

**STUDENT RESEARCH IN AN ANALOG LUNAR HABITAT : EUROMOONMARS & ANALOG ASTRONAUT TRAINING CENTER POLAND EMMPOL 2023 CAMPAIGNS 14 & 15.** A. L. Hutchison<sup>1</sup>, J. Cottee<sup>2</sup>, M. Gil Natividad<sup>3</sup>, S. Wurtz-Pra<sup>4</sup>, C. Hayes<sup>5</sup>, S. Molony<sup>6</sup>, D. Osoianu<sup>7</sup>, N. Barker<sup>8</sup>, S. Asfour<sup>9</sup>, B. Reymen<sup>10</sup>, A. Kołodziejczyk<sup>11</sup>, B. Foing<sup>12</sup>, S. Crotti<sup>13</sup>, and M. F. Cecchi<sup>14</sup>. <sup>1</sup>Institut d'Études Politiques de Paris & EuroSpaceHub (ava.hutchison@sciencespo.fr), <sup>2</sup>International Space University (ISU, jacinda.cottee@community.isunet.edu), <sup>3</sup>ISU (m.gil-natividad@community.isunet.edu), <sup>4</sup>ISU (solene.wurtz-pra@community.isunet.edu), <sup>5</sup>TU Dublin & ESH (cianhayes02@gmail.com), <sup>6</sup>TU Dublin & ESH (seanmolony35@gmail.com), <sup>7</sup>TU Dublin & ESH (dannielosoianu@gmail.com), <sup>8</sup>TU Delft (cinbarker@gmail.com), <sup>9</sup>Université de Genève (sirine.asfour@gmail.com), <sup>10</sup>EuroMoonMars (brent.euromoonmars@gmail.com), <sup>11</sup>Analog Astronaut Training Center (fichbio@gmail.com), <sup>12</sup>EuroMoonMars/ILEWG & ESH (foing@strw.leidenuniv.nl), <sup>13</sup>EuroMoonMars (serena.crotti@mail.polimi.it), <sup>14</sup>ISU (maria-f.cecchi@community.isunet.edu).

**Introduction:** The International Lunar Exploration Working Group (ILEWG) EuroMoonMars program includes research activities for data analysis, instruments tests and development, field tests in MoonMars analogue, pilot projects, training and hands-on workshops, and outreach activities. [1-10]. EuroMoonMars field campaigns have been organized in specific locations of technical, scientific and exploration interest. Field tests have been conducted in ESTEC, EAC, at Utah MDRS station, Eifel, Rio Tinto, Iceland, La Reunion, LunAres base at Pila Poland [1-10], and HiSEas base in Hawaii, and AATC Poland. In 2023 LUNEX EuroMoonMars activities were coordinated with EuroSpaceHub Academy. Since the first AATC Poland and EuroMoonMars collaboration for EMMPOL 1 in 2020, this partnership has yielded fruitful and engaging findings for student researchers in various scientific fields and from international backgrounds. These projects were focused on the habitability conditions on the Moon and on conducting experiments in lunar simulation habitat, supported remotely by a mission control team and science support, which was all made possible by the Analog Astronaut Training Center facility in Poland. The upcoming 14th and 15th EMMPOL campaigns will take place about 120 km from Krakow, Poland in a Habitat in Reziennik close to Queen Jadwiga Astronomical Observatory, between the 18th-26th of February and the 1st-9th of March 2023, during which we expect to deepen and diversify the types of research done in simulated lunar isolation. Please find below the descriptions of the mission crew, as well as the preliminary experiment designs from EMMPOL14 and 15 crew campaign, which we intend to evaluate considering possible applicability to the ongoing ARTEMIS mission control and science support.

**EMMPOL 14 Campaign Crew & Experiments :** There are six principal members of the EMMPOL14 crew and one alternate member. Three of the crew are students at the International Space University (ISU), and three are students at the Technological University of Dublin. Mirella Gil Natividad is a Spanish Master's

student in Space Studies at ISU specializing in Space Architecture and Surface Habitation. Cian Hayes is an Irish student in Physics Technology at TU Dublin. Jacinda Cottee is a retired airline pilot from Australia, and now a ISU Master of Space Science student specializing in cognition optimization. Solène Wurtz-Pra is a French mechanical engineer and Master's student in Space Studies with a focus on astronaut mental and physical health at ISU. Both Sean Molony and Danniell Osoianu are TU Dublin students in Medical Physics and Bioengineering. Alternate crew member Sirine Asfour is a French student of International Relations and Law at the Université de Genève in Switzerland, and one of the co-founders of the Swiss Space Law Forum. Hayes, Molony, Osoianu, and Asfour are all student researchers with EuroSpaceHub Academy. The experiments that Crew 14 plan to conduct in isolation are the following :

*MoonLAB Exploration:* An evaluation of habitat research instrumentation equipment necessary for a future surface mission to the Moon, both for internal vehicular activities (IVA) and for extravehicular activities (EVA). For this, the basic instrumental equipment of the module will be studied together with the specific added equipment for this mission EMMPOL14 in terms of IVA and the realization of VR for EVA simulation.

*Hydroponic System for Plant Growth & Mental Health :* As a follow-up to the individual project developed in the SHEE environment at ISU on the growth of chamomile in hydroponic systems, this study will develop multiple usage of this plant, from the optimization of tea extraction protocols, to the creation of decorative elements in the spacecraft, as well as the fabrication of make-up remover. This experiment will not only provide significant scientific results, but will also enhance the mental health of the astronauts.

*Supersize your Brain – Cognition Optimization of Long Duration/Deep Space Missions:* A continuous Fine Motor Skill Assessment for crew members during isolation through origami construction to study the maintenance or possible improvement of fine motor skills during a space analog mission. The findings of

this research are directly related to concerns regarding cognitive performance during long-term space habitation, in which neurogenesis is possibly reduced due to radiation.

*Heart Atrophy* : This investigation will study the function of the heart and cardiovascular system under various low-gravity conditions with the goal of understanding the influence of extended periods of deep-space travel on heart function and atrophy.

*Effects of Cryotherapy and Human Flexibility as a Metric for Joint Health* : This experiment is intended to investigate the effects of Partial-Body Cryotherapy (PBC)/Whole-Body Cryotherapy (WBC) on joint health/performance. Prolonged exposure to microgravity has documented effects and degradation on both bone mass and joint cartilage, and thus this hopes to more deeply explore how cryotherapy can be used to slow or even prevent this degenerative effect using flexibility as a metric.

*Mental and Physical Behavior of Confined and Isolated Habitants* : The purpose of this study is to understand the impact of confined space has on habitants and its effect on regular and irregular mental and physical behaviors through regular interviews and assessments throughout the mission.

#### **EMMPOL 15 Campaign Crew & Experiments :**

There are five confirmed members of the EMMPOL15 Campaign Crew, the sixth and alternate members are currently being selected at the time of submission of this abstract. Ava Hutchison is an American student of Law and Political Science at the Institut d'Études Politiques de Paris (SciencesPo) and the Université de Genève, as well as a student researcher in international outer space law at EuroSpaceHub. Nicolas Barker is a Dutch-American student in Electrical Engineering at the Delft University of Technology and the École polytechnique fédérale de Lausanne (EPFL). EMMPOL14 Crew members Cian Hayes, Sean Molony, and Danniell Osoianu (descriptions above) are continuing their experiments in isolation as members of the EMMPOL15 Crew.

*Eye Biometric Measurements* : This study with document iris structure and pupillary light reflex with high resolution macro imaging to establish a method of eye data collection for future analog missions. This data, particularly in combination with other biometrics such as skin conductivity, heart rate, and blood pressure, are useful indicators of stress, irritation, focus, and overall eye health.

*Organic Crew Organization & Decision-Making* : The purpose of this investigation is to research how analog astronaut participation in the creation of lunar base governance regime outside of the

traditional authoritarian style of mission governance (descending hierarchical structure of commander, vice-commander, medical officer, communications specialist, etc.) and decision-making influences crew cohesion, research efficacy, and independence, as well as potential long-term effects for extended deep space missions.

*Continuation of the 'Heart Atrophy', 'Effects of Cryotherapy and Human Flexibility as a Metric for Joint Health', and 'Mental and Physical Behavior of Confined and Isolated Habitants' experiments described above.*

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