

CHEMICAL EVOLUTION AND THE ORIGIN OF LIFE

Bibliography Supplement 1970

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Bibliography

- 1589 Abell, P. I., Draffan, G. H., Eglinton, G., Hayes, J. M., Maxwell, J. R., and Pillinger, C. T.: 1970, 'Organic Analysis of the Returned Lunar Sample', *Science* **167** (3918), 757–9, January 30.
- 1590 Abell, P. I., Draffan, C. H., Eglinton, G., Hayes, J. M., Maxwell, J. R., and Pillinger, C. T.: 1970, 'Organic Analysis of the Returned Apollo 11 Lunar Sample', in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. **34** Pergamon, New York, **2**, 1757–73.
- 1591 Abell, P. I., Eglinton, G., Maxwell, J. R., Pillinger, C. T., and Hayes, J. M.: 1970, 'Indigenous Lunar Methane and Ethane', *Nature* **226** (5242), 251–2, April 18.
- 1592 Allen, G.: 1970, 'Natural Selection and the Origin of Life', *Perspect. Biol. Med.* **14**, 109–26, Autumn.
- 1593 American Association for the Advancement of Science: 1970 'Apollo 11 Lunar Science Conference', Papers presented at the Lunar Science Conference held at Houston, Texas, from 5 to 8 January 1970, AAAS, Washington, D. C. Pages 449 through 784 printed in *Science* **167** (3918), 30 Jan. 1970, ('The Moon Issue').
- 1594 Bahadur, K. and Ranganayaki, S.: 1970, 'The Photochemical Formation of Self-sustaining Coacervates', *J. Brit. Interplan. Soc.* **23**, 813–29.
- 1595 Baratava, L. A., Gol'danskii, V. I., Kosygin, M. Y., and Yampol'skii, P. A.: 1970, 'Effects of Shock Waves on α -Amino Acids', *Biokhimiya* **35**, 1216–18, (Russian).
- 1596 Bar-Nun, A., Bar-Nun, N., Bauer, S. H., and Sagan, C.: 1970, 'Shock Synthesis of Amino Acids in Simulated Primitive Environments', *Science* **168** (3930), 470–3, April 24.
- 1597 Bar-Nun, A., Bar-Nun, N., Bauer, S. H., and Sagan, C.: 1970, 'Amino Acid Synthesis in Simulated Primitive Environments, Reply to Comments', *Science* **170** (3961), 1001–2, November 27, (Refers to item 1657).
- 1598 Barghoorn, E. S.: 1969, 'The Antiquity of Life on Earth', in *The Primitive Earth: A Symposium* (ed. by J. E. Bever). Transcript of an oral presentation held October 18, 1968. Sponsored by the Dept. of Geol., Miami University, Oxford, Ohio, p. B1–11.
- 1599 Barghoorn, E. S.: 1970, 'Micro-Paleontological Study of Lunar Material from Apollo 11', in

- Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. 34, Pergamon, New York, 2, 1775–7.
- 1600 Barghoorn, E. S., Philippott, D., and Turnbill, C.: 1970, 'Micro-Paleontological Study of Lunar Material', *Science* 167 (3918), 775, January 30.
- 1601 Belsky, T. and Kaplan, I. R.: 1970, 'Light Hydrocarbon Gases, C¹³, and Origin of Organic Matter in Carbonaceous Chondrites', *Geochim. Cosmochim. Acta* 34, 257–78.
- 1602 Bianchi, L. M. and Hamann, J. R.: 1970, 'The Origin of Life: Preliminary Considerations on Necessary and (Possibly) Sufficient Conditions', *J. Theor. Biol.* 28, 489–96, September.
- 1603 Bjornson, L. K.: 1970, 'Chemical Evolution: Condensation Reactions of Nucleotides and Amino Acids in Aqueous Solutions', Thesis, University of California, Lawrence Radiation Lab., Berkeley, California, March. Available from NTIS, UCRL-19733.
- 1604 Boichenko, E. A., Udel'nova, T. M., and Yuferova, S. G.: 1969, 'Evolution of Reducing Functions of the Biosphere', *Geokhimiya* (11), 1392–6, (Russian).
- 1605 Boyer, J. H. and Dabek, H.: 1970, 'Iminoacetonitriles, a New Family of Compounds – N-t-Butylimino-Acetonitrile', *Chemical Communication* No. 18, 1204–5.
- 1606 Brooks, J. and Shaw, G.: 1970, 'Relation of Kerogen and Sporopollenin, Reply to Comments', *Nature* 227 (5254), 195–6, July 11, (Refers to item 1612).
- 1607 Burlingame, A. L., Haug, P. A., Schnoes, H. K., and Simoneit, B. R.: 1969, 'High Resolution Mass Spectrometry in Molecular Structure Studies, XXVII. Fatty Acids Derived from the Green River Formation Oil Shale by Extractions and Oxidations – A Review', in *Advances in Organic Geochemistry 1968*. Proceedings of the 4th International Meeting on Organic Geochemistry, Amsterdam, September 16–18, 1968 (ed. by P. A. Schenck and I. Havenaar), Pergamon Press, Oxford, p. 85–129.
- 1608 Burlingame, A. L., Calvin, M., Han, J., Henderson, W., Reed, W., and Simoneit, B. R.: 1970, 'Lunar Organic Compounds: Search and Characterization', *Science* 167 (3918), 751–2, January 30.
- 1609 Burlingame, A. L., Calvin, M., Han, J., Henderson, W., Reed, W., and Simoneit, B. R.: 1970, 'Study of Carbon Compounds in Apollo 11 Lunar Samples', in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. 34, Pergamon, New York, 2, 1779–91.
- 1610 Burton, F. G., Neuman, M. W., and Neuman, W. F.: 1969, 'On the Possible Role of Crystals in the Origins of Life. I. The Adsorption of Nucleosides, Nucleotides and Pyrophosphates by Apatite Crystals', *Curr. Mod. Biol.* 3, 20–6, October.
- 1611 Calvin, M.: 1969, 'Abiogenic Information Coupling between Nucleic Acid and Protein, or, How Protein and DNA were Married', *Proc. Roy. Soc. Edinburgh Sect. B* 70 (pt. 4), 273–94.
- 1612 Calvin, M.: 1969, 'Molecular Paleontology', *Perspect. Biol. Med.* 13, 45–62, Autumn.
- 1613 Chagovets, R. V. and Lakhno, Y. V.: 1970, 'Generation of Life and Main Stages of Biochemical Evolution of Life', *Visn. Akad. Nauk Ukr. RSR* (5), 48–59, (Ukrainian).
- 1614 Chang, S., Flores, J., and Ponnampereuma, C.: 1969, 'Peptide Formation Mediated by Hydrogen Cyanide Tetramer: A Possible Prebiotic Process', *Proc. Nat. Acad. Sci. U.S.A.* 64, 1011–15 November.
- 1615 Chang, S., Smith, J. W., Kaplan, I., Lawless, J., Kvenvolden, K. A., and Ponnampereuma, C.: 1970, 'Carbon Compounds in Lunar Fines from Mare Tranquillitatis – IV. Evidence for Oxides and Carbides', in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. 34, Pergamon, New York, 2, 1857–1869.
- 1616 Chang, S., Williams, J., Ponnampereuma, C., and Rabinowitz, J.: 1970, 'Phosphorylation of Uridine with Inorganic Phosphates', *Space Life Sci.* 2, 144–50.
- 1617 Cinati, J.: 1969, 'Inorganic-Organic Multimolecular Complexes of Salt Solutions, Culture Media and Biological Fluids and Their Possible Significance for the Origin of Life', *J. Theor. Biol.* 23, 1–10, April.
- 1618 Cloud, P. E.: 1969, 'Environments and Organisms on the Primitive Earth', in *The Primitive Earth: A Symposium* (ed. by J. E. Bever). Transcript of an oral presentation at a symposium held October 18, 1968, Dept. of Geol., Miami University, Oxford, Ohio, p. Clo 1–12.
- 1619 Cloud, P. E. (ed.): 1970, *Adventures in Earth History*. W. H. Freeman, San Francisco. Reprints of previously published articles, items no 14, 306, 647, 1555, and 1562 in Bibliography, *Space Life Sci.* 2 (1970), 226, 238, 251, 287.
- 1620 Cloud, P. E., Margolis, S. V., Moorman, M., Barker, J. M., Licari, G. R., Krinsley, D., and

- Barnes, V. E.: 1970, 'Micromorphology and Surface Characteristics of Lunar Dust and Breccia', *Science* **167** (3918), 776-7, January 30.
- 1621 Cloud, P. E., Margolis, S. V., Moorman, M., Barker, J. M., Licari, G. R., Krinsley, D., and Barnes, V. E.: 1970, 'Micromorphology and Surface Characteristics of Lunar Dust and Breccia' in *Proceeding of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. **34**, Pergamon, New York, **2**, 1793-98.
- 1622 Cooper, B. S. and Murchison, D. G.: 1970, 'Identity of Sporopollenins with Older Kerogens Questioned. Comments', *Nature* **227** (5254), 194-5, July 11. Comment on item 1387 in Bibliography, *Space Life Sci.* **2** (1970) 280.
- 1623 Dose, K.: 1970, 'On the Origin of Life. Report on the Third International Conference on the Origin of Life at Pont-A-Ousson', *Naturwiss.* **57**, 555-60, December, (German).
- 1624 Douglas, A. G., Eglinton, G., and Henderson, W.: 1970, 'Thermal Alteration of the Organic Matter in Sediments', in *Advances in Organic Geochemistry*, Proceedings of the Third International Congress, London, 1966 (ed. by G. D. Hobson and G. C. Speers). Pergamon Press, Oxford, p. 369-88.
- 1625 Douglas, A. G., Eglinton, G., and Maxwell, J. R.: 1969, 'The Organic Geochemistry of Certain Samples from the Scottish Carboniferous Formation', *Geochim. Cosmochim. Acta* **33** (5), 579-90, May.
- 1626 Dowler, M. J., Fuller, W. D., Orgel, L. E., and Sanchez, R. A.: 1970, 'Prebiotic Synthesis of Propionaldehyde and Nicotinamide', *Science* **169** (3952), 1320-1321, September 25.
- 1627 Eaton, T. H., Jr.: 1970, 'Origin of Life' in *Evolution*, W. W. Norton & Co., New York, p. 196-205 (Chapter 13).
- 1628 Echlin, P.: 1970, 'Primitive Photosynthetic Organisms', in *Advances in Organic Geochemistry*, Proceedings of the Third International Congress, London, 1966 (ed. by G. D. Hobson and G. C. Speers), Pergamon Press, Oxford, p. 523-37.
- 1629 Eglinton, G.: 1969, 'Hydrocarbons and Fatty Acids in Living Organisms and Recent and Ancient Sediments', in *Advances in Organic Geochemistry 1968*, Proceedings of the 4th International Meeting on Organic Geochemistry, September 16-18, 1968 (ed. by P. A. Schenck and I. Havenaar), Pergamon Press, Oxford, p. 1-24.
- 1630 Eglinton, G. and Murphy, M. T. J.: 1969, *Organic Geochemistry: Methods and Results*, Springer Verlag, Berlin.
- 1631 Ferris, J. P., Goldstein, G., and Beaulieu, D. J.: 1970, 'Chemical Evolution. IV. Evaluation of Cyanovinyl Phosphate as a Prebiotic Phosphorylating Agent', *J. Amer. Chem. Soc.* **92**, 6598-603.
- 1632 Ferris, J. P. and Kuder, J. E.: 1970, 'Chemical Evolution. III. Photochemical Conversions of Enaminonitriles to Imidazoles', *J. Amer. Chem. Soc.* **92** (8), 2527-33, April 22.
- 1633 Ferris, J. P., Kuder, J. E., and Catalano, A. W.: 1969, 'Photochemical Reactions and the Chemical Evolution of Purines and Nicotinamide Derivatives', *Science* **166** (3906), 765-6, November 7.
- 1634 Fesenkov, V. G.: 1970, 'Conditions for Life in the Universe', *Priroda*, No. 1, 20-27, January (Russian). Translated into English in *JPRS Soviet Studies of Universe*, January, 1970, p. 1-16. Available NTIS, JPRS-50185.
- 1635 Fesenkov, V. G.: 1970, 'The Evolution and Physical Properties of the Earth and Planets as a Consequence of the Characteristics of Their Origin/Evoluytsiya i Fizicheskie Svoystva zemli i Planet Kak Sledstvie Osobennostey Ikh Proyiskhozheniya', in *Tr. Astrofizicheskogo Inst. Akad. Nauk Kazakh SSR* (Alma-Ata) Vol. **9**, 1967, 109-120. Available in English from NTIS, NASA-TT-F-12916.
- 1636 Florkin, M.: 1969, 'Organic Abiogenic and Biochemical Continuiums', *Bull. CL. Sci. Acad. Roy. Belg.* **55**, 257-61 (French).
- 1637 Folsome, C. E. and Morowitz, H. J.: 1969, 'Prebiological Membranes: Synthesis and Properties', *Space Life Sci.* **1** (4), 538-544.
- 1638 Fox, S. W.: 1967, 'Comment la Vie a Commerce', *La Biogenese* **10**, 51-61. Special annual number: *Physique et Chimie*.
- 1639 Fox, S. W.: 1967, 'Recent Studies on the Origin of Life', *Protein, Nucleic Acid, and Enzyme* (Tokyo) **12**, 1231-1241. Discussion and comments by A. I. Oparin under title 'Meaning of Proteinoid and Coacervate' 1240-41.
- 1640 Fox, S. W.: 1970, 'Experimentally Derived Explanations of Some Aspects of the Origin of Life /Ob'yasnenie Nekotorykh Aspectov Proiskhozhdeniya zhizni, Osnovannoe na Eksperimental'-

- 'nykh Dannykh', *Zh. Evol. Biokhim. Fiziol.* **6**(2), 131–147. (Russian with English Summary). Also published in English by Institute of Molecular Evolution, Miami University, Coral Gables, Florida, Contribution No. 137. Available from NTIS, NASA-CR-113795.
- 1641 Fox, S. W., Harada, K., Hare, P. E., Hinsch, G., and Mueller, G.: 1970, 'Bio-organic Compounds and Glassy Microparticles in Lunar Fines and Other Materials', *Science* **167** (3918), 767–70, January 30.
- 1642 Fox, S. W., Harada, K., Krampitz, G., and Mueller, G.: 1970, 'Chemical Origins of Cells', *Chem. Eng. News.* **48**, 80–94.
- 1643 Fox, S. W., Harada, K., Windsor, C. R., and Hare, E. P.: 1970, 'Amino Acids Obtained from Lunar Soil and from Laboratory Synthesis'. A paper presented at the International Symposium on Hydrogeochemistry and Biogeochemistry, Tokyo, Japan, September 7–15.
- 1644 Fox, S. W., Krampitz, G., and Waehneltd, T. V.: 1967, 'Origin of Life', *Bild. Wiss.* **4**, 1015–25, (German).
- 1645 Fox, S. W., McCauley, R. J., Montgomery, P. O'B., Fukushima, T., Harada, K., and Windsor, C. R.: 1969, 'Membrane-like Properties in Microsystems Assembled from Synthetic Protein-like Polymer', in *Physical Principles of Biological Membranes* (ed. by F. Snell *et al.*), Gordon and Breach, New York, p. 417–30.
- 1646 Fox, S. W., Wang, C. T., Waehneltd, T. V., Nakashima, T., Krampitz, G., Hayakawa, T., and Harada, K.: 1970, 'Methods for Producing Octadecatonic Anhydropolymers of Amino Acids', in *Peptides: Chem. Biochem., Proc. Amer. Peptide Symp.* 1st, 1968 (ed. by B. Weinstein), Marcel Dekker, New York, p. 499–527.
- 1647 Fox, S. W. and Windsor, C. R.: 1970, 'Synthesis of Amino Acids by the Heating of Formaldehyde and Ammonia', *Science* **170**, 984–6, November 27.
- 1648 Friedmann, N. and Miller, S. L.: 1969, 'Phenylalanine and Tyrosine Synthesis under Primitive Earth Conditions', *Science* **166** (3906), 766–7, November 7.
- 1649 Ganapathy, R., Keays, R. R., Laul, J. C., and Anders, E.: 1970, 'Trace Elements in Apollo 11 Lunar Rocks: Implications for Meteorite Influx and Origin of Moon', in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. **34**, Pergamon, New York, **2**, 1117–42.
- 1650 Ganti, T.: 1968, 'Primeval Ocean in a Test Tube. I. Origin of Organic Compounds with Small Molecules', *Termeszt Vilaga* **99**, 413–15, (Hungarian).
- 1651 Gehrke, C. W., Zumwalt, R. W., Aue, W. A., Stalling, D. L., Duffield, A., Kvenvolden, K. A., and Ponnamperuma, C.: 1970, 'Carbon Compounds in Lunar Fines from Mare Tranquillitatis – III. Organosiloxanes in Hydrochloric Acid Hydrolysates', in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. **34**, Pergamon, New York, **2**, 1845–56.
- 1652 Gelpi, E., Han, J., Nooner, D. W., and Oro, J.: 1970, 'Organic Compounds in Meteorites. III. Distribution and Identification of Aliphatic Hydrocarbons Produced by Open-Flow Fischer-Tropsch Processes', *Geochim. Cosmochim. Acta* **34** (9), 965–79, September.
- 1653 Gelpi, E., Nooner, D. W., and Oro, J.: 1970, 'Ubiquity of Hydrocarbons in Nature: Aliphatic Hydrocarbons in Dust Samples', *Geochim. Cosmochim. Acta* **34** (3), 421–5, March.
- 1654 Gelpi, E. and Oro, J.: 1970, 'Organic Compounds in Meteorites. IV. Gaschromatographic – Mass Spectrometric Studies on the Isoprenoids and Other Isomeric Alkanes in Carbonaceous Chondrites', *Geochim. Cosmochim. Acta* **34** (9), 981–94, September.
- 1655 Gelpi, E. and Oro, J.: 1970, 'Organic Compounds in Meteorites. V. Gas-Chromatographic – Mass Spectrometric Studies on the Isoprenoids and Other Isomeric Alkanes in Graphitic Nodules of Iron Meteorites', *Geochim. Cosmochim. Acta* **34** (9), 995–1005, September.
- 1656 Gelpi, E. and Oro, J.: 1970, 'Comparative Mass-Spectrometric Studies on the Isoprenoids and Other Isomeric Alkanes in Terrestrial and Extraterrestrial Samples', *Int. J. Mass Spectrom. Ion Phys.* **4**, 323–35.
- 1657 Gelpi, E., Schneider, H., Doctor, V. M., Tennison, J., and Oro, J.: 1969, 'Gas Chromatographic Mass Spectrometric Identifications of the Hydrocarbons and Fatty Acids of Plantago Ovata Seeds', *Phytochemistry* **8**, 2077–2081.
- 1658 Gelpi, E., Schneider, H., and Mann, J.: 1970, 'Lipids of Geochemical Significance in Microscopic Algae. I. Hydrocarbons of Geochemical Significance in Microscopic Algae', *Phytochemistry* **9**, 603–12.
- 1659 *Geochimica et Cosmochimica Acta*: 1970, Suppl. **1**, Vol. **34**. *Proceedings of the Apollo 11 Lunar*

- Science Conference*, Houston, Texas, January 5–8, 1970, Vol. II, *Chemical and Isotope Analyses* (ed. by A. A. Levinson), Pergamon Press, New York.
- 1660 Gibert, J. M. and Oro, J.: 1970, 'Gas Chromatographic–Mass Spectrometric Determination of Potential Contaminant Hydrocarbons of Moon Samples', *J. Chromatogr. Sci.* **8**, 295–6, May.
- 1661 Halpern, B. and Hodgson, G. W.: 1970, 'Search for Porphyrins in Lunar Fines from Apollo 11 and 12', Final report, August 15, NASA-CR-108671, Stanford Univ., Dept. of Genetics, California. Available from NTIS.
- 1662 Han, J. and Calvin, M.: 1969, 'Hydrocarbon Distribution of Algae and Bacteria, and Microbiological Activity in Sediments', *Proc. Nat. Acad. Sci. U.S.* **64**, 436–43.
- 1663 Harada, K.: 1969, 'Origin of Organic Substances in Meteorites', *Tampakushitsu Kakusan Koso* **14**, 1197–201, (Japanese).
- 1664 Harada, K.: 1970, 'Chemical Evolution – Chemical Basis for Origin of Life', *Protein (Tokyo)* **15**, 855–69, July, (Japanese).
- 1665 Harada, K.: 1970, 'Origin and Development of Optical Activity of Organic Compounds on the Primordial Earth', *Naturwiss.* **57**, 114–19.
- 1666 Hare, F.: 1970, 'Evolution of Systems Active in Abiogenesis', *J. Chim. Phys. Physicochim. Biol.* **67**, 1681–704, (French).
- 1667 Hare, P. E., Harada, K., and Fox, S. W.: 1970, 'Analyses for Amino Acids in Lunar Fines', in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. **34**, Pergamon, New York, **2**, 1799–1803.
- 1668 Henderson, W., Wollrab, V., and Eglinton, G.: 1969, 'Identification of Steranes and Triterpanes from a Geological Source by Capillary Gas Liquid Chromatography and Mass Spectrometry', in *Advances in Organic Geochemistry 1968*, Proceedings of the 4th International Meeting on Organic Geochemistry Amsterdam, September 16–18, 1968 (ed. by P. A. Schenck and I. Havenaar), Pergamon Press, Oxford, p. 181–207.
- 1669 Henley, R. R.: 1969, 'The Degradation of Insoluble Natural Polymers under Simulated Primitive Earth Conditions and the Resultant Geochemical Cycle', Thesis (Ph. D.) Biophysics Program, Stanford University, Palo Alto, Calif.
- 1670 Hodgson, G. W., Peterson, E., and Baker, B. L.: 1969, 'Trace Porphyrin Complexes: Fluorescence Detection by Demetallation with Methane Sulfonic Acid', *Mikrochemica Acta* (Wein), 805.
- 1671 Hodgson, G. W., Bunnenberg, E., Halpern, B., Peterson, E., Kvenvolden, K. A., and Ponnamparuma, C.: 1970, 'Carbon Compounds in Lunar Fines from Mare Tranquillitatis – II. Search for Porphyrins', in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. **34**, Pergamon, New York, **2**, 1829–44.
- 1672 Hodgson, G. W., Holmes, M. A., and Halpern, B.: 1970, 'Biogeochemistry of Molecular Complexes of Amino Acids with Chlorines and Porphyrins', *Geochim. Cosmochim. Acta* **34** (10), 1107–19, October.
- 1673 Hodgson, G. W., Peterson, E., Kvenvolden, K. A., Bunnenberg, E., Halpern, B., and Ponnamparuma, C.: 1970, 'Search for Porphyrins in Lunar Dust', *Science* **167** (3918), 673–5, January 30.
- 1674 Hofmann, H. F. and Jackson, C. D.: 1969, 'Precambrian (Apebian) Microfossils from Belcher Islands, Hudson Bay', *Can. J. Earth Sci.* **6** (5), 1137–1144.
- 1675 Hollahan, J. R. and Emanuel, C. F.: 1970, 'Studies on Protein-like Products from Radio-frequency Plasmas of CO, N₂ and H₂', *Biochem. Biophys. Acta.* **208** (2), 317–327.
- 1676 Hulett, H. R.: 1970, 'Amino Acid Synthesis in Simulated Primitive Environments. Comments', *Science* **170** (3961) 1000–1, November 27, (Refers to item 1594).
- 1677 Hulett, H. R.: 1970, 'Nonenzymic Hydrolysis of Adenosine Phosphates', *Nature* **225** (5239), 1248–9, March 28.
- 1678 Jeffery, P. M. and Anders, E.: 1970, 'Primordial Noble Gases in Separated Meteorite Minerals, I', *Geochim. Cosmochim. Acta* **34** (11), 1175–1198, November.
- 1679 Johnson, R. D. and Davis, C. C.: 1970, 'Pyrolysis – Hydrogen Flame Ionization Detection of Organic Carbon in a Lunar Sample', *Science* **167** (3918), 759–60, January 30.
- 1680 Johnson, R. D. and Davis, C. C.: 1970, 'Total Organic Carbon in the Apollo 11 Lunar Samples', in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. **34**, Pergamon, New York, **2**, 1805–12.
- 1681 Kamshilov, M. M.: 1968, 'Ultraviolet Rays and One-Celled Organisms/Ultrafoletovye Luchi:

- Odnokletochnye Organizmy', in *Abiogenesis and the Initial Stages of the Evolution of Life/Abiogenez i Nachel'nye Stadii Evoliutsii Zhizni* (ed. by A. I. Oparin), Izdatel'stvo Nauka, Moscow, 1968, p. 119–21. Available in English from NTIS, NASA-TT-F-13188. Translation of item 847 in Bibliography, *Space Life Sci.* **2** (1970) 257.
- 1682 Kaplan, I. R. and Smith, J. W.: 1970, 'Concentration and Isotopic Composition of Carbon and Sulfur in Apollo 11 Lunar Samples', *Science* **167** (3918), 541–3, January 30.
- 1683 Kaplan, I. R., Smith, J. W., and Ruth, E.: 1970, 'Carbon and Sulfur Concentration and Isotopic Composition in Apollo 11 Lunar Samples', in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. **34**, Pergamon, New York, **2**, 1317–29.
- 1684 Karpinskaya, R. S. and Merzlov, V. P.: 1968, 'Evolution of Chemical Structures During the Emergence of Life on Earth' in *Probl. Razv. Sovrem. Estestvozn* (ed. by D. I. Gordeer), Izd. Moskov Univ., Moscow, p. 152–63, (Russian).
- 1685 Kenyon, C. N. and Stanier, R. Y.: 1970, 'Possible Evolutionary Significance of Polyunsaturated Fatty Acids in Blue-green Algae', *Nature* **227**, 1164–6, September 12.
- 1686 Kenyon, D. H. and Steinman, G.: 1969, *Biochemical Predestination*, McGraw-Hill, New York.
- 1687 Khenokh, M. A. and Nikolaeva, M. V.: 1970, 'The Effect of Ultraviolet Light (PRK-2) on Pentoses in the Presence of Various Minerals', in *Life Sciences and Space Research VIII; COSPAR Plenary Meeting, 12th Open Meeting of Work Group V, Symposium on Biological Rhythms and Symposium on Nutrition of Man in Space*, Prague, Czechoslovakia, May 11–24, 1969. Proceedings (ed. by W. Vishniac and F. G. Favorite), North-Holland, Amsterdam, p. 82–89.
- 1688 Khilchevska, R. I.: 1970, 'Stereoisomerism in Animate Nature – Its Role in Processes of the Origin of Life on Earth', *Fiziologichnii Zh.* **16**, 810–817, November–December, (Ukrainian).
- 1689 Krampitz, G., Baars, S., Haas, W., and Kempfle, M.: 1969, 'Condensation of Aminoacyladenylates, a Model for Abiogenic Protein Synthesis', *Naturwiss.* **56**, 416, August, (German).
- 1690 Krouse, H. R. and Modzeleski, V. E.: 1970, '¹³C/¹²C Abundances in Components of Carbonaceous Chondrites and Terrestrial Samples', *Geochim. Cosmochim. Acta* **34**, 459–474.
- 1691 Kvasha, L. G.: 1968, 'Carbonaceous Chondrites/Uglistye Khondrity' in *Abiogenesis and the Initial Stages of Life/Abiogenez i Nachal'nye Stadii Evoliutsii Zhizni* (ed. by A. I. Oparin), Izdatel'stvo Nauka, Moscow, 1968, p. 16–22. Available in English from NTIS, NASA-TT-F-13183. Translation of item 847 in bibliography, *Space Life Sci.* **2** (1970), 259.
- 1692 Kvenvolden, K. A. et al.: 1970, 'Carbon Compounds in Lunar Fines from Mare Tranquillitatis – I. Search for Molecules of Biological Significance', in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. **34**, Pergamon, New York, **2**, 1813–28.
- 1693 Kvenvolden, K. A., Lawless, J., Pering, K., Peterson, E., Flores, J., Ponnampuruma, C., Kaplan, I. R., and Moore, C.: 1970, 'Evidence for Extraterrestrial Amino Acids and Hydrocarbons in the Murchison Meteorite', *Nature* **228** (5275), 923–6, December 5.
- 1694 Kvenvolden, K., Peterson, E., and Brown, F. S.: 1970, 'Racemization of Amino Acids in Sediments from Saanich Inlet, British Columbia', *Science* **169**, 1079–82.
- 1695 Kvenvolden, K. A. and Ponnampuruma, C.: 1970, 'A Search for Carbon and its Compounds in Lunar Samples from Mare Tranquillitatis', NASA-SP-257, NASA Ames Research Center, Moffet Field, Calif. Available from NTIS.
- 1696 Lam, J. and Pedersen, K. R.: 1968, 'Precambrian Organic Compounds from the Ketilidian of Southwest Greenland. II', *Medd. Groenland* **185** (6), 1–15.
- 1697 Lederburg, J.: 1970, 'Cytochemical Studies of Planetary Microorganisms: Explorations in Exobiology', Summary Report 1 July 1969 – 1 July 1970. CSCL-06M, NASA-CR-112847, Stanford Univ. Instrumentation Research Lab., California. Available from NTIS.
- 1698 Lemmon, R. M.: 1970, 'Chemical Evolution', *Chemical Rev.* **70**, 95–109.
- 1699 Levy, R. L., Wolfe, C. J., Grayson, M. A., Gibert, J., Gelpi, E., Updegrove, W. S., Zlatkis, A., and Oro, J.: 1970, 'Organic Analysis of the Pueblito de Allende Meteorite', *Nature* **227** (5254), 148–50, July 11.
- 1700 Levy, R. L., Wolfe, C. J., and Oro, J.: 1970, 'Gas Chromatographic Method for Characterization of the Organic Content Present in an Inorganic Matrix', *J. Chromogr. Sci.* **8**, 524–6.
- 1701 Lipskey, S. R., Cushley, R. J., Horvath, C. G., and McMurray, W. J.: 1970, 'Analysis of Lunar

- Material for Organic Compounds', *Science* **167** (3918), 778–9, January 30. Also published in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. **34**, Pergamon, New York, **2**, 1871–73.
- 1702 Margulis, L.: 1969, 'New Phylogenies of the Lower Organisms: Possible Relation to Organic Deposits in Precambrian Sediment', *J. Geol.* **77**, 606–17.
- 1703 Margulis, L.: 1970, *Origin of Eukaryotic Cells: Evidence and Research Implications for a Theory of the Origin and Evolution of Microbial, Plant and Animal Cells on the Precambrian Earth*, Yale University Press, New Haven, Conn.
- 1704 Mason, B. and Melson, W. G.: 1970, *The Lunar Rocks*, John Wiley, New York.
- 1705 Matisto, A.: 1969, 'On the Microfossils of *Corycium Enigmaticum*', *Bull. Geol. Soc. Finland* **41**, 199–202.
- 1706 Matsuo, S.: 1969, 'Origin and Evolution of the Terrestrial Atmosphere', *Kagaku No Ryoiki* **23**, 345–51, (Japanese).
- 1707 Meinschein, W. G., Cordes, E., and Shiner, V. J., Jr.: 1970, 'Search for Alkanes of 15 to 30 Carbon Atom Length', *Science* **167** (3918), 753–4, January 30.
- 1708 Meinschein, W. G., Jackson, T. J., Mitchell, J. M., Cordes, E., and Shiner, V. J., Jr.: 1970, 'Search for Alkanes of 15 to 30 Carbon Atom Length in Lunar Fines', in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. **34**, Pergamon, New York, **2**, 1875–7.
- 1709 Merek, E. L. and Oyama, V. I.: 1970, 'Integration of Experiments for the Detection of Biological Activity in Extraterrestrial Exploration', in *Life Sciences and Space Research, VIII* (ed. by W. Vishniac and F. G. Favorite), North Holland, Amsterdam, p. 108–15.
- 1710 Miami Univ., Inst. of Molecular Evolution, Coral Gables, Fla.: 1970, 'Experiments and Activities of the Institute of Molecular Evolution', Annual Report, ASA-CR-109371 AR-5.
- 1711 Miller, S. L.: 1969, 'The Origin of Life', in *Biology and the Physical Sciences* (ed. by S. Devons), Columbia Univ. Press, New York, p. 335–365.
- 1712 Moll, H. M.: 1970, 'Bioastronautics and Extraterrestrial Life/Bioastronautica y Vida Extraterrestre', *Revista de Aeronautica y Astronautica* **30**, 663–673, September, (Spanish).
- 1713 Moore, L. R., Moore, J. R. M., and Spinner, E.: 1969, 'A Geomicrobiological Study of the Precambrian Nonesuch Shale', *Proc. Yorkshire Geol. Soc.* **37**, 351–94.
- 1714 Morowitz, H. J.: 1969, 'Physical Foundations of Prebiological Evolution' in *Biology and the Physical Sciences* (ed. by S. Devons), Columbia Univ. Press, New York, p. 324–34.
- 1715 Murphy, M. E., Modzeleski, V. E., Nagy, B., Scott, W. M., Young, M., Drew, C. M., Hamilton, P. B., and Urey, H. C.: 1970, 'Analysis of Apollo 11 Lunar Samples by Chromatography and Mass Spectrometry: Pyrolysis Products, Hydrocarbons, Sulfur, Amino Acids', in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. **34**, Pergamon, New York, **2** 1879–90.
- 1716 Murphy, R. C., Preti, G., Nafissi-V, M. M., and Biemann, K.: 1970, 'Search for Organic Material in Lunar Fines by Mass Spectrometry', *Science* **167** (3918), 755–7, January 30.
- 1717 Murphy, R. C., Preti, G., Nafissi-V, M. M., and Biemann, K.: 1970, 'Search for Organic Material in Lunar Fines by Mass Spectrometry', in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. **34**, New York, Pergamon, **2**, 1891–1900.
- 1718 Nagy, B.: 1970, 'Porosity and Permeability of the Early Precambrian Onverwacht Chert: Origin of the Hydrocarbon Content', *Geochim. Cosmochim. Acta* **34** (4), 525–7, April.
- 1719 Nagy, B., Drew, C. M., Hamilton, P. B., Modzeleski, V. E., Murphy, M. E., Scott, W. M., Urey, H. C., and Young, M.: 1970, 'Organic Compounds in Lunar Samples: Pyrolysis Products, Hydrocarbons, Amino Acids', *Science* **167** (3918), 770–3, January 30.
- 1720 Nagy, B. and Nagy, L. A.: 1969, 'Investigations of the Early Precambrian Onverwacht Sedimentary Rocks in South Africa', in *Advances in Organic Geochemistry* 1968, Proceedings of the 4th International Meeting on Organic Geochemistry, Amsterdam, September 16–18, 1968 (ed. by P. A. Schenck and I. Havanaar), Pergamon Press, Oxford, p. 209–15.
- 1721 Nagy, B., Scott, W. M., Modzeleski, V., Nagy, L. A., Drew, C. M., McEwan, W. S., Thomas, J. E., Hamilton, P. B., and Urey, H. C.: 1970, 'Carbon Compounds in Apollo 11 Lunar Samples', *Nature* **225** (5237), 1028–32, March 14.
- 1722 Nagy, B. and Urey, H. C.: 1968, 'Organic Geochemical Investigations in Relation to the Analyses of Returned Lunar Rock Samples', *Life Sci. Space Res.* **7**, 31–46.

- 1723 Nakashima, T., Lacey, J. C., Jr., Jungck, J., and Fox, S. W.: 1970, 'Effects of Several Factors on Chemical Condensation of Mixed Amino Acid Adenylates', *Naturwiss.* **57**, 67–8.
- 1724 Nakaparksin, S., Gil-Av, E., and Oro, J.: 1970, 'Study of the Racemization of Some Neutral α -Amino Acids in Acid Solution Using Gas Chromatographic Techniques', *Anal. Biochem.* **33** 374–82.
- 1725 Neuman, M. W., Neuman, W. F., and Burton, F. G.: 1969, 'On the Possible Role of Crystals in the Origin of Life: II. The Adsorption of Amino Acids by Apatite Crystals', *Curr. Mod. Biol.* **3**, 69–73, October.
- 1726 Neuman, M. W., Neuman, W. F., and Lane, K.: 1970, 'On the Possible Role of Crystals in the Origins of Life: III. The Phosphorylation of Adenosine to AMP by Apatite', *Curr. Mod. Biol.* **3**, 253–59, July.
- 1727 Neuman, M. W., Neuman, W. F., and Lane, F.: 1970, 'On the Possible Role of Crystals in the Origins of Life: IV. The Phosphorylation of Nucleotides', *Curr. Mod. Biol.* **3**, 277–83, July.
- 1728 Nicholson, I.: 1970, 'Chemical Evolution of Protein Sequences', *J. Macromol. Sci., Chem.* **4**, 1619–25.
- 1729 Olson, J. M.: 1970, 'The Evolution of Photosynthesis', *Science* **168** (3930), 438–46, April 24.
- 1730 Oparin, A. I.: 1968, *Genesis and Evolutionary Development of Life|Vozniknovenie i Nachal'noe razvitie zhizni* (Translation by E. Maass), Academic Press, New York. Translation of item 1074 in Bibliography, *Space Life Sci.* **2**, (1970), 268.
- 1731 Oparin, A. I.: 1970, 'Philosophical and Natural-Historical Aspects of the Origin of Life', *Izv. Akad. Nauk SSSR, Ser. Biol.* (5), 635–42, Sep–Oct. (Russian).
- 1732 Oparin, A. I., Serebrovskaia, K. B., and Vasil'eva, N. V.: 1968, 'Constructing a Model of Prebiological Selection of Supra-Molecular Systems (Coacervate Drops)', *Dokl. Akad. Nauk SSSR* **181**, 744–6, July 21, (Russian).
- 1733 Oro, J. *et al.*: 1970, 'Organogenic Elements and Compounds in Surface Samples from the Sea of Tranquillity', *Science* **167** (3918), 765–7, January 30.
- 1734 Oro, J. *et al.*: 1970, 'Organogenic Elements and Compounds in Type C and D Lunar Samples Apollo 11', in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. **34**, Pergamon, New York, **2**, 1901–20.
- 1735 Oro, J. and Gelpi, E.: 1969, 'Gas Chromatographic Mass-Spectrometric Studies on the Isoprenoids and Other Isomeric Alkanes in Meteorites', in *Meteorite Res., Proc. Symp., 1968* (ed. by P. M. Millman), D. Reidel Publ. Co., Dordrecht, Neth., p. 518–23, 537.
- 1736 Oro, J., Gibert, J., Updegrove, W. S., McReynolds, J., Ibanez, J., Gil-Av, E., Flory, D. A., and Zlatkis, A.: 1970, 'Gas Chromatographic and Mass Spectrometric Methods Applied to the Analysis of Lunar Samples from the Sea of Tranquillity', *J. Chromatogr. Sci.* **8**, 297–308.
- 1737 Oro, J. and Nooner, D. W.: 1970, 'Aliphatic Hydrocarbons from the Precambrian of North America and South Africa', in *Advances in Organic Geochemistry*, Proceedings of the 3rd International Congress, London, 1966 (ed. by G. D. Hobson and G. C. Speers), Pergamon Press Oxford, p. 493–506. Publication of item 1127 in Bibliography, *Space Life Sci.* **2** (1970) 270.
- 1738 Oro, J., Nooner, D. W., and Olson, R. J.: 1970, 'Hydrocarbons in Meteorites', in *Advances in Organic Geochemistry*, Proceedings of the 3rd International Congress, London, 1966 (ed. by G. D. Hobson and G. C. Speers), Pergamon Press, Oxford, p. 507–521.
- 1739 Oro, J., Updegrove, W. S., and Flory, D. A.: 1968, 'Isotopic Carbon Analysis of Meteorite Organic Matter', NASA-CR-103427. Available from NTIS.
- 1740 Oshima, T.: 1969, 'Primitive Protein Models', *Seibutsu Butsuri* **9**, 101–9, (Japanese).
- 1741 Oyama, V. I.: 1970, 'Apollo 11 Lunar Sample. A Search for Viable Organisms', *Chemist (New York)* **47**, 90–4.
- 1742 Oyama, V. I., Merek, E. L., Silverman, M. P.: 1970, 'A Search for Viable Organisms in a Lunar Sample', *Science* **167** (3918), 773–5, January 30.
- 1743 Oyama, V. I., Merek, E. L., and Silverman, M. P.: 1970, 'A Search for Viable Organisms in a Lunar Sample', in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. **34**, Pergamon, New York, **2**, 1921–27.
- 1744 Paecht-Horowitz, M., Berger, J., and Katchalsky, A.: 1970, 'Prebiotic Synthesis of Polypeptides by Heterogeneous Polycondensation of Amino-acid Adenylates', *Nature* **228** (5272), 636–39, November 14.
- 1745 Pedersen, K. R. and Lam, J.: 1970, 'Precambrian Organic Compounds from the Ketilidian of Southwest Greenland. III', *Medd. Groenland* **185** (7), 1–42.

- 1746 Pokorny, V.: 1970, 'Paleontology and the Earth's Atmosphere', *Cas. Mineral. Geol.* **15**, 297-311, (Czechoslovakian).
- 1747 Ponnampereuma, C.: 1970, 'Chemical Evolution and the Origin of Life', *N. Y. State J. Med.* **70**, 1169-75, May 15.
- 1748 Ponnampereuma, C.: 1970, 'Editorial: Space Biology and the Origin of Life', *Space Life Sci.* **2** 119-120.
- 1749 Ponnampereuma, C.: 1970, 'Search for Life on the Moon', *Priroda* No. 8, 61-65, (Russian).
- 1750 Ponnampereuma, C.: 1970, 'The Search for Organic Matter on the Moon', *Atomes* **25**, No. 174, 169-174.
- 1751 Ponnampereuma, C. *et al.*: 1970, 'Search for Organic Compounds in the Lunar Dust from the Sea of Tranquillity', *Science* **167** (3918), 760-2, January 30.
- 1752 Ponnampereuma, C., Caren, L., and Gabel, N.: 1970, 'Molecular Differentiation in Primordial Systems', in *Cell Differentiation* (ed. by O. A. Schjeide and J. de Velis), Van Nostrand, Chapter 2.
- 1753 Ponnampereuma, C. and Klein, H. P.: 1970, 'The Coming Search for Life on Mars', *Quart. Rev. Biol.* **45**, 235-58, September.
- 1754 Pontecorvo, G.: 1969, 'Template Processes in Heredity and Evolution', in *Biology and the Physical Sciences* (ed. by S. Devons), Columbia Univ. Press, New York, p. 26-37.
- 1755 Pozharitskaya, L. M. and Starostin, B. A.: 1970, 'Initial Stages of the Development of Organic Matter of the Earth's Crust', *Zh. Obshch. Biol.* **31**, 189-200, (Russian).
- 1756 Rabinowitz, J.: 1970, 'Peptide and Amide Bond Formation in Aqueous Solutions of Cyclic or Linear Polyphosphates as a Possible Prebiotic Process', *Helv. Chim. Acta* **53**, 1350-55, (French Summary).
- 1757 Rabinowitz, J., Flores, J., Krebsbach, R., and Rogers, G.: 1969, 'Peptide Formation in the Presence of Linear or Cyclic Polyphosphates', *Nature* **224**, 795-96, November 22.
- 1758 Randhawa, M. S., Singh, J., Dey, A. K., and Mittre, V.: 1969, *Evolution of Life*, Publications and Information Directorate, Hillside Road, New Delhi, India.
- 1759 Reuter, J. H.: 1970, 'On the Synthesis of Peptides under Primitive Earth Conditions', in *Advances in Organic Geochemistry*, Proceedings of the 3rd International Congress, London 1966 (ed. by G. D. Hobson and G. C. Speers), Pergamon Press, Oxford, p. 539-545. Publication of item 1285 in Bibliography, *Space Life Sci.* **2** (1970) 276.
- 1760 Rho, J. H., Bauman, A. J., Yen, T. F., and Bonner, J.: 1970, 'Fluorometric Examination of a Lunar Sample', *Science* **167** (3918), 754-5, January 30.
- 1761 Rho, J. H., Bauman, A. J., Yen, T. F., and Bonner, J.: 1970, 'Fluorometric Examination of the Returned Lunar Fines from Apollo 11', in *Proceedings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. **34**, Pergamon, New York, **2**, 1929-32.
- 1762 Rich, A.: 1970, 'Prospects for the Study of Protein Biosynthesis', in *Funkts Biochem. Kletochnykh Strukt* (ed. by A. I. Oparin), Nauka, Moscow, p. 218-31.
- 1763 Rohlfling, D. L.: 1970, 'Catalytic Activities of Thermally Prepared Poly-Amino Acids: Effect of Aging', *Science* **169** (3949), 998-1000, September 4.
- 1764 Rohlfling, D. L. and Fox, S. W.: 1969, 'Catalytic Activities of Thermal Polyanhydro- α -Amino Acids', *Advan. Catal. Relat. Subj.* **20**, 373-418.
- 1765 Rutten, M. G.: 1970, 'The History of Atmospheric Oxygen', *Space Life Sci.* **2**, 5-17.
- 1766 Sanchez, R. A. and Orgel, L. E.: 1970, 'Studies in Prebiotic Synthesis: V. Synthesis and Photoanomerization of Pyrimidine Nucleosides', *J. Mol. Biol.* **47** (3), 531-543, February 14.
- 1767 Schidlowski, M.: 1970, 'Electron Microscopic Identification of Cell-like Structure from the Precambrian of the Witwatersrand System ($> 2.15 \times 10^9$ years)/Elektronenoptische Identifizierung Mikrostrukturen aus dem Prae-Kambrium des Witwatersrand-Systems (> 2.15 Mrd. Jahre), *Palaeontol. Z.* **44** (3/4), 128-33, (German with English Summary).
- 1768 Schneider-Bernloehr, H., Gelpi, E., Bennett, E. O., and Oro, J.: 1970, 'Lipids of Geochemical Significance in Microscopic Algae. II. Fatty Acids of Geochemical Significance in Microscopic Algae', *Phytochemistry* **9**, 613-17.
- 1769 Schopf, J. W.: 1970, 'Electron Microscopy of Organically Preserved Precambrian Microorganisms', *J. Paleontol.* **44**, 1-6.
- 1770 Schopf, J. W.: 1970, 'Micropaleontological Studies of Lunar Samples', *Science* **167** (3918), 779-80, January 30.
- 1771 Schopf, J. W.: 1970, 'Micropaleontological Studies of Apollo 11 Lunar Samples', in *Proceed-*

- ings of the Apollo 11 Lunar Science Conference* (ed. by A. A. Levinson), *Geochim. Cosmochim. Acta*, Suppl. I, Vol. 34, Pergamon, New York, 2, 1933-4.
- 1772 Schwartz, A. W.: 1970, 'Exobiology', in *Recent Advances in Aerospace Medicine*, Proceedings of the 18th International Congress of Aviation and Space Medicine, Amsterdam, Netherlands, September 15-18, 1969 (ed. by D. E. Busby), D. Reidel Publishing Co., Dordrecht, p. 48-52.
- 1773 Scott, W. M., Modzeleski, V. E., and Nagy, B.: 1970, 'Pyrolysis of Early Precambrian Overwacht Organic Matter ($> 3 \times 10^9$ years old)', *Nature* **225** (5238), 1129-30, March 21.
- 1774 Sedlak, W.: 1967, *Rola Krzemu W Ewolucji Biochemicznej Zycia*. Panstwowe Wydawnictwo Naukowe, Warsaw. (Komisja Ewolucjonizmu Polskiej Akademii Nauk. Materiały z Ewolucjonizmu).
- 1775 Sidorenko, A. V., Rosen, O. M., Gimmel'Farb, G. B., and Tenyakov, V. A.: 1969, 'Abundance of Carbonate Deposits in the Precambrian', *Dokl. Akad. Nauk SSSR* **189**, 1336-9. (Geol.), (Russian).
- 1776 Sidorenko, A. V. and Sidorenko, S. A.: 1970, "'Hydrocarbon Respiration" of Precambrian Graphite-Containing Strata', *Dokl. Akad. Nauk SSSR* **192**, 184-7 (Geochem), (Russian).
- 1777 Siegel, B. Z. and Siegel, S. M.: 1970, 'Biology of the Precambrian Genus Kakabekia: New Observations on Living Kakabekia Barghoorniana', *Proc. Nat. Acad. Sci. U.S.* **67**, 1005-1010.
- 1778 Siemion, I. Z.: 1969, 'Some Problems in Chemical Evolution/Z zagadnien ewolucji chemicznej', *Kosmos (Warsaw) Ser. A.* **18**, 507-20, (Polish).
- 1779 Simmonds, P. G., Bauman, A. J., Bollin, E. M., Gelpi, E., and Oro, J.: 1969, 'Unextractable Organic Fraction of the Pueblito de Allende Meteorite: Evidence for its Indigenous Nature', *Proc. Nat. Acad. Sci. U.S.* **64**, 1027-34.
- 1780 Simoneit, B. R., Schnoes, H. K., Haug, P., Burlingame, A. L.: 1970, 'High Resolution Mass Spectrometry in Molecular Structure Studies. XXXII. Nitrogenous Compounds of the Colorado Green River Formation Oil Shale: Preliminary Analysis by Mass Spectrometry', *Nature* **226** (5240) 75-6, April 4.
- 1781 Smith, J. W., Schopf, J. W., and Kaplan, I. R.: 1970, 'Extractable Organic Matter in Precambrian Cherts', *Geochim. Cosmochim. Acta* **34** (6), 659-75, June.
- 1782 Soran, V.: 1970, 'Contemporary Directions and Achievements on the Origin of Life', *Natura (Bucharest)* **22**, 9-17, (Romanian).
- 1783 Stecker, F. W.: 1969, 'Primordial Cosmic Ray Sources', *NASA Tech Memo*, NASA-TM-X-63658. Available from NTIS.
- 1784 Swain, F. M., Bratt, J. M., and Kirkwood, S.: 1970, 'Carbohydrates from Precambrian and Cambrian Rocks and Fossils', *Geol. Soc. Amer. Bull.* **81**, 499-504.
- 1785 Thompson, P. D.: 1969, *Abiogenesis: From Molecules to Cells*, J. B. Lippincott, Philadelphia.
- 1786 Timofeev, B. V.: 1970, 'A Discovery of Phycomycetes in the Precambrian/Une Decouverte de Physcomycetes dans le Precambrien', *Rev. Palaeobot. Palynol.* **10**, 79-81, (French).
- 1787 Timofeev, B. V.: 1970, 'Giant Sphaeromorphida from the Late Precambrian/Sphaeromorphida geants dans le Precambrien Avance', *Rev. Palaeobot. Palynol.* **10**, 157-160, (French).
- 1788 Tondeur, D.: 1970, 'Dissipative Structures. A New Concept in the Thermodynamics of Irreversible Processes', *Entropie* No. 34-35, 3-12, (French).
- 1789 Van Hoesen, W., Jr.: 1969, 'Organic Geochemistry', Thesis (Ph. D.), Univ. of California, Berkeley, Calif. Available from University Microfilms No. 69-18984.
- 1790 Van Hoesen, W., Maxwell, J. R., and Calvin, M.: 1969, 'Fatty Acids and Hydrocarbons as Evidence of Life Processed in Ancient Sediments and Crude Oils', *Geochim. Cosmochim. Acta* **33** (7), 877, July.
- 1791 Vdovykin, G. P.: 1965, 'Composition of the Carbonaceous Matter in Meteorites', in *Problems of Geochemistry* (ed. by N. I. Khitarov). Israel Program for Scientific Translations, 1969, p. 66-74. Translation into English of *Problemy Geokhimii*, a Jubilee Collection dedicated to the 70th birthday of Academician A. P. Vinogradov (ed. by N. I. Khitarov). Izd. Nauka, Moscow, 1965. Available from NTIS, TT-68-50450.
- 1792 Vdovykin, G. P.: 1967, *Carbonaceous Matter in Meteorites (Organic Compounds, Diamonds, Graphite)*/Uglerodistoye Veshchestvo Meteoritov (Organicheskiye Soyedineniya, Almazy, Grafity), Nauka, Moscow, p. 5-240. Available in English from NTIS, NASA-TT-F-582.
- 1793 Vdovykin, G. P.: 1969, 'Carbon Polytypism in Meteorites', in *Advances in Organic Geochemistry 1968*, Proceedings of the 4th International Meeting on Organic Geochemistry, Amsterdam, September 16-18, 1968 (ed. by P. A. Schenck and I. Havenaar), Pergamon Press, Oxford, p. 593-603.

- 1794 Verdejo Vias, G.: 1969, 'Experimental Basis of Abiogenesis. II', *Farm. Nueva* **34**, 941-8, (Spanish).
- 1795 Vologdin, A. G. and Drozdova, N. A.: 1969, 'Algae of the Family Gloeocapsaceae in Precambrian Deposits of the Batenev Ridge/Vodorosli sem. Gloeocapsaceae v Osadkakh Dobrebriya Batenevskogo Kryazha', *Dokl. Akad. Nauk SSSR* **186** (6), 1419-1421.
- 1796 Vysotskii, Z. Z., Danilov, V. I., and Strelko, V. V.: 1967, 'Properties of Polysilicic Acid Gels and Conditions of the Origin and Development of Life', *USP Sovr. Biol.* **63**, 362-79, May-June, (Russian).
- 1797 Welte, D. H.: 1970, 'Organic Carbon and the Evolution of Photosynthesis on Earth', *Naturwiss.* **57**, 17-23, January, (German).
- 1798 West, M. W. and Ponnamperna, C.: 1970, 'Chemical Evolution and the Origin of Life: A Comprehensive Bibliography', *Space Life Sci.* **2**, 225-95.
- 1799 Woods Hole Oceanographic Institution, Mass.: 1970, 'Chemical Evolution of Phosphate, Part 3'. Available from issuing agency.
- 1800 Yuki, A. and Fox, S. W.: 1969, 'Selective Formation of Particles by Binding of Pyrimidine Polyribonucleotides or Purine Polyribonucleotides with Lysine-Rich or Arginine-Rich Proteinoids', *Biochem. Biophys. Res Commun.* **36**, 657-663.

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