

9TH EUROPEAN WORKSHOP ON ASTROBIOLOGY EANA'09,
 Royal Library, Lippens Auditorium, 4 Boulevard de l'Empereur, Brussels
 October 12-14, 2009

Date: 11 October 2009				
17:00 – 19:00		Registration at Hotel IBIS Grand Place, Brussels		
Date: 12 October 2009				
08:00		Registration at the Royal Library		
09:00 Opening Session				
	9:00	Welcome	Official 1	
			Official 2	
			ISS crew	Message from the ISS crew
			G. Horneck	President of EANA
			E. Javaux	Belgian Astrobiology Group
			C. Muller	Chair of LOC of EANA 09
	10:00	Break		
Session 1: In homage to Darwin's theory of evolution I: Prebiotic chemical evolution				
Co-Chair: M. Gargaud				
Co-Chair: J. Reisse				
No.	time			
01.1	10:30	Fuzzy-logic and the search for a definition of life G. Bruylants [1], K. Bartik [1], J. Reisse [1] <i>[1] Université Libre de Bruxelles, Brussels, Belgium</i>		
01.2	10:45	The Rise of Chemical Complexity from Meteorite sources. Implications for Origin-of-life studies D. E. Bryant [1], K. E. R. Marriott [1], D. Greenfield [2], S. A. Macgregor [3], C. Smith [4], M. A. Pasek [5], T. P. Kee [1] <i>[1] School of Chemistry, University of Leeds, Leeds, UK; [2] Centre for Corrosion Technology, Materials and Engineering Research Institute, Sheffield Hallam University, Sheffield, UK; [3] School of Engineering & Physical Sciences, Heriot-Watt University, Edinburgh, UK; [4] Department of Mineralogy, The Natural History Museum, London, UK; [5] NASA Astrobiology Institute, University of Arizona, Tucson, Arizona, USA</i>		
01.3	11:00	Polymerisation on the rocks : new data and new questions. J-F. Lambert [1], L. Stievano [1,2], I. Lopes [1], M. Fradj [1] <i>[1] Laboratoire de Réactivité de Surface - UMR 7197 (CNRS), Université Pierre et Marie Curie, Paris, France ; [2] AIME - Institut Charles Gerhardt, UMR 5253 CNRS, Université de Montpellier Montpellier Cedex 5 (France).</i>		
01.4	11:15	Recent Developments in the Prebiotic Chemistry of Amino Acids H. Strasdeit [1] <i>[1] Department of Bioinorganic Chemistry, Institute of Chemistry, University of Hohenheim, Stuttgart, Germany</i>		
01.5	11:30	Organic matter in hydrothermal systems on the Russian Far East in the context of prebiotic chemistry V. N. Kompanichenko [1], V.A. Poturay [1], V.L Rapoport [2] <i>[1] Institute for Complex Analysis, Birobidzhan, Russia; [2] Center for Ecological Monitoring, Khabarovsk, Russia</i>		
01.6	11:45	Chemical evolution and chimiotactism M. Troublé [1] <i>[1] PY AUTOMATION, Robotics & AI</i>		
	12:00	Lunch break, business meeting of EANA EC		

Session 2: In homage to Darwin's theory of evolution II: Early biosphere and biological evolution		
Co-Chair: E. Javaux		
Co-Chair: F. Westall		
No.	time	
02.1	14:00	Taxonomic framework and possible affinities of diverse and complex microfossils from c. 3.0 Ga chert in the Pilbara Craton, Western Australia K. Sugitani [1], K. Grey [2,3], T. Nagaoka [1], K. Mimura [1], M.R. Walter [3] <i>[1] Nagoya University, Nagoya, Japan; [2] Geological Survey of Western Australia, Perth, Australia ; [3] Australian Centre for Astrobiology, UNSW, Sydney, Australia</i>
02.2	14:15	The implications of carbonate nanophases in a 3.334 Ga-old microbial mat from the Barberton greenstone belt, South Africa F. Westall [1], B. Cavalazzi [1], F. Foucher [1], C. Andreazza [2], J.-N. Rouzaud [3], L. Lemelle [4], M. Salomé [5], A. Simionovici [6], Y. Marrocchi [7], A. Meibom [7], S. Mostefaoui [7], F. Robert [7] <i>[1] Centre de Biophysique Moléculaire-CNRS, l'Université d'Orléans et l'OSUC, Orléans, France ; [2] Centre de la Matière Divisée-CNRS, Orléans, France ; [3] Laboratoire de Géologie de l'Ecole Nationale, Paris, France ; [4] Laboratoire des Sciences de la Terre, Ecole Normale Supérieure, Lyon, France ; [5] ID21 Beamline, European Synchrotron Radiation Facility (ESRF), Grenoble, FRANCE. [6] Lab. Géophysique Interne & Tectonophysique, Grenoble, France ; [7] Laboratoire d'Etude de la Matière Extraterrestre, Museum National d'Histoire Naturelle, Paris, FRANCE</i>
02.3	14:30	Common biogenicity markers in Barberton (South Africa) and Warrawoona (Australia) archean cherts M. Bourbin [1] <i>[1] Bioemco</i>
02.4	14:45	Metals binding by the early Earth analogue microorganism, Archaea <i>Methanocaldococcus jannaschii</i> and its effects on silicification F. Orange [1,2,3], J- R Disnar [2], F. Westall [1,3], D. Prieur [4], P. Baillif [2] <i>[1] Centre de Biophysique Moléculaire, CNRS, Orléans, France ; [2] Institut de Sciences de la Terre d'Orléans (Université d'Orléans, INSU), Orléans, France ; [3] Observatoire des Sciences de l'Univers en région Centre, Orléans, France; [4] Institut Universitaire Européen de la Mer, Plouzané, France.</i>
02.5	15:00	Large and small bombardments on the Earth - Moon system S. Goderis [1,2], P. Claeys [1] <i>[1] Earth System Sciences, Vrije Universiteit Brussel, Brussels, Belgium; [2] Dept. of Analytical Chemistry, Universiteit Gent, Gent, Belgium</i>
02.6	15:15	Molecular evolution of informational polymers: nonlinear analysis of Bacteria, Archaea and Eukarya RNAs G. Bianciardi [1,2], L. Borruso [2] <i>[1] Dipartimento di Patologia Umana e Oncologia, Università di Siena, Siena, Italia; [2] Centro Studi di Esobiologia, Milano, Italia</i>
	15:30	Break
Session 3: Planetary protection		
Co-Chair: G. Kminek		
Co-Chair: C.S. Cockell		
No.	time	
03.1	16:00	Biodiversity in the context of planetary protection C. Conley [1] <i>[1] NASA Headquarters</i>
03.2	16:15	Anaerobes and Other Microbial Specialists in Spacecraft Associated Environments P. Schwendner [1], R. Wirth [1], C. Moissl-Eichinger [1] <i>[1] Regensburg University, Department of Microbiology and Archaea Center, Regensburg, Germany</i>
03.3	16:30	Toward protecting snowballs! P. Ehrenfreund [1], R. Greeley [2], V. Hipkin [3], N. Peter [4], J. Rummel [5], M. Viso [6] <i>[1] George Washington University, Washington DC, USA; [2] Arizona State University, Tempe, Arizona, USA; [3] Canadian space Agency, Montreal, Canada; [4] European Space Policy Institute, Vienna, Austria; [5] Chairman of the Planetary Protection Panel of COSPAR, East Carolina University, USA; [6] Exobiology, CNES, Paris, France</i>

03.4	16:45	Astrobiology Roadmap of Societal Issues: Integrating Science and Societal Perspectives M. S. Race [1] [1] SETI Institute, Mountain View CA USA
	17:00	Poster session see detailed program below
Invited lecture in Royal Academy of Sciences, Letters and Fine Arts of Belgium, Palais des Académies, 1, rue Ducale, Brussels		
	20:00	Darwin's warm little pond: the origin and early evolution of life A. Lazcano [1] [1] Autonomous University of Mexico, Mexico

Date: 13 October 2009

Session 4: Life in extreme environments I

Co-Chair: H. Stan-Lotter

Co-Chair: A. Wilmotte

No.	time	
04.1	09:00	The Microbial Diversity of Volcanic Rocks C. S. Cockell [1], A. Herrera [1], L. Kelly [1], V. Marteinson [2], K. Olsson [1], A. Simpson [1], S. Summers [1], T. Thorsteinsson [3], P. Wilkinson [1] [1] CEPSAR, Open University, Milton Keynes. MK7 6AA. UK; [2] Matis/Prokaria - Food Research, Innovation and Safety, Reykjavik, Iceland; [3] Hydrology Division, National Energy Authority, Reykjavik, Iceland
04.2	09:15	Cryophile biosignature preservation in Arctic glacial ice: 'survival of the fittest' and what does this mean for planetary exploration? L. G. Benning [1], S. J. Villar [2], J. L. Eigenbrode [3], D. J. Tobler [1], M. Fogel [4], A. Steele [4], H. G. M. Edwards [5], AMASE [6] [1] Earth and Biosphere Institute, School of Earth and Environment, University of Leeds, UK; [2] Area Geodinamica Interna, Facultad de Humanidades y Education, Universidad de Burgos, Spain; [3] NASA Goddard Space Flight Center for Astrobiology, Greenbelt, Maryland, USA; [4] Geophysical Laboratory, Carnegie Institution of Washington, USA; [5] Chemical and Forensic Sciences, University of Bradford, UK; [6] Arctic Mars Svalbard Analog Expedition teams 2005-2008.
04.3	09:30	Unravelling the DNA protection and repair mechanisms in desert strains of Chroococciopsis under extreme terrestrial and extraterrestrial environments D. Billi [1], P. Ghelardini [1,2], L. Grenga [1], K.A Warren-Rhodes [3], C.P. McKay [3] [1] Dipartimento di Biologia, Università di Roma "Tor Vergata", Rome, Italy; [2] Istituto di Biologia e Patologia Molecolari CNR, Rome, Italy; [3] NASA-Ames Research Center, Moffett Field, CA, USA
04.4	09:45	Endolithic microorganisms from mound evaporite deposits (southern Tunisia) N. Stivaletta [1], R. Barbieri [1], P. López-García [2], L. Boihem [3], D. Mille [4] [1] Dipartimento di Scienze della Terra e Geologico-Ambientali, Università di Bologna, Bologna, Italy; [2] Unité d'Ecologie, Systématique et Evolution, CNRS UMR 8079, Orsay Cedex, France; [3] USDA-ARS-SRRC, LA, USA; [4] Florida Institute of Oceanography University of South Florida St. Petersburg, FL, USA
04.5	10:00	Detection of halophilic bacteria and archaea in extreme environments represented by salt attacked stone monuments J. Etenauer [1], G. Piñar [1], K. Sterflinger [1] [1] University of Applied Life Sciences, Department for Biotechnology, Vienna, Austria
04.6	10:15	The Genetics of a microbe-mineral interaction K. Olsson-Francis [1], *R. Van Houdt [2], N. Leys [2], M. Mergeay [2], C.S. Cockell [1] [1] CEPSAR, Open University, Milton Keynes, UK; [2] Unit of Microbiology, Belgian Nuclear Research Centre (SCK•CEN), Mol, Belgium
	10:30	Break

Session 5: Life in extreme environments II		
Co-Chair: P. Rettberg		
Co-Chair: A. Pavlov		
No.	time	
05.1	11:00	Recent data about physico-chemical limits for life on Earth D. Prieur [1] <i>[1] Laboratoire de Microbiologie des Environnements extrêmes, UMR 6197 CNRS, Ifremer, UBO Technopôle Brest-iroise, Plouzané, France</i>
05.2	11:15	Halophilic life in fluid inclusions of halite in terrestrial and extraterrestrial environments H. Stan-Lotter [1], S. Fendrihan [1, 2], A. Legat [1], M. Dornmayr-Pfaffenhuemer [1], M. Grösbacher [1], C. Gruber [1], A. Holzinger [1], K. Schwimbersky [1] <i>[1] University of Salzburg, Division of Molecular Biology, Department of Microbiology, Salzburg, Austria; [2] Romanian Bioresource Center and Advanced Research Association, Bucharest, Romania</i>
05.3	11:30	High survival capacity of rock inhabiting photosynthetic organisms in a simulated interplanetary transfer R. de la Torre [1], the Lithopanspermia Consortium [2], PI of the Life Consortium [3] <i>[1] INTA (Spanish Aerospace Research Establishment, Madrid, Spain); [2] Lithopanspermia consortium: R. De la Torre, L.G Sancho, G. Horneck, P. Rettberg, T. Berger, C. Ascaso, A. de los Ríos, J. Wierzchos, J.P. de Vera, S. Ott, C. Cockell, K. Olsson, J.M. Frías, R. Demets; [3] PI of Life consortium: S. Onofri</i>
05.4	11:45	Exposure of a rock-dwelling cyanobacteria community to Low Earth Orbit K. Olsson-Francis [1], R. de la Torre [2], C.S. Cockell [1] <i>[1] Geomicrobiology Research Group, CEP SAR, Open University, MK7 6AA, UK; [2] Instituto Nacional de Técnica Aeroespacial, Torrejón, Madrid, Spain</i>
05.5	12:00	High Survival Capacities of Lichens on Space Exposure Experiments: - a Signature for Pre-Adaptation to Space? J.-P.P. de Vera [1], R. de la Torre [2], G. Horneck [3], S. Onofri [4], R. Demets [5] <i>[1] German Aerospace Center, Institute of Planetary Research, Division of Experimental Planetary Physics, Berlin, Germany; [2] INTA (Spanish Aerospace Research Establishment), Madrid, Spain; [3] German Aerospace Center, Institute of Space Medicine, Division of Radiation biology /Astrobiology, Cologne, Germany; [4] Ordinario di Botanica Sistemica, Università degli Studi della Tuscia, Viterbo, Italy; [5] ESA (European Space Agency), ESTEC, Noordwijk, the Netherlands</i>
05.6	12:15	“Sleeping chironomid” <i>Polypedilum vanderplanki</i>: morphological, genetical and biochemical tricks for survival in outer space O. Gusev [1,2], T. Kikawada [1], R. Cornette [1], V. Sychev [3], M. Levinskikh [3], N. Novikova [3], L. Malutina [2], T. Okuda [1] <i>[1] Anhydrobiosis Research Unit, National Institute of Agrobiological Sciences, Tsukuba, Japan; [2] Invertebrate Zoology Department, Faculty of Biology, Kazan, Russia; [3] State Research Center, Institute of Biomedical Problems, Moscow, Russia</i>
	12:30	Lunch break, business meeting of EANA EC
Session 6: Astrobiology of planets and small bodies I: Mars		
Co-Chair: V. Dehant		
Co-Chair: H. Lammer		
No.	time	
06.1	14:00	Geophysics and Habitability of Mars V. Dehant [1], D. Breuer [2], T. Spohn [2], A. Chicarro [3] <i>[1] Royal Observatory of Belgium, Brussels, Belgium; [2] DLR German Aerospace Center, Research & Space Science Dept, Berlin, Germany; [3] ESA/ESTEC, Solar System Missions Division, Noordwijk, The Netherlands</i>
06.2	14:15	Modeling Mars water ice clouds and precipitation as observed by the Phoenix lander F. Daerden [1], J. Whiteway [2], R. Davy [2] <i>[1] BIRA-IASB (Brussels, Belgium); [2] York University (Toronto, Canada)</i>
06.3	14:30	The three types of liquid water in the surface of Mars D. Möhlmann [1] <i>[1] DLR Institut für Planetenforschung, Berlin, Germany</i>

06.4	14:45	External energy and nutrient sources for martian subsurface life A. K. Pavlov [1,2], V. N. Shelegedin [3], M. A. Vdovina [1] [1] <i>Ioffe Physico-Technical Institute RAS, St. Petersburg, Russia</i> ; [2] <i>Russian Astrobiology Center, St. Petersburg, Russia</i> ; [3] <i>St. Petersburg Polytechnical State University, St. Petersburg, Russia</i>	
06.5	15:00	Isothermal microcalorimetry: a novel tool for non-disruptive analysis of microbial heat production in mineralogical subsurface ecosystems O. Braissant [1], S. Bindschedler [2], G. Cailleau [2], R. Aubrecht [3], L. Kovacic [4], N. Lee [5] [1] <i>Lab. for Biomechanic and Biocalorimetry (UniBas), Basel, Switzerland</i> ; [2] <i>Institut de géologie et de paleontology (UNIL), Lausanne, Switzerland</i> ; [3] <i>Department of Geology and Paleontology Comenius University in Bratislava, Slovakia</i> ; [4] <i>Department of Botany, Comenius University, Bratislava, Slovakia</i> ; [5] <i>Technical University, München, Germany</i>	
06.6	15:15	Raman spectra of biomarkers and carbonates obtained under low temperature high altitude conditions using miniaturised portable Raman spectrometer J. Jehlicka [1], P. Vitek [1], A. Culka [1], H. G. M. Edwards [2] [1] <i>Charles University in Prague, Institute of Geochemistry, Mineralogy and Mineral Resources, Prague, Czech Republic</i> ; [2] <i>School of Life Sciences, Division of Chemical and Forensic Sciences University of Bradford, Bradford, UK</i>	
	15:30	Break	
Session 7: Astrobiology of planets and small bodies II: Moons, comets and meteorites			
Co-Chair: A. Gimenez			
Co-Chair: F. Raulin			
No.	time		
07.1	16:00	Astrobiology in the Saturn system: news from Cassini-Huygens F. Raulin [1], P. Coll [1], S. I. Ramirez [1, 2], Y. Bénilan [1], H. Cottin [1], M.-C. Gazeau [1], A. Jolly [1] [1] <i>LISA, CNRS / Universités Paris 7 & Paris 12, Créteil, France</i> ; [2] <i>Centro de Investigaciones Químicas, Universidad Autónoma del Estado de Morelos, México</i>	
07.2	16:15	Titan's aerosols interacting with its surface: the potential role of ammonia S. I. Ramirez [1, 2], *P. Coll [1], C. Brassé [1], A. Buch [3], F. Raulin [1] [1] <i>Laboratoire Interuniversitaire des Systèmes Atmosphériques, Universités Paris 7, Paris 12 et CNRS, France</i> ; [2] <i>Centro de Investigaciones Químicas, Universidad Autónoma del Estado de Morelos, México</i> ; [3] <i>Ecole Centrale de Paris, Chatenay-Malabry, France</i>	
07.3	16:30	Organic compounds analysis by TOF-SIMS in the frame of Rosetta/COSIMA space mission L. Le Roy [1, 2], C. Briois [1], L. Thirkell [1], H. Cottin [2], N. Fray [2], G. Poulet [1], M. Hilchenbach [3] [1] <i>LPC2E, Orléans, France</i> ; [2] <i>LISA Univ. Paris 12 & Paris 7, Créteil, France</i> ; [3] <i>MPS Max-Planck, Katlenburg-Lindau, Germany</i>	
07.4	16:45	Meteorites and astrobiology: Some basic thoughts B.A. Hofmann [1] [1] <i>Natural History Museum Bern, Bern, Switzerland</i>	
Panel: European Projects Related to Astrobiology			
Co-Chair: G. Horneck			
Co-Chair: C. Muller			
	17:00	J. Hatton	ESA projects in astrobiology
		J. Vago	ExoMars
		D. Schmitt	Space exploration policy at EC
		C. Ellis	CAREX, Coordination Action for Research Activities on life in Extreme Environments
		H. Lammer	EuroPlanet
		T. Berger	HAMLET
		C. Muller	ULISSE
		N. Walter	THESEUS
		W. Geppert	The Chemical Cosmos; Understanding Chemistry in Astronomical Environments (COST)
		M. Hofmann	PECB, Protecting the Environment of Celestial Bodies
		Burchell	Astrobiology teaching in U.K.
	18:00		Discussion

	19:00	Guided tour of the historical “Grand Place”
	19:45	Dinner at “Chez Léon”, rue des Bouchers, Brussels

Date: 14 October 2009

Session 8: Astrobiological aspects in astrophysics and astrochemistry

Co-Chair: E. Szuszkiewicz

Co-Chair: C. Cosmovici

No.	time	
08.1	09:00	The classification of habitats and the evolution of habitable planets H. Lammer [1] <i>[1] Austrian Academy of Sciences, Space Research Institute</i>
08.2	09:15	UV-olution: investigation of photochemistry of organic compounds in low Earth orbit. A review of the main results. H. Cottin [1], Y.Y. Guan [1], F. Stalport [1, 2], F. Macari [1], M. Jérôme [1], C. Philippon [1], P. Coll [1], N. Fray [1], C. Szopa [3], F. Raulin [1] <i>[1] LISA, University Paris 7 & Paris 12, UMR 7583 CNRS, Créteil, France ; [2] NASA, GSFC, Atmospheric Experiments Laboratory, Greenbelt, MD, USA; [3] LATMOS, University Paris 6 & Versailles, UMR 8190 CNRS, Verrières le Buisson, France</i>
08.3	09:30	Strategy for the Future BION-10M Flight Experiment: Study of Radiation Behavior of Organic Molecules Protected by Extraterrestrial Minerals N. Gontareva [1], E. Kuzicheva [1], V. Ilyin[2] <i>[1] Institute of Cytology, Laboratory of exobiology, St Petersburg, Russia; [2] Institute of Medico-Biological problems, Moscow, Russia</i>
08.4	09:45	Formation of Complex Amino Acid Precursors in Dense Clouds and Their Delivery to the Primitive Earth K. Kobayashi [1], H. Fushimi [1], T. Motoyama [1], T. Taniuchi [1], T. Kaneko [1], Y. Takano [2], J. Takahashi [3], H. Mita [4], H. Yabuta [5], H. Hashimoto [6], S. Yokobori [7], A. Yamagishi [7] <i>[1] Graduate School of Engineering, Yokohama National University; [2] Japan Agency for Marine-Earth Science and Technology; [3] NTT Microsystem Integration Laboratories; [4] Faculty of Engineering, Fukuoka Institute of Technology; [5] Graduate School of Science, Osaka University; [6] Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency; [7] Faculty of Life Science, Tokyo University of Pharmacy and Life Science</i>
08.5	10:00	The Amino Acids Produced from HCN and Mixed HCN/HCHO Reactions: Implications for Organic Chemistry in Extraterrestrial Bodies H. J. Cleaves II [1]*, J.P. Dworkin [2] <i>[1] Geophysical Laboratory, the Carnegie Institution of Washington, Washington, USA; [2] Solar System Exploration Division, NASA Goddard Space Flight Center Greenbelt, USA</i>
08.6	10:15	On the importance of cosmic rays in astrobiology F. Ferrari [1], E. Szuszkiewicz [1] <i>[1] CASA and Institute of Physics, University of Szczecin, Szczecin, Poland</i>

10:30 Break

Session 9: Human exploratory missions and astrobiology

Co-Chair: M. Mergeay

Co-Chair: T. Berger

No.	time	
09.1	11:00	Culture in simulated microgravity affects quorum sensing in the life support bacterium <i>Rhodospirillum rubrum</i> S1H F. Mastroleo [1,2], R. Van Houdt [1], M. Mergeay [1], L. Hendrickx [1], R. Wattiez [2], N. Lays [1] <i>[1] Expert group Molecular and Cellular Biology, Belgian Nuclear Research Center (SCK•CEN), Mol, Belgium; [2] Laboratory for Proteomics and Protein Biochemistry, University of Mons, Mons, Belgium</i>

09.2	11:15	Immunotoxicity and genotoxicity testing for in-flight experiments under microgravity: The TRIPLELUX-B experiment E. Unruh [1], P. D. Hansen [1] <i>[1] Technische Universität Berlin Berlin Institute of Technology, Berlin, Germany</i>
09.3	11:30	The Complete Genome Sequence of the Alkaliphilic Nonheterocystous Cyanobacterium <i>Arthrospira (Spirulina) platensis</i> PCC8005 P. J. Janssen, N. Morin, P. Monsieurs, N. Leys [1] <i>[1] Unit of Microbiology, Institute for Environment, Health and Safety - Belgian Nuclear Research Centre SCK•CEN, MOL, Belgium</i>
09.4	11:45	Effects of ionizing radiation on the physiology and morphology of the life-support system cyanobacterium <i>Arthrospira</i> sp. PCC8005 N. Morin [1, 3], K. Maes [2], L. Hendrickx [1], A. Wilmotte [3], N. Leys [1] <i>[1] Laboratory of Molecular and Cellular Biology, Belgium Nuclear Research Center (SCK•CEN), Mol, Belgium; [2] Group T - Leuven Engineering College, Leuven, Belgium; [3] Centre for Protein Engineering, Institute of Chemistry, Sart Tilman, University of Liège, Liège, Belgium</i>
	12:00	Closing Session with poster awards
	12:30	End of 9th European Workshop on Astrobiology EANA'09

Post-EANA-meeting:

October 14 (noon) – October 16

Editorial meeting of Encyclopedia in Astrobiology