Discovery of Extraterrestrial Life: Assessment by Scales of its Importance and Associated Risks

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One dimensional scales

- ***Mostly for natural phenomena (important risk):***
- **Temperature scales**
- **Storms: Beaufort**
- **Hurricanes: Saffir-Simpson**
  Tornados: Fujita
- **Earthquakes: Richter, Mercalli-Cancani-Sieberg**

More than one dimensional scales

- Solar flare classification
- Space weather: NOAA scale
- *Torino Scale* (1997) to communicate about the level of threat posed by newly discovered NEOs (asteroids, comets) on a near collision course with the Earth

Purpose

- To communicate to the public (on a simple scale) the importance/significance/risk of the detection or discovery of a high-consequences, but low-probability event

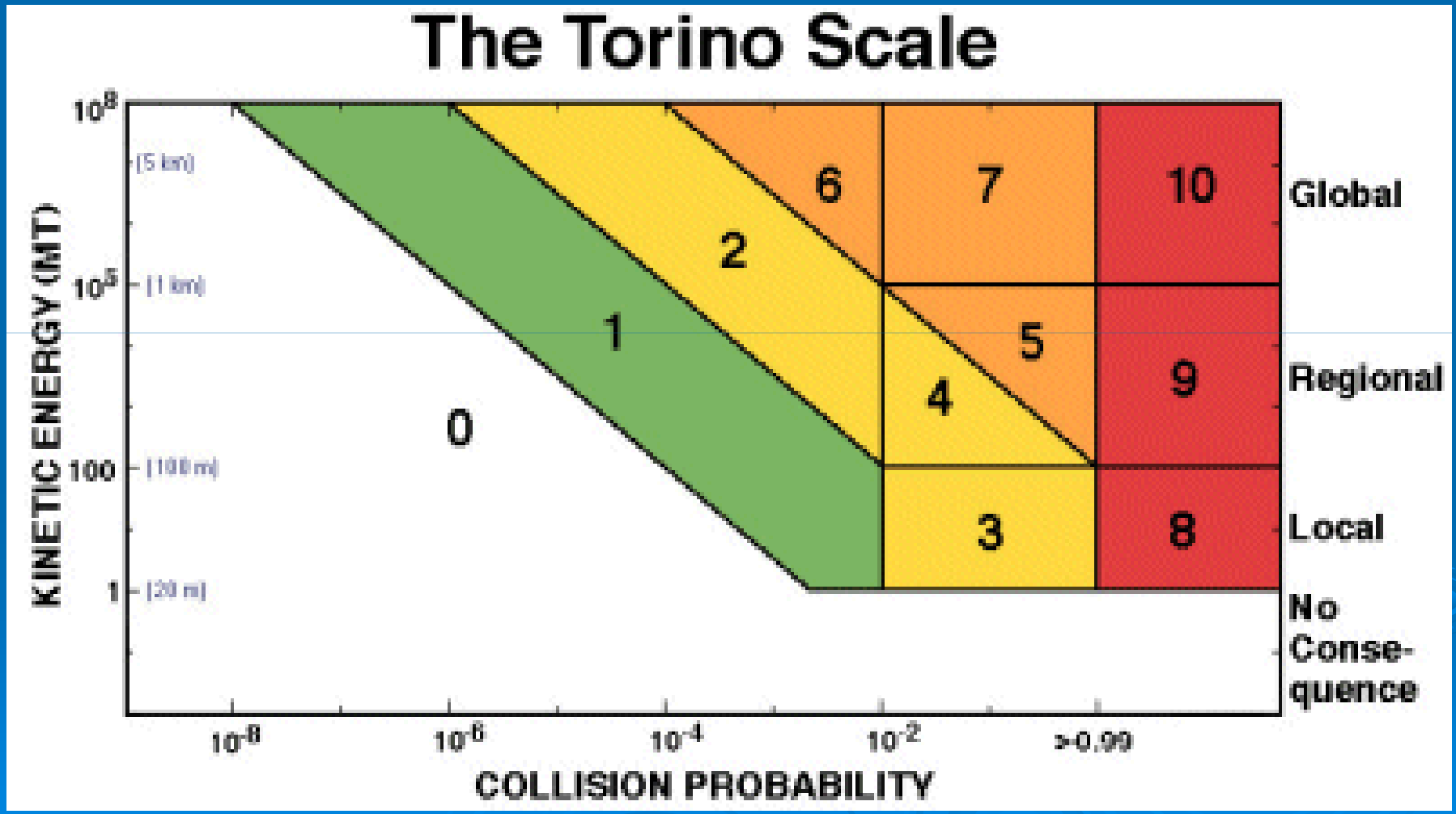
For whom and to whom?

- For the experts (group of experts) to evaluate the potential importance or risk giving the scale value…
- 1. to the social scientist who want to investigate potential consequences
- 2. through the media to the public!

The Torino Scale

- The two-dimensional Torino Scale (published by *Binzel* in 1997) takes into account
- both the damage caused by the potential impact of a NEO of an estimated kinetic energy
- and the probability that it will collide with the Earth.

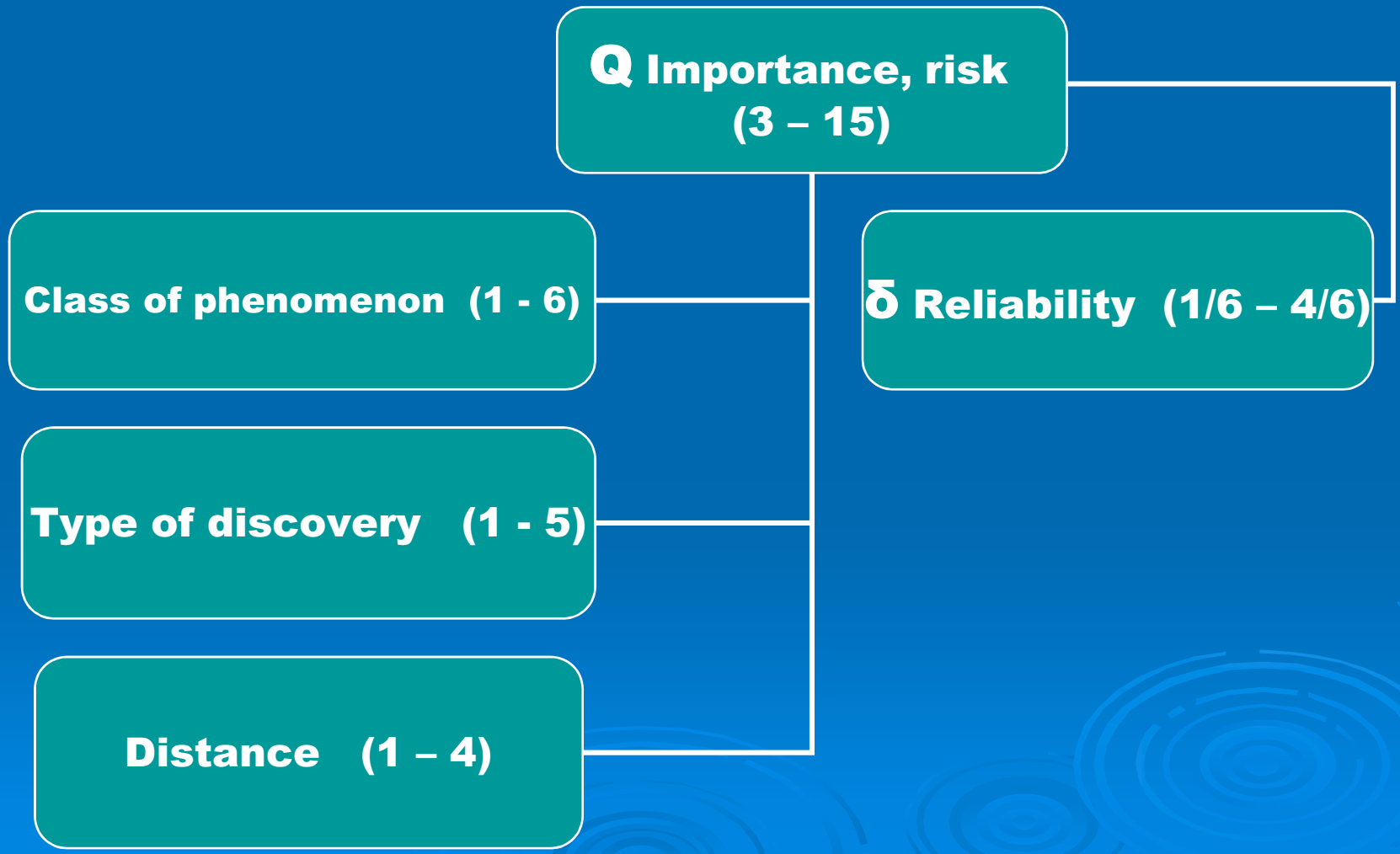
Each point is inside a sector labeled by a 0 (no hazard) to 10 (certain global catastrophe) value of the Scale



The Rio Scale

- Proposed in 2000 in Rio de Janeiro by I.Almár and J. Tarter
- to quantify the impact of any public announcement regarding evidence of *extraterrestrial intelligence or civilization*
- - in order to bring some objectivity to the otherwise subjective interpretation of any claimed ETI detection.

Structure of the Rio Scale
Q x δ = RSI



Q = an estimated level of consequences

- Selecting one line in each of the 3 sub- categories and adding the 3 numbers gives a Q value from 3 to 15. (If a sub-category is uncertain limiting values for Q are determined.)
- Multiplying Q by δ (reliability of the claim) gives the ***Rio Scale Index*** (RSI), an importance value from 0 to 10.

Class of Phenomenon	
Indication of technological activity or ET artifact (purpose unknown)	1
Leakage radiation or ET artifact (purpose understandable)	2
Omnidirectional beacon or ET artifact (general message)	3
Earth-specific beacon or ET artifact (message to mankind)	4
Omnidirectional message or a functioning artifact	5
Earth-specific message or an ET artifact capable of contact or a physical encounter	6

Discovery type	
A posteriori discovery without possibility of verification	1
Non-SETI/SETA observation of a transient phenomenon (never repeated)	2
SETI/SETA observation of a transient phenomenon (never repeated)	3
Non-SETI/SETA observation of a steady, verifiable phenomenon	4
SETI/SETA observation of a steady, verifiable phenomenon	5

Distance	
Extragalactic	1
Within the Galaxy	2
Within a distance which allows communication within a lifetime	3
Within the solar system	4

Reliability factor δ	
Obviously fake or fraudulent	0
Very uncertain, but worthy of verification efforts	1/6
Possible, but should be verified	2/6
Very probable, with verification already carried out	3/6
Absolutely reliable, without any doubt	4/6

Rio Importance
10 Extraordinary
9 Outstanding
8 Far-reaching
7 High
6 Noteworthy
5 Intermediate
4 Moderate
3 Minor
2 Low
1 Insignificant
0 None

Who should decide?

- Accepted by the SETI Committee of the International Academy of Astronautics (2002).
- Its Post-detection Working Group to be charged to select the proper RSI in case of a claimed detection of ETI.

SETI and astrobiology – are they converging?

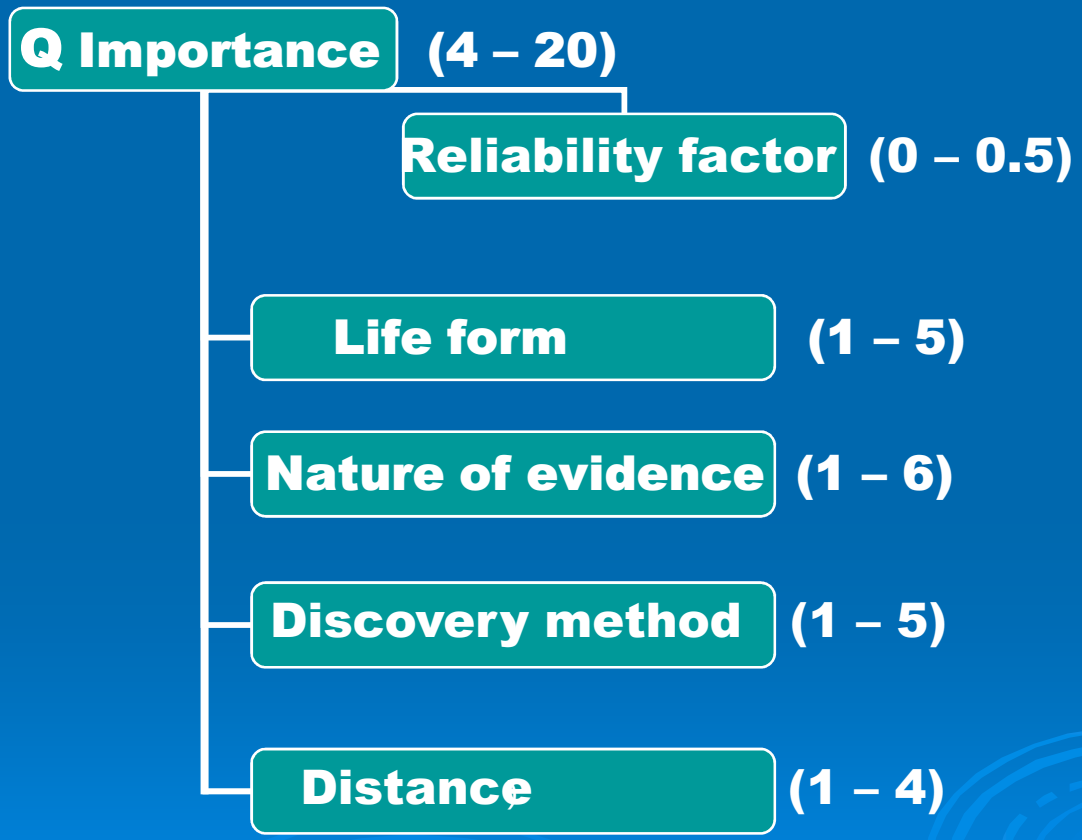
- **SETI start (1960): Project OZMA**
  Astrobiology start (1976): Viking
- ***New projects.*** **SETI: SETA**
  Astrobiology: study of meteorites and atmospheric samples
  Both cases: targeted telescopic observations of stellar systems with „habitable” planets

The London Scale for astrobiology

To assess the scientific importance, validity and potential consequences of an alleged discovery of *ET life*.

- Its structure and logic are intentionally analogous to the Rio Scale.

Structure of the London Scale: Q x δ = LSI



The London Scale Index

- After selecting a line in each of the four sub-categories and adding the four numbers gives a Q value of 4 to 20. (If a sub-category is uncertain, limiting values for Q are determined.)
- Multiplying Q by δ (reliability of the claim) gives the ***London Scale Index*** (LSI), an importance value from 0 to 10.

Class of phenomenon: Life Form	
Possible signature of life, but indirect information only	1
Terrestrial type life form, but some uncertainty remains	2
A previously unknown variant of terrestrial life	3
Likely to be non-terrestrial, but some uncertainty remains	4
Completely alien life form	5

Nature of Evidence	
Biomarkers	1
Fossilized life or remnants of life forms	2
Uncertain whether living or not	3
Extant life with suspended functioning	4
Simple life (low level of organization)	5
Complex life (high level of organization)	6

Type of discovery	
By remote sensing	1
By a surface robot, *in situ*, on another celestial body	2
By a manned mission, *in situ*, on another celestial body	3
By analyzing something found on Earth	4
By analyzing the result of a sample return planetary mission	5

Distance to the discovered life form	
Beyond the Solar System (*in situ* research impossible)	1
On or outside the orbit of Jupiter, but in the Solar System	2
Inside the orbit of Jupiter	3
Zero distance (on Earth)	4

Reliability factor δ	
Obviously fake or fraudulent	0
Probably not real	0.1
Controversial, but not rejectable	0.2
Testable, needs further evidence	0.3
Probably real	0.4
Certain or highly reliable	0.5

The Importance of a Discovery

- Currently there is no policy on what to do.
- It raises a variety of societal questions.
- How communication should be handled and by whom?
- A varified discovery of ET life might alter our world view.

Risk categories

- It is appropriate to consider what kind of risks are associated
- *Risk* is a relationship between the *hazard* combined with the *exposure* and *vulnerability*
- Forward and back contamination
- The 4 categories of risk *to Earth* of a discovery of ET life:

Risk categories belonging to a type of ET life discovery

Category	Type of Discovery	Risk Concerns
I	Remotely sensed signatures of life	No risk, no biohazard
II	Sample return from bodies without biological potential	No risk, no biohazard
III	ET life delivered by natural influx	Not controllable
IV	Intentional sample return with biological potential	Assumed biohazardous

Who should decide?

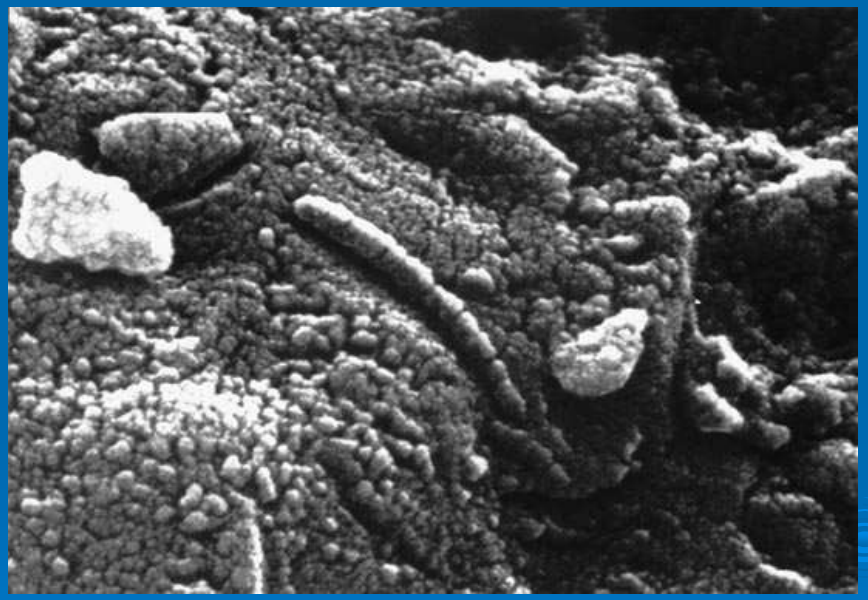
- There is no established group of experts yet to review all discovery claims for ET life.
- Some agencies are already committed (advisory groups).
- In either case the LSI value can help to communicate a discovery.

Examples

- Already, we can anticipate a variety of discovery scenarios that may involve media announcements about ET life.
- The four examples show how the LS may be used to evaluate such claims and assess their validity.

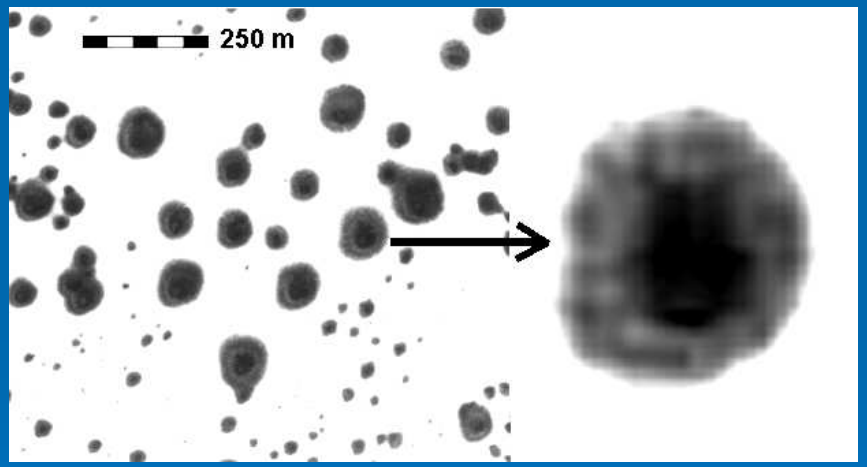
Fossiles in ALH84001 Martian meteorite?

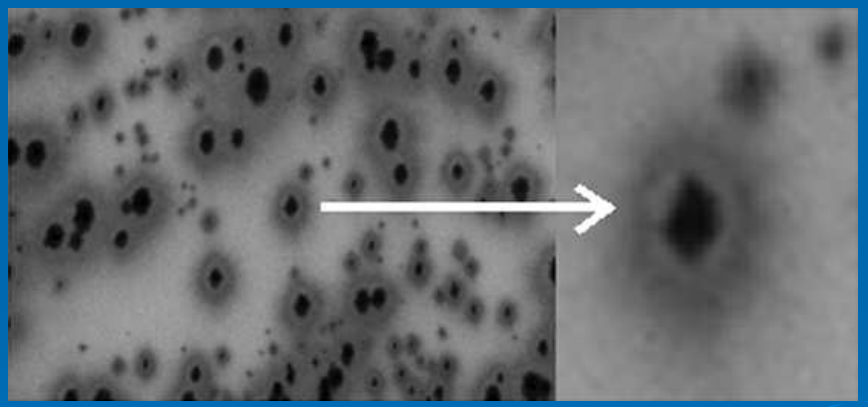
LSI: (2 + 2 + 4 + 4)0.3 = 3.6



Dark Dune Spots – Martian Surface Organisms?

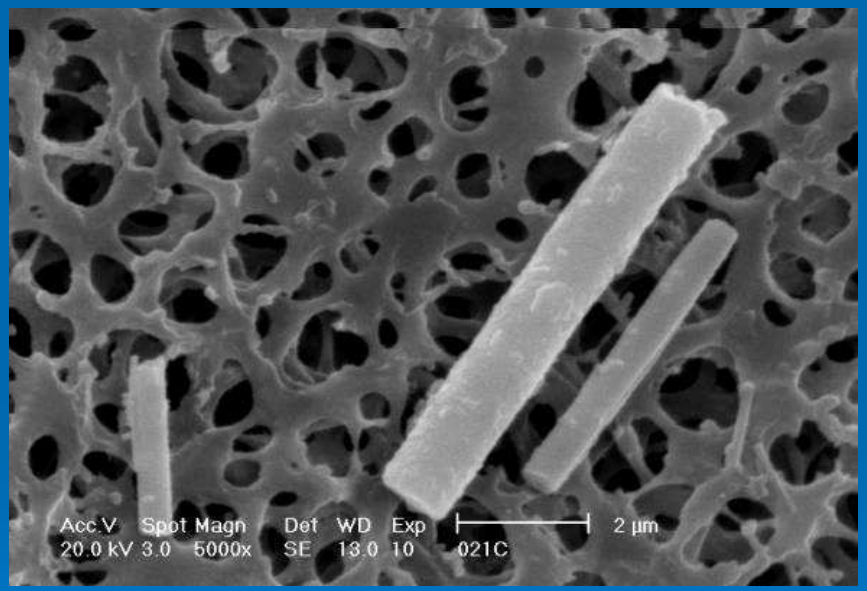
LSI: (2 + 5 + 1 + 3)0.3 = 3.3

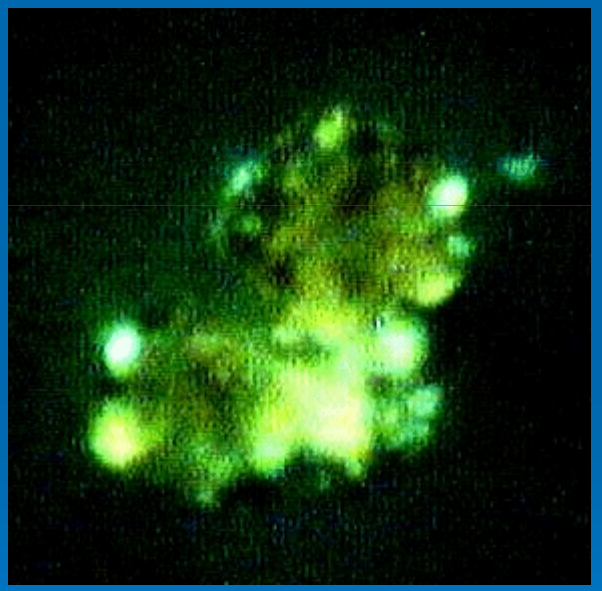




Hoyle-Wickramasinghe hypothesis of panspermia

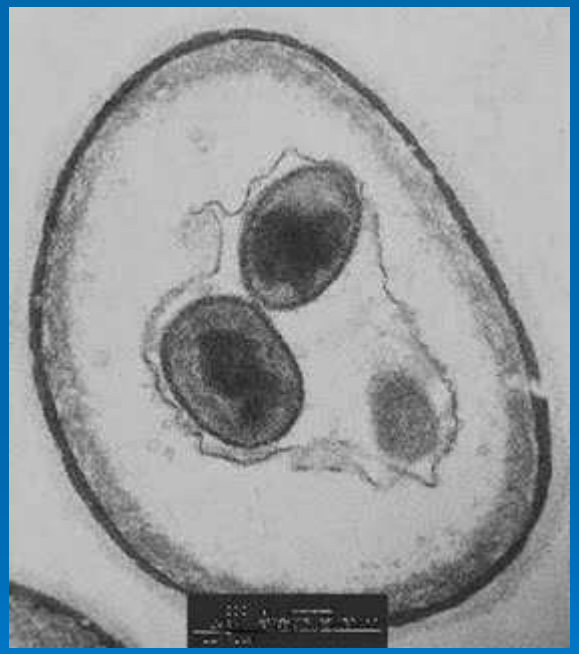
LSI: (2 + 4 + 4 + 4)0.1 or 0.2 = 1.4 – 2.8





Red rain in Kerala, India

LSI: (2 + 3 + 4 + 4)0.1 = 1.3



Conclusions

- „We want to make sure this is available as a tool for people to interpret new discoveries” *and*
- „My view is that any tool that helps understanding is a good tool”
- ***Richard Binzel***

inventor of the Torino Scale

Thank you for your attention!

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