1

also Northridge 23 March '77
also Am. Nuclear Soc. San Diego 6 Oct 77

Friday 5 Nov 76

Directed Panspermia

Also Aarhus Thurs. 8 Sept 77

~~Scripps~~ Scripps Inst. of Oceanography

Directed Panspermia.

Leslie Orgel. Erivan: Soviet Armenia: published in Icarus.

What is Panspermia?

Arrhenius ~ spores – light pressure
very unlikely

UCSD Physics Coll. 4pm. Nov 9 77 "The origin of Life" Room 2622 USB.

meteorite theory: again ~~so~~ very unlikely.

~~Does it~~ ?

Objection: only transfers the problem elsewhere

not tenable: does matter where it started.

might have been impossible to start on this planet
only possible on another
mineral? ~~[illegible]~~ special compound?
etc.

Conditions for origin of our sort of life

Need water (ie. ~~not~~ a liquid, not a solid or a gas)

Thus planet must be sufficient size
right distance from a star to give right temperature.
Star must not be too massive or its life too short.

our atmosphere is not the primary atmosphere but gassed out.

Need raw materials: if a reducing atmosphere
then radiation ~~plus~~ etc → soup (Stanley Miller, Harold Urey)
also ① outer space ② volcanoes
Soup has suggestive raw materials.

How many planets satisfy these conditions?
10^{11} – 10^{10} ? stars. in the galaxy.
% with planets? angular momentum?
double stars?
Arguments weak.
% which are just right ~ : probably at least 1%.
Thus could be very many

What is needed for life (as we know it.)?
Accurate Replication – DNA (or RNA) a natural
(Leslie O. will report progress)
Mutation – no problem!
Expression – now done by proteins.

How did protein synthesis start?

Now need elaborate apparatus - who somes, tRNA, etc.

Could there have been a simple system? EXPAND

(Leslie b.)

But conclusion is that it might have been a common event

OR it might have been an extremely rare one

(propositus argument).

Thus either ① life very common in galaxy

or ② life very rare but

soup very common.

~~Note: Life very homogeneous (optical activity & chance?)~~

~~but Genetic Code suggests a bottleneck~~

Time needed

age of earth $4\frac{1}{2} \times 10^9$ (billion) years.

earliest organisms $\simeq 3 \times 10^9$ years.

(real fossils $\sim \frac{1}{2} \times 10^9$ years)

cannot argue that it will always need this time

but not implausible that it needs times of this order.

Age of galaxy $13?? \times 10^9$ years.

need ~~to form~~ for early ~~stars~~ stars, to form high elements.

but this might only need 2×10^9 years.

Thus could have had early planets at 11×10^9 years.

i.e. time for two generations (or even three?!)

Picture of the Others.
their view of the galaxy ~ perhaps many sterile scraps.
their missionary zeal
(psychology not understood!)

Not implausible they should try to start life.

How to transmit life?

~~Pro~~ Principle of Detailed Cosmic Reversibility.
i.e. How would we do it.

Problems: the distances ∴ the times
delivery: the environment on arrival.

obvious idea to send microorganisms on an unmanned rocket
= Directed Panspermia.

Why microorganisms?: can send v. many 1000 kg ~ 10^{17} bugs.
can last very long & near ~ 0°K.
can be delivered easily.
can adapt easily to early environment

5/

nearest 4½ light years.

~1000 within 100 light years possibles.

The rocket problem

how fast? very fast → damage

too slow takes too long.

needs to ~~be~~ "home"

probably needs to decelerate

delivery ~ entry problems.

aim for perhaps 100 light years.

60,000 mph = 10^6 years.

$\frac{1}{1000}$ light speed = ~~100~~ 100,000 years.

$\frac{1}{100}$ = 10,000 years.

Main problem, : to develope somewhat better rockets

: to make them still work after a long journey.

Why not mice or men? Science Fiction.

Bugs can always go further: ~~EXPAND to 10^n years~~ ahead.

EXPAND to 10^n years ahead.

~~also note that~~ Note that unlikely to be infected by ~~the~~ higher organisms (unless from identical origin).

Thus theory is not ~~ridiculous~~ ridiculous — moon rockets swarms

Is it Science fiction? Numbers ~ hopefully testable in time

Any evidence? Molybdenum?

The Homogeneity of Life

same 20 a.a.

~~[illegible]~~

The Genetic Code.

appears to have arbitrary elements.

all suggests a "bottleneck"

real moral is that subject is still in its early stages? — or we could ~~go~~ estimate ~~gen~~ whether a theory was implausible or not.

Thus need to pursue both approaches.

Orthodox approach — L.E.O.

Directed Panspermia: ~~roche~~
Feasibility studies — rockets — expand
— bug transport & life
— bugs in soup

But plea not to contaminate the galaxy!

Wider questions: are the Others still there?
did they seed ~~of~~ many planets
or run out of funds!
where are those planets now?
is there a village in the galaxy?
(dispersion of stars?)

only time will show.