

# Surveys of the scientific community on the existence of extraterrestrial life

Peter Vickers, Emma Gardiner, Catherine Gillen, Byron Hyde, Cyrille Jeancolas, Samantha Mitchell Finnigan,  
Julie Nekola Nováková, Henning Strandin, Ufuk Tasdan, Henry Taylor & Sean McMahon

**During February-June 2024 we conducted four surveys among researchers regarding the likely existence of basic, complex, and intelligent extraterrestrial life. Our results offer a snapshot of community opinion and reveal a significant degree of consensus that extraterrestrial life is likely to exist.**

Does extraterrestrial life exist? In 1964, George Gaylord Simpson famously remarked, “[astrobiology] has yet to demonstrate that its subject matter exists!” [1]. Whilst such comments in no way problematize astrobiology as a *bona fide* scientific field [2], it is still true today, some sixty years later, that we don’t know if extraterrestrial life exists.

But astrobiologists needn’t feel any pressure to ‘demonstrate’ or ‘know’ that extraterrestrial life exists; it may yet be the case that relevant experts have grounds for believing that it likely does exist, at least in a basic form. It might even be the case that relevant experts are largely in agreement that complex, or even intelligent, extraterrestrial life likely does exist. Up until now we have lacked good data that would reveal scientific community opinion on existence-of-extraterrestrial-life questions. It has sometimes been speculated that astrobiologists are more optimistic about the existence of extraterrestrial life than other scientists, as those individuals more likely to enter the field in the first place. It has also been speculated that physicists tend to be more optimistic about extraterrestrial life than biologists. But data is needed to test these alleged correlations.

During February-June 2024 we conducted a set of four surveys to address a range of questions. Three statements S1-S3 were used to gauge opinions on the existence of ‘basic’, ‘complex’, and ‘intelligent’ extraterrestrial life within the astrobiology community (with ‘astrobiologist’ broadly construed; see S.I.):

(Statement S1 – ‘Life’): *It is likely that extraterrestrial life (of at least a basic kind) exists somewhere in the universe.*

(Statement S2 – ‘Complex Life’): *It is likely that extraterrestrial organisms significantly larger and more complex than bacteria exist somewhere in the universe.*

(Statement S3 – ‘Intelligent Life’): *It is likely that extraterrestrial organisms with advanced cognitive abilities comparable to or superior to those of humans exist somewhere in the universe.*

An additional survey targeted non-astrobiologist scientists vis-à-vis statement S1, for the purposes of making a comparison with astrobiologists, and to provide a basic bias check regarding the astrobiology community results. In all four surveys – whilst votes were anonymous – we kept tabs on votes from physicists and biologists, to test the idea that physicists are more optimistic than biologists.

The questions we set out to answer were:

- Q1. How confident are astrobiologists vis-à-vis the likely existence of basic/complex/intelligent extraterrestrial life?
- Q2. Is there a marked difference between (i) drop-off/decline in confidence when we move from ‘basic’ to ‘complex’ life, and (ii) drop-off/decline in confidence when we move from ‘complex’ to ‘intelligent’ life?
- Q3. Are astrobiologists more optimistic than non-astrobiologists regarding existence of extraterrestrial life?
- Q4. Are physicists more optimistic than biologists regarding existence of extraterrestrial life?

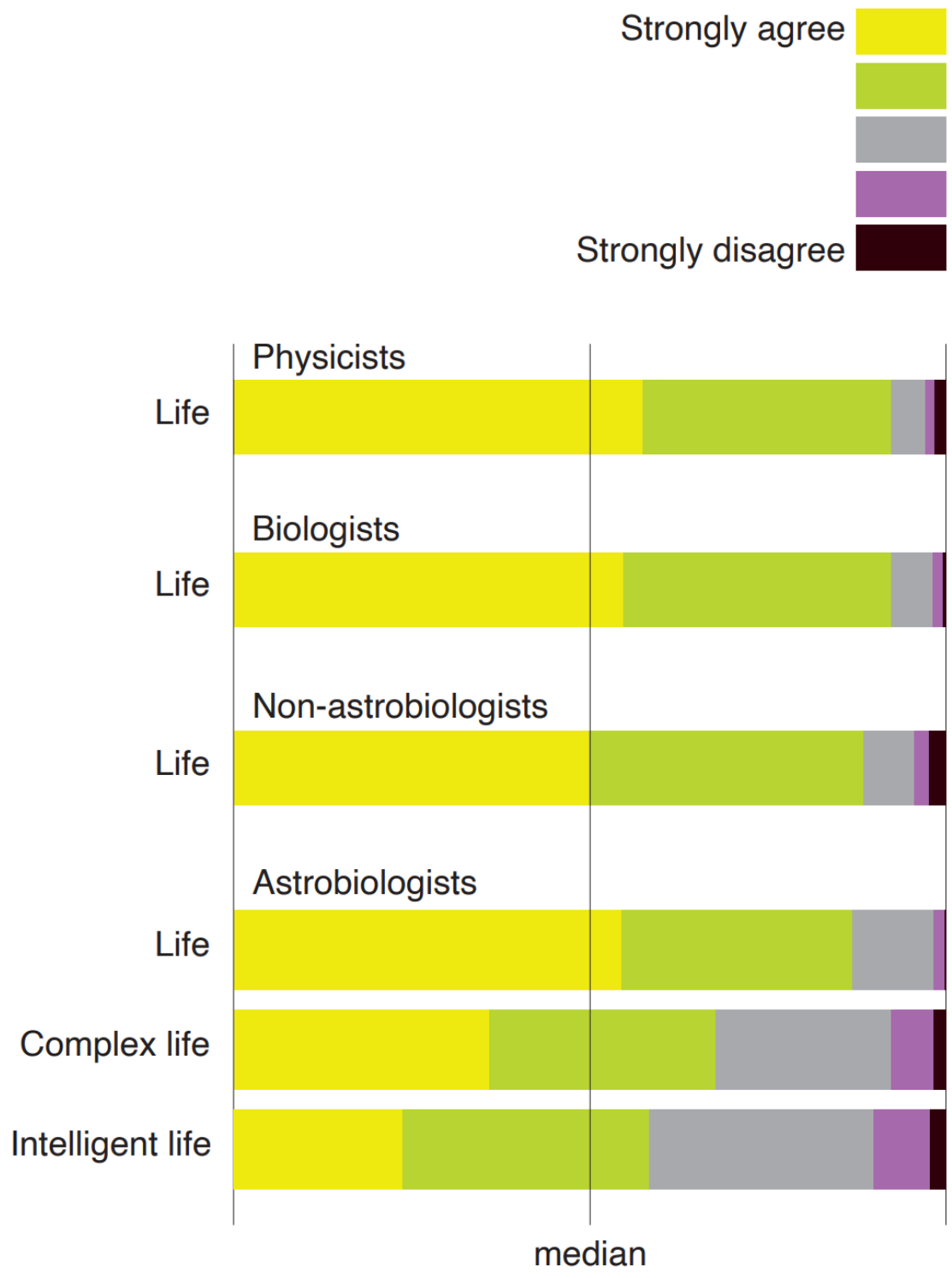
We appropriated a newly developed surveying platform and methodology [3] to ensure a high number of participants (N) and high response rate. (For detailed information on methodology, see S.I.)

## Results

---

First, we surveyed the astrobiology community on statement S1 – ‘Life’. Disregarding undeliverables, 1,176 astrobiologists were emailed on February 10, 2024, and 521 had responded when the survey closed on February 24, two weeks later (a response rate of 44.6%). Overlapping this exercise, we conducted an exactly similar survey for non-astrobiologist scientists. Disregarding undeliverables, 1,397 scientists were emailed on February 21, 2024, and 534 had responded when the survey closed on March 6, two weeks later (a response rate of 38.2%).

The results for statement S1 are displayed in **Fig. 1**, middle two bars; overall agreement for astrobiologists was 86.6%, and overall agreement for non-astrobiologist scientists was 88.4%. Whilst these results suggest no significant difference for agreement, there is a statistically significant difference for disagreement, with 2.4% ‘strongly disagree’ for non-astrobiologists compared to 0.4% for astrobiologists. (See S.I. for further details and additional results). There is little or no difference between physicists and biologists.



**Fig. 1.** Six key results emerging from the four surveys conducted. In particular, they allow for (i) comparison of physicists and biologists, (ii) comparison of astrobiologists and non-astrobiologist scientists, and (iii) comparison of astrobiology community opinion vis-à-vis the likely existence of ‘basic’, ‘complex’, and ‘intelligent’ extraterrestrial life. On the LHS, ‘Life’ refers to a survey on Statement S1, ‘Complex life’ refers to a survey on Statement S2, and ‘Intelligent life’ refers to a survey on Statement S3.

Concerning the other two questions, only addressed to astrobiologists, the response rate was slightly lower (36.9% for S2 and 37.9% for S3) and the overall agreement also significantly lower than S1, respectively at 67.4% and 58.2%.

## Discussion

---

We set out to answer the four questions stated in the Introduction, Q1-Q4.

Regarding Q1, we found a reasonably strong overall agreement score (86.6%) for statement S1, with this score weakening through S2 and S3, but still retaining an overall agreement of 58.2% for S3, with overall disagreement for S3 at only 10.2%. We stress that an agreement score derived from a standard 5-point Likert scale requires careful interpretation. For example, an 86.6% agreement (for S1) is consistent with both 0% disagreement and 13.4% strong disagreement, with the former much more reasonable to describe as ‘consensus’ than the latter. The case at hand is closer to the former, with overall disagreement less than 2%, which tells in favour of using the word ‘consensus’.

Turning to Q2, a drop-off/decline in agreement from S1 to S3 was expected, given widely accepted relationships between basic, complex, and intelligent life. Four distinct phenomena within our results can be interpreted as revealing a drop-off in confidence through surveys 1-3: (i) lower overall agreement; (ii) migration of ‘strongly agree’ votes to ‘agree’; (iii) increase in overall disagreement votes; (iv) increase in ‘neutral’ votes. Regarding (iv), it is known that survey participants hit ‘neutral’ for more than one reason [4]-[5]. In the current context two obvious reasons (supported by informal feedback from participants) are, (1) reduced confidence, and (2) a reluctance to speculate.

We observe that the S1-S2 drop-off is more pronounced than the S2-S3 drop-off (see **Fig. 1**, bottom three bars, especially overall agreement, neutral, and overall disagreement results). According to a z-test, the difference is statistically significant (see S.I.). Thus we may say that the community finds the gap between basic and complex life a bigger leap than the gap between complex and intelligent life.

Regarding Q3, we tested the self-selecting force effect. The idea is that astrobiologists would be more optimistic about extraterrestrial life than others *not* because they are more informed, but because of a selection effect that removes the sceptical to pursue the field.

Our *agreement* results are consistent with no such selection effect. A small effect for ‘strongly agree’ might exist, but if so, a large N would be needed to establish it. However, we do find a significant difference in *disagreement* results, both for overall disagreement, and for ‘strongly disagree’. Thus, tentatively, we suggest that astrobiologists are *less* likely to *disagree* with the proposition that ET life is likely to exist than non-astrobiologists (but not more likely to agree with the proposition).

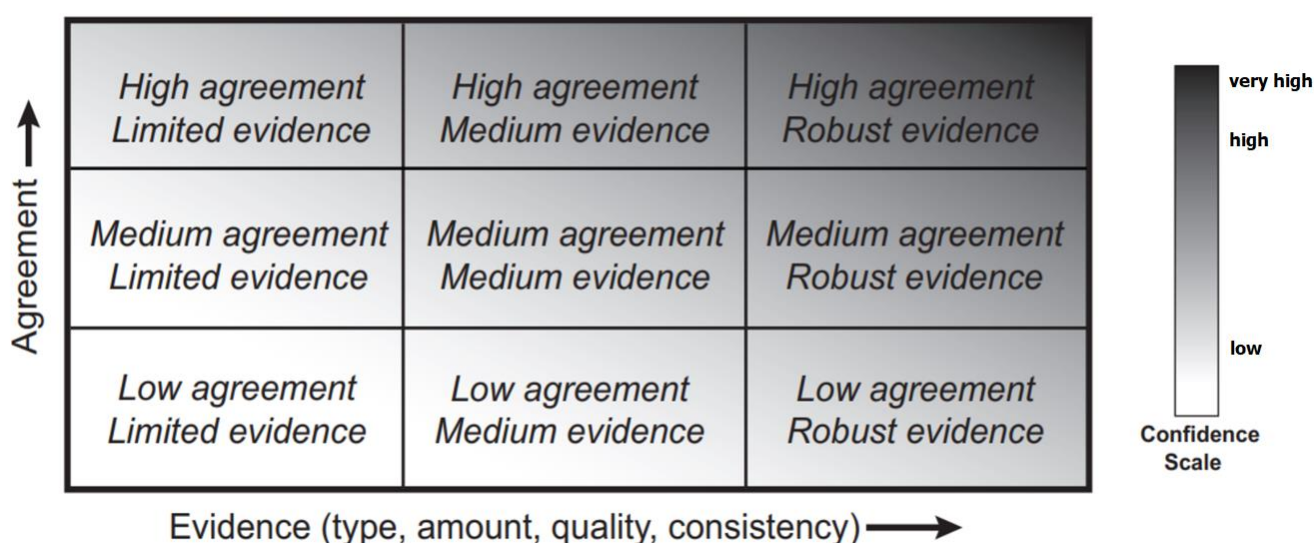
The lack of a selection effect (or a very small selection effect) for *agreement* may be because of the inclusive way in which we have selected ‘astrobiologists’: our participants included very few scientists whose very careers assume the existence of extraterrestrial life. For example, scientists specialising in prebiotic chemistry and working on ‘origin of life’, and publishing in the journal *Discover Life* (previously *Origins of Life and Evolution of Biospheres*), do not generally ask questions that assume that

extraterrestrial life is likely. But they count as ‘astrobiologists’ within the context of our study (see S.I. for further details).

It is not uncommon to hear it said that physicists and biologists think different (see for example [6]). Specifically regarding Q4, it may be suggested that physicists tend to emphasise the size of the universe and the vast opportunity for low probability events to occur, whereas biologists tend to emphasise the complexities and contingencies of life on Earth. However, our results indicate that such generalisations cannot be empirically supported. Responses from physicists and biologists were not significantly different (see S.I. for details).

## Does extraterrestrial life exist?

A solid scientific consensus amongst relevant experts regarding a particular scientific claim X is often taken as a reliable indicator that X is true [7]-[8]. According to our results, the consensus of relevant experts – broadly construed – that extraterrestrial life (of at least a basic kind) exists, stands at 86.6%, with less than 2% disagreement. The significant proportion of ‘neutral’ votes (11.5%) is, however, revealing, and probably reflective of the lack of direct evidence supporting an agreement or disagreement vote. To take this into account, we here draw on the IPCC uncertainty framework (as recommended in [9], Section 5).



**Fig. 2:** A depiction of evidence and agreement statements and their relationship to confidence. Confidence increases towards the top-right corner as suggested by the increasing strength of shading. Generally, evidence is most robust when there are multiple, consistent independent lines of high-quality evidence. (Reproduced from [10])

This framework (**Fig. 2**) offers a measure of confidence for a given statement, but takes two variables into account: (i) community agreement, and (ii) the evidence base. If the agreement is high, but the

evidence base is weak (scientists feel that they are largely speculating), then one's overall confidence in the focus statement should not be high.

In our view, whilst our data reveal a significant consensus that extraterrestrial life likely does exist, this should not give us *high* confidence in the claim. Scientific claims warranting high confidence are those where a very strong evidence base lies behind a solid scientific consensus of relevant experts. However, our results indicate that moderate confidence, at least, is justified, given both the 86.6% overall agreement result, and the very small disagreement (<2%).

One anonymous reviewer suggested that moderate confidence cannot be justified, given that the 'evidence' is effectively zero. However, in our view, such an interpretation assumes that only *direct* evidence counts as evidence. On 8<sup>th</sup> July 2024 we carried out an informal assessment of the 'evidence' measure: a panel of four individuals based at the UK Centre for Astrobiology in Edinburgh, UK, were tasked with determining a score for 'evidence', for Statement S1. Following approximately 20 minutes of deliberation, they agreed on a score of 7/10. Whilst this may seem high, they were interpreting the *evidence* concept broadly (for example to include indirect evidence). In addition, they wished to emphasise that statement S1 does not state that extraterrestrial life exists, but rather "It is likely that" extraterrestrial life exists, which is significantly weaker. Whilst this assessment was rather informal, it does speak against the idea that 'evidence' should be scored at zero (rather than 'limited', say).

This study establishes an essential baseline for future surveys. We commit to repeating these surveys every five years, thereby concretely tracking any shifts in community opinion over time.

**Peter Vickers<sup>1\*</sup>, Emma Gardiner<sup>1</sup>, Catherine Gillen<sup>1</sup>, Byron Hyde<sup>2,3</sup>, Cyrille Jeancolas<sup>1</sup>, Samantha Mitchell Finnigan<sup>4</sup>, Julie Nekola Nováková<sup>5,6</sup>, Henning Strandin<sup>7</sup>, Ufuk Tasdan<sup>1</sup>, Henry Taylor<sup>8</sup> & Sean McMahon<sup>9</sup>**

1. Department of Philosophy, University of Durham, Durham, UK

2. School of Philosophy, Religion and History of Science, University of Leeds, Leeds, UK

3. Research on Research Institute, University College London Department of Science, Technology, Engineering and Public Policy, London, UK

4. Advanced Research Computing, University of Durham, Durham, UK

5. Department of Philosophy and History of Science, Faculty of Science, Charles University, Prague, Czech Republic

6. Institute of Physics, Czech Academy of Sciences, Prague, Czech Republic

7. Department of Philosophy, Stockholm University, Stockholm, Sweden

8. Department of Philosophy, University of Birmingham, Birmingham, UK

9. UK Centre for Astrobiology, School of Physics and Astronomy & School of GeoSciences, University of Edinburgh, Edinburgh, UK

\* Corresponding author

E-mail: [peter.vickers@durham.ac.uk](mailto:peter.vickers@durham.ac.uk) (PV)

## References

1. Simpson GG, *Science* **143**, 769–75 (1964).
2. Jeancolas C, Gillen C, McMahon S, Vickers P, *Nat. Astron.* **8**: 5-7 (2024).
3. Vickers P et al., ‘Development of a novel methodology for ascertaining scientific opinion and extent of agreement’, *PLOS ONE*, forthcoming. DOI: 10.1371/journal.pone.0313541.
4. Krosnick JA and Fabrigar LR, In L. Lyberg et al. (eds), *Survey Measurement and Process Quality* (New York: Wiley): 141-64. (1997).
5. Blasius J, Thiessen V ., *J. Official Statistics* **17**: 351–67. (2001).
6. Benner SA, Bains W, Seager S *Astrobiology*, **13**(5), 510-513 (2013).
7. Oreskes N (2019). *Why Trust Science?* Princeton: Princeton Univ. Press.
8. Vickers P (2022). *Identifying Future-Proof Science*. Oxford: Oxford Univ. Press.
9. Vickers P, Cowie C, Dick SJ, Gillen C, Jeancolas C, Rothschild LJ, McMahon S, *Astrobiology* **23**(11). (2023).
10. Mastrandrea M et al., *Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties* (p. 7); IPCC (2010).

## Acknowledgements

For helpful discussion and feedback we would like to thank delegates at the Kavli-IAU symposium, ‘(Toward) Discovery of Life Beyond Earth and its Impact’, held at the University of Durham, UK, 15-19<sup>th</sup> April 2024. Thanks to Kathryn Denning and Inge Loes ten Kate in particular, for extended discussion. Thanks also to two anonymous reviewers for helpful suggestions.

## Competing interests

The authors declare no competing interests.



**Citation on deposit:** Vickers, P., Gardiner, E., Gillen, C., Hyde, B., Jeancolas, C., Mitchell Finnigan, S., Nováková, J. N., Strandin, H., Tasdan, U., Taylor, H., & McMahon, S. (in press). Surveys of the scientific community on the existence of extraterrestrial life. *Nature*

*Astronomy*, <https://doi.org/10.1038/s41550-024-02451-0>

**For final citation and metadata, visit Durham Research Online URL:**

<https://durham-repository.worktribe.com/output/3335320>

**Copyright statement:** This accepted manuscript is licensed under the Creative Commons Attribution 4.0 licence.

<https://creativecommons.org/licenses/by/4.0/>