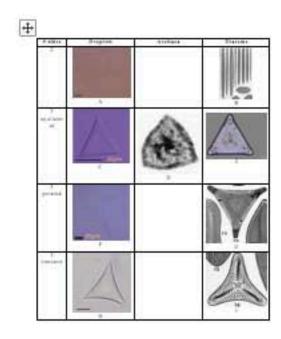
HABITATS FOR SHAPED **DROPLETS** IN THE **ORIGIN OF** LIFE

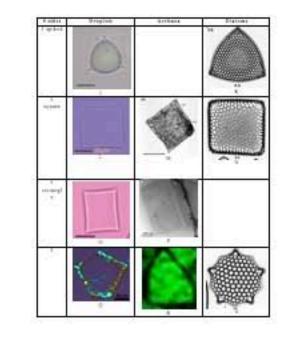
Richard Gordon Martin M. Hanczyc Stoyan K. Smoukov Most approaches to the origin of life assume no initial protocell structure, other than a spherical vesicle or oil or water droplet.

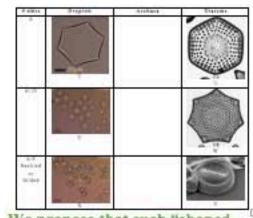
In 2015 a discovery was made that oil droplets in water, with some surfactant, acquire flat polygonal shapes if they are cooled slowly over a few minutes:

Denkoy, N., S. Tcholakoya, I. Lesoy, D. Cholakoya, & S.K. Smookoy (2015). Self-shaping of oil droplets via the formation of intermediate rotator phases upon cooling, Nature 528(7582), 392-395.

↑ Liquid Oil



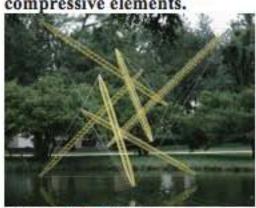




We propose that such "shaped droplets" were the original protocells.

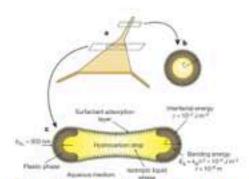
Similar shapes are seen in many prokaryotic Archaea and in some eukaryotic centric diatoms.

Shaped droplets may be looked upon as tensegrity structures, with stiff elements held together in space by

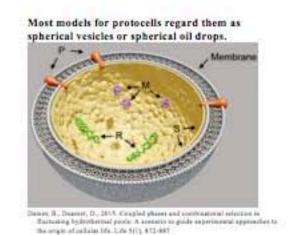


compressive elements. 50-100 layers of oil (plastic crystal)

> Surfactant and oil make a well-packed Layer and template the plastic crystal



The plastic phase along the edges is the stiff component and the surface tension is the compressive component.

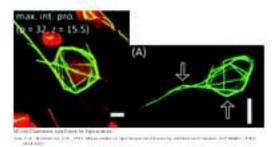


Oil droplets can exhibit:

- * Metabolism . Cell division
- . Chemotaxis
- · Minimal cognition · Collective behavior
- Baterse, M. M. 2014. Droplets: Unconventional protocell model with life-like dynamics and room to grow. Life 4(4), 1038-1049.

These properties may extend to shaped oil draplets.

However, linear polymers in confined volumes reshape their containers into polygonal structures.



We therefore suggest that the edges of shaped droplets could have been the sites of polymerization of linear polymers and that those polymers stabilized the shapes of the shaped droplets.

Given periodic cooling at night and warming during the day, the polymers might have carried the structure through each day, as their time constants for polymerization/ depolymerization were longer.

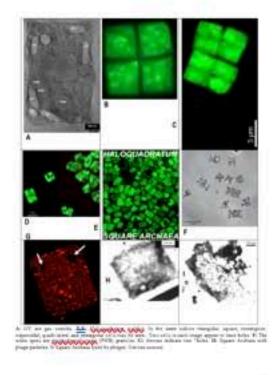
Are polygonal Archaea direct descendants of shaped droplet protocells?

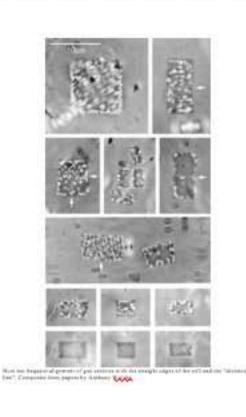
Unfortunately, we do not know the basis for the shape of polygonal Archaea.

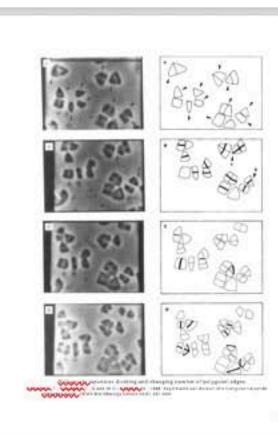
We can list properties they have in common:

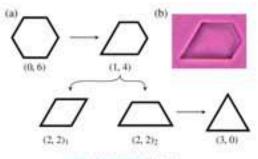
- · Sharp corners
- Straight edges
- · Very thin
- · Same size range
- Ability to change # of edges
- . Thin spots or even holes in the middle
- Reversion to spherical shape under changed conditions

1µm









Conclusions:

- Protocells as shaped oil droplets could have had advantages such as survivability, resource allocation.
- Supports Lipid World hypothesis County D., Brot-Cla, D., Occasio, D. W., & Lancet, D. (2001). The lipid world: Gregors of Life and Fundation of the Mangher 12(1-2), 110-
- · Confines habitats for origin of life to those
- supporting shaped droplets
- Day/night cycles may have driven a polymerization of linear molecules along shaped droplet edges





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origin of life, in: Gordee, R., Skapps, A.A. (Eds.), Habitability of the Universe Before Earth [Volume 1 in series: Astrobiology: Exploring Life on farth and Beyond, eds. Educationique Bangalosta, Joseph Scabbach, & Richard Gordon), Elization B.V., Amsterdam, pp. 427-490.

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Mason, P.A., Gordon, R. (Eds.), 2018.

Hanczys, M.M., Smoukox, S., Seskhach, J.,

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