

SCIENTOMETRICS ANALYSIS OF 'ASTROBIOLOGY' RESEARCH

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ABSTRACT -

The study is an attempt to quantify the research publications on 'Astrobiology'. The data pertaining to the study were collected from Web of Science (WoS) database. The bibliographic data of 2723 unique publications published up to 2021 were retrieved from the WoS database. The study found that the growth of literature was gradual. Charles S. Cockell was the most prolific authors whereas Manasvi Lingam was the most promising author for recent years. 'Astrobiology' followed by 'Astrophysical Journal' were the most preferred journals by the scholars publishing astrobiology research. However, 'Proceedings of the National Academy of Sciences of The United States of America' has only 32 articles and the highest number of citations among the highly ranked journals.

Keywords - Astrobiology, Scientometrics, Author's collaboration, VOS Viewer, Prolific author

INTRODUCTION

The term 'Astrobiology' was coined by Joshua Lederberg who was an American molecular biologist. It is an area of investigation on the evolution of planets, biological environment in extraterrestrial planets, Mars as a habitable planet, life in the solar system, chemical elements of objects in space (International Journal of Astrobiology 2021). Interchangeably, it was also called as Exobiology that indicated the investigations on similar fields. Coccia suggested that the area of 'Astrobiology' is generated by five different disciplines viz., planetary science, physics, astronomy, agriculture and biological sciences (Coccia, 2017).

A Scientometrics study on 'Astrobiology' is an indicator of research trend and its influence on the scholars and scientists of Physics and allied subjects. Counting of publications, journals, and prolific authors bring out the notable findings.

These results direct the future researchers and institutions to conduct more applied research that demands ground breaking exploration.

REVIEW OF LITERATURE

A notable quantum of publications have been published on ‘astrology’, ‘astrophysics’, ‘astronomy’, and allied subjects (Uzun and Ozel, 1996; Garg, 2003; Bar- Ilan, 2014; Taskin and Aydinoglu, 2015; Wildgaard, 2015; Senthilkumar and Ulaganathan, 2017; Ravi et al., 2019). ‘Astrobiology’ is a recent area of research that has been gained attentions of physicists in recent years. Here an attempt has been made to review related literature which adopted Scientometrics methods and techniques to analyze the data retrieved from databases such as Web of Science and Scopus.

Another area related to astronomy is the use of telescopes and other facilities. Trimble (2009) has made an attempt to quantify the number of paper published on astronomy. A total of 2184 papers with 14,237 citations were considered for knowing the significance of astronomical telescopes and other facilities. The paper found that California was dominating in optical astronomy whereas UK and Australia were dominating in radio astronomy. The paper also found that the astronomical facilities have been increased enormously during 40 years of time.

Taskin and Aydinoglu (2015) undertaken a bibliometric investigation on publications by NASA Astrobiology Institute (NAI). A total of 1210 papers published between 2008 and 2012. The study found that NAI researchers prefer to publish their works in high-impact journals and Astronomy and astrophysics were the highly prioritized areas of research. The paper further

stated that NAI also had international collaboration. Further, the paper also stated that NAI authors have no domination in the field of astrobiology.

Glanzel and Thijs (2017) carried out a research project i.e. ‘Measuring the Diversity of Research’. In this work they have used the core documents available on the Web of Science database to represent and map the astronomy. The study was able to develop three clear hierarchical structure with varied number of clusters which resulted in a high quality of classification.

Coccia (2017) conducted a scientometric analysis of data on human microbiome, evolutionary robotics, and astrobiology. The Data were collected from Scopus database. The author stated some empirical properties of the evolution of research fields. The author suggested that the evolution of research fields are driven by existing disciplines, path-dependent critical disciplines, new discipline originated, and applied and basic sciences.

A study by Khanna et al. (2017) attempted to quantify the research publications of the Guru Nanak Dev University in physics and astronomy. This paper analysed 652 papers in physics and astronomy published during 2006-2015. The University had the h-index of 29 and stand 16th rank in average citation per paper i.e. 7.01%. The paper also showed that 68.71% of publications were in collaboration was National level.

Dabas and Kumar (2018) conducted a scientometric analysis on research productivity by women in the area of Astronomy and Astrophysics during 2011-2015. The study found that of the 583 professionals of Indian research institutions, only 73 were women scientists who have published 713 research papers during the

mentioned period. The majority of articles were published through the collaboration of three to five authors. Aditi Sen De and G C Anupama were the most prolific women authors. The paper found the gender disparity in the research institutions.

Satish Kumar (2020) conducted a study to know the research productivity of Astronomy and Astrophysics research in India during 1988-2017. Total 20,311 research papers were considered. The paper showed that India had 3.46% of share of publications at the global level. More than 88% of publications were in the form of journal articles. Interestingly, 30.56% of publications were open access. The journals viz., ‘Physics Review D’ and ‘Physical Letters B’ were the most prolific journals.

OBJECTIVES OF THE STUDY

1. To identify the growth of publications in the area of Astrobiology
2. To find out the most prolific authors
3. To examine the authorship collaboration
4. To create the ranked list of journals and the average citations per paper by those journals

ANALYSIS AND INTERPRETATION OF DATA

Table-1: Year-wise publication, Relative Growth Rate and Doubling Time of Astrobiology literature

Year	No. of publications	Percentage	Cum. Publications	Percentage	W1	W2	Relative Growth Rate	Doubling Time
Before 2000	25	0.92	25	0.92	0.00	3.22	0.00	0.00
2001	31	1.14	56	2.06	3.22	4.03	0.81	0.86
2002	44	1.62	100	3.67	4.03	4.61	0.58	1.20
2003	48	1.76	148	5.44	4.61	5.00	0.39	1.77
2004	70	2.57	218	8.01	5.00	5.38	0.39	1.79
2005	91	3.34	309	11.35	5.38	5.73	0.35	1.99

5. To find out the authors’ priority towards journals to publish their research

METHODOLOGY

Based on the objectives of the study, the Web of Science (WoS) database was used to collect the primary data for the present study. A total of 2723 publications were identified and considered for this study. The advanced search options available in WoS database was used to locate and retrieve the bibliographic data on ‘Astrobiology’. No time frame was set during the search in order to collect the exhaustive data. The search term “TS=Astrobiology” was used to retrieve the relevant data. The collected data were downloaded in MS-Excel and ‘.txt’ formats. The data in ‘.txt’ format was used in VOS Viewer software to create a graphical representation of authorship collaboration. The Scientometrics techniques such as Relative Growth Rate, Doubling Time were used to find out the growth of literature. Further, simple percentage was used to analyze the data.

2006	116	4.26	425	15.61	5.73	6.05	0.32	2.17
2007	116	4.26	541	19.87	6.05	6.29	0.24	2.87
2008	87	3.20	628	23.06	6.29	6.44	0.15	4.65
2009	78	2.86	706	25.93	6.44	6.56	0.12	5.92
2010	115	4.22	821	30.15	6.56	6.71	0.15	4.59
2011	126	4.63	947	34.78	6.71	6.85	0.14	4.85
2012	153	5.62	1100	40.40	6.85	7.00	0.15	4.63
2013	153	5.62	1253	46.02	7.00	7.13	0.13	5.32
2014	177	6.50	1430	52.52	7.13	7.27	0.13	5.24
2015	181	6.65	1611	59.16	7.27	7.38	0.12	5.81
2016	161	5.91	1772	65.08	7.38	7.48	0.10	7.28
2017	176	6.46	1948	71.54	7.48	7.57	0.09	7.32
2018	217	7.97	2165	79.51	7.57	7.68	0.11	6.56
2019	200	7.34	2365	86.85	7.68	7.77	0.09	7.84
2020	214	7.86	2579	94.71	7.77	7.86	0.09	8.00
2021	144	5.29	2723	100.00	7.86	7.91	0.05	12.75
Total	2723	100.00						

Table-1 depicts that the year-wise publications have been increasing since 2001. The highest number of articles are published in the year 2018 (7.97%) followed by 2020 (7.86%). Relative Growth Rate was 0.81 in the year 2001 which

decreased to 0.05 in the year 2021 whereas the Doubling Time was increased from 0.86 in the year 2001 to 8.00 in the year 2021 (Figure-1). The growth of literature has witnessed negligible ups and downs during 2007-2010.

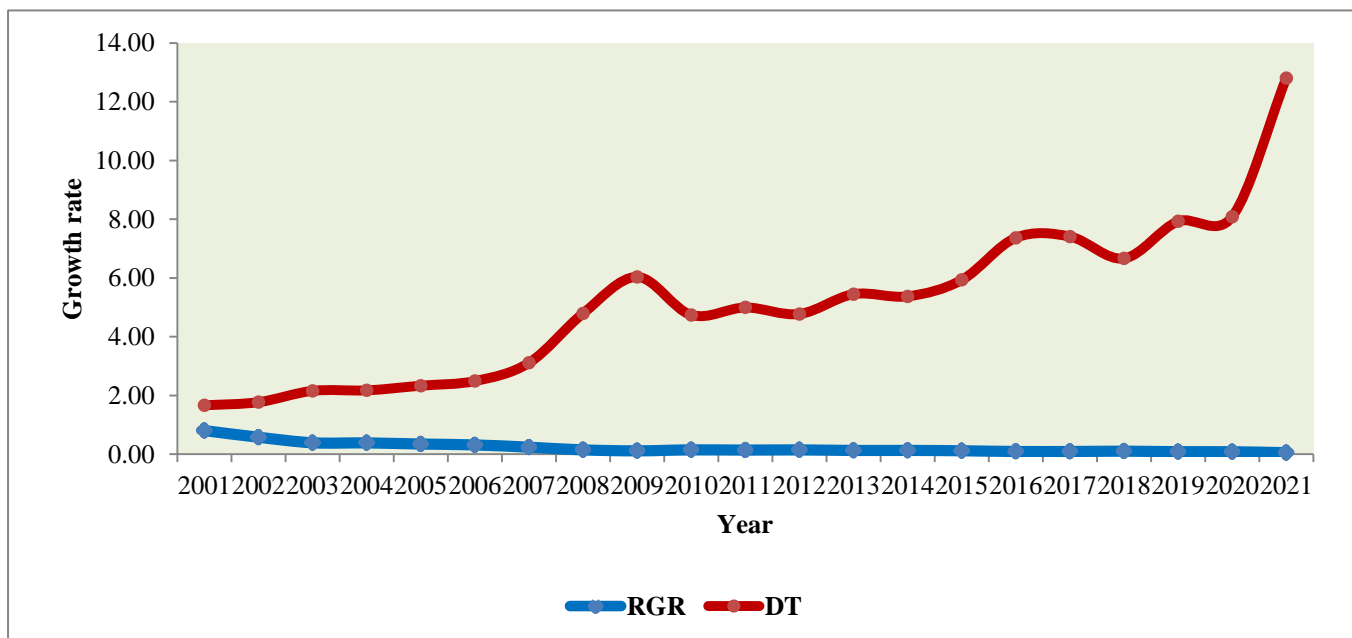


Figure -1: Relative Growth Rate (RGR) and Doubling Time (DT)

Table-2: Most Prolific Authors and their positions

Author Name	Total Articles	Rank	Author's position in article					
			1	2	3	4	5	>5
Cockell, Charles S.	67	1	18	13	8	6	9	13
Ehrenfreund, Pascale	38	2	5	4	3	1	6	19
Edwards, Howell G. M.	37	3	6	13	5	4	1	8
Kaltenegger, Lisa	35	4	12	16	3		1	3
Lingam, Manasvi	34	5	25	3	5	1		
Kane, Stephen R.	29	6	18	3	2	2	1	3
Westall, Frances	28	7	3	6	2		1	16
Rettberg, Petra	28	8	2	7	4	3	1	11
Loeb, Abraham	27	9	1	21	4		1	
McKay, Christopher P.	27	9	4	2	4	4	6	7
Abbot, Dorian S.	22	10	6	5	5	2	1	3

Table-2 indicates that Charles Cockell is the most prolific author in the area of Astrobiology who has 67 articles to his credit followed by Pascale Ehrenfreund (38 articles), Howell Edwards (37 articles), Lisa Kaltenegger (35 articles). Interestingly, the highest number of contributions as primary author is made by Manasvi Lingam followed by Charles Cockell, Stephen Kane, and

Lisa Kaltenegger. Meanwhile the authors at the second, third, and fourth rank have been published their papers as the authors at second and later positions. It can be argued that the collaborative authorship is dominating these years and it is obvious that the contribution as the primary author matters over solo authored contributions.

Table-3: Block period-wise publications by prolific authors

Author Name	Total Articles	Years of publication	Block Years					Average article per year
			On or Before 2000	2001-2005	2006-2010	2011-2015	2016 onwards	
Cockell, Charles S.	67	2001-2021	-	5	11	25	26	3.19
Ehrenfreund, Pascale	38	2000-2021	1	8	4	7	1	1.73
Edwards, Howell G. M.	37	2004-2021	-	2	13	18	3	2.06
Kaltenegger, Lisa	35	2007-2021	-	-	7	8	20	2.33
Lingam, Manasvi	34	2016-2021	-	-	-	-	34	5.67
Kane, Stephen R.	29	2012-2020	-	-	-	8	21	3.22
Westall, Frances	28	2001-2021	-	3	5	7	13	1.33
Rettberg, Petra	28	2004-2021	-	4	3	9	12	1.56

Loeb, Abraham	27	2012-2021	-			3	24	2.70
McKay, Christopher P.	27	2002-2021	-	1	7	13	6	1.35
Abbot, Dorian S.	22	2011-2021	-	-	-	10	12	2.00

Table-3 shows the block period-wise contribution of the most prolific authors. Table shows that Charles Cockell has been publishing more papers since 2011 followed by Lingam who has been publishing articles on Astrobiology after 2016. Stephen Kane, Abraham Loeb and Dorian Abbot are the authors who have been publishing their research papers in recent years. These authors have been showing a promising contribution in recent years in the area of Astrobiology.

Collaboration among authors

Figure-2 shows that authorship collaboration in the area of Astrobiology. The authors region that include Ricardo Amils, Alberto Fairen have the highest density of collaboration. The collaboration between the most prolific authors i.e. Charles Cockell and Kaltenegger has also been shown in figure-2. The high density of collaboration is also found among Petra Rettberg, Fabien Stalport, Corinna Panitz and others.

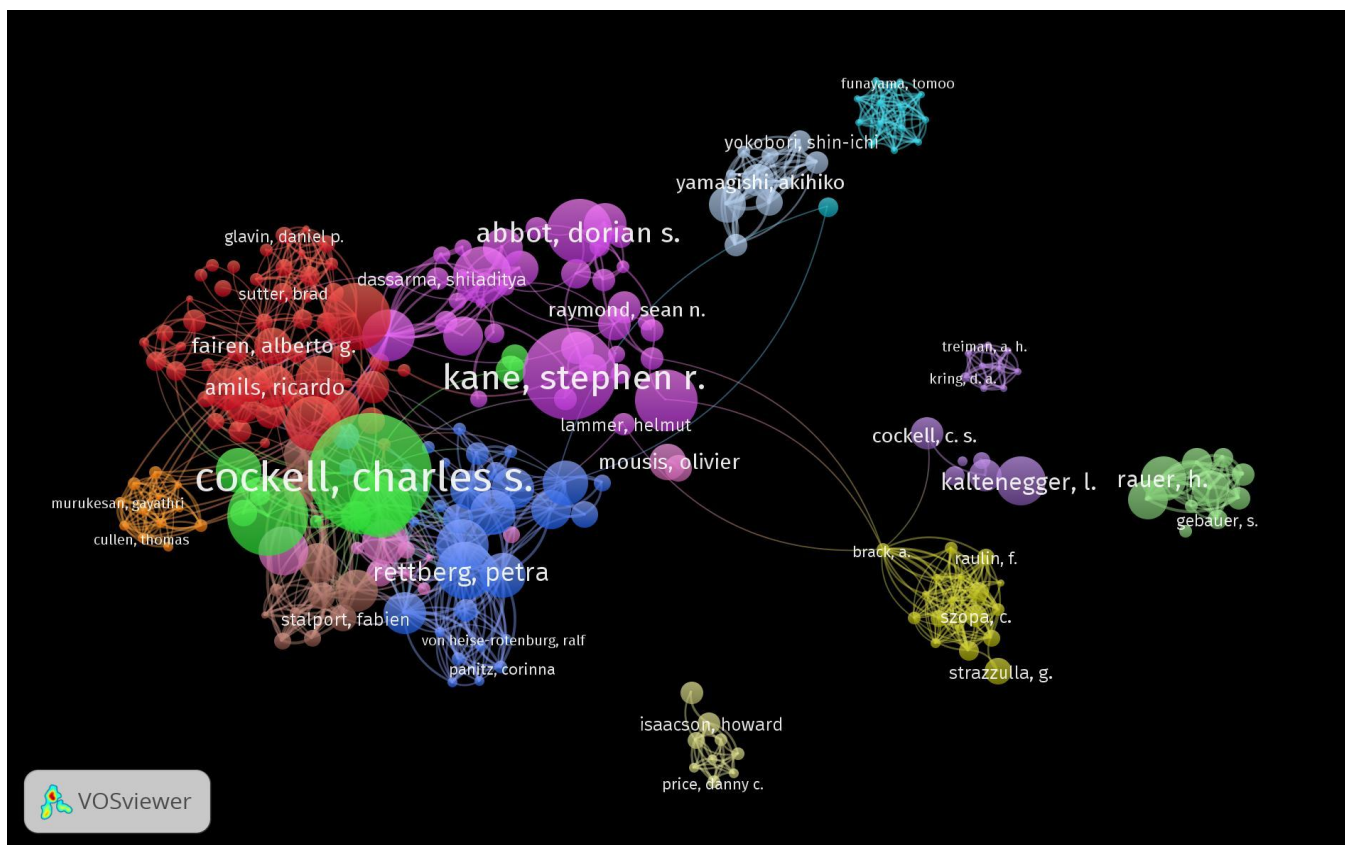


Figure-2: Authorship collaboration

Table-4: Most preferred journals

Name of the journal	TP	TC	ACPP	Block period					Country
				before 2000	2001-2005	2006-2010	2011-2015	2016 onwards	
Astrobiology	529	10598	20.03	-	55	102	172	200	USA
Astrophysical Journal	318	12150	38.21	-	39	61	103	115	UK
International Journal of Astrobiology	183	1276	6.97	-	5	50	58	70	USA
Astronomy & Astrophysics	131	4801	36.65	-	9	27	39	56	France
ICARUS	127	3423	26.95	-	4	33	61	29	USA
Astrophysical Journal Letters	106	3297	31.10	-	-	11	33	62	England
Monthly Notices of the Royal Astronomical Society	103	1741	16.90	-	7	6	25	65	England
Planetary and Space Science	78	1469	18.83	-	5	21	33	19	England
Origins of Life and Evolution of Biospheres	69	1119	16.22	-	8	30	15	16	Netherland
Astronomical Journal	48	628	13.08	-	-	2	3	43	England
Acta Astronautica	45	378	8.40	1	1	7	21	15	England
Life-Basel	34	119	3.50	-	-	-	-	34	Switzerland
Proceedings of the National Academy of Sciences of The United States of America	32	3338	104.31	1	5	4	16	6	USA
Frontiers in Microbiology	26	311	11.96	-	-	-	1	25	Switzerland
Journal of Geophysical Research-Planets	24	426	17.75	-	-	3	3	18	USA
Philosophical Transactions of the Royal Society a-Mathematical Physical and Engineering Sciences	24	433	18.04	-	-	3	18	3	England
Advances in Space Research	23	276	12.00	-	-	10	9	4	England
Space Science Reviews	21	415	19.76	-	1	8	2	10	Netherland
Earth and Planetary Science Letters	19	933	49.11	-	5	5	7	2	Netherland
Earth Moon and Planets	18	224	12.44	3	5	10	-	-	Netherland
Science	18	104	5.78	2	9	6	1	-	USA
Astrophysics and Space Science	17	99	5.82	-	1	9	1	6	Netherlands

Table-4 indicates the top 20 preferred journals to publish Astrobiology research. ‘Astrobiology’ journal published from USA has the highest number of articles. It has highly preferred in recent years by the authors. It is followed by ‘Astrophysical Journal’ with 318 articles, ‘International Journal of Astrobiology’ with 183 articles, and ‘Astronomy and Astrophysics’ with 131 articles stand at the consecutive positions in the ranked list. The table shows that the most preferred journals have been publishing more

number of articles related to astrobiology in recent years. Further, the impact of the journals can be known by their citations. Even though the journal ‘Proceedings of the National Academy of Sciences of The United States of America’ has only 32 research papers, it has an average citation per paper (ACPP) of 104.31 followed by ‘Earth and Planetary Science Letters’ with an ACPP of 49.11, and ‘Astrophysical Journal’ with an ACPP of 38.21.

Table-5: Authors’ preference towards journals to publish their research

Name of the author	High preferred journal (no. of articles)	2nd preferred journals (no. of articles)	3rd preferred journals (no. of articles)
Cockell, Charles S.	Astrobiology (25)	International Journal of Astrobiology (6)	ICARUS (5)
Ehrenfreund, Pascale	International Journal of Astrobiology (8)	Astrobiology (3)	Advances in Space Research (3)
Edwards, Howell G. M.	Philosophical Transactions of the Royal Society a-Mathematical Physical and Engineering Sciences (8)	Analytical and Bioanalytical Chemistry and Astrobiology (5)	International Journal of astrobiology (3)
Kaltenegger, Lisa	Astrophysical journal (12)	Astrophysical journal letters (10)	Monthly notices of the royal astronomical society (7)
Lingam, Manasvi	Astrophysical Journal Letters (13)	Astronomical Journal (10)	monthly notices of the royal astronomical society (5)
Kane, Stephen R.	Astronomical Journal (17)	Astrophysical Journal Letters (6)	Astrobiology, Journal of Geophysical Research-planets (2)
Westall, Frances	Astrobiology (10)	International Journal of Astrobiology, Planetary and Space Science, Space Science Reviews (3)	ICARUS (2)
Rettberg, Petra	Astrobiology (6)	Acta Astronautica, International journal of Astrobiology, Space Science Reviews (3)	Frontiers in microbiology, Microbiome,Origins of Life and Evolution of Biospheres, Space Life Sciences: Search for Signatures of Life, and Space flight Environmental Effects on the Nervous System (2)
Loeb, Abraham	Astrophysical Journal Letters (9)	Astronomical Journal (8)	International Journal of Astrobiology, Monthly Notices of the Royal

			Astronomical Society (3)
McKay, Christopher P.	Astrobiology (9)	Proceedings of the National Academy of Sciences of the United States of America (5)	International Journal of Astrobiology (3)
Abbot, Dorian S.	Astronomical Journal (12)	Astrophysical Journal Letters (7)	Annual Review of Earth and Planetary Sciences, Journal of Geophysical Research-Atmospheres, Monthly Notices of the Royal Astronomical Society (1)

Table-5 shows that the most prolific authors have preferred specific journals to publish their articles. In support to this, Charles Cockell has published 25 articles in Astrobiology Journal. Similarly, Stephen Kane, Manasvi Lingam, Dorian Abbot, and Lisa Kaltenegger have prioritized specific journals to publish their majority of articles. Meanwhile, several authors have also preferred more than one journal as their second and third priority to publish their works.

DISCUSSION AND CONCLUSION

This study is a Scientometrics analysis of the bibliographic data pertaining to the area of ‘Astrobiology’. The study has witnessed that the growth of publications in this area has been gradual and consistent. Among the most prolific authors, Charles Cockell has been published the highest number of papers. However, Manasvi Lingam is the most promising author in recent years. The majority of the authors have preferred to publish their works in the journals published from the USA and United Kingdom. Arguably, the highly preferred journals that publish Astrobiology research are originated from these countries. The study found that prolific authors have published more articles in a specific selected journal. Hence, it can be argued that the prolific

authors choose a specific journal that matches their area of interest to publish their works. In other words, the scope of the journals and the authors’ area of interest are the key factors that determine the longer relationship between authors and journals.

The research in the area of astrobiology is gaining momentum and the scholars who have been working in this area are publishing a good number of articles. The results of the present study provide avenues to look for the trend of research and the people involved in the area of ‘Astrobiology’

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