Nw Univ Xian	41	8	Massey Univ	18
4	Univ Illinois	37	9	Peking Univ	18
5	Univ Western Australia	26	10	Cent South Univ Forestry Technol	17

Table 2: Top 10 authors of Sichuan snub-nosed monkey research.

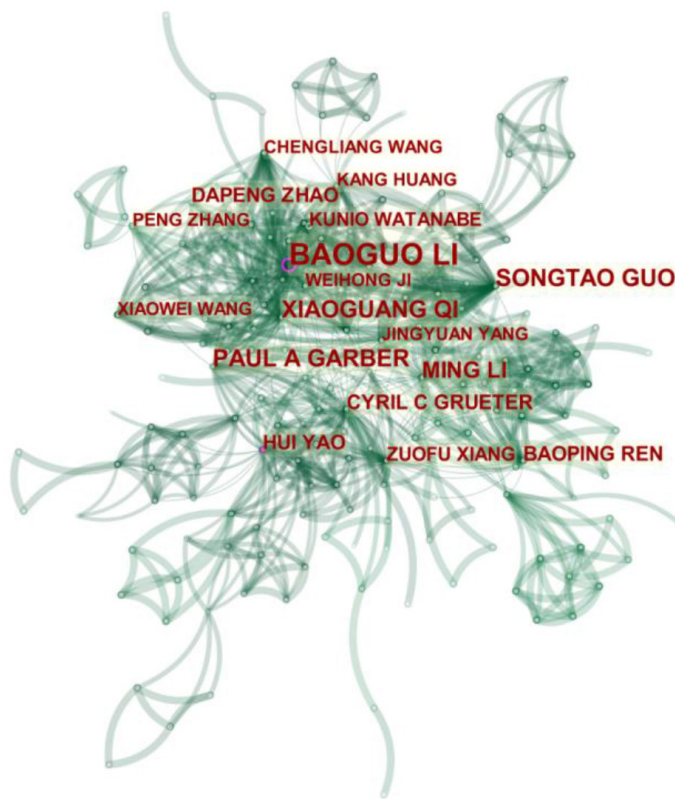
No.	Author	Number of papers	No.	Author	Number of papers
1	LI BG	82	6	REN BP	22
2	QI XG	36	7	XIANG ZF	20
3	LI M	34	8	WANG XW	18
4	GARBER PA	28	9	ZHAO DP	18
5	GUO ST	27	10	JI WH	17

seen that Baoguo Li has issued the most articles (82), and the other scholars in the top ten rankings are also rich in research results, with the number of articles above 17. Nine of the top 10 authors in the world are Chinese scholars. This indicates that Chinese scholars occupy a leading position in Sichuan snub-nosed monkey research worldwide. In Figure 5, there are many connecting lines among scholars, indicating that the collaboration among scholars with a high number of publications on Sichuan snub-nosed monkeys is very close. Based on the author's Atlas, we can see that the authors in the field of Sichuan snub-nosed monkey research are characterized by a large number of authors and dense relationships, and their research is linked to each other, with sufficient cooperation and communication.

Collating the table of author citations, as in Table 3. The top-ranked item by citation counts is (LI BG), with citation counts of 125. The second one is (KIRKPATRICK RC), with citation counts of 85. The third is (Zhang P), with citation counts of 79. The 4th is (Qi XG), with citation counts of 68. The 5th is (Li YM), with citation counts of 64. The 6th is (ALTMANN J) in, with citation counts of 57. The 7th is (Guo SG), with citation counts of 53. The 8th is (Xiang ZF), with citation counts of 49. The 9th is (GRUETER CC), with citation counts of 47. The 10th is (Zhao DP), with citation counts of 43. Chinese scholars account for 7 of the top 10 authors.

Analysis of Core Journals

As shown in Table 4, the amount of Sichuan snub-nosed monkey research literature is concentrated, and the top 10 key publications accounted for 58.36% of the 257 valid sample publications. The top 4 key publications, American Journal of Primatology, Primates, International Journal of Primatology, and Folia Primatologica, accounted for 41.64%, indicating that these 4 key publications are the main journals for Sichuan snub-nosed monkey research, and they are important channels for related scholars and researchers to explore Sichuan snub-nosed monkeys, and they are also important targets for future research. The four key publications are the major journals of Sichuan snub-nosed monkey research, which are important channels for related scholars and researchers to explore Sichuan snub-nosed monkeys, and are also important targets for future research. In terms of the types of publications included, two of the top 10 key publications are comprehensive journals, accounting for 20% of the total, indicating that the attention of scholars to comprehensive journals cannot be ignored, and they can obtain the frontier of research by tracking the information of comprehensive journals. The quality level of the top 10 journals is judged by the impact factor of journals in 2019 and the last five years. 80% of the key journals with impact factor above 1.0 in 2019 and 70% of the key journals with impact factor above 1.0 in the last five years. 40% of the

**Figure 5:** The author's Atlas.

follows: the time interval was “1942–2021”, the node type was “Author”, and the data selection criteria were “Top N=100, LRF=2. 0, LBV=2. 0,e=1. 0”. The size of nodes in the graph is proportional to the number of articles published by authors, and the connecting lines represent the collaboration between authors. Combining Table 2 and Figure 5, it can be

Table 3: Top 10 authors of Sichuan snub-nosed monkey research by citation counts.

No.	Author	Citation counts	No.	Author	Citation counts
1	LI BG	125	6	ALTMANN J	57
2	KIRKPATRICK RC	85	7	Guo SG	53
3	Zhang P	79	8	Xiang ZF	49
4	Qi XG	68	9	GRUETER CC	47
5	Li YM	64	10	Zhao DP	43

Table 4: Top 10 publication sources.

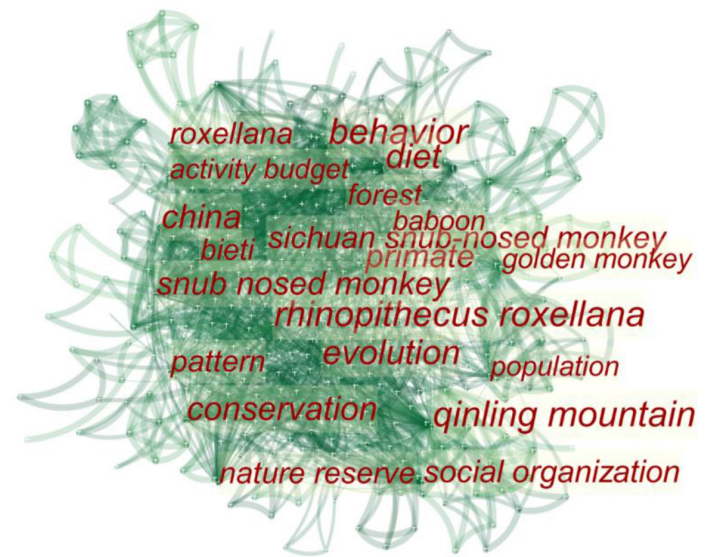
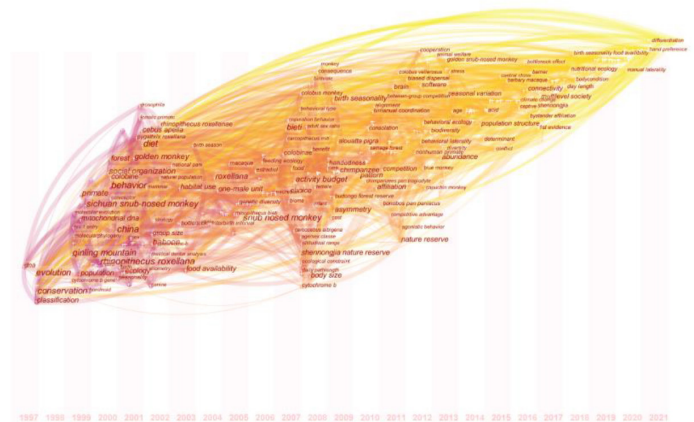
No.	publication sources	Number of papers	% of 257
1	American Journal of Primatology	37	14.397
2	Primates	25	9.728
3	International Journal of Primatology	24	9.339
4	Folia Primatologica	21	8.171
5	Chinese Science Bulletin	10	3.891
6	Integrative Zoology	9	3.502
7	Plos One	9	3.502
8	American Journal of Physical Anthropology	5	1.946
9	Conservation Genetics Resources	5	1.946
10	Current Zoology	5	1.946

key journals with impact factor above 2.0 in 2019 and 40% of the key journals with impact factor above 2.0 in the last five years. The proportion of key journals with impact factors above 2.0 in 2019 was 40%, and the proportion of key journals with impact factors above 2.0 in the past five years was 40%. The results indicate that the quality of the key journals on Sichuan snub-nosed monkeys is high, and we can continue to focus on this key journal in future research.

Keywords Analysis

Because very few articles were published before 1997, the effect on the results can be ignored. Therefore, for the convenience of mapping, the time threshold in CiteSpace software was set to 1997–2020 with a time interval of 1. The number of nodes (N) of the generated keyword co-occurrence map was 464, the number of connected lines (E) was 1559, and the density=0.0145. As shown in Figure 6, it can be seen that there are global studies on Sichuan snub-nosed monkeys, mainly on behavior, diet, activity budget, evolution, population, conservation, and social organization. By and large, these research themes are focused on social structure and behavioral areas.

To get a clear picture of the emergence time and evolution process of each research theme in the field of Sichuan snub-nosed monkeys, the keywords that appeared for the first time were arranged according to time, and a time zone map was

**Figure 6: Clustering knowledge map of keywords in Sichuan snub-nosed monkey literature.****Figure 7: Time zone map of Sichuan snub-nosed monkeys.**

generated to get the distribution of hot topics in each period. As shown in Figure 7, in the time zone map, each vertical axis corresponds to a period, the time axis where the keyword is located is the time of the first appearance of the keyword, the size of the keyword node represents the frequency of the keyword, and the line between the keywords represents the joint appearance of two keywords. As can be seen from Figure 7, the research topics on Sichuan snub-nosed monkeys have experienced two explosive periods: (1) 1999–2002, when the research on Sichuan snub-nosed monkeys was in a booming stage, the research topics suddenly increased and showed a trend of year-on-year growth, and after this explosive period, the research topics on snub-nosed monkeys suddenly decreased. There are two possible reasons for this: (1) the decrease in the number of Sichuan snub-nosed monkey studies worldwide during that period, and (2) the possibility that the research topics of researchers during that period remained within the scope of the topics of the 1st outbreak period and

did not open up new research directions; (2) 2007–2009, another outbreak period of research topics. The emergence of this phase indicated that the previous research themes no longer met the research needs of researchers worldwide, and many new areas of Sichuan snub-nosed monkey research emerged. Unlike the numerical trough after the 1st outbreak period, that outbreak period was still followed by a long period of non-stop emergence of new research directions and fields. What is alarming is that since 2014, the number of new studies on Sichuan snub-nosed monkeys around the world is gradually decreasing, indicating that Sichuan snub-nosed monkey research is at a stage where it is gradually reaching saturation, and it is not yet known whether there will be an explosion of new research areas in the future.

CONCLUSION

1. Throughout the 80 years of Sichuan snub-nosed monkey research, it can be summarized into three developmental stages. During the 57 years from 1942 to 1998, few researchers focused on this field, which was the beginning stage of Sichuan snub-nosed monkeys; while during the 8 years from 1999 to 2006, researchers from various countries and regions began to focus on this field, which was the development stage of Sichuan snub-nosed monkeys; from 2007 to the present, the number of publications on Sichuan snub-nosed monkeys remained at a stable and high level, which was the peak stage of Sichuan snub-nosed monkeys research.

2. Investigating the countries/regions, institutions, authors, and core journals of Sichuan snub-nosed monkey research throughout the past 80 years, we found that the research on Sichuan snub-nosed monkey, as an endemic species in China, is still dominated by Chinese research units and personnel, and the research units and researchers from various countries or regions are very close in their research relationships, and the papers published by these researchers are also concentrated in some core journals.

3. Throughout its 80-year history, the subject of Sichuan snub-nosed monkeys has undergone two explosive periods,

after which it gradually reached saturation in the research field.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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