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BRIEF REPORT

International conference on "Photosynthesis and Hydrogen Energy Research for Sustainability-2023": in honor of Robert Blankenship, Győző Garab, Michael Grätzel, Norman Hüner and Gunnar Öquist

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Abstract

The 11th International Photosynthesis Conference on Hydrogen Energy Research and Sustainability 2023 was organized in honor of Robert Blankenship, Győző Garab, Michael Grätzel, Norman Hüner, and Gunnar Öquist, in Istanbul, Türkiye at Bahçeşehir University Future Campus from 03 to 09 July 2023. It was jointly supported by the International Society of Photosynthesis Research (ISPR) and the International Association for Hydrogen Energy (IAHE). In this article we provide brief details of the conference, its events, keynote speakers, and the scientific contribution of scientists honored at this conference. Further, we also describe the participation of young researchers, their talks, and their awards.

Keywords Robert Blankenship · Győző Garab · Michael Grätzel · Norman Hüner · Gunnar Öquist · Photosynthesis Research · Hydrogen Energy Research · Sustainability

Introduction

In oxygenic photosynthesis, light energy facilitates the transformation of water and CO_2 into oxygen and organic compounds, encompassing water oxidation (releasing oxygen) and the reduction of CO_2 (forming carbohydrates). Comprehensive insights into these processes can be found in review articles (Blankenship and Hartman 1998; Blankenship et al. 2007; Liu and Blankenship 2019; Oliver et al 2023). Approximately 3.5 billion years ago, primordial cyanobacteria initiated the transformation of Earth's anaerobic atmosphere, laying the foundation for a diverse array of life forms (Renger 2010; Hohmann-Marriott and Blankenship 2011; Stirbet et al. 2020). Harnessing solar energy, these organisms contributed to the accumulation of fossil fuels, resources that contemporary industrialized societies are depleting at an unsustainable pace (Hou et al. 2023). Given this, innovative solutions are imperative to address our future energy needs. The combustion of fossil fuels and its resultant environmental ramifications pose pressing challenges. A potential solution lies in emulating natural photosynthesis to artificially generate energy. Advances in biochemistry, biophysics, molecular biology, and both theoretical and experimental chemistry have enabled detailed explorations into the architecture and operational dynamics of photosynthetic assemblies and their associated reactions (Kiang et al. 2007). Cutting-edge methodologies have elucidated the molecular structures of not only photosystem (PS) I and II but also the light-harvesting antenna complexes (Suga et al. 2014; Nelson and Junge 2015; Shevela et al. 2023) and the cytochrome b_6f complex (Kurisu et al. 2003; Cramer et al. 2006). These molecular insights are refining our understanding of the mechanisms underlying light-induced water oxidation, culminating in $NADP^+$ reduction. Such knowledge is anticipated to guide the conceptualization of biomimetic strategies for sustainable energy generation.

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Nonetheless, a comprehensive molecular perspective on the photochemical processes and photosynthetic machinery across a broad spectrum of photosynthetic entities remains elusive.

The 11th International Photosynthesis Conference on Hydrogen Energy Research and Sustainability 2023 was organized in honor of Robert Blankenship (USA), Győző Garab (Hungary), Michael Grätzel (Switzerland), Norman Hüner (Canada), and Gunnar Öquist (Sweden), at Bahçeşehir University Future Campus, Istanbul from 3 to 9 July 2023. It was a great occasion for discussions of previous, present, and future research on photosynthesis and hydrogen energy, from molecular to global perspectives. The event also offered an exciting scientific program that covered the breadth and depth of photosynthesis and hydrogen energy. It spanned from fundamental and applied aspects of research to artificial photosynthesis and nanobiotechnology, bringing together researchers in these fields from around the world. This meeting served as a forum for students, postdoctoral fellows, and scientists from different countries to enhance their knowledge and understanding, broaden professional contacts, create new opportunities, and establish collaborations. Furthermore, one of the sessions was dedicated to young scientists' talks and their awards. As anticipated, scientists from over thirty countries attended the event (Algeria, Australia, Austria, Azerbaijan, Armenia, Bulgaria, Canada, China, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Israel, India, Iran, Italy, Japan, Korea, Kazakhstan, Lithuania, New Zealand, Poland, Russia, Romania, Serbia, Switzerland, Sweden, Singapore, Slovakia, Taiwan, Türkiye, United Kingdom, and USA).

Prior to this meeting, the conference was held in Canada (2004), Russia (2006, 2014, 2016, and 2019), Azerbaijan (2011, 2013, and 2018), Greece (2015), and India (2017), see (Allakhverdiev et al. 2012, 2013, 2014, 2016, 2019; Borisova-Mubarakshina et al. 2020; Tsygankov et al. 2017).

Below are brief details about the distinguished individuals honored at the event.

Robert E. Blankenship, Departments of Biology and Chemistry, Washington University in St. Louis, USA.

Professor Blankenship's research emphases on explicating the mechanisms involved in the energy-storing reactions of photosynthetic organisms and understanding the origin and early evolution of photosynthesis. For his credentials he has published over 450 articles and received several significant awards. He explored the chemical reactions leading to long-term energy storage in photosynthetic systems. Especially, the membrane-bound reaction center complex and its associated group of proteins encompassing an electron transport chain. The major finding of his research has been the identification of molecular parameters responsible for the efficient conversion of absorbed photons into stable products. To obtain these results, his work emphasised kinetic, thermodynamic, and structural measurements on antenna complexes, reaction centers, electron transport proteins, and isolated pigments.

Blankenship's lab sequenced and analysed the whole bacterial genomes and showed the complex evolutionary histories, including substantial horizontal gene transfer. For more information on Professor Blankenship's work, refer to the following papers (Blankenship and Hartman 1998; Blankenship 1992, 2010, 2021; Olson and Blankenship 2004; Blankenship et al. 2007, 2011; Hohmann-Marriott and Blankenship 2011). These publications provide in-depth insights into his research and contributions to photosynthesis and evolutionary biology (Fig. 1).

Győző Garab, former head of the Photosynthetic Membranes Laboratory at the Biological Research Center of the Hungarian Academy of Sciences.

Győző Garab graduated in Physics (1971) from Szeged University (JATE) and earned his PhD in 1974 in Biophysics. Garab's primary research interest is biophysics and physiology of photosynthesis. He has (co-) authored two monographs and over 200 papers in peer-reviewed international journals. His research discoveries include the functioning of chlororespiration in higher plants; the biological thermo-optic effect (light-induced reversible reorganizations driven by ultrafast local thermal transients due to dissipation of excess excitation energy); structural and functional roles of non-bilayer lipids and non-lamellar lipid phases in plant thylakoid membranes; the light-adapted charge-separated

Fig. 1 Robert Blankenship. Photo courtesy by Robert Blankenship, USA

state and structural dynamics of Photosystem II reaction centers. Prominent accomplishments include his works on the quasi-helical organization of the granum-stroma thylakoid membrane assembly; the structural plasticity of multilamellar membrane systems of oxygenic photosynthetic organisms as revealed by small-angle neutron scattering; structurally flexible chiral macrodomains of the protein complexes in vivo and in vitro. Additionally, Professor Garab has designed and constructed scientific instruments, including the Integrated Cavity Absorption Meter (ICAM) for weakly absorbing turbid materials and Differential-Polarization Laser Scanning Microscopes (DP-LSMs) for mapping the anisotropy of microscopic samples. He received several prestigious awards, including the Order of Merit of Hungary. For further details on his work, refer to the following articles (Garab et al. 1989, 2022; Mustárdy et al. 2008; Garab 2016; Sipka et al. 2021) (Fig. 2).

Michael Grätzel, Laboratory of Photonics and Interfaces, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland.

Professor Michael Grätzel is a pioneering personality in the field of molecular photovoltaics, being the first to conceptualize and actualize mesoscopic photosystems based on molecular light harvesters that establish highly efficient conversion of light into electricity. The resulting new generation of solar cells, stemming from his ground-breaking research, can now compete with or even surpass the performance of conventional photovoltaics. Grätzel is recognized for advancing the photovoltaic field from the principle of light absorption via diodes to the molecular level. His innovative cell design introduces a three-dimensional mesoscopic junction, departing from the planar p-n architecture employed in traditional solar cells. The prototype of this novel photovoltaic family is the dye-sensitized solar cell (DSC), frequently referred to as a "Grätzel cell."

Grätzel has also played an important role in the recent development of perovskite solar cells, which directly evolved from DSCs. Their rapid advancement to a solar-to-electric power conversion efficiency of 26.1% in 2019 has gathered significant attention and research interest. Additionally, Grätzel has applied his mesoscopic design concept to create photoelectrochemical cells that efficiently generate chemical fuels from sunlight and offer a new avenue for future renewable energy sources which can be stored. With 1650 publications receiving approximately 470,000 citations and an h-index of 298 (as of November 2023), Professor Michael Grätzel is a highly influential figure in his field. A recent ranking by Stanford University placed him in the first position on a list of 100,000 top scientists across all fields. For more information on his work, see these papers (Bach et al. 1998; Grätzel 2003, 2004; Nazeeruddin et al. 2005) (Fig. 3).

Norman Hüner, Department of Biology, University of Western Ontario, London, Canada.

The Antarctic green alga, recently renamed *Chlamydomonas priscuii* (UWO 241), is the primary focus of study in the Hüner Laboratory, serving as a model system for exploring life in extreme conditions. He addressed the photoautotrophic lifestyle demands the integration of photophysical, photochemical, and biochemical processes involved in converting light energy into stable storage forms of carbon for growth and metabolism. The long-term goal of the research program in the Hüner Lab is the wide-ranging physiological, biochemical, and molecular characterization of *Chlamydomonas priscuii* (UWO 241). This includes understanding the structure and function of its unique photosynthetic apparatus to address how this psychrophilic maintains cellular energy balance under extreme environment and elucidate the molecular basis of psychrophilic.

For more information on his work, see the following papers (Hüner et al. 1998; Öquist and Hüner 2003; Morgan-Kiss et al. 2006; Hüner et al. 2012; Hüner et al. 2016; Cvetkovska et al. 2018; Zhang et al. 2021; Szyszka-Mroz et al. 2022; Hüner et al. 2022) (Fig. 4).

Fig. 2 Győző Garab. Photo courtesy by Győző Garab, Hungary

Fig. 3 Michael Grätzel. Photo courtesy by Michael Grätzel, Switzerland

Fig. 4 Norman Hüner**.** Photo courtesy by Norman Hüner, Canada

Fig. 5 Gunnar Öquist. Photo courtesy by Gunnar Öquist, Sweden

Gunnar Öquist, Professor Emeritus, Umeå Plant Science Centre, Department of Plant Physiology, Umeå University, SE-90187 Umeå, Sweden

Professor Gunnar Öquist, born in 1941, pursued studies in chemistry and biology at Uppsala University, earning his graduation in 1967. In 1981, Gunnar Öquist was appointed Professor of Plant Physiology at Umeå University. His primary research focuses on stress and adaptation mechanisms in photosynthesis, with a precise emphasis on understanding the physiological responses of photosynthesis under low temperature and high light conditions. His extensive work involves the study of photosynthesis in evergreen conifers, herbaceous plants, cyanobacteria, and algae under diverse environmental conditions. His cyanobacterial research also encompasses in-depth investigations into the acclimation of photosynthesis to limiting iron supply. Öquist published approximately 200 publications in international journals and was recognized by Thomson-Reuters as an ISI Highly Cited Researcher in 2002 (http://isihighlycited.com/). Gunnar Öquist has received a number of medals and international orders for his service to science and research. For more information on his work, see these papers (Clarke et al. 1993; Hüner et al. 1998; Öquist et al. 1993; Öquist and Hüner 2003) (Fig. 5).

Conference overview

The first day of the conference started with an opening ceremony, which was followed by plenary lectures by Gunnar Öquist, Robert Blankenship, and Ibrahim Dincer (Canada). Figure 6A, B shows the opening ceremony and the group photo of this meeting. The lecture of Gunnar Öquist provided insight on the topic "breakthrough research and the Nobel prize" (Fig. 7).

Robert Blankenship shared 50 years of his photosynthesis journey, which was really inspiring and thoughtful, and Ibrahim Dincer, Ontario Tech University, Faculty of Engineering and Applied Science, Ontario, Canada. Discussed developments in green hydrogen production. Figure 8 shows the online lecture of Prof. Robert Blankenship.

The afternoon session mostly discussed photosynthetic machinery stability in extremophiles and under stress conditions by Győző Garab and Norm Hüner. Subsequently, Michael Grätzel gave his online talk on "Solar hydrogen generation and artificial photosynthesis".

The talks for the second day were started by Thomas D. Sharkey (USA) on cytosolic carbon metabolism where he showed that cytosolic sucrose synthesis was important to allow moderate to high rates of photosynthesis. As a results of the oxygenation reaction of Rubisco the photorespiratory metabolic pathway that involves mitochondria and peroxisomes are needed. Also, discussed the metabolic pathway that are closely associated with the Calvin-Benson-Bassham cycle, fatty acid synthesis, isoprenoid synthesis and phenylpropanoid metabolism. Mahdi Najafpour (Iran) presented his work on the topic of the water-oxidation reaction in the presence of manganese compounds—focusing on artificial photosynthesis. Marc Nowaczyk (Germany) gave a talk on structural insights into PSII assembly. Nowaczyk showed his recent work on cryo-electron microscopic structure of partially functional PSII from thermophilic cyanobacterium, *Thermosynechococcus vestitus BP-1* where it contains three assembly factors (Psb27, Psb28, Psb34) and addressed its molecular function. His group identified for the first time that fully matured PsbJ in the structure of PSII.

After a coffee break, the lectures continued by Yutaka Shibata (Japan) on the topic "Cryo-optical microscopy study on regulation mechanism of photosynthetic light harvesting". The work was focused on the intracellular rearrangements in state transitions and fluctuation of energy transfer within the PSI from *Chlamydomonas*. His work also reported that the free LHC's were in highly quenched state in PSI enriched complexes. Subsequently, Jan Kern (USA) delivered an insightful presentation on the oxidation mechanism of water, drawing upon data from global synchrotron

Fig. 6 **A** Introduction and opening remarks by Suleyman Allakhverdiev. Photo by Rajagopal Subramanyam, India; **B** Group photograph. Photo by Girayhan Yilmaz, Türkiye

Fig. 7 Photo of Prof. Gunnar Öquist. Photo by Tatsuya Tomo, Japan

Fig. 8 Photo of Prof. Robert Blankenship's online lecture, Prof. Győző Garab in the foreground. Photo by Rajagopal Subramanyam, India

radiation facilities. Kern also showed their work using X-ray pulses from XFELs and data for PSII crystals at different time points during the light driven water oxidation reaction. Their results showed that the structure obtained at 2 Å resolution for the four stable states (S_0 to S_3) (Kern et al. 2018) also for the time points in the S_2-S_3 transitions (Ibrahim et al. 2020; Hussein et al. 2021) and the S_3 to S_0 transition (Bhowmick et al. 2023). This was followed by a lecture from Iftach Yacoby (Israel) on hydrogen energy production. His group used *Chlamydomonas reinhardtii pgr-5* mutant to show the accumulation of H_2 production as result in this mutant showed increased respiration and a slower Calvin cycle, enabling sustainable H_2 production for an extended period of 12 days under ambient mesotrophic conditions.

After lunch, the lecture series resumed. Stefano Santabarbara (Italy) explored the light-induced triplet states in PS I based on chlorophyll *d* of *Acaryochloris marina*. Santabarbara Group predominantly showed femtosecond spectroscopy to understand the role of Chl-*d* in PSI. Rajagopal Subramanyam then delved into *Chlamydomonas reinhardtii* mutants, highlighting the correlation between high-light-induced changes in cyclic electron transport. Further, he addressed the composition of thylakoid supercomplexes in conjunction with high-light-induced alterations in whole-cell proteomic profiles. He showed that *lhcsr3* and *psbs genes* were differentially expressed in these strains due to various expression of carotenoid pigments (Yadav et al. 2023). In this study, the *pgr5* is more sensitive to high light than *pgrl1*. Following this, Cristopher Gisriel (USA) discussed the structure–function relationships of far-red light-absorbing allophycocyanins. He presented their data on cryo-electron microscopy and time resolved absorption spectroscopy to show the structure and functional relationship of allophycocyanin complexes during acclimation to low light. Concluding the session, Anna Frank (Germany) presented on the rational design of biological photoelectrodes for in vitro biocatalysis. Poster sessions started in the evening and continued for the fourth and fifth days. Broadly the posters covered most of the photosynthetic light reactions, and energy generation and artificial photosynthesis. The poster sessions were chaired by a four-member committee including Stefano Santabarbara (Italy), Rajagopal Subramanyam (India), Kostas Stamatakis (Greece) and Maria Borisova-Mubarakshina (Russia). Poster sessions were very interactive, and young researchers shared their discoveries with the whole scientific community at the meeting (Fig. 9).

On day three, the first lecture was given by Lorenzo Ferroni (Italy) on the topic "Chloroplast and photosynthetic acclimation in a lycophyte, *Selaginella martensii:* a window on the photosynthesis of ancient vascular plants?". This group shows that the *S. martensii* is ancient vascular plant lineage having ancestral feature of photosynthesis. This species can acclimate to high light and can perform non-photochemical quenching which is very important to understand the evolution of photosynthesis. Tatsuya Tomo (Japan) presented the role of red-shifted chlorophyll in photosystems from isolated complexes. He also discussed the energy transfer between Chl *a* to *f*. Yoshifumi Ueno (Japan) reported their results about state transitions in gray algae, a symbiotic alga. This group showed clearly that gray algae also perform similar type of state transition. Arvi Freiberg (Estonia) explored the significance of excitons in light-harvesting of sulfur and no-sulfur purple bacteria using optical spectroscopy at reduced temperatures. Keisuke Kawakami (Japan) presented on the "Structure of the far-red light utilizing PS I of *Acaryochloris marina*." Their structural information emphasized that a unique Type I reaction center utilizes Chl *d* and Pheo *a* electron carrier; their data help explain the mechanism of efficiently utilizing far-red light for driving oxygenic photosynthesis. Francesco Francia discussed the "Use of bacterial photosynthetic vesicles to evaluate the effect of ionic liquids on the permeability of biological membranes"; he showed that carotenoids associated with LHCII act as endogenous spectral probes of the membrane electrical potential. Kentaro Ifuku (Japan) elaborated on "The extrinsic subunits of PS II optimizing the oxygen-evolving reaction and functional significance of chloride in the water-oxidation reaction", showing that D139N

Fig. 9 Photos of several speakers during the conference. **A** Arvi Freiberg; **B** Kawakami and Kern; **C** Kentaro Ifuku; **D** Kostas Stamatakis; **E** Barry Bruce; **F** Agepati S. Rahavendra; **G** Marek Živčák; **H** Ondrej Dlouhy. Photos by Rajagopal Subramanyam, India

mutation enhances the Cl^- retention ability of PsbP. Also discussed the structural differences of PSII structures of plants from cyanobacteria, red algae and diatom; their work strongly suggested the importance of one of the chloride ions (‘Cl-2’) in the functioning of the oxygen evolving complex. Concluding the session, Kostas Stamatakis (Greece) addressed “Enhanced hydrogen production of *Synechococcus* sp. PCC 7942 cells”. This group have genetically engineered strain of S7942 that accumulates good amount of sucrose and glycogen which viable alternative to H_2 formation via anaerobic dark fermentation. He concluded that marked H_2 production and indicates the glucose derived from the endogenous glycogen as the main carbon substrate fermented (Broussos et al. 2024).

The afternoon session of the third day featured lectures by Barry Bruce (USA), Maria Borisova-Mubarakshina (Russia), and Suleyman Allakhverdiev (Russia/Türkiye). Barry Bruce delivered his lecture on the topic “Evolutionary changes in the oligomeric states of PS I: Three- Two- Four- One”. This work has been fascinating to many in the audience as he showed the evolutionary structural models of tetrameric PSI complexes in cyanoacteria. Maria Borisova-Mubarakshina gave a lecture on the plastoquinone pool of higher plant chloroplasts and relationship of reactive oxygen species, and the production of hydrogen peroxide, superoxide anion radicals in chloroplast. The lecture by Suleyman Allakhverdiev on Artificial Photosynthesis dealt with modified PSI and PSII; he showed how to create an artificial system capable of generating H_2.

The fourth day morning session started with an invited lecture by Agepati S. Raghavendra (India). He gave a lecture on “Redox signals between cellular organelles to modulate photorespiratory enzymes in pea leaves”. Mainly he discussed the photorespiratory system which responded strongly to the reactive oxygen species and nitric oxide; and also discussed the inter-organelle responses. It was followed by a talk on “Monitoring activity and regulation of electron transport at PSI to uncover specific stress responses in crop plants” by Marek Živčák (Slovakia). This group mainly focused on the PSI photoinhibition and its photoprotection in various stress conditions in wheat plants; they also showed alterations in proton gradient, proton conductance and non-photochemical quenching of PSI. The talk by Ondřej Dlouhý (Czech Republic) on the “Role of non-lamellar lipid phases in the structure and function of the plant” interpreted their data within the frameworks of the Dynamic Exchange Model, which proposes that non-lamellar lipid phases contribute to the structural plasticity of the highly organized vesicular membrane systems and safe-guard the high protein-to-lipid ration of thylakoid members. Following a coffee break the presentations continued with talks about “Alternative electron transport pathways in microalgae” by Milán Szabó (Hungary). He discussed results showing the effects of various environmental conditions on the wave phenomenon of the relaxation of flash-induced chlorophyll fluorescence; and revealed the components of various electron transfer processes related to the wave phenomenon in a range of microalgae species. Václav Karlický (Czech Republic) talked on “Acclimation of photosynthetic apparatus to different light intensities in Norway spruce”. This group reported on changes in the macro-organization of PSII-LHCII supercomplexes in thylakoid membranes of high light acclimated spruce and observed the unchanged distribution of the excitation energy between two photosystems after grana unstacking. Also, noticed a considerable increase of bilayer lipid sulfoquinovosyl-diacylglycerol at the expense of non-bilayer lipid monogalactosyl-diacylglycerol in high light acclimated spruce. Afternoon lecture sessions covered topics related to thylakoid protein phosphorylation, non-photochemical quenching and PsbS expression, potential biohydrogen production, and the participation of thylakoid carbonic anhydrases in the photosynthesis of higher plants by various scientists.

The fifth day started with the final invited lecture session of the conference from pioneering scientists worldwide, Anjana Jajoo (India) was the first speaker who gave lecture on “Arbuscular Mycorrhizal fungi (AMF) protects photosynthetic apparatus of wheat under drought stress”. These results revealed that AMF colonization of plants alleviated to large extent the drought stress-induced damage to the structure and function of the two PSs. The lecture of Bekzhan Kossalbayev (Kazakhstan) was on hydrogen energy production and that of Dmitry Dunikov (Russia) on metal hydride reactor for hydrogen storage and purification. The final invited lecture of the conference was given by Mohammad Yusuf Zamal (India) who delivered a talk on the photosynthetic apparatus of *Rhodobacter alkalitolerans*. He reported that the stability of the photosynthetic complexes was better in high pH and high light conditions. These data might pave the way towards developing alkali-tolerant algae and higher plants. After this talk, the young researchers selected from the poster session gave their talks After their fabulous talks each of them was awarded a certificate and a cash prize (Fig. 10).

Fig. 10 Winners of the young researcher awards (front row), from left: Avratanu Biswas (Hungary), Kinga Ilona Böde (Hungary), Daria Vilyanen (Russia), Elena Zadneprovskaya (Russia), Sabit Mohammad Aslam (Hungary), and Pavithra Ramachandran (India). Some of the selection committee members and organizers are also in the second row, from left: Suleyman Allakhverdiev, Tom Sharkey, Francesco Francia, Győző Garab, Stefano Santabarbara, Tatsuya Tomo and Rajagopal Subramanyam. Photo by Girayhan Yilmaz, Türkiye

Appendix

List of the titles of the presentations by young scientists who were selected for poster talks (arranged alphabetically, with the titles of their papers):

- Avratanu Biswas (Hungary), "Modelling of energy transfer from phycobilisomes to PS I in the cyanobacterium *Synechocystis* sp. PCC6803"
- Kinga Ilona Böde (Hungary), "Evidence for the role of isotropic lipid phase in the fusion of PS II membranes"
- Sabit Mohammad Aslam (Hungary), "Differences in the heat susceptibility and involvement of NDH-2 in alternative electron transport in coral endosymbiont algae, Symbiodiniaceae"
- Pavithra Ramachandran (India), "Photosynthetic efficiency and transcriptome analysis of *Dunaliella salina* under hyper saline: a retrograde signalling mechanism in the chloroplast"
- Daria V Vilyanen (Russia), "New insight into inhibitory activity of dinitrophenol ether of iodonitrothymol and the functional properties of cytochrome b_6f complex"
- Elena V. Zadneprovskaya (Russia), "Biotechnological potential of the green microalgae *Coelastrella* sp. IPPAS H-626"

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Data availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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