IAAS 2019 meeting program

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08:00-08:45	Registration + Coffee		
Room 1 - ALMOG			
09:00-09:15	IAAS Welcome + General assembly, Prof. Orit Sivan, President of the IAAS		
09:15-10:00	Plenary talk: Prof. Tom Ian Battin, EPFL *The pores and chimneys of stream ecosystems*		
Room 1 - ALMOG		Room 2 - AQUAMARINE	
Session 1: Marine research for supporting environmental policy in the Mediterranean Sea Chair: Olga Zlatkin and Matan Oren		**Session 2: Dynamics of streams and estuaries** Chairs: Tom Topaz and Shai Arnon	
10:00-10:15	**Barak Herut**: The national monitoring Program for Israeli Mediterranean waters: New perspectives	10:00-10:15	**Invited: Ute Risse-Buhl**: Flow variability affects multi-trophic levels of fluvial biofilms: Within and across microbial groups effects
10:15-10:30	**Ilana Berman-Frank**: The impacts of brine discharges from seawater desalination facilities on coastal environment	10:15-10:30	**Shulamit Nussboim**: Diagnose transport processes for geochemical components (solute and suspended solid) over a basin through rain, flows and soil moisture
10:30-10:45	**Nurit Kress**: Environmental status of Israel's Mediterranean coastal waters: Setting reference conditions and thresholds for nutrients, chlorophyll-a and suspended particulate matter	10:30-10:45	**Idan Barnea**: Evaluation of vegetated agricultural drainage ditches (VADDs) approach in reduction of phosphorous leaching from farm fields to waterways
10:45-11:00	**Yaron Toledo**: East Med currents, waves and low frequency oscillations - an attempt to acquire a wholesome understanding from theoretical, numerical modelling and field measurement perspectives	10:45-11:00	**Ami Nishri**: The ecological system of the Yarqon Estuary
11:00-11:15	**Oded Katz**: Mass-wasting related marine geo-hazard along the continental slope off shore Israel	11:00-11:15	**Tom Topaz**: Evaluating the ecological risk of exposure to multiple pesticides in a Mediterranean Micro-Estuary
11:15-11:30	**Yizhaq Makovsky**: Seafloor gas seepage in the southeastern Mediterranean Sea: controls and implications	11:15-11:30	**Yaron Hershkovitz**: Toward a standardized ecological assessment of streams in Israel: a current state of affairs
11:30-12:00	Coffee break		
Room 1 - ALMOG		Room 2 - AQUAMARINE	
Session 3: Small bugs big impact: Microbial interactions and ecology Chairs: Miguel Frada and Noa Barak-Gavish		**Session 4: Advances in physical oceanography and its integration in multidisciplinary studies** Chairs: Ayah Lazar and Yael Amitai	
12:00-12:15	**Invited: Maxim Rubin-Blum**: Molecular basis for the success of tubeworm symbioses in the deep-sea chemosynthetic habitats	12:00-12:15	**Dror Malul**: Dancing out-of-phase: Mechanical properties of coral tentacles contribute to mass transfer under wave induced flow
12:15-12:30	**Tamar Zohary**: There to stay: invasive filamentous green alga Mougeotia in Lake Kinneret, Israel	12:15-12:30	**Jennifer L. Irish**: Wave propagation and runup in patchy vegetation
12:30-12:45	**Hila Dror**: Core and dynamic microbial communities of two invasive	12:30-12:45	**Hezi Gildor**: Monitoring of the Eastern Levantine with mobile autonomous systems

	ascidians: can host-symbiont dynamics plasticity affect invasion capacity?		
12:45-13:00	**Tal Luzzatto-Knaan**: Variation and stability in the physiology and metabolome of *Prochlorococcus* MED4 life cycle in mono vs. co-culture with Alteromonas HOT 1A3	12:45-13:00	**Yosef Ashkenazy**: Non-hydrostatic effects in the Dead Sea
13:00-13:15	**Ilia Maidanik**: Population dynamics of T7-like cyanophages and their hosts in the Gulf of Eilat, Red Sea	13:00-13:15	**Invited: Eyal Heifetz**: A Physical Interpretation of the Wind-Wave Instability as Interacting Waves
13:15-13:30	**Chana F. Kranzler**: Silicon limitation facilitates virus infection and mortality of diatoms	13:15-13:30	**Kaushal Gianchandani**: Biogeochemistry under globally glaciated snowball Earth conditions
13:30-14:30	Lunch break		
14:30-15:30	Poster session + coffee		
Room 1 - ALMOG		Room 2 - AQUAMARINE	
Session 5: The ecology and biodiversity of marine biota Chairs: Tamar Guy-Haim and Shevy B.S. Rothman		**Session 6: Biogeochemistry and sedimentary processes** Chairs: Valeria Boyko and Gilad Antler	
15:30-15:45	**Daniel Weihs**: Spinner sharks (*Carcharhinus brevipinna*) spin to remove remoras	15:30-15:45	**Invited: Meir Abelson**: The onset of modern-like Atlantic meridional overturning circulation at the Eocene-Oligocene transition - evidence, causes, and possible implications for global cooling
15:45-16:00	**Sahar Chaikin**: Large breeding aggregations of batoids in the Eastern Levantine coast	15:45-16:00	**Nitai Amiel**: The impact of iron reduction in methanogenic sediments on sedimentary magnetisms
16:00-16:15	**Or Ben-Zvi**: *Euphyllia paradivisa* as a case study for mesophotic coral fluorescence	16:00-16:15	**Yossi Mart**: Analog structural modeling, ocean-ocean subduction and oceanic core complexes
16:15-16:30	**Debra Ramon**: Microplastic ingestion by marine fishes in Israeli coastal waters: A systematic approach	16:15-16:30	**Akos Kalman**: Natural versus anthropogenic imprints on the shallow shelf of the northern Gulf of Aqaba-Eilat, Red Sea
16:30-16:45	**Martina Mulas**: Marine algal forests in the Levantine basin: The case of *Cystoseira rayssiae* along the Israeli coast	16:30-16:45	**Yael Amitai**: West versus East Mediterranean climate over the last millennium from Vermetid skeleton isotopes and CMIP5/PMIP3 models
16:45-17:00	**Invited: Michal Grossowicz**: Using stable carbon and nitrogen isotopes to investigate the impact of desalination brine discharge on marine food webs	16:45-17:00	**Tal Ben-Ezra**: Quantifying and understanding the seasonal changes in nutrient dynamics in the Israeli shelf using biogeochemical measurements
Room 1 - ALMOG			
17:00-17:15	**Dr. Naama Charit-Yaari**: Everyone studies the sea: Partnership in research and education		
17:15-18:00	Concluding remarks, student's best poster/talk awards. Wine/beer on the balcony…		

Posters summary

First author	Title	Session	Number
Talmon Alexandri	Acoustic Localization of Tagged Sharks in a Noisy Sea Environment	Marine Research for supporting environmental policy in the Mediterranean Sea	1
Dikla Aharonovich	Long-term interactions between abundant marine bacteria: *Prochlorococcus* and Alteromonas	Small Bugs Big Impact: Microbial Interactions and Ecology	2
Ronen Alkalay	DeepLev marine observatory - Carbon export and drivers in the southeastern Levantine Basin	Biogeochemistry and sedimentary processes	3
Gilad Antler	A Critical Look at the Combined Use of Sulfur and Oxygen Isotopes to Study Microbial Metabolisms in Methane-Rich Environments	Biogeochemistry and sedimentary processes	4
Edo Bar-Zeev	Impact of Brine from Large-Scale Desalination Facilities on Sessile Organisms	Marine Research for supporting environmental policy in the Mediterranean Sea	5
Hadar Berman	Plankton and nutrient dynamics in the Gulf of Elat (Aqaba): biophysical feedbacks vs. internal dynamics	Advances in physical oceanography and its integration in multidisciplinary studies	6
Steve Brenner	Modeling the dispersion of discharge brine from five desalination facilities along the Mediterranean coast of Israel	Marine Research for supporting environmental policy in the Mediterranean Sea	7
Natalie Chernihovsky	Seasonal flux patterns of planktonic foraminifera in a deep, oligotrophic, marginal sea: sediment trap time series from the Gulf of Aqaba, northern Red Sea	The Ecology and Biodiversity of Marine Biota	8
Chao Deng	The effect of bed form migration on oxygen consumption in the hyporheic zone	Dynamics of streams and Estuaries	9
Matan Elad	The timing and sedimentary structure of submarine landslides offshore Israel	Marine Research for supporting environmental policy in the Mediterranean Sea	10
Efrat Eliani-Russak	Anaerobic oxidation of methane in subarctic lakes	Biogeochemistry and sedimentary processes	11
Jenia Eliya-Iankelevich	PLASTISPHERE: understanding microplastic biota composition and dynamics along the coasts of Israel	The Ecology and Biodiversity of Marine Biota	12
Michal Elul	The effects of temperature on methane related iron reduction in Lake Kinneret deep methanogenic zone	Biogeochemistry and sedimentary processes	13
Eyal Geisler	Aquatic aggregates as a hotspot for heterotrophic diazotrophy in the Qishon Estuary	Small Bugs Big Impact: Microbial Interactions and Ecology	14
Shira Givati	The effect of temperature on bacterioplankton macromolecular composition and N:P ratio in selected cultures	Small Bugs Big Impact: Microbial Interactions and Ecology	15
Tal Idan	Protecting the secret gardens: community structure analyses of four East-Mediterranean mesophotic sponge grounds	Marine Research for supporting environmental policy in the Mediterranean Sea	16
Chen Kenigsberg	The effect of long-term brine discharge from desalination plants on benthic foraminifera	Marine Research for supporting environmental policy in the Mediterranean Sea	17
Nivi Kessler	Selective collection of iron-rich dust particles by natural *Trichodesmium* colonies	Small Bugs Big Impact: Microbial Interactions and Ecology	18
Lee Kroeger	Environmental impacts of offshore aquaculture in Israel	Small Bugs Big Impact: Microbial Interactions and Ecology	19

Irina Kurashova	Kinetic parameters of thiocyanate formation by the reaction of cyanide and its iron complexes and thiosulfate	Biogeochemistry and sedimentary processes	20
Ayah Lazar	Intermediate dense water formation and current variability at the DeepLev moored station in the southeastern Levantine Basin	Advances in physical oceanography and its integration in multidisciplinary studies	21
Yael Leshno	Applying live and dead molluscan assemblages to assess the ecological quality of the Eastern Mediterranean	Marine Research for supporting environmental policy in the Mediterranean Sea	22
Noam Lotem	The role of Iron in anaerobic oxidation of methane in Sihailongwan Lake, China	Biogeochemistry and sedimentary processes	23
Sophi Marmen	The role of land uses and water quality parameters in structuring microbiomes of connected lakes system	Small Bugs Big Impact: Microbial Interactions and Ecology	24
Oriya Moav-Barzel	Increased dissolution of the Eilat Nature Reserve coral reef due to ocean acidification	The Ecology and Biodiversity of Marine Biota	25
Israela Musan	The isotopic composition of dissolved O_2 as a new tracer of deep water processes, formation and change	Advances in physical oceanography and its integration in multidisciplinary studies	26
Omri Nahor	Sporulation studies in seaweeds: towards full domestication of *Ulva* (Chlorophyta) aquaculture	The Ecology and Biodiversity of Marine Biota	27
Chen Rabi	The effect of desiccation events and habitat complexity on the spatial distribution and temporal stability of species in the rocky intertidal	The Ecology and Biodiversity of Marine Biota	28
Eyal Rahav	Phytoplankton and bacterial response to desert dust deposition in the coastal waters of the southeastern Mediterranean Sea; A four year in-situ survey	Small Bugs Big Impact: Microbial Interactions and Ecology	29
Tom Reich	Annual bacterioplankton productivity and distribution in the EMS as observed during the THEMO monthly cruises	Small Bugs Big Impact: Microbial Interactions and Ecology	30
Sydney Riemer	Bioturbation and the Phanerozoic Sulfur Cycle: A Model Approach	Biogeochemistry and sedimentary processes	31
Benyamin Rosental	Evolutionary origin of the mammalian hematopoietic system found in a colonial chordate: Functional and molecular characterization of *Botryllus Schlosseri* immune system	Small Bugs Big Impact: Microbial Interactions and Ecology	32
Dalit Roth-Rosenberg	Are all cells in batch culture equal? Single-cell heterogeneity and the evolution of chlorotic sub-populations in *Prochlorococcus*	Small Bugs Big Impact: Microbial Interactions and Ecology	33
Maxim Rubin-Blum	Abundance, activity, and diversity of Bacteria and Archaea in the deep sediments of the southeastern Mediterranean Sea	Small Bugs Big Impact: Microbial Interactions and Ecology	34
Yael Shai	The effect of oil pollution on marine microbial populations in Israeli coastal waters	Small Bugs Big Impact: Microbial Interactions and Ecology	35
Guy Sisma-Ventura	DOP limits heterotrophic bacteria in the southeastern Mediterranean coastal waters during summertime: A microcosm approach	Small Bugs Big Impact: Microbial Interactions and Ecology	36
Raz Tamir	Light environment drives the shallow to mesophotic coral community transition	The Ecology and Biodiversity of Marine Biota	37
Yoni Teitelbaum	Effect of fine particle deposition on hyporheic exchange Flux under mobile-bed form conditions	Dynamics of streams and Estuaries	38

Julie Wood	Modelling the far field spatial-temporal distribution of desalination brines discharged from multiple sources along the Mediterranean coast of Israel	Marine Research for supporting environmental policy in the Mediterranean Sea	39
Eyal Wurgaft	Methane related biogeochemical processes in the sediments of the Southeastern Mediterranean Continental Shelf	Marine Research for supporting environmental policy in the Mediterranean Sea	40
Itamar Yacoby	Geosteophic adjustment on the f-plane: Beyond discontinuous initial condition in an infinitely long channel	Advances in physical oceanography and its integration in multidisciplinary studies	41
Omer Yorshansky	Iron effect on sulfate-coupled anaerobic oxidation of methane in the SMTZ of deep marine sediments of the Eastern Mediterranean Continental Shelf and the Yarqon Estuary	Biogeochemistry and sedimentary processes	42
Adam Weissman	Cold seep communities and cold water corals of the Palmachim Disturbance – biodiversity hotspots at an edge system	The Ecology and Biodiversity of Marine Biota	43
Gil Rilov	Ten Years of Levant rocky shore ecological monitoring: evidence for a highly seasonal, unstable, increasingly-stressed ecosystem	The Ecology and Biodiversity of Marine Biota	44

Plenary talk

The pores and chimneys of stream ecosystems

Prof. Tom Ian Battin

Stream Biofilm and Ecosystem Research Laboratory, School of Architecture, Civil and Environmental Engineering, École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland

Our perception of stream ecosystems has drastically changed over the last ten years. Today, we understand streams and rivers as major contributors to the global carbon cycle, with atmospheric CO_2 exchange fluxes within the same order of magnitude as for the oceans. And yet have we neglected the streams that drain the mountains of our planets. They figure among the smallest streams on Earth, quite abundant though, and draining catchments with low primary production. In this talk, I will make the case why mountain streams should be considered for future upscaling of CO_2 evasion fluxes from inland waters. Down beneath the surface water start the realm of the biofilm mode of microbial life. The second part of my talk will shed new light on the architectural adaptation of biofilms colonising the porous environment of streambeds. Hopefully, my talk will give a new appreciation on stream ecosystems from the global to the microbial scale.

Session: Marine Research for supporting environmental policy in the Mediterranean Sea

Session chair: Olga Zlatkin

Oral presentations (in order of appearance):

The National Monitoring Program for Israeli Mediterranean Waters: New perspectives

Barak Herut[1*], Dror Zurel[2] and Einat Magal[3]

[1] Israel Oceanographic & Limnological Research
[2] Israeli Ministry of Environmental Protection
[3] Israeli Ministry of Energy

In December 2018, a Government Decision on a 'National Monitoring Program for Israeli Mediterranean Waters' was adopted in line with the United Nations Environmental Program's (UNEP) Integrated Monitoring and Assessment Plan (IMAP) under the Barcelona Convention and aligned with climate change perspectives. According to UNEP – MAP, Israel's national practice brings Israel to the forefront of IMAP implementation and serves as an example of the best practices to be followed by the contracting parties to the Barcelona Convention. Israel has an ongoing National Marine Environmental Monitoring Program since the late 1970's conducted by the Israel Oceanographic & Limnological Research aiming to provide a scientific base for environmental management of the coastal waters area, including enforcement of the provisions of relevant national legislation and international conventions. During the years, the monitoring was expanded both in space and in content to contain marine pollution, climate change and biodiversity aspects. The new adopted program will cover also the Israeli Exclusive Economic Zone in the Mediterranean and is based on the implementation of the Ecosystem Approach (EcAp) in the Mediterranean under the auspices of UNEP/MAP Barcelona Convention with the ultimate objective of achieving Good Environmental Status (GES) of the Mediterranean Sea. For implementing the EcAp and assessing the GES, 11 ecological objectives were defined and their common indicators for the Mediterranean are developed. The status of the Israeli monitoring activities and some cases of long-term changes will be presented.

The Impacts of Brine Discharges from Seawater Desalination Facilities on Coastal Environment

Ilana Berman-Frank[1,2], Natalia Belkin[1], Nurit Kress[3], Gideon Gal[4], Michal Grossovich[4], Steve Brenner[1]

[1] Mina and Everard Goodman Faculty of Life Sciences, Bar Ilan University, Ramat Gan

[2] Leon H. Charney School of Marine Sciences, University of Haifa

[3] Israel Oceanographic and Limnological Research, National Institute of Oceanography, Haifa

[4] Yigal Alon Kinneret Limnological Laboratory, Israel Oceanographic and Limnological Research

In contrast to the huge technological developments in seawater desalination technologies and the expansive growth of plants along coastal areas, scant information has been published either locally or globally demonstrating the impacts of desalination discharges on the coastal microbial communities comprising the foundation of the aquatic food webs. Our specific objectives were: 1. To identify and describe how sea water reverse osmosis desalination (SWRO) brine and associated chemicals will impact the structure and function of microbial communities including primary producers and heterotrophic bacteria; 2. To determine the temporal (seasonal) influence of these impacts and assess the cumulative effects of constant brine discharge on the microbial populations; 3. To employ hydrodynamic modeling to quantify the spatial extent of the brine discharge influence; and 4. To determine how the impacts of the discharge influence the aquatic food web especially the primary producers and consumers. We combined both experimental simulations (mesocosms and microcosms) on ambient coastal microbial populations and in-situ seasonal surveysat the desalination facilities. Seven seasonal surveys took place during 2016-2018 near the discharge sites of Ashkelon, Palmahim/Soreq, and Hadera SWRO facilities with sampling stations determined in situ along temperature and salinity gradients at each site. Our results reflect two important issues that should be considered for each desalination facility. The natural spatial and temporal variability of the planktonic communities in the coastal environment influences the response of the community that is further modified by additional factors (e.g. increased nutrient inputs,well amelioration, or temperature changes due to the proximal power plants). The modeling task focused on improving the hydrodynamic (far field) model simulations by using higher quality and resolution external forcing data including bathymetry, lateral oceanographic boundary conditions, and atmospheric data. Also, the SWRO discharges now reflect more realistic values for the input depth distribution based on a near field model, and include cooling water where relevant. Preliminary results show that after five years of simulation, the lenses of saline brine from the three subsurface outfalls remain coherent and identifiable near the bottom over a distance of several grid points whereas the brine from the two near surface outfalls, where it is mixed with cooling water, disperses more efficiently. At the grid points containing the subsurface outfalls, the near bottom salinity is typically 0.5-0.6 psu higher than the values in the control run. Ecological modeling was developed and applied by conducting day and night sampling of the lower trophic levels at several stations during the seasonal surveys. Enumeration of the samples was completed providing the first quantitative assessment of zooplankton densities along the Israeli shoreline. Stable isotope analyses of the samples were conducted allowing us to validate the food web models and providing insight into the food sources of multiple trophic levels. We also identified, based on the stable isotopes, anthropogenic N loads from ground water amelioration discarded along with the brine. We completed construction of Eco-path with Eco-sim and Eco-space food web models for regions around two desalination plants. The models successfully simulated the food webs in the two regions. Both the stable isotope analysis and the results from the models suggested only a limited impact of the brine outflow from the desalination plants on the local food web.

Environmental status of Israel's Mediterranean coastal waters: Setting reference conditions and thresholds for nutrients, chlorophyll-a and suspended particulate matter

Nurit Kress, Eyal Rahav, Jacob Silverman, Barak Herut

Israel Oceanographic & Limnological Research, The National Institute of Oceanography, nurit@ocean.org.il

In this study we proposed reference and threshold concentrations for eutrophication related parameters in order to achieve and preserve good environmental status (GES) of the oligotrophic Israeli Mediterranean coast. A five-year data set including measurements of dissolved inorganic nutrients, chlorophyll-a (Chl-a) and suspended particulate matter (SPM) (2010-2014, ca. 800 data points) was analyzed using statistical methods and best professional judgement. The coastal waters were divided into four provinces, data gaps were identified, and seasonal reference and threshold values for each province determined as the median and 1.5 times the median, respectively. Application of the derived criteria to data up to 2016 showed the coastal waters to be mainly in GES, with a few exceptions. Possible simplifications of the proposed criteria for environmental management were addressed as well. In other countries, less stringent methods for the determination of reference and threshold concentrations were applied, such as the 90^{th} percentile concentration as the reference condition, and twice the reference as the threshold value. The decision as to which method for determining the criteria to adopt falls to the regulators and environmental policy makers that need to balance conflicting stake-holders' views. Moreover, while the coastal division into areas and seasons is statistically sound, such detailed criteria may not be necessary for environmental management and may even hinder their use. However, in order to strengthen and simplify the criteria without compromising the protection of the environment, it is imperative to close the existing data gaps identified in this study by surveying under-sampled provinces and seasons.

East Med currents, waves and low frequency oscillations — an attempt to acquire a wholesome understanding from theoretical, numerical modelling and field measurement perspectives

Teodor Vrecica, Nir Haim, Rotem Soffer, Sara Nauri, Andrey Zavadsky, Eliezer Kit, Yaron Toledo

Marine Engineering and Physics laboratory (MEPLab) School of mechanical engineering, Tel-Aviv University, Israel

The first part of the talk will be dedicated to present the measurement infra-structure of TAU's MEPLab in order to advance our knowledge on waves and currents in the East Mediterranean region. The second part of the talk will present works on the topic of infra-gravity waves related to harbour agitation and waves of even lower frequencies, which relate to shelf- and bay-scale oscillations. Infra-gravity waves are waves that lie outside of the wind-wave spectral regime. They are related to longer wave periods of few tens to few hundreds of seconds. Even though their wave heights are an order of magnitude lower than the ones in the wind wave spectral peak, their comparably large wavelengths (O(1-10km) depending on the bottom depth) can largely influence marine conditions due to basin resonances, harbor agitations and their influence on beach morphology. Their primary generation mechanisms are related to shoaling and breaking of the nearshore wave field. Thus, the focus of most previous related works has been limited to coastal areas. Based on the analysis of pressure cell measurements, we show evidence of IG wave generation by deep sea storms and present a new mechanism connecting seemingly unrelated phenomena of the comparably slow wind gusts and very fast IG waves. A simulation of IG wave generation, combining reflection of nearshore generated IG waves and deep water generation, shows good agreement with deep water measurements in the Pacific. Sea level elevation observations ADCPs, tide gauges and wave staves indicate the existence of persistent low-frequency oscillations on the Israeli continental shelf. The dominant frequencies are shown to be consistent with extremely high nonlinear nearshore tide harmonics and shelf resonance models. A shallow water numerical model of Haifa Cape to Achziv shelf edge shows that this constellation enables energy trapping and occurrence of resonating standing waves. It has been found that the resonance periods fit also the ones of tsunami and metro-tsunami events with capability to deep-to-shallow signal increase of up to two orders of magnitude(!) indicating Haifa Bay and Naharia areas to be extremely vulnerable to such events.

Mass-wasting related marine geo-hazard along the continental slope off shore Israel

Oded Katz, Orit Hyams-Kaphzan, Shani Sultan-Levi, Ahuva Almogi-Labin

Geological Survey of Israel, Jerusalem Israel

Submarine mass wasting events (e.g. landslides, debris flows, turbidity currents) are part of the morpho- dynamic evolution of continental slopes. These events pose a significant geo-hazard in cases where they directly hit communication or energy related infrastructure, or if they induce tsunami. There is ample evidence of Quaternary landslides along the eastern Mediterranean continental-slope. Furthermore, historical reports suggest that submarine landslide-induced tsunamis are not uncommon. We recently mapped 447 submarine landslides (area range: 0.0024 - 91 sq-km) along the south-central Israeli continental slope, which appear as up to 50 m deep depressions in the current sea-floor and cover over 20% of the studied continental slope. Their pronounced relief suggests that these landslides are young and might pose a current offshore geo-hazard; however, their age is only vaguely determined. Here we explore the dynamic and the temporal setting of these submarine landslides using 3 - 4 m long gravity-cores sampled offshore southern Israel in 2002, at about 900 m water depth. At first we CT- scanned these cores to create an X-ray based 3D tomography. Next we sliced the cores lengthwise, described their stratigraphy, and sub-sampled along their axis. We utilized oxygen isotopes and foraminiferal taxonomy along the cores to locate the transition to the Holocene (dated ca. 12 kyr). High TOC values (>2.5%) define the last S1 sapropel event (dated ca. 10 - 7 kyr). Adding to the above temporal proxies, a profile of radiocarbon ages (on G. ruber shells) was used to better constrain the event ages. Based on their heterogeneous deformational structures, at least 3 suspected intervals of potential instability events were detected along core AM113 (sampled in a mapped landslide scar). Events predate S1 (located ~1 m down core) and are contemporaneous or closely-predating the transition to the Holocene. The largest event, 0.5 m thick, showed mixing of glacial and interglacial foraminiferal species, in contrast to the under and overlaying hemipelagic sequences that host either cold or warm water planktonic foraminifera species. Radiocarbon-age along AM113 increases with depth and indicates an average sedimentation rate of 14 cm/kyr. However, within the instability intervals (dated: 22.1, 18.7, 14.5-12.8 kyr) ages do not increase with depth, but are rather mixed or constant. Suspected instability events were also detected in two cores sampled further north, out of a mapped landslide scar (AM015, AM137). Similarly to AM113, events predate S1 and are contemporaneous or closely-predating the transition to the Holocene. This is supported by radiocarbon ages of 16 and >30 kyr in AM015 and >22 kyr in AM137. In contrary, core AM149, sampled near AM113, reveals heterogeneous interglacial sediment all along its entire 3 meters, thus representing a Holocene landslide deposit. The above novel results might suggest that mass wasting activity along the studied continental slope is declining since the transition to the Holocene, with AM149 being the single exception. Results also reveal that thin mud-flows are widespread along the studied slope, and are found in or beyond landslides scars area. We assign relative hazard levels to the different parts of the continental slope by weighting the size of the relevant natural hazardous process and its reoccurrence time, i.e. relative high hazard characterizes areas where large and frequent landslides are expected.

Seafloor gas seepage in the southeastern Mediterranean Sea: controls and implications

Yizhaq Makovsky, Or Bialik

Charney School of Marine Sciences (CSMS), University of Haifa, Israel, yizhaq@univ.haifa.ac.i

A variety of seepage features were recently discovered in the southeastern Levant Basin. Here we provide a preliminary review of the scope, geological context and variability of gas seepage within the relatively small Israeli offshore. This review encompasses a set of works, and is based on geophysical analysis of 3D seismic data, coupled with ROV surveying of E/V Nautilus in 2010 and 2011, the EUROFLEETS2 2016 expedition SEMSEEPS onboard R/V Aegaeo, CSMS-IOLR 2017 ROV cruise and some of Leviathan Partnership extensive seafloor AUV and ROV surveying. The seepage features include pockmarks of various types and sizes; carbonate buildups, intense seafloor perturbations, chemosynthetic fauna and sporadic gas bubbles emission. The predominance of microbial methane within these seeps is preliminarily suggested by two short sediment cores, and low δC13 values of authigenic carbonates and sampled biota. Two distinct domains of 'active' seepage edifice are defined by us. The first relating to shallow buried channel-lobe complexes of the Nile deep sea fan, and the other relating to salt retreat structures at the base of the continental slope of Israel. The Nile fan seepage sites may be associated with changes in the boundary of hydrates stability, currently at 1250 m water depth. Additional, apparently inactive and presumably more ancient, seepage related carbonates currently host an overgrowth of deep-sea corals and associated phenomena. Activity of these seepage edifices is suggested to be controlled by changes in the water properties of the Levantine Deep Water, as a consequence of global and regional changes. Importantly these seepage-related features constitute biological and biogeochemical hotspots, which may have a crucial environmental role in the ultra-oligotrophic southeastern Mediterranean.

Session: Marine Research for supporting environmental policy in the Mediterranean Sea - Poster presentations:

Acoustic Localization of Tagged Sharks in a Noisy Sea Environment

Talmon Alexandri and Roee Diamant

Department of Marine Technology, University of Haifa, Haifa 3498838, Israel

We describe a novel approach to combat the challenge of localizing acoustically tagged sharks in a noisy sea environment. The common methodology for localizing acoustically tagged marine fauna involves triangulization based on time difference of arrival measurements. Yet, especially in a high noise sea environment, often the tag's acoustic emissions are received by less than three receivers, and localization ambiguity arises. We refer to this problem as under-ranked localization, and offer a solution- based on the concept of belief propagation in a hidden Markov Model that only requires detection by two receivers. Specially, to solve the localization ambiguity, we use the forward-backward algorithm to propagate prior solutions while constrain the expected maximum speed of the shark. We showcase our approach over a database of detections from tagged sharks, collected in the vicinity of the Hadera power station. Our results show that our method accurately solves the localization ambiguities, and, as a result, allows the usage of a significantly larger dataset of under-ranked detections, which is usually wasted.

Impact of Brine from Large-Scale Desalination Facilities on Sessile Organisms

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Seawater reverse-osmosis (SWRO) desalination facilities continuously discharge brine-effluent with potential implications to the integrity of marine coastal environments. Typical SWRO brine consists of hypersaline-seawater, antiscalants (phosphonate-based) and coagulants. To date, the effects of brine from large-scale SWRO facilities on sessile organisms such as benthic bacteria, meiofauna and stony corals are under-studied. Here, we discuss the chronic effects of brine discharge from three large-scale desalination facilities on benthic bacteria and meiofauna at the Mediterranean coast, as well as to Red Sea stony corals. Our results indicate that benthic bacterial abundance and activity increased 1.3-2.6-fold at the outfall area than the reference (pristine) areas. Meiofauna abundance and diversity decreased by ~90% and 70%, respectively, at the outfall compared to background levels during the autumn. Concomitant analysis pointed that bacterial community structure at the brine discharge area was significantly different than the reference station and varied between each of the desalination facilities along the Mediterranean coast. Overall we found that the impact of the brine effluent on benthic bacteria and meiofauna were site-specific and localized (<1.4 Km^2) around the discharge point. In addition, we also show, for the first time, the possible impacts of SWRO facilities that are planned to be built around the Gulf of Aqaba on stony corals. We tested the impacts of increased salinity (10% above ambient) and presence of antiscalants (0.2 mg L^{-1}) on three reef-building coral species; *Stylophora pistillata*, *Acropora tenuis* and *Pocillopora verrucosa*, from the Gulf of Aqaba. Our results point that stony corals as well as their associated bacteria and algae were significantly impaired by the elevated salinity and antiscalants, leading to partial bleaching. Following the above, we propose that the ecotoxicological criteria should be determined per desalination site and relay on the sensitivity of key species in the community dominating the area affected by brine discharge.

Modeling the dispersion of discharge brine from five desalination facilities along the Mediterranean coast of Israel

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At current production levels, more than 600 MCM of fresh water (nearly 50% of the water consumed in Israel) is provided by five large scale desalination facilities that are located along the Mediterranean coast between Ashkelon and Hadera. A roughly equivalent amount of discharge brine, with salinity nearly twice that of seawater, is returned to the sea. At three facilities the brine is discharged through subsurface outfalls which are located ~1.5 km offshore (~22 m bottom depth). Brine released at ambient temperature will be significantly denser than seawater and some is expected to sink even when discharged through a diffuser. At the remaining two facilities (Ashkelon and Hadera) the brine is mixed with the cooling water from the adjacent power plants before being discharged through canals at the surface. The long term dispersion and potential cumulative effects of the discharge brine from all five facilities are assessed through a series of high spatial resolution (~450 m grid) simulations conducted with the Princeton Ocean Model for the five year period 2011-2015. Preliminary results from the simulations indicate that: (1) the near bottom salinity in the vicinity of the subsurface outfalls is typically 0.5-0.8 psu higher than background; (2) in summer the brine is mainly transported to the north following the prevailing along slope currents; (3) in winter and in the transition seasons the brine is more likely to be transported across the shelf and downslope to the open sea; and (4) the brine diluted with cooling water from power plants mixes and disperses more effectively than the brine discharged through subsurface outfalls. In addition, very high resolution (<~30-50 m grid) shorter term (up to several weeks) simulations are being run in the immediate vicinity of two of the outfalls (one submerged, one with cooling water).

Applying live and dead molluscan assemblages to assess the ecological quality of the Eastern Mediterranean

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The EU has established monitoring directives to preserve and protect marine environments around the Mediterranean in response to increasing anthropogenic stress. The directives standardize the ecological health state of water systems by defining an 'ecological quality status' (EcoQS) that quantifies the deviation from pre-impacted reference conditions. However, in many cases information on pre-impacted conditions is incomplete or missing, leading to potential bias in evaluation of environmental quality. Long-term accumulation of shells on the sea floor average out short-term variations in the community and can be used for a more complete definition of the ecological system. These death assemblages serve as a baseline for the composition and structure of live communities. We live and dead mollusca across eutrophication gradients in the oligotrophic Israeli shallow shelf. Over 10,600 bivalve individuals were collected. Bentix and Shannon-Wiener indices were calculated for live and dead assemblages from polluted and control stations near the Dan Region Wastewater Project (Shafdan), to evaluate their utility as indicators of EcoQS in the Eastern Mediterranean. The Bentix and Shannon-Wiener indices show a significant decrease in ecological conditions over time, from a moderate EcoQS in the dead- to a poor EcoQS in the live assemblage. Although Bentix was developed specifically for Eastern Mediterranean living taxa, it failed to show a significant difference in the live assemblage between the polluted and control stations of the Shafdan, highlighting the importance of applying the death assemblage as a baseline recorder of multiannual time scales. Adjustments to the Bentix index concerning naturally abundant pollution-tolerant benthic fauna, e.g *Corbula gibba* of the oligotrophic Israeli coast improves its utility in monitoring shallow shelves around the Mediterranean. The Shafdan case study showed that live-dead comparisons of molluscan assemblages are valuable in evaluating ecological conditions before the onset of human activity and should be applied in future monitoring procedures.

The timing and sedimentary structure of submarine landslides offshore Israel

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Submarine slides play a significant role in shaping the structure of continental margins, via transport of large amounts of sediments from the continental slope towards the deep basin. Yet, important parameters of submarine slides, such as timing and frequency, are often poorly constrained. A multi-proxy approach was applied to sediment cores from the head scar (PHS) and toe (PTL) domains to unravel the structure, stratigraphy and recent evolution of the Goliath Slide Complex, offshore southern Israel. Our integrated analysis divides the sedimentary sequence in the head scar into two different generations of deposits, separated by the slide detachment surface. Two concordant ^{14}C ages were obtained for the sediments immediately overlying this surface, suggesting that the northern head scar was formed during one major event that occurred 7.6±0.1 cal ka BP. The age-model of core PHS-5 reveals a major age-gap of ~19 kyrs at the slide detachment surface, and also suggests the existence of a hiatus in the upper Holocene sedimentary sequence that covers the time period of ~6.2 to ~2.5 ka BP. These age-gaps are also constrained by the planktonic foraminifera assemblage and correspond with significant changes in the sediment density and magnetic susceptibility. Results from the toe domain show a 1.2 m long continuous undisturbed sequence that represents the last ~14 ka BP and includes the sapropel S1 layer. This sequence overlies three disturbed units interpreted as mass transport deposits (MTD). Various deformation features, sharp contacts and shear surfaces within these units suggest that they underwent significant modification during transport. The ^{14}C age at the base of the undisturbed sequence is 13.99±0.17 cal ka BP, representing the minimum age of the sliding event that transported the MTD units. The age-model of core PTL-3 shows that the ages of the MTD units are substantially older (18.6 to 28.9 cal ka BP) than above it. The age-model also reveals an age-inversion within the MTD sequence, which supports the interpretation of these units as slide-related. The timing of the delineated Goliath sliding events corresponds with a period of rapid sea-level rise following the last deglaciation, accompanied by high sedimentation rates and increased riverine influx from the Nile River. Together these may have promoted slope instability and acted as preconditioning factors to the sliding events. In addition, the Goliath ~14 ka BP event corresponds with the occurrence of cave seismites in the Soreq Cave, located 40 km to the West of the tectonically active Dead Sea Transform, suggesting that a significant earthquake might have triggered this event. The multi-disciplinary approach has proven to be useful when interpreting complex sedimentary sequences such as slide scars, and provides key insights regarding the development of the Goliath Slide Complex through time.

Protecting the secret gardens: community structure analyses of four East-Mediterranean mesophotic sponge grounds

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In this study we explored mesophotic sponge grounds (MSG) that lay at 100-130m depth, using a remotely operated vehicle (ROV). Three of the studied locations, Herzliya, Hadera and Atlit, are structured as a series of pinnacles, part of a submerged sandstone ridge. The forth location, Haifa, is the underwater extension of the terrestrial Carmel mountain ridge. Based on quantitative surveys we estimated that over 100 sponge species reside at these sites. Sponge cover was on average 30% 11% 32% and 37% in Herzliya, Hadera, Atlit and Haifa, respectively, and constituted about 80% of total live coverage. Communities at these sites were rich and divers and differed significantly in all measures of diversity. Sponges, in addition to being the most dominant phylum in these mesophotic habitats, also act as ecosystem engineers, increasing the structural complexity and creating niches for invertebrates and fish. Overall 42 species were collected from the MSG, 32 of them are absent from the upper-photic zone of the Israeli coast, 14 species are new to the Levantine Sea, and some might be novel species. Some of the mesophotic species have disappeared decades ago from Israel's shallower coastal habitats and were re-discovered as flourishing in these much deeper habitats. We suggest that the MSG may serve as refugia for species stressed by the rising temperatures in shallow waters, and by other anthropogenic disturbances which mostly affect the shallower coastal habitats. The MSG sensitive environment can be adversely affected by physical activities, e.g. drilling, pipeline installation, structure or vessel anchoring to sea bottom, which might cause irreversible physical damage to benthic rock habitats and suspension of thin sediment or drilling lubricants could cover and clog the filtering apparatus of the sponges. This study provided the data needed for decision makers to promote the establishment of MPA’s in these unique habitats.

The effect of long-term brine discharge from desalination plants on benthic foraminifera

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Desalination plants along the Mediterranean coast of Israel currently provide ~587 million m^3 drinking water/year, and their production is planned to increase to 750 million and 1.8 billon m^3 drinking water/year by 2020 and 2050, respectively. A nearly equivalent volume of brine with a salinity of ~80 is discharged into the shallow coastal water, where the normal marine salinity is up to 40. Brine-waste is often denser than the receiving environment, and therefore sinks and flows as a saline plume in adjacency to the sea floor where mixing is limited. The brine-waste and other desalination-associated discharged contaminants (such as anti-scalants, ferrous oxides and nutrients) can potentially impact marine ecosystems. Hence, the overarching goal of this study was to examine whether benthic foraminifera, which are known to be a sensitive marine proxy, are affected by this chronic discharge. With this aim, the prolonged effect of brine was investigated seasonally during 4 cruises between June 2016 and April 2017 near three operating desalination facilities along the Mediterranean coast of Israel, from south to north: Ashkelon, Sorek and Hadera. Surface sediment samples were collected in triplicates by grabs from the outfall (in immediate proximity to the discharge site), the brine-plume (where elevated salinity was measured in real-time) and an unimpacted reference station at each study site. Our results highlight that the most robust responses were observed when the brine was discharged along with other anthropogenic stressors (i.e. thermal stress of nearby power plants). The total foraminiferal abundance and diversity were, generally, lower near the outfalls, and increased towards the control stations. Changes in the abundances of selected species indicate their sensitivity to the brine-waste discharged. The most noticeable response to elevated salinity, was the distinct decline of benthic foraminifera with “loose shells” consist of mineralized particles cemented by organic matrix. The distinct differences in their abundances between the control and outfall stations at the Sorek Site, indicate that they are particularly more sensitive to elevated salinity compared to foraminifera with dense mineralized shells.

Modelling the far field spatial-temporal distribution of desalination brines discharged from multiple sources along the Mediterranean coast of Israel

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Climate change, population growth and mismanagement of natural sources of drinking water are increasing water scarcity worldwide. Many countries, including Israel have started to produce drinking water by desalination of seawater. Currently, desalination brines are discharged into the surrounding sea, but very few studies have investigated their long range dispersal and regional scale impact on the marine environment. In this study we use a high resolution, three dimensional, hydrodynamic numerical model to simulate the dispersal of brines discharged from five high capacity desalination plants ($0 10^8 m^3$/year each), located along a ~100 km stretch of the Israeli Mediterranean shoreline. The simulations show that small salinity anomalies associated with the brine discharges propagate above the sea bottom in the form of density currents (DCs) and spread along much of the Israeli continental shelf with interaction between brine plumes originating from adjacent outfalls. The generated DCs entrain and transport downslope a maximum annual mean of 2100 $m^3 \cdot s^{-1}$ and increase the near bottom meridional velocities by 6 to 15% as far as 5km away from the outfalls. In winter, due to a highly convectively mixed water column, the brine plumes are well defined and propagate downslope beyond the edge of the continental shelf with the aid of convectively driven DCs. In contrast, during the summer, when the water column is stably stratified, the brine plumes are confined to the shelf region and spread along it covering it entirely. Our results highlight the possibility that brine discharge from multiple sources may affect the shelf water dynamics in a non-negligible manner. Furthermore, the high density layer of desalination brine propagating above the sea bottom over much of the Israeli continental shelf, could potentially impact the vertical transport of recycled nutrients from the sediments to the water column above possibly resulting in reduced productivity of coastal waters.

Methane related biogeochemical processes in the sediments of the Southeastern Mediterranean Continental Shelf

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This study showed for the first-time geochemical evidence for biogenic methane formation (methanogenesis) and anaerobic oxidation of methane (AOM) in the shallow sediments of the oligotrophic SE Mediterranean continental shelf at water depths between 50-90 meter. This is by using 5-8-meter depth-profiles of methane concentrations and related chemical and isotopic parameters in the porewater. Then, we focused on methane coupling to sulfur and iron cyclings. The sulfate-methane transition zone (SMTZ) was investigated, and the role of the sulfate reduction by oxidation of organic material (OSR) versus oxidation of methane (S-AOM) was determined. For this purpose, total alkalinity (TA) and dissolved inorganic carbon (DIC) profiles were used considering the fact that each of the sulfate reduction processes has a different stoichiometric effect on TA and DIC. Our results demonstrate that OSR is responsible for a significant fraction of sedimentary sulfate reduction, even in this ultra-oligotrophic environment. Furthermore, we calculated that although OSR contributes 85% of the carbonate alkalinity, it is the onset of S-AOM, which is likely to promote carbonate minerals precipitation due to the pH increase it induces. We investigated also the deep methanogenic zone and saw geochemical evidence for microbial iron reduction. The link to the methane cycle based on porewater and sedimentary profiles were discussed and three mechanisms were proposed.

Session: Small Bugs Big Impact: Microbial Interactions and Ecology

Session chairs: Miguel Frada and Noa Barak-Gavish

Oral presentations (in order of appearance):

Molecular basis for the success of tubeworm symbioses in the deep-sea chemosynthetic habitats

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Discharge of reduced compounds in hydrothermal vents and hydrocarbon seeps fuels chemosynthesis, forming oases of life in the food-limited deep seabed. Several invertebrate lineages, such as the long-lived/fast-growing siboglinid tubeworms, established obligate nutritional symbioses with chemosynthetic bacteria, driving ecology and biogeochemical cycling in their habitats. To better understand the molecular processes that underpin the success of these symbioses, this study investigated the genetic diversity of the tubeworm symbionts and their free-living relatives. Comparative genomics and genome-centered transcriptomics showed that the symbionts carry and express functions that may enhance the efficiency of carbon fixation under fluctuating redox conditions: These thioautotrophic symbionts are among the very few bacteria that are able to fix carbon via both the reverse tricarboxylic acid (rTCA) and the Calvin-Benson-Bassham (CBB) cycles. A rare variant of NADH dehydrogenase/heterodisulfide reductase, which bifurcates electrons to fuel the rTCA cycle, may increase the efficiency of carbon fixation in these bacteria. Micro- and macro-scale genome comparisons suggest that biotic interactions play an important role in shaping the symbiont pangenomes. While most siboglinid tubeworms host a single symbiont ribotype, two symbiont populations with distinct 16S rRNA gene sequences were found in *Lamellibrachia anaximandri*, the endemic Mediterranean tubeworm, which forms dense colonies at the hydrocarbon seeps offshore Israel. This provides an exciting opportunity to study how these organisms interact with their hosts and adapt to the ultra-oligotrophic seabed of the eastern Mediterranean Sea.

There to stay: invasive filamentous green alga Mougeotia in Lake Kinneret, Israel

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Mougeotia sp. (Zygnematales, Charophyta) first appeared in the plankton of Lake Kinneret in 1998. While initially rare, from 2004 onwards it was present in the plankton continuously, forming massive blooms in spring (2005, 2006, 2012) or in winter (2010), clogging fishermen's nets. Occasionally different morphological and life-cycle forms of *Mougeotia* were observed. *Mougeotia* maintained its population under a wide range of water temperatures, nutrient concentrations, solar radiation, pH levels and stratification patterns, making it a highly versatile alga. In multiple regression, year and month as the only predictors explained 36 % of the pattern of *Mougeotia* biomass. To explain the lack of relationships with the environmental parameters we hypothesize that (1) *Mougeotia* possesses exceptional physiological plasticity and/or (2) Lake Kinneret may host two or more genetically distinct cryptic species of *Mougeotia* with different environmental niches. Preliminary molecular determinations suggest that indeed several different species that look alike are present in Lake Kinneret. Both explanations may hinder any inference on *Mougeotia* - environment relationships and require further confirmation by experimental work.

Core and dynamic microbial communities of two invasive ascidians: can host-symbiont dynamics plasticity affect invasion capacity?

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Ascidians (Chordata, Ascidiacea) are considered prominent marine invaders, able to tolerate highly polluted environments and fluctuations in salinity and temperature. We examined the seasonal and spatial dynamics of the microbial communities in the inner-tunic of two invasive ascidians, *Styela plicata* (Lesueur 1823) and *Herdmania momus* (Savigny 1816), in order to investigate the changes that occur in the microbiome of non-indigenous ascidians in different environments. Microbial communities were characterized using Illumina sequencing of partial (V4) 16S rRNA gene sequences. A clear differentiation between the ascidian-associated microbiome and bacterioplankton was observed and two distinct sets of operational taxonomic units (OTUs), one core and the other dynamic, were recovered from both species. Ten and 17 core OTUs were identified in *S. plicata* and *H. momus*, respectively, including taxa with reported capabilities of carbon-fixing, ammonia-oxidization, denitrification, and heavy-metal processing. For *S. plicata*, core OTU structure was maintained independently of location. The dynamic OTUs of both species clustered in response to site and season but significantly differed from the bacterioplankton community structure. The relative abundance of the dynamic OTUs in *H. momus* was higher than in *S. plicata*. This may be the result of profound differences in environmental factors resulting from a recent "two-step introduction": first from the Red Sea into the Mediterranean on artificial structures, and then onto the natural rocky reef, to which *H. momus* has adapted over a relatively short time-scale. These findings suggest that the associations between invasive ascidians and their symbionts may enhance host functionality while maintaining host adaptability to changing environmental conditions.

Variation and stability in the physiology and metabolome of *Prochlorococcus* MED4 life cycle in mono vs. co-culture with *Alteromonas* HOT 1A3

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Marine microorganisms are major players in the biogeochemical cycle of our planet. Therefore, understanding the changes in physiology and metabolism following interactions with other microorganisms, is of high impact. In this study, we explore the variations in the cell physiology and metabolome of a primary producer, *Prochlorococcus* MED4, in a cycle of bloom and collapse as mono-culture and in association with a heterotrophic bacterium (*Alteromonas macleodii* HOT1A3). Untargeted metabolomics was used to depict differentially expressed metabolites by high-resolution mass spectrometry. We have characterized the chemical patterns across the growth cycle of *Prochlorococcus* and highlight masses associated with the phases of growth and culture decline complemented with fluorescence measurements, cell counts and electron microscopy. We found that living in association with heterotrophic bacteria aids in reaching physiological stability and balancing the oxidation of functional molecules, such as pigments. Our vision is that these analyses will help identify the molecular mechanisms of microbial interactions, and potentially provide novel biomarkers on the physiology and metabolic exchange of these important microorganisms in their natural marine environment.

Population dynamics of T7-like cyanophages and their hosts in the Gulf of Eilat, Red Sea

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Synechococcus and *Prochlorococcus* are the numerically dominant primary producers in the oceans and contribute significantly to global primary production. They are infected by T7-like cyanophages, as well as by other cyanophages. Phylogenetic analyses show two discrete T7-like cyanophage lineages, clade A and B. Phages from clade B infect either *Synechococcus* or *Prochlorococcus*, whereas most phages from clade A infect *Synechococcus*. Laboratory experiments on three different pairs of clade A and B phages infecting three different hosts showed that clade A phages have shorter latent periods, greater virulence and larger burst sizes. To assess the population dynamics in the environment of these two clades we used the solid-phase PCR-based polony method on samples collected every month for a year in the Red Sea. Furthermore, during three consecutive spring periods surface samples were collected daily. Clade A phages were at least an order of magnitude less abundant than clade B phages in all samples. Abundances of clade B phages varied from a minimum of 2*104 phages·ml-1 to a maximum of ~1.3*106 phages·ml-1 in the upper 200 m of the water column and followed the population dynamics of *Prochlorococcus*. However, during the period of the spring bloom the abundances of clade B phages were correlated with *Synechococcus* and negatively correlated with *Prochlorococcus*. In addition, a cycling pattern of change from negative to positive correlations between clade B and the cyanobacteria was observed in a sliding window of ten days, suggesting a predator-prey relationship between clade B phages and their hosts. The differences between the environmental abundances of the clades may be due to differences in their infection physiology: we suggest that the less aggressive strategy of the clade B phages maintains host populations at a sustainable level and allows clade B phages to thrive in the oligotrophic Red Sea.

Silicon limitation facilitates virus infection and mortality of diatoms

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Diatoms, one of the most globally distributed and ecologically successful groups of organisms in the modern ocean, contribute upwards of 40% of the total marine primary productivity. With their obligate silicon (Si) requirement for cell wall formation, diatoms effectively couple the Si and carbon (C) cycles, converting dissolved Si into biogenic silica that ballasts substantial vertical flux of C out of the euphotic zone into the mesopelagic and deep ocean. Viruses are key players in ocean biogeochemical cycles, yet little is known about how viruses specifically impact diatom populations. Here we show that Si limitation drives viral infection and mortality in diatoms in the highly productive coastal waters of the California Current Ecosystem. Early, active and lytic stages of viral infection were diagnosed across a gradient of Si stress using a suite of chemical and biological measurements alongside metatranscriptomic analyses of cell-associated diatom viruses and targeted, quantitative PCR of free, extracellular viruses. In Si-limited cultures of the centric, bloom-forming diatom, *Chaetoceros tenuissimus*, viral-induced mortality was accelerated, with unimpaired viral production. Together, these findings contextualize viruses within the ecophysiological framework of Si availability and diatom-mediated biogeochemical cycling.

Session: Small Bugs Big Impact: Microbial Interactions and Ecology- Posters

Long-term interactions between abundant marine bacteria: *Prochlorococcus and Alteromonas*

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Interactions such as symbiosis, competition and allelopathy are a central feature of natural microbial communities in the marine environment. Most studies of microbial interactions in the lab focus on the exponential growth phase, when nutrients are replete, yet microbes in the ocean may experience conditions of starvation. Here, we study the interactions under long-term starvation conditions between *Prochlorococcus*, a globally abundant marine cyanobacterium which is one of the most abundant photosynthetic organisms in the ocean, and *Alteromonas*, heterotrophic bacteria belonging to the γ-Proteobacteria. Five strains of *Prochlorococcus* and five strains of *Alteromonas* were grown over extended periods in binary co-cultures, forming a 5x5 matrix of interactions encompassing the natural genetic diversity of these organisms. The dynamics of *Prochlorococcus* were measured using culture fluorescence, and bacterial cell numbers were counted by flow cytometer every time the cultures were transferred after long-term starvation (up to 140 days). All *Prochlorococcus* strains survived long-term starvation in the presence of the heterotrophs but not when grown alone. Closely related *Prochlorococcus* strains behave more similarly than distantly-related ones in co-culture, providing an avenue to identify specific genes and pathways involved in long-term microbial interactions. Furthermore, each strain of *Prochlorococcus* maintains a similar and relatively low concentration of heterotrophs during long-term culture. These results suggest that in the oligotrophic ocean, co-occurring with "helper" heterotrophic bacteria may support *Prochlorococcus* survival under nutrient stress.

Aquatic aggregates as a hotspot for heterotrophic diazotrophy in the Qishon Estuary

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Accumulating evidences suggest that N_2 fixation occurs at high rates in N-rich aquatic environments such as estuaries, river-deltas and fjords. The reasons how this process is performed under such 'unfavorable' environments are ambiguous. Here, we show that aquatic aggregates comprised by transparent exopolymer particles (TEP) may support heterotrophic N_2 fixation in N-rich environments. To this end, we developed a direct staining technique that captures simultaneously active heterotrophic diazotrophs, TEP and total bacteria. We tested this method in the eutrophic N-rich Qishon River (SE Mediterranean) and the oligotrophic environment in two seasons, along with complementary measurements of N_2 fixation, bacterial abundance and production. N_2 fixation rates were overall high in all samplings, with higher rates found in the stream (~6.6 nmol N L^{-1} d^{-1}) than in the estuary (~2.5 nmol N L^{-1} d^{-1}), further, we found that high N_2 fixation rates occurs in bioaggregates. Our micrographs indicate that active heterotrophic diazotrophs were mostly confined to the TEP rather than free-living, suggesting these aggregates are 'hotspots' for diazotrophy. The experimental approach described here may also be applied in other aquatic regimes that holds adverse conditions for diazotrophy (e.g., coastal waters, aphotic waters, depths below the chemocline etc.) and may explain why high ambient N does not necessarily preclude N_2 fixation.

The effect of temperature on bacterioplankton macromolecular composition and N:P ratio in selected cultures

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The bacterioplankton community plays a major role in shaping the marine environment. Their macromolecular composition depends on multiple causes such as the identity and composition of the microbial community, nutrient supply and growth rate. Recent data suggest that temperature has the ability to alter bacterioplankton macromolecular stoichiometry composition by affecting the cellular resource allocation. According to the translation-compensation hypothesis, under high temperature the rate of protein synthesis (N-rich) increases while ribosome production (P-rich) reduces and vice versa under cold temperatures. This may lead to skewed N:P stoichiometry compared to the canonical 16:1 Redfield ratio often found in aquatic environments. Laboratory-controlled experiments with *Alteromonas* are conducted in order to assess the relationship between temperature and bacterioplankton macromolecular composition and N:P ratio. *Alteromonas* is a common heterotrophic marine bacteria, inhabiting a variety of niches across the ocean from surface (*A. macleodii* HOT1A3) to deeper (*A. mediterranea* DE) waters. Preliminary results indicate that protein:RNA ratio of *A. macleodii* HOT1A3 is highly affected by temperature, while protein:RNA ratio of *A. mediterranea* DE ratio depends virtually on growth rate. This suggest that the translation-compensation hypothesis may be more important in dynamic habitats where temperature changes frequently as in the surface water.

Selective collection of iron-rich dust particles by natural *Trichodesmium* colonies

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Dust is an important iron (Fe) source to the ocean, but its utilization by phytoplankton is constrained by rapid sinking and slow dust-Fe dissolution. Colonies of the globally important cyanobacterium, *Trichodesmium*, overcome these constrains by efficient dust capturing and active dust-Fe dissolution. In this study we examined the ability of *Trichodesmium* colonies to maximize their Fe supply from dust by selectively collecting Fe-rich particles. Using NanoSIMS we show that natural *Trichodesmium* collect Fe-minerals and shuffle them to their colony core. Testing for selectivity in particle collection, we supplied ~600 individual colonies, from the Gulf of Aqaba, with natural dust and silica minerals that were either cleaned of or coated with iron and counted the number of particles retained by the colonies over 24 hrs. We observed a strong preference for Fe-rich particles over Fe-free particles throughout an entire bloom season. Moreover, some colonies discarded the Fe-free particles they initially collected. The preferred collection of Fe-rich particles and disposal of Fe-free particles suggest that *Trichodesmium* can sense Fe and selectively choose dust particles. These findings reveal that *Trichodesmium* is incredibly adapted to utilize dust as an iron source, further highlighting its important role in nutrient cycling and productivity in the ocean.

The role of land uses and water quality parameters in structuring microbiomes of connected lakes system

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At the last 150 years, since the industrial revolution, there are major anthropogenic influences on environments, ecology and animal's populations. These effects do not end only at the level of macro-environments, and most probably there is an influence also on the microbial ecology. It is known that in water systems, there is a direct correlation between water quality properties and microbial populations; however, it is unclear how the anthropogenic effect influence these parameters. In this study, we investigate the degree of influence of land uses and chemo – physical water parameters in structures microbiome composition among connected lakes system. Using 16S illumine sequencing we characterize microbiome composition of 46 lakes located within 7 drainage basins. Through GIS, we mapped the lands of the drainage basins and focused on 5 major uses. Examination of three optional distribution hypothesis through connected water bodies, revealed an indirect effect of land uses on structuring microbial communities. Furthermore, we found patterns of grouping of bacteria among sites with specific water properties. Finally, we concluded our findings in a model describing the correlation between anthropogenic influences through Forests and Urban lands, to certain water parameters, which play a role in shaping water microbiomes.

Phytoplankton and bacterial response to desert dust deposition in the coastal waters of the southeastern Mediterranean Sea; A four year in-situ survey

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Atmospheric dust/aerosol deposition is an important source of external nutrients to the surface of the ocean. This study shows high resolution observational data gathered *in-situ* over a period of 4-years on bacterial and phytoplankton abundance and activity during typical-background atmospheric conditions, and during intense dust storm events in the low nutrient low chlorophyll (LNLC) coastal waters of the southeastern Mediterranean Sea (SEMS). Chlorophyll *a* (an estimate for phytoplankton biomass) and bacterial abundance show moderate changes in response to dust deposition/events (-10% and +20%, respectively), while rate measurements such as primary production, bacterial production and N_2 fixation rates were all significantly and positively affected (+25 to +40%; $p<0.05$) by deposition. The rapid changes in bacterial and/or phytoplankton rate parameters suggest that the released micro/macronutrients from atmospheric deposition are tunneled directly in metabolic processes and, to a lesser extent, for biomass accumulation. The predicted expansion of LNLC areas in the future oceans and the projected increase in dust emission due to desertification may affect the production of marine microbial communities in the surface of the ocean, yet only moderately affect their biomass or standing stock. Such alteration may likely impact carbon sequestration to the deep ocean.

Annual bacterioplankton productivity and distribution in the EMS as observed during the THEMO monthly cruises

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Phytoplankton and bacterioplankton form the base of marine food webs, and their dynamics over time and space affect the entire marine ecosystem. We investigated the temporal variability of phytoplankton and heterotrophic bacteria on a monthly basis at an offshore station (~1500 m bottom depth) located in the southeastern Mediterranean Sea as part of the THEMO cruises. Our results show a seasonal change in both abiotic and biological parameters: stratification begins in April and ends by December, with a deepening of the Deep Chlorophyll Maximum (DCM). The DCM is observed by a strong fluorescence signal that correlates with large phototrophic bacteria counts, mainly *Prochlorococcus*. As the mixing season comes to an end but before the top water column becomes stratified, we see a strong rise in primary and bacterial productivity. While primary productivity is limited to the surface water and decreases gradually between March and July, the peak in bacterial productivity during April extends to the bottom of the photic zone and has disappeared by March. Cell counts of the main phototrophs groups, *Prochlorococcus*, *Synechococcus* and picoeukaryotes, show that *Prochlorococcus* dominates the deep water layers inside the photic zone, and is most abundant during the summer period. In contrast, *Synechococcus* is most abundant in the top water layer and exhibits a seasonal peak during the winter season, potentially due to a nutrient flux from the deep that rises with the seasonal deep mixing. Picoeukaryotes Don′t show strong contribution to cell counts but do show a tendency to proliferates adjacent to the DCM. his study provides a unique time-series of bacterioplankton communities in the ultra-oligotrophic southeastern Mediterranean, which will be complemented shortly by assessments of the phytoplankton community structure using pigment HPLC and of bacterioplankton communities using 16S amplicon sequencing. Observations of the microbial populations over time and depth are the first step towards identifying the environmental factors affecting these dynamics in the EMS and will help assessing how these will be affected in future climate scenarios.

Are all cells in batch culture equal? Single-cell heterogeneity and the evolution of chlorotic sub-populations in *Prochlorococcus*

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# These authors contributed equally to this study

Many microorganisms produce resting cells with very low metabolic activity that allow them to survive prolonged stress conditions. In cyanobacteria and some eukaryotic phytoplankton, this process is accompanied by a loss of photosynthetic pigments (chlorosis). Here, we show that a chlorosis-like process occurs under multiple stress conditions in lab cultures of *Prochlorococcus*, the dominant phytoplankton in the oligotrophic ocean. *Prochlorococcus* strain MIT9313, chlorotic cells are smaller than non-chlorotic ones and, similar to other freshwater cyanobacteria, show no metabolic activity that can be measured as C and N uptake by NanoSIMS. However, unlike many other cyanobacteria, chlorotic *Prochlorococcus* cells are not viable and do not re-grow under axenic conditions when transferred to new media. Essentially all of the *Prochlorococcus* cells in natural populations from the deep euphotic zone of the Eastern Mediterranean, where nutrients and light levels are both low, are metabolically active, and only few chlorotic cells were identified. Single-cell carbon uptake rates at these depths were low compared to N uptake and to previously published growth rates, suggesting an important role for mixotrophy in supporting the cells carbon demand. We propose that reliance on co-occurring heterotrophic bacteria or on the DOM they produce ("The Black Queen Hypothesis"), rather than the ability to survive long periods of stress as resting cells, underlies the ecological success of *Prochlorococcus* in the oligotrophic ocean.

Abundance, activity, and diversity of Bacteria and Archaea in the deep sediments of the southeastern Mediterranean Sea

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Bacteria and Archaea inhabit benthic deep-sea ecosystems, driving biogeochemical cycles. In the easternmost Levantine basin, which is characterized by high bottom water temperatures and very low downward fluxes of organic carbon, ecological functions of benthic microbial communities are still largely unknown. In 2018, we initiated an effort to establish a spatiotemporal background for abundance, activity, and diversity of Bacteria and Archaea in the marine sediments offshore Israel. Sections from 1, 2, 5, 10 and 20 cm below sediment surface were sampled from 8 stations at water depths ranging from 80 to 1900 m. The abundance and the activity of prokaryotes decreased drastically as both the water depth and the vertical distance below the sediment surface increased. Diverse communities (H = 5.4±0.2) of Bacteria (mainly Proteobacteria, Chloroflexi, Planctomycetes and Acidobacteria) and Archaea (mainly Thaumarchaeota, Nanoarchaeota and Euryarchaeota) inhabited the sediments, showing clear distribution patterns determined by water depth and the distance from the sediment surface. Correlation analyses of abundance profiles, nutrient and total organic carbon (TOC) content revealed niche preferences of selected taxa (e.g., the relative abundance of Archaea positively correlated with TOC). Asking if microbial communities are sensitive to environmental perturbations, we compared the background parameters with those determined for the heavily burrowed sediments in the vicinity of Palmahim hydrocarbon seeps, which were collected in 2016. Prokaryotic abundance and activity in the seep sediments were significantly higher than the background values. Microbial lineages that are indicative of natural gas occurrence (such as the aerobic methane-oxidizing Methylococcales) were found only in sediments affected by seepage, although the methane concentrations were below detection limit. Taken together, our results suggest that analyses of microbial abundance, activity and diversity yield sensitive indexes that can reveal natural and anthropogenic perturbations in the marine environment.

The effect of oil pollution on marine microbial populations in Israeli coastal waters

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The high demand for fossil fuels and its by-products is symptomatic of the 21st century and occasionally leads to oil spills and pollution of coastal waters. Marine oil pollution may originate from a variety of sources - urban runoff, tanker cleaning, drilling activities and oil spills. These events may release large amounts of highly toxic polycyclic aromatic hydrocarbons (PAHs) and other pollutants to coastal water, thereby threatening local marine life. Here, we investigated the effects of crude oil on the temporal dynamics of phytoplankton and heterotrophic bacteria in Israeli coastal waters. To this end, we added crude oil (500 µm thick layer, with and without additional nutrients; NO_3 and PO_4) to mesocosms (1m^3 bags) containing oligotrophic surface coastal water collected near Haifa during summer and winter. Changes in phytoplankton biomass, activity and diversity were monitored daily for 5-6 days. Our results demonstrate that crude oil addition resulted in a pronounced decrease in phytoplankton biomass and production rates, while heterotrophic bacterial production increased significantly. Importantly, a few days post addition we found that the oil-degrading bacteria, *Oleibacter* sp. and *Oleispira* sp. appeared in the mesocosms, and that the addition of nutrients (along with the crude oil) further increased this trend. This suggests that oil-degrading bacteria may be NO_3 and PO_4 limited in Israeli coastal waters. The results of this study should enable us to establish improved science-based environmental policy with respect to handling crude oil pollution in this region.

DOP limits heterotrophic bacteria in the southeastern Mediterranean coastal waters during summertime: A microcosm approach

Sisma-Ventura Guy and Rahav Eyal

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Phytoplankton and heterotrophic bacteria rely on a suite of inorganic and organic macronutrients for their cellular metabolism and catabolism. Here, we explored the effect of dissolved inorganic phosphate (PO_4) and dissolved organic phosphorus (ATP as DOP surrogate) additions on the activity and biomass of coastal water autotrophic and heterotrophic microbial populations of the Southeastern Mediterranean Sea (SEMS) during summer. To this end, surface waters were supplemented with PO_4 and ATP (either solely or simultaneously), and the PO_4 turnover time (Tt), alkaline phosphatase activity (APA), heterotrophic bacterial production (BP), primary production (PP), and the abundance of the different microbial components were measured. Our results show that PO_4 addition alone did not trigger any significant change in most of the autotrophic/heterotrophic bacterial variables tested. Contrary, DOP or PO_4+ATP additions simulated heterotrophic bacterial biomass and activity within a few hours post addition, while autotrophic abundance and PP remained unchanged. These results suggest that autotrophic microbes are outcompeted by heterotrophic bacteria for cellular P in the presence of elevated DOP, and that PO_4 additions is only a secondary limiting nutrient in the coastal water of the SEMS during summer.

Environmental impacts of offshore aquaculture in Israel

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Aquaculture production is an accepted, viable source of marine protein in the face of the rising global population trend. The demand for production requires stakeholders to look to national marine space to keep with product demand and, thus, the question of environmental impact verges. In the Levantine Sea of the eastern Mediterranean system (EMS), a multitude of biotic and abiotic challenges face the expansion of the industry in the ultraoligotrophic waters. It is a region threatened with the highest increase of invasive marine species, coupled with rapid changes in sea surface temperature (SST) and other climatic changes. In such an impacted, specialised system, the need to determine the assimilative carrying capacity is prescient. Nutrient budgets have been calculated for metabolic wastes (ammonia, dissolved organic nitrogen, and phosphate) in mesocosms previously, but an estimate of reform wild fish biomass has not been attempted. This poster attempts to combine nutrient concentration data (speciated) sampled *in-situ* from a monoculture fish cage site (*Sparus aurata*) and collate waste effluent and budget data from previous literature on this species, in order to further clarify particulate and dissolved matter trajectories, whilst defining the amount of organic carbon introduced into the marine ecosystem from this industry. Impacts to local primary productivity rates and contextual implications from the generation of organic carbon are also discussed.

Evolutionary origin of the mammalian hematopoietic system found in a colonial chordate: Functional and molecular characterization of *Botryllus Schlosseri* immune system

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Hematopoiesis is an essential process that evolved in multicellular animals. At the heart of this process are hematopoietic stem cells (HSCs), which are multipotent, self-renewing and generate the entire repertoire of blood and immune cells throughout life. Here we studied the hematopoietic system of *Botryllus schlosseri*, a colonial tunicate that has vasculature, circulating blood cells, and interesting characteristics of stem cell biology and immunity. Self-recognition between genetically compatible *B. schlosseri* colonies leads to the formation of natural parabionts with shared circulation, whereas incompatible colonies reject each other. By means of flow-cytometry in combination with screened antibodies by Cytof, lectins, and fluorescent enzymatic reagents, we isolated 34 *B. schlosseri* cell populations. Using whole-transcriptome sequencing of defined cell populations, and diverse functional assays, we identified HSCs, progenitors, immune-effector cells, and the HSC niche. Our study implies that the HSC and myeloid lineages emerged in a common ancestor of tunicates and vertebrates and suggests that hematopoietic bone marrow and the *B. schlosseri* endostyle niche evolved from the same origin. Furthermore, we identified a *B. schlosseri* cytotoxic cell population originating from large granular lymphocyte-like cells and demonstrated that self-recognition inhibits cytotoxic reaction.

Session: Dynamics of streams and Estuaries

Session chairs: Tom Topaz and Shai Arnon

Oral presentations (in order of appearance):

Flow variability affects multi-trophic levels of fluvial biofilms: Within and across microbial groups effects

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Near bed flow is an important physical driver of microbial community structure in freshwater biofilms. However, most studies so far focused on single microbial groups in biofilms. Here we tested the effects of near bed flow on distinct microbial groups (i.e., autotrophic cyanobacteria and protists, bacteria and heterotrophic protists) of biofilm communities within and across trophic levels in two mountainous streams with different nutrient backgrounds. Our results demonstrate that near bed flow velocity (ū) and turbulent kinetic energy (TKE) were important physical drivers for the abundance and diversity of microbial groups. ū or TKE significantly affected community structure of all microbial groups, although explaining only between 1.9% to 3.8% of the variability in the community structure. Seasonally varying physicochemical factors, including temperature, light, dissolved carbon and nutrient concentrations explained between 3% and 15% of the variability in the community structure of the studied biofilm groups. Changes in these physicochemical factors were identical in both streams suggesting that biofilm succession was driven by environmental boundary conditions at larger temporal scales (season), whereas locally the microbial diversity of fluvial biofilms was shaped by near bed flow. Near bed flow affected the abundance and diversity of larger sized primary producers and heterotrophic protists, but not that of the smaller sized bacteria. Abundance of autotrophs was in the majority of cases positively correlated with increasing ū and TKE indicating that biofilms shifted towards increasing autotrophy with increasing shear stresses. The contribution of filamentous traits of algae increased with ū and TKE providing a protected area from the physical shear forces for the smaller sized bacteria. The abundance of heterotrophic protists decreased with ū and TKE leading to decreasing grazer to prokaryote ratios. The control of bacteria thus shifted from a biological control (i.e. grazing by heterotrophic protists) at slowly-flowing and less turbulent sites to a physical control (i.e. shear stress) at fast-flowing more turbulent sites. Nitrogen uptake of fluvial biofilms was positively correlated with near bed flow. In conclusion, our results suggest that near bed flow possibly impact the magnitude and the direction of matter fluxes through the microbial food web and can potentially affect the ecosystem function of fluvial biofilms.

Diagnose transport processes for geochemical components (solute and suspended solid) over a basin through rain, flows and soil moisture

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Transport processes of geochemical component, i.e. solutes and suspended solids, in a basin are of a great interest for water quality issues. In addition, transport processes reflect hydrological processes, e.g. water flow paths over the basin during and after rain event. Simple methods, such as mixing equation and hydrograph separation, are practical to implement on one hand, and enable insight into main basin processes on the other hand. However, Mediterranean basins experience a long dry season before the rainy period and consequently the effect of soil water content is fundamental to determine flow and transport processes. Concentration of several geochemical components were measured manually for this study during the 2018-19 winter. Examination of TSS (total suspended solids) data against flows allows clear distinction between three different stages of the winter: 1) first rains 2) before flood, which is a wetting period and 3) floods stage, where soil is effectively saturated. At the first stage no concentration rise occurs. The rise in concentration at the second stage is characterized in a very low or negligible rise in flows. Later, after transition to the third stage, concentrations of geochemical components rise similarly to the beginning of the winter. However, since they accompanied a flood event the concentration to flow ratio (C/Q) is much lower at the floods stage than the second stage. This difference between winter stages is established through soil water content data as well via different flow patterns of water inside soil. In the second stage, rain water flow downwards by infiltration, i.e. from top soil downwards, while during the floods stage preferential flow is more dominant. The different flow patterns and the different C/Q ratio at stages 2 and 3 of the winter, establishes the involvement of different transport processes during the winter.

Evaluation of vegetated agricultural drainage ditches (VADDs) approach in reduction of phosphorous leaching from farm fields to waterways

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During the 20th century, the Hula lake and marshes were drained for agricultural use, like other large wetland areas worldwide. As a result, those areas no longer function as a sink for nutrients but have become the source, increasing the risk of eutrophication downstream. Although the main objective of the Hula Project was to prevent nutrients loads, mainly phosphorus (P), to Lake Kinneret, it has been recently claimed that since its setup (1994) which partially disconnected the Hula basin from the northern Jordan River basin, ecological instability in the lake is evident. It's expressed by the absence of the constant *Peridinium* spring blooming and by increasing cyanobacteria bloom events, probably due to the decrease of nitrogen loads versus high phosphorus availability. The main objective of this work was to examine the applicability of the Vegetated Agricultural Drainage Ditches method (VADDs) to reduce P leachate from agricultural fields of the Hula canals using emergent macrophytes. Phosphorus removal ability of four local macrophyte species (*Cyperus papyrus*, *Cyperus dives*, *Typha domingensis*, and *Sparganium erectum*) was tested in a lysimeters ($24X1m^3$) experiments. *Cyperus dives* displayed the highest P removal efficiency of 32% of the added P versus 12% in other plants. Next, the VADDs method was examined in largescale experiments conducted in six $50m^2$ compartments simulating the Hula drainage ditches. These experiments, examined scenarios of steady P and excessive P load, support our hypothesis that emergent macrophytes can remove a substantial amount of P (6.8 to 9.8 grP m^{-2}). Upscaling the results show removal capacity of 2-3 KgP per 100m drainage canal, which translate to 1.8-ton P removal potential by applying the VADD method across the northern part of the Hula project. Applying this concept in agricultural regions like the Hula Valley could restore the historic function of wetlands as 'the kidney of nature'.

The ecological system of the River Yarqon Estuary

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Ecological aspects of the River Yarqon Estuary were studied during 2018. Chemical, physical and biological parameters were monitored monthly along the river, particularly in its estuary. There were two goals for this study: I. To set the protocol for a long-term monitoring program of ecological parameters in this river, and II. To examine the current oxidizing regime of the estuary bed in comparison to loads of BOD transported from the upper part of the river. The second goal required performing an oxygen mass balance of the estuary floor, and evaluating phytoplankton growth in this aquatic system; using data of both phytoplankton abundance and of loads of soluble nutrients imported from the upper part of the river. In addition, we also monitored fecal coli abundance. Results from this monitoring efforts and preliminary outcomes/conclusions will be presented.

Evaluating the ecological risk of exposure to multiple pesticides in a Mediterranean Micro-Estuary

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Micro-Estuaries are small water bodies characterized by a shallow depth of few meters, length of few kilometers, and a surface area of less than a square kilometer. Despite their prevalence along semiarid coastlines such as the Mediterranian, their vicinity to urban centers, and the multiple ecological services they provide, micro-estuaries are among the least studied water-bodies in the world. In the Anthropocene, micro-estuaries are also among the most stressed water bodies, due to a combination of anthropogenic pollution, eutrophication, the loss of natural water sources and changes in land use and management of the catchment area that results in low baseflows during the dry season and high discharges during stormwater flow events at winter. An additional stressor is introduced to the estuarine environment by chronic exposer to multiple pesticides in baseflows and runoff events. The present work aims to elucidate and quantify the potential of the acute and chronic risk to Micro-Estuaries by using a Pesticide Toxicity Index (PTI) that sum the toxcity of multiple pesticides and compare it to published benchmarks for common taxa. A biannual monitoring work was done in the Alexander Micro-Estuary and a total of 149 samples were collected from 8 flood events and 20 months of baseflow. The samples were analyzed for 80 pesticides, out of those a total of 51 compounds were detected and quantified: 15 fungicides, 21 herbicides, and 15 insecticides. While overall PTI for fish and cladocerans was relatively low,10% of baseflow samples exceeded the acute toxicity threshold for sediment dwellers, and 60% and 66% of flood samples exceeded the acute toxicity threshold for sediments dwellers and algae, respectively. As the main contributor for algae PTI was the Herbicide Diuron, several compounds accounted for the sediment dwellers PTI. The effect of floods tail water, potential chronic toxicity and additional stressors in the system are also discussed.

Toward a standardized ecological assessment of streams in Israel: **a current state of affairs**

Yaron Hershkovitz

Israel National Center for Aquatic Ecology, The Steinhardt Museum of Natural History, Tel Aviv University

The use of aquatic organisms for the assessment and monitoring of freshwater ecosystems (streams, rivers), is a well-established practice worldwide. It provides stream managers and restoration practitioners an additional component for understanding the functioning and of the ecosystem. Its main advantage over chemical monitoring stems from the fact that biological entities can potentially integrate the impact of different environmental factors over space and time. In Israel, although being recognized, the application of biological assessment of streams has not yet established on a national scale. The main goal of the Israel Aquatic Ecology Center (est. 2015) is to advance the use of biological components for the assessment of streams in Israel. In this talk I will present the fundamentals of biological monitoring using macroinvertebrates and discuss the various means by which it may be applied in the assessment and management of streams in Israel.

Session: Dynamics of streams and Estuaries- Poster presentations:

The effect of bed form migration on oxygen consumption in the hyporheic zone

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Dissolved oxygen (DO) is one of the key solutes of river ecosystems because it controls the redox processes and fuels the metabolism of organisms living in the water and the hyporheic zone. Oxygen dynamics in sandy streambeds have been extensively studied under conditions that are characterized by stationary bed forms, despite the fact that bed form migration is common in most streams. Therefore, we evaluated the effect of overlying water velocity and bed form celerity on hyporheic exchange flux (HEF) and oxygen consumption under moving bed conditions. We measured the two-dimensional DO distribution under various water velocities using a planar optode in an experimental recirculating flume system (260 cm × 29 cm), packed with natural sandy sediment collected from the Yarkon River in Israel. Hyporheic exchange flux was measured with conservative tracer additions. Bed form height increased slightly from 8.8 mm to 11.8 mm under increasing overlying water velocity conditions, while bed form celerity increased at the same time rapidly from 3.7 cm/h to 67 cm/h. The oxygenated zone in the sediment expanded when the stationary bed started to migrate upon increase in water velocity, but remained relatively constant despite further increase in celerity. By combining the DO distributions with HEF measurements we calculated the average DO consumption rates in the oxygenated zone. The average DO consumption rate decreased at faster velocities due to the increasing role of bed movement, and decreasing role of advective exchange. These results are important for understanding stream metabolism, and the role of the hyporheic zones during bed form migration.

Effect of fine particle deposition on hyporheic exchange flux under mobile-bedform conditions

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Hyporheic exchange is an ecologically important process that controls the exchange of nutrients between the water column and microbe-rich sediment bed in a stream. Fine particle deposition induces clogging and reduces hyporheic exchange and larger stream-groundwater interactions. This phenomenon has primarily been studied with stationary bedforms. We conducted experiments to study the effect of fine suspended particle deposition on clogging and hyporheic exchange with mobile bedforms. Experiments were conducted in a recirculating flume (640 cm X 30 cm) packed with homogeneous sand. This flume has a unique ability to impose up- or down-welling flow through the entire sediment bed. Hyporheic exchange flux was quantified using salt tracer additions, and observed visually by adding a dye tracer to the overlying water. We also obtained high-frequency time series of bedform morphodynamics and water column clay concentration. While clogging occurs close to the surface in stationary streambeds, we observed clogging below the active mobile bed sediment in our experiments. Unlike the case with stationary bedforms, in which clay accumulates primarily on the upstream slope of each bedform and reduces exchange starting from that location, moving bedforms redistribute deposited clay and shift the location of hyporheic inflow as the bedforms propagate downstream. This leads to clay accumulation primarily below the maximum scour depth of the series of bedforms. Additional experiments under gaining and losing flow conditions demonstrate variable clogging patterns. These experimental results represent unique observations of the effects of fine particle deposition on hyporheic exchange dynamics for losing, neutral, and gaining fluxes under mobile bed conditions. These results are important for understanding the multi-scale complexity of hyporheic exchange in rivers with both bedform-induced hyporheic exchange flow and reach-scale patterns of up or down-welling groundwater.

Session: The Ecology and Biodiversity of Marine Biota

In memory of Tomer Borovsky

Chairs: Tamar Guy-Haim and Shevy B.S. Rothman

Oral presentations (in order of appearance):

Spinner sharks (*Carcharhinus brevipinna*) spin to remove remoras

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Remoras (also known as sharksuckers) are fish that adopted a semi-parasitic behavior of hitching a ride on large fish & cetaceans. Some of these animals have developed ways of removing the remoras, by jumping out of the water, and spinning rapidly. This behavior was analyzed for spinner dolphins showing that the remoras are dislodged by the centrifugal force acting to peel the remora off, and throwing it to a distance. The analysis there described mainly vertical jumps and the remora weight was not considered. In the present work, we show that spinner sharks have independently adopted spinning as a way to remove the remoras, and are actually performing more complex motions than dolphins to dislodge the remoras. Many of the recorded jumps by sharks were horizontal or almost so. This has two advantages, which will be examined here. 1) Horizontal jumps are more effective for the task at hand energetically, as more of the jump energy can be applied to the rotation, accelerating horizontally (especially in shallow waters and in currents or waves, by going in the direction of the swell). 2) A horizontal spin can add the weight of the remora as a lateral force, to which the remora is more susceptible. On the other hand, remoras have developed some defensive behaviors, such as they seem to prefer locations on the shark body, where the body diameter is narrower, so that the centrifugal force is reduced. In addition, they seem to try and readjust so as to head into the direction of the turn, to reduce the weight issue. This probably starts if it senses the start of a rapid spin. We calculate the rates of spin, and bending motions required to produce enough force to remove a remora of given size, and show that some of the observed jumps are sufficient for this purpose. Measurements from available footage of Shark jumps show good agreement with these predictions.

Large breeding aggregations of batoids in the Eastern Levantine coast

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Batoids are globally threatened by overexploitation, particularly so in the Mediterranean Sea. Nevertheless, we have very little information about their ecology, behavior and taxonomy in the Eastern Mediterranean (Levant), where water temperature, salinity and the impact of invasive species is relatively high. Specifically, although it was suggested that some batoids may aggregate in the Levant, it remains unclear: (1) which batoids are present in the coastal rocky reef habitat? (2) what are their temporal dynamics? and (3) what are their sex ratios? This research focuses on assessing batoid identity, their trends of abundance, behavior, and sex ratios in a coastal rocky habitat of the Levant. In order to do so we conducted non-lethal visual surveys, which allow the documentation of batoid behavior and differ from most available data based on fishery catches. The census took place within a Marine Protected Area (MPA) over a total period of three years. Altogether, 675 observations of a diverse communities composed of six different batoid taxa were observed. We found clear seasonal patterns, with observations during spring and early summer, where densities exceeded 27 individuals per km, and batoids absent over the rest of the year. In addition, we found indications of reproduction behavior in *Dasyatis* sp. (e.g. courtship, followed by more active males, the appearance of gravid females, and finally juveniles). We also recorded the first documentation of *Dasyatis* sp. courtship in the Mediterranean. This research revealed large seasonal batoid aggregations in shallow waters that, to our knowledge, have never been documented in the Mediterranean before. The lack of similar aggregations elsewhere in the Mediterranean could attest to data deficiency or represent a unique Levant phenomenon. This study has great conservation implications on batoid research and deepens our understanding of batoid ecology and life history in the Mediterranean Sea.

Euphyllia paradivisa as a case study for mesophotic coral fluorescence

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Fluorescence is a wide spread and intriguing phenomenon in the marine environment. The emissions of light by a substance that has absorbed shorter-wavelength light, had been discovered and described in many coral species. Coral fluorescence had been found to be a result of the presence of fluorescent proteins (FPs) from the green fluorescent protein family (GFP-like proteins). The biological role of these special proteins was previously studied in shallow corals and two major hypotheses were suggested; 1) photoprotection against high and harmful radiation (i.e. the "sunscreen hypothesis"), or 2) enhancement of photosynthesis where light is scarce by energy transfer or by light transformation. While evidences for the photoprotective role of FPs were reported in several shallow coral species, the role of fluorescence in deeper habitats, such as mesophotic reefs (30-120 m) are yet to be determined. Mesophotic corals display striking fluorescence colors and patterns and therefore presenting us with a new model for potential testing of the previously suggested hypotheses. In this study we tested both the sunscreen hypothesis and the photosynthesis enhancement roles of fluorescence in different color morphs of the mesophotic coral *Euphyllia paradivisa*. We examined the photosynthetic and physiological characteristics of three different fluorescence morphs in order to test the relationships between fluorescence and photosynthesis and subjected the corals to high-light and ultra-violet radiation (UVR) stress to assess whether different fluorescence morphs will differ in their stress response. We found no significant differences between the three fluorescence morphs in the amount of UVR induced damage, symbiont density or chlorophyll concentration, therefore not supporting either of the suggested hypotheses. However, we did find photoprotective mechanisms that were only known from shallow corals such as accumulation of UVR absorbing compounds and tissue contraction. Our results contribute to a better understanding of the physiology of mesophotic corals and posit that for these corals, other roles of fluorescence should be tested, including a role in prey attraction or antioxidant activity.

Microplastic ingestion by marine fishes in Israeli coastal waters: A systematic approach

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Vast amounts of plastic pollution threaten the health of marine systems, where these materials accumulate in mass. While it is understood that the Mediterranean Sea aggregates large amounts of plastic debris and microplastics, the possible effects on Israeli biota have not been thoroughly explored. This study aims to provide an initial investigation of microplastic (plastic particles smaller than 5 mm) ingestion by local marine biota while providing a baseline for future work. The central component of this study assesses the consumption of microplastic by a local fish community in order to give insight of the interaction dynamics of microplastics within it. Here, the most elementary question we aim to answer is if fish in local water are consuming microplastics and if consumption differences relate to the organism's trophic level or habitat. We confirm that microplastics are not only present in Israeli marine waters but are interacting with local biota through ingestion. Both microplastic particles and fibers were present in fish, with polymer makeup originating from both synthetic and semi-synthetic sources. Pelagic-neritic fish were found to have significantly higher ingestion rates compared to other lifestyles. Within this lifestyle two planktivorous fish, *Scomber colias* and *Engraulis encrasicolus*, had higher particle contamination as well as a significantly higher ingestion rate. Looking at surface waters samples, the habitat of these species, ratios between microplastics and plankton indicate overlap of potential prey and pollutant. Particle presence in fish appear to be highly influenced by biology and lifestyle while fibers, on the other hand, despite being quantitatively much more dominant, do not appear to follow any pattern but are broadly present and available throughout the marine system and freer to interact with organisms. The findings indicate that certain species are affected more so than others, and conservation requires identification of problematic areas before initiating monitoring efforts.

Marine algal forests in the Levantine basin: The case of *Cystoseira rayssiae* along the Israeli coast

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The SE Levantine Basin is the hottest, fastest warming and most alien-invaded corner of the Mediterranean Sea. These characteristics make this region a natural laboratory to test the effects of climate change and bioinvasion pressures on benthic communities. Along the Israeli Mediterranean Sea coast, an endemic species of the genus *Cystoseira*, *C. rayssiae*, was first described by Ramon in 2000. Since then little has been done to study its ecology. This is in contrast to the Western Mediterranean, where many *Cystoseira* species, known to be important habitat formers, have been studied extensively and are listed in the Annex I of the Conventions of Bern and Barcelona because of many anthropogenic threats. The lack of knowledge on *C. rayssiae* ecology in the SE Levantine Basin prevents the development of protection measures for this high risk species. This study presents results on the annual dynamics of *C. rayssiae* in the Haifa region in terms of growth, reef cover, biomass and metabolic ecosystem functions (associated species, oxygen production and carbon budget). Our results show that its branched form only appears in winter and spring when it provides habitat for multiple species (two-fold higher associated taxa richness compared to turf), high oxygen production (12 mmol $O_2/m^2/h$) and high capacity for C sequestration (-12 mmol $C/m^2/h$) compared to turf and alien dominated macrophyte communities. During the warmer months (July-November) it becomes branchless and dormant with lower habitat provisioning capacity, metabolism and a three-fold decrease in length from May to August, from the peak season to the dormant phase. These data suggest that the expected fast warming in the Levant basin may pose a considerable threat to this important habitat forming species and to the whole reef metabolism, with a possible replacement by similar non-indigenous, thermophilic macroalgae.

Using stable carbon and nitrogen isotopes to investigate the impact of desalination brine discharge on marine food webs

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Stable isotope ratios were used to trace the impact of anthropogenically derived brine from desalination plants on organisms at different trophic levels (primary producers and consumers) along the highly urbanized ultra-oligotrophic Israeli coast (southeast Mediterranean). Primary producer and consumer organisms were collected from two sampling stations at two desalination plants sites: an "Impacted station", near the brine discharge outlets, and a "Control station" situated further offshore to the impacted zone. and values of both producers and consumers displayed minor variations between the impacted and control stations, indicating little effect of brine discharge on the coastal trophic structure. The coastal values were generally higher than those of similar pelagic communities of the southeastern Mediterranean. These were particularly high in benthic invertebrates and benthic carnivores (fish) from the southern site, where high anthropogenically N loads from ground water amelioration are discarded alongside the brine. The observed differences in the of the benthic components between the two study sites suggest that brine derived density plumes from desalination plants are a possible vector of nutrients to benthic communities. The results indicate that the benthic components were the most sensitive group to anthropogenic derived N pollution, and provide insight into site-specific processes.

Session: The Ecology and Biodiversity of Marine Biota- Poster presentations

PLASTISPHERE: understanding microplastic biota composition and dynamics along the coasts of Israel

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Since its introduction to the market in the late 1940's, plastic has become a key material in many man-made products. The most common plastic polymers that are currently being used in the industry are polyethylene and polypropylene as well as polyvinylchloride, polyurethane, polyethylene terephthalate, polystyrene and polyesters. Every year, an estimated 4.8–12.7 million tons of plastic debris (PD) find their way to the oceans. Plastic pollutants are persistent and remain in the ocean circulation for long periods of time and therefore serve as potential substrates for biological growth. A variety of organisms have adapted to live on marine PD including species of diatoms, algae, fungi and bacteria of which some are considered as plastic biodegrades. This biological community on PD is termed "plastisphere". In this study we aim to characterize the plastisphere species composition and abundance and to understand its dynamics under different conditions including different marine environments (open sea vs. confined marina), different seasons and circulation time. We extracted environmental DNA from marine PD, collected in shallow water at the Bat-Galim beach, Haifa. The DNA was subjected to the amplification of multiple sites on different genetic prokaryotic and eukaryotic barcoding markers (i.e. 16s, 18s, COI and Rubisco) followed by high-throughput third generation MinION nanopore sequencing and bioinformatic analysis. This work pipeline allows rapid identification the plastisphere species composition without the need of cloning and sequencing of individual amplicons. In addition to the molecular identification of species we use a variety of techniques to identify the plastic polymer type and to characterize the plastisphere morphology. These techniques include FT-IR spectrometry to identify the different plastic polymers by their spectral signature, hydrophobicity assay, biofilm staining assay and scanning electron microscopy (SEM). Taken together, this exploratory study is expected to provide basic information on this man-made ecological niche of marine plastic and lay the foundation for further research on the subject.

Image-Based 3-Dimensional (3D) Modeling for Depiction of Coral Reef Community Structure

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Coral reefs are the most complex and diverse ecosystems in the marine environment. These epic structures are built mainly by colonial organisms of the phylum Cnidaria; Scleractinian Corals. As ecosystem engineers, and pioneers in an oligotrophic oasis, their growth by biomineralization modulates the availability of resources to a wide variety of organisms. While many studies have focused on the biology of these holobionts, much remains to be learned of their spatial distribution and community structure dynamics, a research frontier which is confined by the available technological tools. My work can be divided, in general, in two fields; development of novel computer vision tools, and their application in research and monitoring; primarily of coral reef ecosystems. Underwater photography and image-based modeling is utilized to create wide-scale (km), high resolution (genus specific), true color and texture 3D maps of the shallow and mesophotic coral reefs of Eilat. These maps are automatically analyzed using semantic segmentation, a machine learning task that provides information regarding every pixel in the image-based map. Highly detailed map models provide both the fine scale topography of the benthos (terrain complexity), and the distribution of key sessile groups which are automatically detected and segmented through computer-vision and deep-learning. The multivariate spatial data is used to examine phenomena in benthic ecology such as the neighbor relations, size frequency distribution, and depth-related zonation of sessile invertebrates. Furthermore, it enables to test specific hypotheses such as the relation between terrain complexity (rugosity) and biodiversity through an automated framework. The replacement of traditional methods for rapid underwater ecological assessment with accurately derived metrics from image-based 3D map models represents a paradigm shift soon to be actualized in underwater research and monitoring.

Light environment drives the shallow to mesophotic coral community transition

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Light quality is a crucial physical factor driving coral distribution along depth gradients. Currently, a 30m depth limit, based on SCUBA regulations, separates shallow and mesophotic coral ecosystems (MCEs). This definition, however, fails to explicitly accommodate environmental variation. Here, we posit a novel definition for a regional or reef-to-reef outlook of MCEs based on the light vs. coral community-structure relationship. A combination of physical and ecological methods enabled us to clarify the ambiguity in relation to that issue. In the aim to characterize coral community structure and the light environment, we conducted wide-scale spatial studies at five sites along shallow and MCEs of the GoE/A (0-100m depth). Surveys of 2320 plots (70*50 cm) were conducted by Tech diving and drop-cameras, in addition to one year of light spectral measurements. We quantify two distinct coral assemblages: shallow (<40m), and MCEs (40-100m), exhibiting markedly different relationships with light. The depth ranges and morphology of 47 coral genera, was better explained by light than depth, mainly, due to the Photosynthetically Active Radiation (PAR) and Ultra Violet Radiation (UVR) (1% at 76m and 36m, respectively). Branching coral species were found mainly at shallower depths i.e., down to 36m and were termed as shallow-specialists. Among the abundant upper mesophotic specialist-corals, *Leptoseris glabra*, *Euphyllia paradivisa* and *Alveopora* spp., were found strictly between 36-76m depth. The only lower mesophotic-specialist, *Leptoseris fragilis*, was found deeper than 80m. We suggest that shallow coral genera are light-limited below a level of 1.25% surface PAR, while the optimal PAR for mesophotic communities is at 7.5%. This study contributes to moving MCE ecology from a descriptive-phase into identifying key ecological and physiological processes structuring MCE coral communities. Moreover, it may serve as a model enabling the division of coral zonation at any given reef world-wide on the basis of light quality data.

Ten Years of Levant rocky shore ecological monitoring: evidence for a highly seasonal, unstable, increasingly-stressed ecosystem

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To capture the natural variability in space and time and to allow detection of human-mediated impacts on the marine environment, long-term time-series of ecological and environmental data across many sites over several spatial scales are required. Surprisingly, long-term, continuous, whole-community time-series in the very accessible rocky shore ecosystem are rather rare, compared for example to coastal soft bottom communities. This was the case also for the Israeli Mediterranean coast until a decade ago. Anecdotal surveys and observations have shown that this coast have gone through dramatic ecological alterations already during the 1980-90s but consistent monitoring of the ecosystem began only in 2009 by IOLR, focusing on the unique and vulnerable vermetid reefs. Monitoring includes annual ecological surveys of 11 sites from north to south, and, in four core sites, seasonal ecological surveys plus monthly water sampling and hourly temperature logging. Results show evidence for small biogeographic differences between north and south communities, clear zonation within sites, and strong seasonally in community structure, with highest taxa diversity at the reef edge and during winter-spring. Inter-annual analysis revealed several intriguing temporal patterns, including large changes in the abundance of key species over time including (1) the total and rapid collapse of a dominant invasive tropical mussel, *Brachidontes pharaonic*, (2) strong fluctuations in the abundance of the vermetid *Vermetus triquetus*, and of an invasive macroalgae, as well as (3) a short, minute, recovery and then disappearance of the Levant endemic reef-building vermetid, *Dendropona anguliferum (*formerly *D. petraeum)*, mainly in Achziv. This ecosystem is also increasingly suffering from stress caused by prolonged desiccation events (PDEs) that lead to massive macroalgal bleaching and invertebrate mortality. The accumulated evidence suggests that rocky shores on the Israeli coast may be experiencing increasingly unstable environmental conditions that are reflected by sharp changes in the ecological community.

Increased dissolution of the Eilat Nature Reserve coral reef due to ocean acidification

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The ecological success of coral reefs depends primarily on their ability to maintain the integrity of their carbonate frameworks, requiring that their calcification is greater than or equal to their erosion. Previous studies have shown that both processes are strongly affected by ocean acidification (OA) and eutrophication. During 2000-02, numerous measurements of net community calcification (G_{net}) in the Nature Reserve Reef (NRR), in the northern Gulf of Eilat (Aqaba), were positively correlated with seawater aragonite saturation (Ω_{arag}) and temperature, and negatively correlated with nutrient levels. Based on these relations, it was predicted that coral reefs worldwide will start to dissolve by the middle of the 21st century. The current study (2015-16), fifteen years later, evaluated the changes in the NRR community calcification and dissolution using the same methodology and site. The results show that G_{net} increased by 40±30% ($p=0.005$) compared to early 2000-02, consistently with the reported increase in live coral cover of the NRR during the same period. These changes most likely reflect the recovery of the reef from the ongoing eutrophication of Gulf waters that ended in 2008. In contrast, annual and winter average maximal nighttime dissolution rates in 2015-16, were higher by a factor of 3 ($p=0.071$) and 4 ($p=0.007$), respectively, and they also displayed a significant negative correlation with Ωarag in seawater ($R^2=0.59$, $p<0.05$). It is highly likely that these changes occurred in response to the accelerated OA occurring in the northern Gulf of Eilat ($\Delta pH/\Delta t = -0.038$/decade). The previously predicted response of coral reefs worldwide to OA did not consider the apparent dependence of dissolution on Ω_{arag} and also underestimated the rate of coral bleaching and loss of live coral coverage due to warming. Therefore, it can be concluded that coral reefs worldwide may start dissolving even earlier than previously predicted.

The effect of desiccation events and habitat complexity on the spatial distribution and temporal stability of species in the rocky intertidal

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One of the major expressions of climate change is the increase in the frequency and intensity of extreme climate events. The Middle East is strongly influenced from the increase of climate change related extreme climate events. On land, these events include increase in heatwaves and droughts, and in the marine environment, extreme events can include strong storms or heatwaves. Recently, a new phenomenon was described: prolonged desiccation events (PDEs) in the rocky intertidal zone of the Israeli Mediterranean coast. These events can cause massive bleaching of algae and mortality in sessile and mobile invertebrates. Climate re-analysis showed that the synoptic systems that produce these PDEs have increased in frequency in the past four decades. These events effect not only air temperature, but also to solar radiation (and thus rock temperature), desiccation and wind. The effect on individual organisms in the intertidal zone is also strongly related to fine-scale 3D structure of the habitat that can create multiple microhabitats with highly variable conditions. Microhabitats can either facilitate abiotic stress in 'hotspots" or offer refugia from extreme abiotic conditions, potentially allowing the persistence of a population during severe weather. For the past year, we monitored shoreline weather with an on-line weather station and the effects of PDE events within fixed quadrats in four sites. Initial analysis shows that such events are highly variable in their character and impacts. The impact of a short PDE (two days) was significantly different between monitored sites and in Shikmona caused 20% algal bleaching, suggesting the damaging potential for longer and stronger events that are still being analyzed. Preliminary LT-50 experiments under varying temperatures and low desiccation conditions showed that topshell snails are quite resilient to extreme cold and hot conditions and die only after 72 hours in 37^0c and low humidity levels (30%).

Seasonal flux patterns of planktonic foraminifera in a deep, oligotrophic, marginal sea: sediment trap time series from the Gulf of Aqaba, northern Red Sea

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Annual and interannual planktonic foraminifera (PF) fluxes, species assemblage composition, their vertical distribution (0-600m) and shell-size-distribution (63-125, 125-500, 500-1000µm) were characterized using sediment traps from the marginal oligotrophic Gulf of Aqaba (GOA), northern Red Sea, between January 2014 and February 2016. PF fluxes in the GOA display strong seasonality, with low values observed during the spring-summer months, gradually increasing during the autumn-winter. This increase is coeval with an increase in primary productivity and surface chlorophyll-*a* concentrations, resulted from winter cooling and deepening of the mixed-layer in the GOA, which drives the admixing of nutrient-rich bottom waters into the euphotic zone.The dominant shell size-fraction is between 63-125µm (55-94% of the total flux), which has generally been overlooked in previous studies, resulting in a significant knowledge gap related to the neanic stages and the small-adult-size PF. Indeed, the 63-125µm size-fraction is dominated by the smallest species *Turborotalita clarkei* (36-92%). The 125-500µm size-fraction (6-45%) is dominated by the species *Globigerinoides ruber*, and only up to 1% of the tests are in the range of 500-1000 µm, dominated by *Orbulina universa*. The GOA is located at the edge of a >2000 km transect that begins in the productive Arabian Sea, across the Red Sea, where a gradual decrease in nutrient availability, imposes a corresponding decrease in PF abundances, fluxes and diversity. Thus, the GOA, is an extreme case of an oligotrophic ecosystem. Over the last few decades, PF species richness decreased in the GOA from 13 to 10, including the disappearance of *Trilobatus sacculifer*, the most common species in the 1970's. Similar changes during the late Quaternary, suggesting that wider scale environmental changes are the drivers of the long-term PF dynamics in the GOA. Therefore, understanding the controls on the PF communities and their dynamics is the key to reconstructing paleo-oceanographic conditions in the GOA and the Red Sea, as analogues for other deep oligotrophic environments.

Sporulation studies in seaweeds: towards full domestication of *Ulva* (Chlorophyta) aquaculture

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The rapid growth of human population, decreasing arable land and fresh water supply question the sustainability of terrestrial agriculture in securing enough nutrients supply for human and livestock. In recent years seaweeds have integrated in numerus industries e.g. cosmetics, pharmaceutical, biofuel industries and more. *Ulva* is a cosmopolitan green marine macroalga characterized by high growth rates and productivities. *Ulva* simple tissues have significant quantities of active metabolites profitable for various industries. The reproductive cycle in this seaweed includes the production of sexual and asexual spores, a process called sporulation. Spores in nature swim, settle and develop into a mature thallus. In *Ulva* aquaculture, sporadic sporulation events could lead to significant decrease in growth rates and overall biomass yields. On the other hand, learning how to induce this process might be helpful to improve *Ulva* domestication by means of strain selection. Previous experimental work on *Ulva* species indicated that sporulation is controlled by 1) abiotic factors, 2) thallus age and 3) specific inhibitors that when washed away may result in sporulation induction. This study shows that for the local *Ulva*, low irradiance (c.a. 10 μmol photons m^{-2} s^{-1}) and mid-range temperature during spore development enhance spore production. *Ulva* species have two distinctive morphologies, long and narrow fronds bearing a single layer of cells, and blade, lettuce-shaped thalli with two layers of cells. Washing-off sporulation inhibitors is much harder in two-cell layer which may explain the relative low sporulation intensity obtained for the lettuce-shaped thalli. Sexual spores (gametes) have differential ability to swim towards a light source in correlation to their autofluorescence, or chlorophyll content. This study is one more step towards understanding and controlling the sporulation process for a more sustainable and profitable *Ulva* cultivation industry.

Cold seep communities and cold water corals of the Palmachim Disturbance –biodiversity hotspots at an edge system

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The Palmachim Disturbance is a 15 km wide feature on the Israeli shelf. The initial exploration by the E/V Nautilus in 2010 revealed a unique biological hotspot, several successive cruises augmented observations and sampling of these coral gardens in 2011 (Nautilus E/V), 2016 (R/V Aegeo, SemSeeps Project) and 2017 (R/V Bat Galim, Cherney School of Marine Sciences).
Using geophysical surveys combined with remotely operated vehicles, we have explored the Palmachim Disturbance discovering two distinct biological communities - thriving cold water coral communities (CWC) growing on seep related authigenic carbonate rocks at 500-800 m depth, and chemosynthetic assemblages at 900-1150 m depth. Collected specimen were identified, genetically barcoded and analyzed using compound specific stable isotope ratio (CSIA). Carbon stable isotope ratios in amino acids from samples in the vicinity of the carbonates reveled methanotrophic activity at the base of the food chain, indicating active methane seepage, this was the first time this method was used to find evidence for active gas seepage. Active seeps provide energy for primary production via chemosynthetic production feeding the local biological communities. Seeps generate authigenic carbonates facilitated by microbial activity which provide substrate for cold water corals, which may settle once the seeps become inactive. These discoveries shed new light on the biogeography of cold water corals and seep communities in the Mediterranean. The discovery of CWC communities at the southeastern Levant, which is both extremely warm and nutrient deprived, has expanded the temperature and depth range of many of the discovered biological species. Both habitats provide new biodiversity records in the south eastern Levant Sea, including species new to science.

Session: Advances in physical oceanography and its integration in multidisciplinary studies

Session chairs: Ayah Lazar and Yael Amitai

Oral presentations (in order of appearance):

Dancing out-of-phase: **Mechanical properties of coral tentacles contribute to mass transfer under wave induced flow**

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Sessile marine organisms rely on ambient flow for nutrient supply and waste removal. Many of them have flexible tentacles, appendages or whole body plans that sway and bend under the influence of waves and currents. Using high speed videography, we recorded motions of tentacles belonging to three Hexacorallia species in-situ and in a standing wave laboratory flume. We visualized and quantified the flow around the tentacle using Particle Image Velocimetry (PIV), a nonintrusive flow measurement technique. Tentacles exhibited an unintuitive motion: they oscillated with the same frequency as the waves, but preceded the waves by around ~1/4 of wave period, generating an out-of-phase motion. Our observations (N>120) led to two research questions: (1) is there a benefit in out-of-phase motion, in terms of mass transfer? (2) What mechanism permits such motion? We used numerical simulations to estimate absorbance of dissolved oxygen from the environment to the tentacles in a wide range of phase differences. Our simulations show that moving out-of-phase with the flow improves mass transfer by up to 20% compared to moving in-phase. We tested a simple mechanical model where tentacles are represented as mass-damper-spring systems. Using our model on Dipsastrea favus tentacles as an example, we non-intrusively estimated the Young's modulus of the tentacles and found it similar to that of the mesoglea of sea-anemone. We postulate that out-of-phase motion is a general phenomenon shared by cnidarian tentacles (and possibly other flexible marine organisms) that may represent an adaptation to wave flow. Our findings demonstrate how these animals, often treated as immobile, can actively affect their interaction with the flow and harness wave motions to improve mass transfer.

Wave propagation and runup in patchy vegetation

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Over the last decade, nature-based infrastructure for coastal hazard mitigation has gained popularity. Field observations from recent tsunamis and tropical cyclones suggest coastal wetlands, coastal forest, and other vegetation have the potential to dampen storm waves and alter inundation by storm surge and tsunami runup. Yet, the characterization of mitigation potential by vegetation is complex because of natural variability in both space and time of vegetation coverage and characteristics. Here, we present findings from both large-scale laboratory experiments (e.g., Irish et al. 2014, *Nat. Hazards*) and Boussinesq simulations of long (e.g., Zainali et al. 2018, *Mar. Geol.*) and short (e.g., Yang & Irish 2018, *Estuar. Coast. Shelf Sci.*) waves in patchy vegetation, with emphasis on the macro-scale influence of the patches. Vegetation is represented either by circular patches comprised of cylinder arrays (laboratory experiments, Basilisk simulations) or as circular patches of increased bottom friction (COULWAVE simulations). In the case of random waves propagating over nearemergent vegetated mounds, wave energy is found to transfer to the higher harmonics. The figure (from Yang & Irish 2018, *Estuar. Coast. Shelf Sci.*; waves propagate from left to right) shows percent change in wave energy at the dominant wave frequency (top, most energy remains at dominant frequency), first harmonic (center), and second harmonic (bottom) between the non-vegetated and vegetated mound cases for an incident dominant wave near the shallow-water limit. In the presence of vegetation, more energy is transferred into higher frequencies in the lee of the mound. In the case of long wave runup in the presence of patchy vegetation onshore, the discontinuous vegetation is found to reduce momentum flux overall (Yang et al. 2017, *J. Waterw. Port C.-ASCE*). Yet, channelization of flow between patches induces locally higher momentum flux in some areas.

Monitoring of the Eastern Levantine with mobile autonomous systems

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Surface circulation and hydrographic conditions in Levantine Sea (Mediterranean Sea) are complex and variable. In this region, mesoscale and sub-mesoscale scale eddies are predominant, and strongly interact with a persistent coastal current. Despite much efforts, there are still a number of circulation features that are poorly observed or understood, to some extent, because political barriers hinder or forbid direct collaborations and dramatically constrain the range and geography of at-sea operations. The knowledge gap is worrying in terms of science but also for societal applications, as for instance it hinders our capacity of mapping the connectivity of marine ecosystems and of responding to intentional or accidential dispersion of contaminants (which do not recognize political borders). We use energy efficient mobile autonomous systems (gliders, drifters and floats) to measure near-surface currents as well as vertical profiles of physical and biogeochemical parameters. During the 1st field experiment, May 24 and July 23, we used 3 ocean gliders (one Italian and two Israeli), deployed 15 surface drifters, and in parallel analysed satellite data. The drifters demonstrated the existence of an eddy with a radius of tens of km offshore the southern coast of Israel. In addition to the rotation around the core of the eddy, inertial oscillations are visible. Four drifters escaped after some time from the eddy and were trapped in a northward coastal current. An interesting observation is the existence of a very narrow, coastally trapped southward current.

Non-hydrostatic effects in the Dead Sea

Yosef Ashkenazy and Oded Padon

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The Dead Sea is the saltiest and lowest terminal lake in the world. For at least three decades, the Dead Sea's water level has been dropping by more than 1 m per year, due to excessive use of the water that previously flowed into it. The Dead Sea constitutes a unique environment and is important from economic, environmental, and touristic points of view. The winter deep convection of the Dead Sea and its deep and narrow basin suggest that nonhydrostatic effects may significantly affect its circulation. Despite these factors, the expected non-hydrostatic effects on the circulation of the Dead Sea have not been investigated. Here we perform high resolution (100 m) ocean general circulation model (the MITgcm) simulations of the Dead Sea and show that the non-hydrostatic results are very different from the hydrostatic ones. Specifically, we show that the winter non-hydrostatic simulations resulted in a layer of dense water overlaying slightly lighter water during the several last hours of the night; this convection process involved plumes of heavier sinking water and the entrainment of the plumes. We also studied the effect of the wind stress's diurnal variability and found it to be important, especially during the summer when the wind's variability drastically increased the surface kinetic energy; however, it did not alter the depth density profile. The results presented here may be important for the Dead Sea's potash industry and for the planned Red Sea-Dead Sea canal that aims to stop and, possibly, to increase the level of the Dead Sea using the Red Sea's water.

A Physical Interpretation of the Wind-Wave Instability as Interacting Waves

Eyal Heifetz

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One mechanism for the growth of ocean surface waves by wind is through a shear instability that was first described by Miles in 1957. A physical interpretation of this wind-wave instability is provided in terms of the interaction of the surface gravity wave with perturbations of vorticity within the critical layer - a nearsingularity in the airflow where the background flow speed matches that of the surface gravity wave. This physical interpretation relies on the fact that the vertical velocity field is slowly varying across the critical layer, whereas both the displacement and vorticity fields vary rapidly. Realizing this allows for the construction of a physically intuitive description of the critical layer vorticity perturbations that may be approximated by a simple vortex sheet model, the essence of the wind-wave instability can then be captured through the interaction of the critical layer vorticity with the surface gravity wave. This simple model is then extended to account for vorticity perturbations in the airflow profile outside of the critical layer and is found to lead to an exact description of the linear stability problem that is also computationally efficient. The interpretation allows, in general, for the incorporation of sheared critical layers into the ‘‘wave interaction theory’’ that is commonly used to provide a physical description and rationalization of results in the stability of stratified shear flows.

Biogeochemistry under Globally Glaciated Snowball Earth Conditions

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The climate system on Earth is ever evolving and there are multiple stable states that it can tend towards. One of the more extreme states is global glaciation, more commonly known as the snowball Earth condition. Geological evidence suggest that Earth's climate was in this extreme state at least twice (710 and 630 million years ago) during the Neoproterozoic era. During these glaciation events, climate became extremely cold and the Earth's surface was dominantly covered with snow/ice. An important piece of evidence to corroborate the snowball Earth hypothesis is the existence of Banded Iron Formations which could only have formed if there was widespread anoxia in the ocean during the glaciation period. The hard snowball hypothesis which claims that the Earth was completely covered with ice/snow explains the widespread anoxia in the ocean, however, in case of the soft snowball where there is a band of open water, it is not clear whether or how the oceans were deprived of oxygen. A soft snowball is also invoked to explain the survival of primitive photosynthesis based lifeforms during these events. The dynamics of oxygen and other passive tracers associated with biogeochemistry of the ocean is studied for a soft snowball Earth using an ocean general circulation model (MITgcm) to explain the existence of Banded Iron Formations as well as the survival of primitive photosynthesis based lifeforms in the ice-free regions during the Neoproterozoic global glaciation events. The ocean circulation is driven by surface fluxes and wind stress estimates for the glaciation periods. The role of bottom topography in inducing anoxia in the ocean is also discussed.

Session: Advances in physical oceanography and its integration in multidisciplinary studies - Poster presentations

Plankton and nutrient dynamics in the Gulf of Elat (Aqaba): biophysical feedbacks vs. internal dynamics

Hadar Berman and Hezi Gildor

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Phytoplankton primary productivity accounts for approximately half of the photosynthesis on earth and thus plays a significant role in removing anthropogenic carbon dioxide from the atmosphere. Annual variability of phytoplankton concentration consists of a spring bloom. Despite the significance of this phenomenon, the mechanisms governing the spring bloom initiation are controversial. Hypotheses emphasizing various physical or biological forcing contributions have been proposed. The physical and biological processes controlling phytoplankton abundance are intermittent in time, nonlinear, inhomogeneous, and span a wide range of spatial and temporal scales. Thus, observing the relevant processes and interpreting the measurements for marine primary productivity is extremely complex and numerical models are crucial for investigating problems in the marine ecological system. These coupled physical-ecological models contain numerous poorly constrained parameters that represent different processes within the system. We use a genetic optimization algorithm to estimate the parameters of a simple NPZD (Nutrient-Phytoplankton-Zooplankton-Detritus) model constructed for the Gulf of Elat. We use this algorithm to study the sensitivity of the model to variations in the different parameters and the parameter space. We implemet these results in a 3D general circulation model (MITgcm) to test the different hypotheses for the spring bloom initiation, and to study the processes that control the ecological system variability.

Intermediate dense water formation and current variability at the DeepLev moored station in the southeastern Levantine Basin

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We present an eighteen month long (Nov 2016-June 2018) high-frequency record of velocity, temperature and salinity of the entire water column (1500 m depth) at the DeepLev station in the southeastern Levantine basin, 50 km off-shore Israel. Continuous temperature and salinity records at the LIW core, and down to 400 m depths, show first concrete evidence for LIW formation in this area during February-March 2017 and January-February 2018. Current meters throughout the water column reveal two separate water masses in terms of velocity. The upper 200 meters and the lower 1000 meters (from 400 m depth almost down to the seafloor), are each completely barotropic and decoupled from each other. The upper layer has a strong seasonal cycle, with strong currents in winter reaching 50 cm s−1 and weak in the summer, whereas the deeper layer shows no seasonal cycle. Near-inertial waves dominate the spectrum at all measured depths.

The isotopic composition of dissolved O_2 as a new tracer of deep water processes, formation and change

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It is generally accepted that formation of deep water around Antarctica involves deep convection during winter when winds are strong and cause rapid equilibration of dissolved and atmospheric O_2. Here we suggest a unique isotopic tracer, excess of ^{17}O in dissolved oxygen ($^{17}\Delta$), which is derived from the ratio between photosynthesis rates to air-sea O_2 gas exchange rate in the ocean's surface. Unlike O_2 concentration, $^{17}\Delta$ is not affected by respiration, thus, in the deep ocean, this tracer can reflect the past conditions at the upper water source regions in which the deep water formed. New measurements from near Antarctica demonstrate that values of $^{17}\Delta$ are high throughout the entire deep water column, indicate the presence of photosynthetic O_2. This presence of photosynthetic O_2 in the deep ocean implies that when this water formed near Antarctica it was not in equilibrium with air O_2. These measurements require that there must be a mechanism that slows down the rate of gas exchange and oxygen isotope equilibration, before the water containing photosynthetic O_2 sinks to the deep ocean. We hypothesis that large fraction of photosynthetic O_2 may be preserved in the illuminated part of the seasonal halocline. Then mixing and entrainment of photosynthetic O_2 to the deep depths are possible when rapid freezing of the sea surface occurs in the fall. We suggest that newly formed sea-ice effectively prevents ventilation of the photosynthetic O_2 that accumulated in the upper halocline during summer.

Geosteophic adjustment on the f-plane: Beyond discontinuous initial condition in an infinitely long channel

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This study extends the classical geostrophic adjustment theory on the *f*-plane derived in Gill (1976) to zonal channels of finite lengths and to continuous initial surface height distribution η_0. As in Gill's theory all field variables of the linear shallow water equations (LSWE) are divided into time-independent (geostrophic) part and time-dependent transients described by Poincaré waves. Explicit analytic expressions are found for both parts and these expressions are validated by numerical solutions of the LSWE. Unlike infinitely long channel the introduction of zonal boundaries blocks the radiation to infinity of the transient waves (that are reflected back to the channel), alters the spatial structure of the geostrophic flow and discretizes the frequency spectrum thus eliminating the near-inertial oscillations. In addition, the fraction of total (kinetic and potential) energy of the geostrophic steady state increases with the channel length, *Lx*, while the complementary fraction of the total energy of the waves decreases with it. Continuous η_0 are typified by a length scale *D* that determines the length over which the smooth η_0 varies between its two limiting values. This case is studied for finite *Lx* only where the integral of the total energy between the two endpoints is conserved and decreases with *D*. The explicit solutions in this case are developed as functions of *D* and show that the fraction of energy contained in the geostrophic steady state decreases with *D* while the fraction of total energy included in the waves increases with *D*. The decrease in initial energy exceeds the increase in fraction of total wave energy so that the wave amplitude decreases with *D*. In this case the amplitude decay of short waves is more pronounced than that of long waves so long waves dominate the spectrum.

Session: Biogeochemistry and sedimentary processes

Session chairs: Valeria Book and Gilad Antler

Oral presentations (in order of appearance):

The onset of modern-like Atlantic meridional overturning circulation at the Eocene-Oligocene transition - evidence, causes, and possible implications for global cooling

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A compilation of benthic $\delta^{18}O$ from the whole Atlantic and the Southern Ocean (Atlantic sector), shows two major jumps in the interbasinal gradient of $\delta^{18}O$ ($\Delta\delta^{18}O$) during the Eocene and the Oligocene: One at ~40 Ma and the second concomitant with the isotopic event of the Eocene-Oligocene transition (EOT), ~33.7 Ma ago. From previously published circulation models and proxies, we show that the first $\Delta\delta^{18}O$ jump reflects the thermal isolation of Antarctica associated with the proto-Antarctic circumpolar current (ACC). The second marks the onset of interhemispheric northern-sourced circulation cell, similar to the modern Atlantic meridional overturning circulation (AMOC). The onset of AMOC-like circulation slightly preceded (100-300 ky) the EOT, as we show by the high resolution profiles of $\delta^{18}O$ and $\delta^{13}C$ previously published from DSDP/ODP sites in the Southern Ocean and South Atlantic. These events coincide with the onset of anti-estuarine circulation between the Nordic seas and the North Atlantic which started around the EOT and may be connected to the deepening of the Greenland-Scotland Ridge. We suggest that while the shallow proto-ACC supplied the energy for deep ocean convection in the Southern Hemisphere, the onset of the interhemispheric northern circulation cell was due to the significant EOT intensification of deepwater formation in the North Atlantic driven by the Nordic anti-estuarine circulation. This onset of the interhemispheric northern-sourced circulation cell could have prompted the EOT global cooling.

The impact of iron reduction in methanogenic sediments on sedimentary magnetisms

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Microbial respiration in marine environments has the potential to change the magnetic properties of the sediments through dissolution of magnetic iron-bearing magnetic minerals and precipitation of authigenic ones. However, the link between geochemical and magnetic records has remained indirect and has been demonstrated only in limited studies. Moreover, recent studies have shown the presence of intensive iron-oxide reduction in many marine sediments in the methanogenic depth, way below the classic iron reduction zone, raising questions regarding its effect on the sediment magnetic properties. Here we report a composite geochemical and magnetic depth profiles from Southern Eastern (SE) Mediterranean continental shelf, and provide a direct link between pore water chemistry and sedimentary magnetic properties. The uppermost oxic and sub-oxic zone contains high magnetic parameters. This zone is underlain by sulfate-methane transition zone that shows decrement in magnetic parameters related to a reductive dissolution of detrital titanomagnetite. At the methanogenic zone, the combined geochemical and magnetic profiles show significant iron reduction accompanied with magnetic enhancement, indicative of authigenic ferrimagnetic minerals precipitation. We suggest that iron reduction in the methanogenic zone plays a major role in marine sedimentary diagenesis should be taken into account when interpreting paleomagnetic data.

Analog structural modeling, ocean-ocean subduction and oceanic core complexes

Yossi Mart

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Oceanic core complexes are lithological composite setting built predominantly of peridotites and serpentinites, located commonly at intersections of slow oceanic spreading centers and fracture zones, embedded within the basaltic oceanic lithosphere. Analog experiments in laboratories of structural geology in the initiation of subduction and the development of back-arc basins suggested a possibility of developing a conceptual model, which will present a novel explanation for the evolution of oceanic core complexes, and account for their unique location and their specific lithological composition. Marine geophysical observations showed that subduction occurs where the denser oceanic crust is driven underneath the lighter continental plate, and the size of ocean floor is reduced. The conventional explanation to these findings is that the oceanic crust is driven due to the expansion of the seafloor in the mid-ocean ridge. Centrifuge experiments showed that subduction would initiate where two tectonic plates of contrasting densities are juxtaposed, provided that the density contrast is significant and the friction between the slabs is low. Such constraints take place between juxtaposed oceanic and continental plates, which is the case along most of the margins of the Pacific Ocean. However, further research showed that some 40% of all subduction occurrences take place between two tectonic slabs built of oceanic lithospheres of different ages and densities, in a process called ocean-ocean subduction. Geometric considerations show that most pf the tectonic plates that participate by ocean-ocean subduction are not driven by seafloor spreading, supporting the Laboratory observations. A significant density contrast between juxtaposed tectonic plates occurs at the intersections of of slow-spreading oceanic ridges and fracture zones, contrast that exceeds 200 kg/m^3, because while the density of fresh basalts at the oceanic ridge is ca. 2700 kg/m^3, the density of the cooled basalts is 2900 kg/m^3 and more. Another characteristic of the ridge – fracture zone intersection is that the thermal gradient under the ridge is some $130^0C/km$ compared with normal thermal gradient of $40^0C/km$ elsewhere. That steep thermal gradient enables the co-occurrence of the peridotites and the serpentinites, which are derived from the oceanic basalts.

Natural versus anthropogenic imprints on the shallow shelf of the northern Gulf of Aqaba-Eilat, Red Sea

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Coastal zones worldwide have always been the scene of terrestrial transport from land to sea, but facing to growing attention as development and population growth in coastal cities increased in the past decades. Urbanization took over natural runoff pathways, and diverse running (ephemeral) rivers with their sediments are now regulated and can only reach the sea through some limited number of channels. In one coastal hyperarid city, Eilat, determinate flowing water and related sediment transport to the sea are now channelized into one particular canal that therefore increases sediment loads at the outlet and decreases at the environment of the built-in area. The results of the multiproxy analysis of sediment cores, collected shore perpendicular illustrate for the first time, how such these landscape alterations left marks in the sedimentation pattern in the sea and altered the natural geological record on the shallow continental shelf. Below the mixing zone, a sharp increase in flood material concurrently occur in long sediment cores, suggesting the presence of a climate shift that resulted increased number of flooding events in the northern hyperarid Gulf of Aqaba circa 500 years ago.

West versus East Mediterranean climate over the last millennium from Vermetid skeleton isotopes and CMIP5/PMIP3 models

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Reef builders vermetid skeletons provide a high resolution reconstruction of the last millennium Mediterranean climate. Vermetid cores obtained from the west, central and east Mediterranean reveals that the different parts of the Sea surface have different thermal behaviors throughout the last millennium. The Sea Surface Temperature (SST), extracted from oxygen isotope measurements, show a signal of the Little Ice Age and of the Medieval Warm Period that is more apparent in the west and central Mediterranean while almost absent in the eastern Mediterranean. The rate of warming in the recent Industrial Period (1850 until present day) is also different according to the SST proxies. In the eastern Mediterranean the rate of warming is 0.54˚ C/100y, and it is more moderate in the central (0.25˚ C/100y) and opposite in the western (-0.1˚C/100y) Mediterranean. By analyzing atmosphere-ocean coupled models from the CMIP5 project, that simulate the global climate of the past 1000 years, we aim to reconcile these behaviors with the variability of the North Atlantic Oscillation (NAO) and of the South Asia Monsoon (SAM) climate systems. We show that even though the NAO is more dominant in the Western Mediterranean, its latitudinal movement, on a centennials time scale, is evident in the Eastern Mediterranean SST signal.

Quantifying and understanding the seasonal changes in nutrient dynamics in the Israeli shelf using biogeochemical measurements

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The Eastern Mediterranean is a unique environment often referred to as a 'marine desert'. It is very scarce in nutrients, has very low primary productivity (PP) rates and has been considered as P-limited in winter. However, there has not been a systematic seasonal examination of the nutrient limiting PP on the shelf; therefore, several questions remain regarding 1) how it changes seasonally 2) how it differs from the off-shore environment 3) what is the system's capability to sustain interferences? We are examining the annual spatial and temporal changes in nutrient concentrations on the Israeli shelf together with nutrient enrichment experiments. This study is the first to produce high quality chemical and biological data analyzed from fresh samples. Our results show opposite seasonal trends in TOxN (N) and Phosphate (P) in the water column. In winter, the water column is depleted of P while N remains well over detection limits, while in summer the trend reverses. In correlation, the N:P ratio signals switch from >16 in winter, through Redfield in early summer to <16 in late summer. Based on the changing trends in nutrient concentrations we conclude the EMS coastal shelf is P-limited in winter, while in summer the remaining N is depleted and drives the system towards co- and finally N-limitation. The changing nutrient limitation conditions can alter phytoplankton communities and requires further investigation. An elemental understanding of the system should serve as groundwork for additional research in the area and is required in order to formulate science-based conservational codes.

Session: Biogeochemistry and sedimentary processes - Poster presentations

DeepLev marine observatory - Carbon export and drivers in the southeastern Levantine Basin

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The DeepLev marine observatory is the first off-shore station in the southeastern Levantine basin, deployed 50 km west of Haifa, at water depth of 1,500m. The station includes an array of sediment traps and instruments measuring physical, chemical, and biological properties along the water column including export fluxes. In this work we present results of C export and ballast data from three consecutive deployments of 18 months in total (November 2016 – June 2018) of the DeepLev station. POC fluxes were measured by automated and single bottle sediment traps and were compared with ^{234}Th profiles. In general, fluxes measured in the traps were relatively low (0.05-1 mmoleC m^{-2} d^{-1} at the base of the euphotic zone during Dec 2017- June 2018). Notably, fluxes were higher in the deep-water traps (0.07-2.4 and 0.15-1.7 mmoleC m^{-2} d^{-1} during the same period). Fluxes were also higher and show large peaks during winter (December through February). This, together with tight correlations with total mass flux (ballast), suggests that despite of its distance from shore, C export is mainly controlled by lateral input, rather than by open sea primary production and vertical fluxes. This lateral input could be either due to coastal discharge or shelf-resuspension during winter storms. This is also demonstrated by lowering POC percentage in the total mass flux during winter peak events. Large deep water ^{234}Th deficits (disequilibrium with its radioactive parent ^{238}U) are not matched by large fluxes in the traps, which suggest that the two methods are not necessarily documenting the same processes. It is suggested that while the traps capture larger particles, which are transported by terrestrial discharge and density currents, and which have relatively short response time, the ^{234}Th method preferentially represents the finer size particle fraction, which could be related to dust deposition, wave resuspension, intermediate water formation, or could document slow settling at the end of the rainy season.

A Critical Look at the Combined Use of Sulfur and Oxygen Isotopes to Study Microbial Metabolisms in Methane-Rich Environments

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Separating the contributions of anaerobic oxidation of methane and organoclastic sulfate reduction in the overall sedimentary sulfur cycle of marine sediments has benefited from advances in isotope biogeochemistry. Particularly, the coupling of sulfur and oxygen isotopes measured in the residual sulfate pool ($\delta^{18}O_{SO4}$ vs. $\delta^{34}S_{SO4}$). Yet, some important questions remain. Recent works have observed patterns that are inconsistent with previous interpretations. We differentiate the contributions of oxygen and sulfur isotopes to separating the anaerobic oxidation of methane and organoclastic sulfate reduction into three phases; first evidence from conventional high methane vs. low methane sites suggests a clear relationship between oxygen and sulfur isotopes in pore-water and the metabolic process taking place. Second, evidence from pure cultures and organic matter rich sites with low levels of methane suggest the sinatures of both processes overlap and cannot be differentiated. Third, we take a critical look at the use of oxygen and sulfur isotopes to differentiate metabolic processes (anaerobic oxidation of methane vs. organoclastic sulfate reduction). We identify that it is essential to develop a better understanding of the oxygen kinetic isotope effect, the degree of isotope exchange with sulfur intermediates as well as establishing their relationships with the cell-specific metabolic rates if we are to develop this proxy into a reliable tool to study the sulfur cycle in marine sediments and the geological record.

Anaerobic oxidation of methane in subarctic lakes

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Methane (CH_4) is an effective greenhouse and it is mostly produced by methanogenesis – one of the last steps of anaerobic respiration. Lakes emission of methane comprises 16% of global methane budget with more than half of them located in the Arctic and the Subarctic. In the subarctic, the current increase of surface temperatures results in thaw of permafrost, and the formation of new lakes and wetlands with new active organic matter available for methanogenesis. Increased methane emissions by methanogenesis are naturally restricted by methanotrophs that oxidize 20 to 60% of the produced methane. In the lake sediments, anaerobic oxidation of methane (AOM) controls the microbial production of methane with nitrate/nitrite (NO^{3-} /NO^{2-}), sulfate (SO_4^{2-}), and manganese or iron oxides as electron acceptors. To better understand AOM in the lakes forming over thawed permafrost, we sampled sediment cores (0.7 to 1.7 m), from several frozen lakes near Fairbanks, Alaska. The lakes area ranged between 0.2 and 1 square km. Water column was 2.5 m deep at sampling locations, close to the active part of the permafrost. According to our core profiles results, methane was present in all cores and was mostly produced by methanogenesis. Methane decrease in the anaerobic sediments combined with increased isotopic values suggest its partial anaerobic oxidation. As nitrite was not detected the more probable candidates as electors for AOM process are sulfate, manganese, iron or humic acids. Core sections will be further incubated to learn more about the electron acceptors and AOM rates in this environment.

The effects of temperature on methane related iron reduction in Lake Kinneret deep methanogenic zone

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Methane is an abundant greenhouse gas in the troposphere. Its relative effectiveness in trapping heat is ~25 times greater than carbon dioxide, thus converting it to carbon dioxide reduces global warming effects considerably. Lake sediment is one of the important sources for natural methane emission. This emission is ultimately regulated by microbial methanogenesis, which occurs in the deep sediments, and methane oxidation (methanotrophy). It has been shown that over 50% of the methane produced in this zone is oxidized anaerobically by microbial processes, and that in low sulfate sediments as lakes iron can be the main electron acceptor. The natural occurrence of anaerobic oxidation of methane (AOM) coupled to iron oxides has been established in Lake Kinneret in the deep methanogenic zone, but many aspects of this process have yet to be explored, such as its kinetics, and specifically the effect of temperature on this process. This research quantifies the influence of surrounding temperature on iron-related AOM process Lake Kinneret sediments. Three sets of incubations were performed with sediments from the deep methanogenic zone with labeled 13-C methane and different temperatures: 15°C (the typical temperature in in deep methanogenic zone), 20°C and 37°C. In each temperature concentrations and stable isotopes of different parameters were measured through time. The results so far suggest that elevated temperature enhances both methanogenesis and AOM through time. In contrast, ferrous iron concentrations seems to be lower in elevated temperature, probably because other competitive process is less significant (as iron reduction by acetate). it is also apparent that the process of iron reduction reaches steady state rather quickly. This research can help us better understand the potential outcome of climate changes on iron-coupled AOM process.

Kinetic parameters of thiocyanate formation by the reaction of cyanide and its iron complexes and thiosulfate

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Reactions between cyanide and reduced sulfur compounds in aqueous media result in formation of thiocyanate (SCN^-). The main source of thiocyanate environmental pollution is waste waters discharged from coke and metal plants. On the other hand, thiocyanate was found in non-polluted natural systems where it can be formed by chemical and biological cyanide detoxification. Thiosulfate is one of the most abundant and stable sulfide oxidation intermediates in natural aquatic systems, which may be formed by biological and chemical sulfide oxidation pathways. Its concentrations vary from several $\mu mol \cdot L^{-1}$ in sediments and water columns to hundreds $\mu mol \cdot L^{-1}$ in salt marshes. The goals of this work were to investigate kinetics of reactions of thiosulfate with free cyanide and its iron complexes to understand mechanisms of these reactions under various concentrations of reactants, pH and temperature. Rate of thiocyanate formation was measured in phosphate buffer solutions with pH 5.3-12.0 in the 2-120 $mmol \cdot L^{-1}$ concentration range. Activation energy of reactions was estimated in the temperature range 25-80ºC. Rate of thiocyanate formations as well as activation energies strongly depend on pH. Observed experimental data may be explained by a combination of two individual reactions: a) fast reaction thiosulfate and cyanide anion; and b) slow reaction between thiosulfate and hydrogen cyanide. The activation energy is 84-93 $kJ \cdot mol^{-1}$ at acidic and neutral conditions (pH=5.3-7.0). At pH 12.0 the activation energy was found to be lower, 37 $kJ \cdot mol^{-1}$. Rate of the reaction of thiosulfate with hexacyanoferrate(II) and hexacyanoferrate(III) complexes were significantly slower than the rates of reaction of thiosulfate with cyanide.

The role of Iron in anaerobic oxidation of methane in Sihailongwan Lake, China

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Methane (CH_4) is the second most important greenhouse gas after CO_2 and 25 times more efficient than CO_2 in heat-trapping. About 70% of non-anthropogenic methane emission originates in lakes and wetlands bottom sediment, as a product of microbial anaerobic respiration. While over 50% of the methane produced is anaerobically oxidized by microorganisms, in most sulfate-depleted freshwater systems its mechanism is still unknown. Past findings show that the anaerobic oxidation of methane (AOM) in the sediment of Lake Kinneret is coupled mainly to iron reduction. This research examines if iron can also be involved in AOM in other iron-rich lakes. Thus, the potential for iron coupled AOM was tested in Sihailongwan Lake, a ferruginous lake in China. This was done by quantitative geochemical methods, throughout an incubation experiment, conducted in sediment depth where pore-water profiles showed the presence of methane and reduced iron. The incubations were labeled with the carbon stable isotope of methane ($^{13}CH4$), as dissolved inorganic carbon isotopic (DIC) values and concentrations were measured over time to test the transformation of the heavy isotope to the DIC pool. $Fe^{(II)}$ and methane concentrations were measured as well. Our results clearly demonstrate that microbial AOM has occurred, and that iron has an effect on this AOM, although further experiments are needed to verify that iron was used as the electron acceptor.

Bioturbation and the Phanerozoic Sulfur Cycle: A Model Approach

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Bioturbation is the range of processes that occur (but not restricted to) when organisms burrow through sediments, flushing their burrows with overlying seawater and mixing sediment particles. It is an ecological innovation that evolved during the late Neoproterozoic and became subsequently more prevalent throughout the Phanerozoic. Bioturbation increases mixing across the sediment-water interface, influencing the redox state of the sediment and the cycling of redox-sensitive elements. Throughout Earth history, the fractionation between the sulfur isotopes of sulfate and pyrite has increased intermittently; the second significant increase occurred during the Precambrian-Cambrian transition. The impact of bioturbation on the sulfur isotope record during this second interval of change has been documented by previous studies, but there has been little consensus on what the exact mechanism for the change in the sulfur isotope record is at this time. Using a simple two-box model, we modelled the concentrations and stable isotope compositions of sulfate and sulfide in bioturbated sediment. We used results from bioturbation experiments to guide our model results and obtain values for the fluxes of components into and out of the sediment, the sulfate reduction rate, and the sulfur isotope fractionation. By fitting our model to the experimental results, we found that the observed fractionation between sulfate and sulfide is greater in the bioturbated sediment. These results support the conclusion that the evolution of bioturbation around the beginning of the Phanerozoic didn't necessarily change the sulfur cycle through the reoxidation of sulfide and pyrite, but rather opened up the sedimentary system to allow for an enhanced supply of isotopically-light sulfate to the sediment.

Benthic nutrient fluxes from deep-sea sediments of the Southeast Mediterranean Sea, the Levantine basin

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Quantifying the magnitude and direction of nutrient fluxes following re-mineralization of deposited organic matter in deep marine sediments is essential for understanding benthic-pelagic coupling in deep water habitats and their effect on deep water nutrient distributions, especially in the ultra-oligotrophic provinces such as the Levantine basin, Southeast Mediterranean Sea (SE-MED). Here we present a set of pore and bottom water data of DIN (NO_2+NO_3+NH_4), PO_4, $Si(OH)_4$, bacterial abundance and production to estimate the benthic nutrient fluxes in the deep basin of the SE-MED. Sediment cores and bottom water were sampled along two cross-shore sections (offshore Haifa and Tel Aviv) at bottom depths of 80-1900m, on board the R/V Bat-Galim during July 2018. Based on pore water measurements, we observed a general decrease in nutrients diffusive flux with increasing bottom depth, reaching minor efflux at depths >1400m. Using the whole core incubation technique, we observed that the bottom sediments acted as a weak net source of Si (f_{Si}=between +36 and +365 μmol m^{-2} d^{-1}) and a weak net sink of DIN (f_{DIN}= between -15.0 and -172 μmol m^{-2} d^{-1}) and PO_4 (f_{PO4}= between -9.0 μmol and -20 m^{-2} d^{-1}) with respect to the overlying water. The increase in bacterial abundance and production (BP) in the sediment-water interface was correlated with the net uptake rates of PO_4 and DIN. This is consistent with water column observations of increased BP near the bottom, suggesting that the bottom is a net source of P and N. The organic matter content in the sediments ranged between 0.2 - 1.1%. Low re-mineralization rates in the deep basin of the SE-MED and relatively high organic matter contents, support that the deposited organic matter is highly refractory.

Iron effect on sulfate-coupled anaerobic oxidation of methane in the SMTZ of deep marine sediments of the Eastern Mediterranean Continental Shelf and the Yarqon Estuary

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The goal of this study is to explore iron reduction process and the influence of the presence of iron minerals in sediments on sulfate-coupled anaerobic oxidation of methane (AOM) in the sulfate-methane transition zone (SMTZ) of two marine diffusive controlled environments: (1) oligotrophic Eastern Mediterranean Continental Shelf (2) the rich organic matter Yarqon Estuary. In order to explore these processes, long term incubation experiments with sediments from those environments were performed. The sediments were divided into different bottles (with duplicates). Each bottle was manipulated differently to explore the factors influencing the anaerobic processes. The bottles were sampled along half to one and a half year, and the samples were measured for the concentration of ferrous, sulfate, sulfide, dissolved inorganic carbon (DIC), $\delta^{34}S_{SO4}$ and $\delta^{13}C_{DIC}$. Headspace was measured for methane (CH_4) concentration and $\delta^{13}CCH_4$. These experiments result showed that iron reduction can occur in the SMTZ in both environments although it is not the main process occurring in these zone. In marine sediments, low reactive iron oxides like hematite can lead to the occurrence of iron reduction simultaneously to sulfate driven AOM and possibly delay the sulfate driven AOM. In the Yarqon Estuary, due to the high amounts of organic matter and high amounts of microorganisms, sulfate reduction with organic matter seems to be the main process in the SMTZ, and Iron oxides presence doesn't seem to effect it. The sulfate reduction process inhibits low reactive iron oxides reduction, methanogenesis and AOM, but not high reactive iron oxides (like amorphous iron) reduction which occurs simultaneously to the sulfate reduction. When the sulfate is depleted, low reactive iron minerals reduction and methanogenesis start to occur in the sediment.